Volume 20, Issue 1/2020 **PRINT ISSN 2284-7995**

E-ISSN 2285-3952

SCIENTIFIC PAPERS

SERIES "MANAGEMENT, ECONOMIC ENGINEERING IN AGRICULTURE AND RURAL DEVELOPMENT"

Scientific Papers Series "Management, Economic Engineering in Agriculture and Rural Development"
PRINT ISSN 2284-7995, E-ISSN 2285-3952

Volume 20, Issue 1/2020
Copyright 2020

To be cited: Scientific Papers Series "Management, Economic Engineering in Agriculture and Rural Development", Volume 20, Issue 1/2020.

Publishers:
University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania. Address: 59 Marasti Blvd., District 1, 011464 Bucharest, Romania, Phone: + 40213182564, Fax: +40213182888**,** www.managusamv.ro
Ceres Publishing House, Address: 29 Oastei Street, District 1, Bucharest, 013701, Phone/Fax: +40213179023, Email: edituraceres@yahoo.com

The papers belong to the following research fields: economic engineering in agriculture, management, marketing and agri-food trade, rural economy, agricultural policies, accounting, financial analysis, finance, agrarian legislation, durable development, environment protection, tourism, agricultural extension and other connected areas.

C O N T E N T

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

GENDER DIFFERENCES IN PERSONAL CHARACTERISTICS AND JOB SATISFACTION OF FORESTRY RESEARCH INSTITUTE OF NIGERIA EMPLOYEES, NIGERIA

Olaoluwa Ayodeji ADEBAYO[1], Oluwakemi Enitan FAPOJUWO[2], Ebunlola OMOLE[1], Hafsah Laraba MOHAMMED[1], Deji JOSHUA[1], Jude CHIKEZIE[1]

[1]Forestry Research Institute of Nigeria, P.M.B. 268, New-Bussa, Niger State, Nigeria, Phone/Fax: +2348062179072; E-mail: oriobatemyl@gmail.com
[2]Federal University of Agriculture, Department of Agricultural Administration, Abeokuta, P.M.B. 2240, Ogun State, Nigeria, Phone/Fax: +2348062403148; Email: kemifapojuwo@gmail.com

Corresponding author: oriobatemyl@gmail.com

Abstract

Individual job satisfaction enhancement alongside gender differences determination could lead to improvements and innovations which is often linked to organisational commitment, turnover intentions and absenteeism in the workplace. This study examined the gender differences and job satisfaction of the Forestry Research Institute of Nigeria employees, Nigeria. Multi-stage sampling procedure was used to select 226 (160 male and 66 female) employees in the study organisation. Primary data were obtained on respondents' personal characteristics and job satisfaction through the use of a structured questionnaire. Job satisfaction was constructed around Herzberg's motivation theory and measured through employee perceptions of extrinsic and intrinsic job characteristics. Percentages, means and Paired-Samples T-Test were used for data analysis. Results showed that the mean age of the employees, their household size, work experience and annual income were 40 years, 4 persons, 9 years and ₦1,272,635 respectively while 87.2% of them were married. The findings revealed that age (t = -3.53), household size (t = -2.83), income (t = -6.65), extrinsic (hygiene factor) motivation (t = 3.05) and job satisfaction (t = 1.81) significantly vary (p < 0.05) between female and male employees in the organisation. The study concluded that with respect to the gender status of the employees, the organisation should consider employees' personal characteristics, motivation factors and job satisfaction attributes by the way they are derived to realize predictable positive organisational results as gender has to do with one's enthusiasm and fulfilment.

Key words**:** *gender, motivation, job satisfaction, employees, organisation*

INTRODUCTION

Human Resources Management in organisations is ascribed to the recruitment, teaching, improving, inspiring and retaining the employees. Recruitment entails strategic human resource planning, recruiting and selection. Some years back, human resources management was much unassuming because labour force was usually similar. Today, employees have transformed from similar to dissimilar form [11].

Managing diversity entails creating a varied labour force to accomplish its potentials in impartial work environs, where no associate or set of members has a gain or drawback. It is very vital for any establishment, especially in this period of globalization. It is required to close the unfair discrimination and hence enable employees to compete on an equal basis [5].

Readings have revealed that the notion of gender is not the same with feminine matters alone in any society. Gender speak of socially centred outlooks of the starring role and conduct of males and females [27]. Similarly, it characterizes male and female in a societal perspective and variances in approach and characters [13]. Additionally, it is a fiscal create, stipulating the inherent illogical measure by which both men and women are cautiously positioned in our social order [34]. It has to do with the anticipated starring role of individuals (males and females) in the society for systematic living, change and progress [14]. Nevertheless, as acquired in the collected works, in emerging cultures contained by the background of scholastic accomplishment, the level of involvement in

governance, work-related structure and the undesirable outmoded behaviours, societal and traditional approaches against females makes gender matters to be tantamount with efforts to comprehend the place, roles, difficulties, challenges and significance of females in males subjugated evolving developments [12].

[2] stated that the perceptions, feelings and attitudes that someone have about his or her work justifies the individual's job satisfaction. It has two basics which are intrinsic and extrinsic job satisfaction [6]. Numerous scholars have shown that in order to determine job satisfaction, pay policies, working conditions and organisational environments are key and essential contributors [7; 8; 9; 10 and 25]. These features are said to be interlinked although happiness with one feature does not confirm gratification with all the other aspects. Besides, many scholars that through alliance with individuals' direct supervisors in relation to the working environment, employees' can institute the level of satisfaction amid them and raise the odds of remaining with the organisation [1]. This suggests that if an employee is dedicated and devoted to his/her administrator, it will positively influence his job satisfaction and raises the possibility to stay on the job. This finding is substantiated by [33], who acknowledged that worthy dealings with managers are linked with individual job satisfaction taking a direct bearing over employee's intention to stay with or quit. Each time an employee senses a discontent from his/her job, then and there are the extreme chances of that employee resigning or exit from the work or job [1].

However, gender variances in echelons of job satisfaction are higher in females likened to males, despite being in jobs with lesser salaries and preferment chances equated to males [6]. This is owing to females having minor expectations at work due to the shoddier position in the workforce market that females have held in the past. This could be transient as they enhanced their workforce market representations over time. [23] in her research on gender differences in job satisfaction while relating statistical and econometric (ordered probit) examination advanced that females are more contented at work equated to males. Nonetheless, she stated that the gender-job satisfaction gap disappears for younger females and also those with greater echelons of education.

In regard to the aforementioned issues, this study examined the following objectives: To

(i)describe the personal characteristics of respondents in the study organisation;

(ii)examine the level of respondents job satisfaction in the study organisation;

(iii)examine the differences in the personal characteristics and level of job satisfaction between male and female respondents in the study organisation.

The following hypotheses were expressed and tested in the null form.

H_{01}: There were no significant differences between the personal characteristics of male and female employees.

H_{02}: There were no significant differences between the intrinsic (motivator factor) motivation of male and female employees.

H_{03}: There were no significant differences between the extrinsic (hygiene factor) motivation of male and female employees.

H_{04}: There was no significant difference between the job satisfaction of male and female employees.

MATERIALS AND METHODS

The study was carried out in the Forestry Research Institute of Nigeria (FRIN). The Forestry Research Institute of Nigeria was established in 1973. The headquarters is situated in Ibadan, Oyo State. Its mandate is to conduct research while the vision is to ensure true scientific research activities and manpower development, sustainable forest resources production, management utilization, biodiversity conservation, forest-based raw materials provision, food production and security through agroforestry and wildlife employment opportunities thereby alleviating poverty, and environmental conservation and management.

Cross-sectional primary data were collected using a structured questionnaire with open and closed-ended questions. Simple random

sampling technique was used for selecting five work locations out of fifteen work locations. Stratified sampling technique was subsequently implemented for choosing employees on the basis of employee status at management, senior and junior staff levels from the list of employees delivered (aiding as the sample frame). A total of two hundred and sixty questionnaires were administered. Only two hundred and twenty-six questionnaires, which was almost 13% of the sample frame and nearly 87% of the sample size, were used in the ensuing examination.

The study used standard questions adopted from earlier studies. The job satisfaction concept was measured using 14 items of [4 and 17]. The rating used was centred on a 7-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (7). The questions were phrased to tap the level of respondent's agreement valued their Intrinsic (motivator) factors and Extrinsic (hygiene) factors. To check reaction predisposition, a limited statement was adversely phrased and thereafter reverse-scored. Information collected were afterwards subjected to Mean Score analysis and Paired-Samples T-Test analysis.

RESULTS AND DISCUSSIONS

The description of the personal characteristics of respondents with respect to sex, marital status, education level, age, household size, work grade level, work experience, employee condition of service and annual income is as presented in Table 1. From the table, the majority of the respondents (70.8%) are males while 29.2% are females. [22] also reported a similar finding that male employees constituted the majority in his study. However, majority of the respondents (87.2%) were married while 12.8% were not married. This is good for the organisation because marriage goes with sense of household tasks, responsibilities and accountabilities which can be show-cased in the work environment. [16] and [33] posited that marital status had a positive relationship with employees' commitment as married employees exhibited more commitment at work than unmarried employees.

Table 1. Personal characteristics of respondents

Personal Characteristics		**%**	$\bar{x}$	**σ**
Sex	Male	70.8		
	Female	29.2		
Marital Status	Married	87.2		
	Not Married	12.8		
Education	ND/HND	40.7		
	Bachelor	12.4		
	Master	23		
	Ph.D.	3.5		
	Others	20.4		
Age (Years)	≤ 35	20.9	40	6.5
	36 – 45	53.5		
	46 – 55	23.7		
	≥ 56	1.9		
Household Size (Members)	≤ 5	76.4	5	2
	≥ 6	23.6		
Work Experience (Years)	≤ 5	17.3	9.16	5.31
	6 – 10	52.4		
	11 – 15	22.7		
	≥ 16	7.6		
Employee condition of service	Research and Academics	54.4		
	Administration	45.6		
Annual Income (per ₦ 1,000,000)	≤ 1	26.5	1.27	0.64
	1 – 2	69.9		
	≥ 2	3.6		

Source: Field Survey, 2018.

The table further showed that the highest educational level of the respondents constituted National Diploma/Higher National Diploma (40.7%), Bachelor Degree (12.7%), Master Degree (23%), PhD Degree (3.5%) and other educational certificate programmes such as Technical/Vocational Certificates (20.4%). [21] noted that employees with higher academic qualifications are less committed to their employing institutions and are prone to change jobs.

More so, majority of the respondents (53.5%) fell within the age group of 35 – 44 years with a mean age of approximately 40 years. This implied that many of the respondents were still within the energetic and economically productive age bracket and that they still had more years to put in the service of the employing organisation. Besides, the finding agreed with [21] and [29] who reported a mean age of 41 years and 40.1 years correspondingly for agricultural faculty and researchers. Past studies have shown that productivity increases with age [15]. The age range of the respondents was a good indication for the organisation.

The household size of the majority of the respondents (76.4%) had at least 5 persons living together under the same roof. The average household size of the respondents was approximately 5 household persons.

More than half of the respondents (52.4%) had work experience of within 6 - 10 years. However, respondents that had work experience of above 10 years constituted 34.7%. Only 17.3% had work experience of fewer than 5 years. The average work experience of respondents in the organisation was found to be 9.16 years. Various studies had shown a relationship between long tenure on the job and performance of employees. [18] emphasized that tenure on the job which is synonymous to work experience is a key resource under the Conservation of Resources Theory.

The mean annual income of the respondents was found to be ₦1,272,635.07 with the majority of respondents (69.9%) earning between ₦1,000,001 to ₦2,000,000 per annum. The findings revealed a low level of income among personnel in the organisation and that remuneration of personnel fell below the demands of the job. [1] recommended a review of the work conditions of the personnel because this has a negative effect for the organisation if not done. [20] also revealed that low remuneration has a negative effect on the employees' commitment.

Job satisfaction measured the following satisfaction domains: those susceptible to intrinsic and to extrinsic satisfaction. Domains that are intrinsic in nature (motivator) include job complexity, recognition, responsibility, work itself, achievement, growth and advancement while extrinsic nature (dissatisfaction) include the relationship with peers, relationship with supervisor, security, quality of supervision, personal life, salary, company policy and administration. The results are presented in Table 2.

Table 2. Level of employees' job satisfaction

Employee Job Satisfaction Survey Statements		**$\bar{x}$**	**σ**	**Sub $\bar{x}$ ± σ**	**Grand $\bar{x}$ ± σ**
Intrinsic (motivator) factors	***Job complexity*** - My work is intellectually challenging.	6.31	1.40	5.23 ± 1.08	5.14 ± 0.77
	Recognition - I sense that my efforts and I are appreciated.	5.30	1.59		
	Responsibility – I do a meaningful job.	5.97	1.40		
	Work itself - My job encounters my experience and abilities.	5.55	1.75		
	Achievement - I can realize my concepts and prospects.	5.91	1.45		
	Growth - I do have openings for personal growth in my organisation.	5.81	1.55		
	Advancement - I have career prospects in my organisation.	5.31	1.58		
Extrinsic (hygiene) factors	***Relationship with peers*** - I do have good interactions with my contemporaries.	5.94	1.59	5.05 ± 0.83	
	Relationship with supervisor - I have faith in my manager.	4.7	1.79		
	Security - Safe and relaxed working milieu is fashioned in my organisation	4.6	1.64		
	Quality of supervision - I do have hope in my organisation headship.	5.13	1.66		
	Personal life - My assignment is wieldy.	5.38	1.60		
	Organisation policy and administration - A clear plan and course is set and made straight with my organisation dream and standards.	5.69	1.09		
	Salary - I am getting remunerated enough for my work.	4.13	1.96		

Source: Field Survey, 2018.

The overall employee job satisfaction was $\bar{x}$=5.14. This implied that generally, employees' have strong positive affective responses to their job. It also acknowledged the multidimensional construct that included strong positive employee feelings about the variation of both intrinsic and extrinsic job elements in the organisation. The degree to which the work environment (i.e. career, co-workers, and supervision) met the needs of the employees was stronger and positive [28 and 35].

Intrinsic job satisfaction is derived from execution of the work and thus undergoing feelings of achievement, self-actualisation and distinctiveness with the task; its variables are related to employees' personal growth and development. It relates to job satisfaction when present but not to dissatisfaction when absent. The study, however, revealed that job complexity ($\bar{x}$=6.31±1.4) was the highest motivation factor while employees' recognition ($\bar{x}$=5.30±1.4) was the least motivation factor in the study organisation. The overall employee intrinsic job satisfaction was $\bar{x}$=5.23 [19; 24 and 30].

Extrinsic job satisfaction is derived from the rewards given upon an individual by his/her peers, supervisors or the organisation; its variables are connected with security in the work environment. It is linked with job dissatisfaction when absent but not with satisfaction when present. Result revealed that employees' good relationship with peers ($\bar{x}$=5.94±1.59) was the most identified hygiene factor while employees' salary ($\bar{x}$=4.13±1.96) was the least. The overall employee extrinsic job satisfaction was $\bar{x}$=5.05 [3; 26; 31 and 32].

The study further sought out to establish a significant difference in the level of job satisfaction between male and female employees. It was hypothesized that the age, education, household size, income, work experience, extrinsic (hygiene factor) motivation, intrinsic (motivator factor) motivation and level of job satisfaction do not significantly differ between male and female employees. The conjecture was that the age, education, household size, income, work experience, extrinsic (hygiene factors) motivation, intrinsic (motivator factors) motivation and level of job satisfaction among men and female don't significantly differ. In response to this supposition and determining the stated objective, a t-test was employed to substantiate or reject the hypothesis, thus, the computed mean indices in Table 3 were compared.

Table 3. Level of employees' job satisfaction

Variables	Gender	Mean	t-value	Sig. (2-tailed)	Interpretation	Decision on H_o
Age	Female	39.02	-3.53	0.00	Significant difference	Rejected
	Male	43.63				
Education	Female	4.47	0.34	0.73	No significant difference	Accepted
	Male	4.38				
Household Size	Female	3.86	-2.83	0.01	Significant difference	Rejected
	Male	4.80				
Annual Income (per ₦100,000)	Female	11.58	-6.65	0.00	Significant difference	Rejected
	Male	18.20				
Work Experience	Female	9.23	-1.29	0.20	No significant difference	Accepted
	Male	10.59				
Extrinsic Motivation (Hygiene Factor)	Female	5.08	3.05	0.00	Significant difference	Rejected
	Male	4.64				
Intrinsic Motivation (Motivator Factor)	Female	5.16	0.28	0.78	No significant difference	Accepted
	Male	5.11				
Job Satisfaction	Female	5.12	1.81	0.04	Significant difference	Rejected
	Male	4.87				

Source: Field Survey, 2018.

As shown in the table, age, household size, income, extrinsic (hygiene) factors motivation and job satisfaction significantly differ between male and female employees in the organisation. It was established that there was a difference in age, household size, income, extrinsic (hygiene) factors motivation and job satisfaction between male and female employees. It was observed that female employees were slightly younger (t = -3.53), had a smaller household size (t = -2.83) and received less income (t = -6.65) than the male employees in the organisation. These female employees were more motivated than male employees by extrinsic (hygiene factors) motivation (t = 3.05) by having good relationships with their colleagues, a manageable workload, trust their supervisors and organisational leadership, a safe and comfortable working environment, a set and aligned clear organisational strategy and direction with organisational vision and values and get paid enough for their job. Interestingly, they are more satisfied with their job in comparison to the male employees in the organisation.

CONCLUSIONS

The findings have clearly established the fact that male employees' personal characteristics (age, household size and income) meaningfully differ from female employees while in contrast and despite the odds of female employees' personal characteristics, they considerably differ from male employees by their extrinsic (hygiene factors) motivation and job satisfaction. Hence, the null hypothesis of no significant difference between personal characteristics, extrinsic (hygiene factors) motivation and job satisfaction of male and female employees in the organisation was rejected and thus the alternate hypothesis was accepted. Therefore, based on the above-mentioned and with respect to the gender status of the employees in Forestry Research Institute of Nigeria, it was recommended that the organisation should consider its employees' personal characteristics, motivation factors and job satisfaction attributes by the way they are derived in order to realize the expected optimistic organisational results since gender has to do with one's enthusiasm and fulfilment.

ACKNOWLEDGMENTS

The authors appreciate the support of the Forestry Research Institute of Nigeria management team and the cooperation of the employees.

REFERENCES

[1]Adebayo, O. A., 2019, Organisational Support and Commitment on Employees' Job Satisfaction and Turnover Intention at Forestry Research Institute of Nigeria, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19 (3): 15-20.
[2]Armstrong, M., Taylor, S., 2014, Armstrong's handbook of human resource management practice, Kogan Page Ltd, Philadelphia, PA, p.842.
[3]Barrow, S., Mosley, R. 2011, The Employer Brand: Bringing the Best of Brand Management to People at Work, John Wiley and Sons Ltd, ISBN 10-04-70012730, p.232.
[4]Bendaravičienė, R., Bakanauskienė, I., 2012, Determinants of different groups of employees' job satisfaction: Lithuania's University case, Human Resources Management and Ergonomics, 6:6-17.
[5]Cascio, W., 2015, Managing Human Resources: Productivity, Quality of Work Life, Profits, McGraw-Hill Education, p. 768.
[6]Clark, A. E. 1997, Job satisfaction and gender: Why are women so happy at work?, Labour Economics, 4: 341-372.
[7]Cohen, A., 1993, Work Commitment in Relation to Withdrawal Intention and Union Effectiveness, Journal of Business Research, 26 (1): 75-91.
[8]Cohen, A., 2000, The relationship between commitment forms and work outcomes: A comparison of three models, Human Relations, 53(3): 387- 417.
[9]Cohen, A., Hudacek, N., 1998, Organisational Commitment Turnover Relationship across Occupational Groups, Group Organisational Management, 18 (2): 188-213.
[10]Cohen, J., 2013, Statistical power analysis for the behavioural sciences, Routledge, p. 567.
[11]David, A. D., Robbins, S. P., 2011, Human Resource Management (10th edition), Wiley India Pvt. Limited, p.432.
[12]Egbon, P. C., Orubu, C. O, 1999, Critical Issues in Nigeria's Development, Faculty of the Social Sciences, Delta State University, p. 140.
[13]Fayomi, O. O., 2005, Strategies for effecting gender balance and the position of the Nigerian State, International Journal of Violence and Related Studies, 1(1): 95-105.

[14]Gberevbie, D. E., Osibanjo, A.O., Adeniji, A, A,, Oludayo, O. A., 2014, An Empirical Study of Gender Discrimination and Employee Performance among Academic Staff of Government Universities in Lagos State, Nigeria, International Journal of Social, Human Science and Engineering, 8 (1):101-108.
[15]Grandley, A. A., Cropanzano, R., 1999, The conservation of resources model applies to work-family conflict and strain, Journal of Vocational Behaviour, 54: 350-370.
[16]Hakim, C., 2000, Work-Lifestyle Choices in the 21st Century: Preference Theory OUP Oxford, p. 356.
[17]Herzberg, F., 1968, One More Time: How Do You Motivate Employees?, Harvard Business Review, 46: 52-53.
[18]Hobfoll, S., 2002, Social and psychological resources and adaptation, Review of General Psychology, 6: 307-324.
[19]Kalinowski, M., 2007, Employee Engagement, Human Resource Partnerships, In: White Paper, www.hrp-inc.com/whitepapers.aspx., Accessed on 02 Feb 2012.
[20]Kutilek, L. M., Gunderson, G. J., Conklin, N. L., 2002, A system approach: Maximising individual car potentials and organisational success. Journal of Extension, 40(2).
[21]Ladebo, O. J., 2001, Appraisal of institutional performance of selected universities offering agriculture in Southern Nigeria, Unpublished Ph. D. Thesis, Department of Agricultural Extension and Rural Development, Faculty of Agriculture and Forestry, University of Ibadan, Nigeria.
[22]Ladebo, O. J., 2003, Organisational commitment as a predictor of job performance among faculty: Implications for the development of agricultural technology in Nigeria, Journal of International Agricultural and Extension Education, 10(3): 57 – 64.
[23]Long, A., 2005, Happily ever after? A study of job satisfaction in Australia, The Economic Record, 81: 303-321.
[24]Macey, W. H., Schneider, B., 2008, The Meaning of Employee Engagement, Industrial and Organisational Psychology, 1: 3–30.
[25]Maertz, C. P. J., Griffeth R. W., 2004, Eight Motivational Forces and Voluntary Turnover: a Theoretical Synthesis with Implications for Research, Journal of Management, 30 (5): 667-683.
[26]Miner, J. B., 2015, Organizational Behavior 1: Essential Theories of Motivation and Leadership, Routledge, p. 416.
[27]Mitra, C., 2003, Women's Development Goals: Reshaping Globalization, Authrspree, New Delhi, p.121.
[28]Olsen, D., Maple, S. A., Stage, F. K. 1995, Women and minority faculty job satisfaction: Professional role interests, professional satisfactions, and institutional fit, Journal of Higher Education, 66(3): 267–293.
[29]Oyedokun, A. O. 2000, Communication factors influencing scientists' job performance in agricultural research institutes in Nigeria, Unpublished Ph. D. Thesis, Department of Agricultural Extension and Rural Development, Faculty of Agriculture and Forestry, University of Ibadan, Nigeria.
[30]Sachau, D. A., 2007, Resurrecting the Motivation-Hygiene Theory: Herzberg and the Positive Psychology Movement, Human Resource Development Review, 6(4): 377–393.
[31]Sartain, L., Schuman, M. 2008, Brand From the Inside: Eight Essentials to Emotionally Connect Your Employees to Your Business, John Wiley and Sons, p. 272.
[32]Scott, H. L., Jeff, H., 2007, Part-time Faculty Job Satisfaction in Higher Education: A Literature Review, Education Resources Information Center Clearinghouse, p.10.
[33]Taiwo, K., 2003, Employee commitment as affected by the locus of control and leadership behaviour, Journal of Psychology, 2(2): 40-51.
[34]Tongo, C. I., 2005, An Agenda for Gender Equality in Globalized Economies, International Journal of Violence and Related Studies, 1(1): 53-64.
[35]Volkwein, J. F., Zhou, Y. 2003, Testing a model of administrative job satisfaction, Research in Higher Education, 44(2): 149–171.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

EFFECT OF OFF-FARM INCOME ON HOUSEHOLD FOOD SECURITY OF SMALL SCALE FARMING IN OYO STATE, NIGERIA

Kemisola O. ADENEGAN, Catherine D. IKEDIASHI, Oluwatosin A. ADEWUSI, Yetunde O. M. OLADOKUN

University of Ibadan, Ibadan, Nigeria, Department of Agricultural Economics, Emails: bumkem@yahoo.com, dumebiikediashi@gmail.com, oyedele_adejoke@yahoo.com, yetunde.oladokun@gmail.com

Corresponding author: oyedele_adejoke@yahoo.com

Abstract

The effect of off-farm income on food security status of small scale farming households was examined in Oyo state. Income is the most important single factor which has continued to sustain food security. Sources of income available to small scale farming households of are vocational activities apart from peasant farming. Multi-stage random sampling technique was used to collect data from 240 respondents in Oyo State. Food security index and probit regression were the analytical tools used. The mean per capita food expenditure was ₦5,486.6. The percentage of households that were food secure was 77.5% while the percentage of those that were 22.5% were not food secure. Off-farm income had a positive influence on food security in the study. Therefore, efforts should be in providing basic infrastructure in the area that would complement agriculture.

Key words**:** *off-farm income, food security, small scale farmers, probit and Oyo State*

INTRODUCTION

In developing countries like Nigeria a major policy to be tackled is the issue of reducing food insecurity [2]. Reports show that Nigeria is one of the countries technically unable to meet her food target goal ultimatum in 2015 with the country having recorded a rise in the number of undernourished from about 10 million in 2010 to 13 million in 2012 [8]. In a household food insecurity can take various forms with the urban poor, rural landless and smallholder farmers being the most vulnerable [12]. They often lack sufficient income and may not have enough food for required nutrition [7].

Off-farm activities are the activities associated with incomes that are not directly based on farming, forestry or fishery [4, 9]. In rural areas the major off activities are mining, food processing, woodwork, metal work and service [10].

The importance of off-farm income generating sources cannot be overemphasized because there is an emergent worry about the feasibility of smallholder agriculture, towards expansion of agriculture into export crops [11].

The collaboration of on-farm income-generating activities with off farm is reported to supplement incomes levels in total [3]. To attain enriched incomes and better livelihood farmers adopt different off-farm enterprises [14]. Initially diversification was not considered as the best option for because it is emphasized as a sensible response by households to lack of chances for specialty [6]. Yet, studies such as [5] recently show that upgrading existing portfolios to augment income can be more accurate and important for food security.

Although, the impact of off-farm income may be positive as they is more resources which may be diverted obtaining access to needed food requirement nut it may also be negative, as the opportunity cost for working outside the farm may be reduced food availability for household [13, 2].

A lot of studies have been carried out on poverty implication of off-farm income, little is known about household food security and nutrition especially in the area of study. This paper is therefore examining the effect of off-farm income on food security of small scale farmers in Oyo State, Nigeria.

MATERIALS AND METHODS

Source of data and method of data collection

Primary data were employed through the use of a semi-structured questionnaires and interview schedule. The data were collected from various households in the study area. The study area is Oyo State. It has a land area of 27,107.93 square kilometers and an estimated population of about 7,743,221. In this study a multi-stage sampling technique was used. Three agricultural zones in Oyo State were purposively selected in the first stage,. They are Ibarapa, Ogbomoso, and Oyo/Iseyin because these zones are purely agrarian communities. In the The second stage two local government areas from each of the three agricultural zones were randomly selected. These include Egbeda, Lagelu, Surulere, Oriire, Afijio and Atiba. In the third stage, from the six local government areas four villages were randomly selected, due to large number of farm households and farming activities in the areas. These are Awaye, Jagun, Erunmu, Osengere, Arulogun, Lalupon, Alagbede, Jagun, Owode, Ilogbo, Aganyan, Iresaadu, Ikoyi-ile, Elega, Olugbeyo, Onikolobo, Awe, Ilora, Iware, Jobele, Agbonrangudu, Agba-akin, Ayetoro, and Akodudu. Finally ten farmers were selected from each village because the farmers were homogenous and this sample can represent the whole population. This accounts for the total of 240 respondents used for this study.

Analytical procedure

Food Security Index(FSI)

The core issues of affordability, availability, and quality are considered in the Global Food Security Index. Using the food security index the households will be classified into food insecure food secure categories hence establishing the food security status of various households. It is given in the following formula:

$$F_i = \frac{per\ capita\ food\ expenditure\ for\ the\ ith\ household}{\frac{2}{3}\ mean\ per\ capita\ food\ expenditure\ of\ all\ household}$$

where:

Fi = Food Security Index
When $Fi \geq 1$= Food secure ith household
When $Fi \leq 1$ = Food insecure ith household

Food poverty line construction

Per capita household food expenditure was used for determining the food poverty line because of its consistency and ability to be static over time [1]. Two-thirds (2/3) Mean Per Capita Households food Expenditure (MPCHFE) was used as a benchmark for poverty line which is a relative poverty approach. Using the 2/3 MPCHFE, households were classified into non-poor and poor groups. Households whose MPCHFE falls above the poverty line are regarded as being food non-poor or food secure while the reverse are food poor or food insecure.

$$PCE = TCE/HHS \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

MPCHFE= THHFE/TNOR …….. (3)

PL= 2/3 *MPCHFE ……..…. (4)

where:
MPCHFE = Mean Per Capita Households food Expenditure
TNOR = Total Number Of Respondent
PCHFE = Per capita household Food expenditure
THHFE = Total household's food expenditure
TFCE = Total Food Consumption Expenditure
HS = Household Size
FPL = Food Poverty Line

To determine the effect of off-farm income on food security of small scale farmers probit regression model was used. The dependent variable is dichotomous, that is, Yes and No; Yes takes the value of 1 and 0 for No. It is expressed thus:

$Pr(Y_i=1|X_i) = [1-\Phi(-\beta X_i)]$

Thus, $\frac{\partial Pr(Yi=1|Xi)}{\partial x_k} = \beta_k \phi\ (\beta x_i)$

The desired quantity $\frac{\partial Pr(Yi=1|Xi)}{\partial x_k}$, is known as the "marginal effect" of x on the binary outcome y. To calculate it, we have to

multiply our estimate of β by the density of Ɛ, which will vary with the level of x.
We specify Probit model as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n + \varepsilon_i$$

where:
Y_i = Farmers' Food Security status obtained from FSI (food insecure=0, food secure =1).
X_1 - X_n include household variables, socio-economic/demographic characteristics
X_1= Age (years)
X_2 = Marital status (single =0, married=1) o
X_3 = Household size
X_4 = Years of education
X_5 = Primary occupation (1= farming, 0=others)
X_6 = Years of farming experience
X_7 = Total farm size owned in hectares
X_8 = Total cultivated land size in hectares
X_9 = Mode of land acquisition (Do not on land =0, own land 1 =)
X_{10} = Being a member of farmers' association (No membership =0, member =1)
X_{11} = Being a member of cooperative society (No membership =0, member =1)
X_{12} = Access to credit
X_{13} = Farm enterprises engaged by farmers
X_{14} = Total on-farm income in Naira
X_{15} = Total off-farm income in Naira (which include every activity outside the farm)
X_{16} = Proximity to urban centre (km)
β_1 - β_n = The coefficients for the respective variables
β_0= Constant
ε_i= error term.

RESULTS AND DISCUSSIONS

Household Food security status of respondents

The MPCHFE was ₦5,486.6 with food poverty line of ₦3,657.73.
This implies that respondents that falls below ₦3,657.73 per month were food insecure and food secure.
In Table 2, factors that significantly influence food security are off-farm income, proximity to urban centre, farm size, age, household size, years of farm experience and on-farm income.

Table 1. Food security distribution for the respondents

Food security status	**Frequency**	**Percentage**
Food secure	186	77.5
Food insecure	54	22.5
Mean Per Capita Households food Expenditure (MPCHFE)	**₦5,486.6**	
2/3 (MPCHFE)	**₦3,657.73**	

Source: Data Analysis, 2018.

Table 2. Probit Regression Analysis Result

Variable	Coefficient	Standard Error	Z-value	P>z	Marginal Effect
Constant	4.49732	392.6913	0.01	0.991	
Age	-0.0675131**	0.0264413	-2.55	0.011	-0.79122
Marital status	-0.0014135	0.5316705	-0.00	0.998	-0.01657
Household size	-0.278041*	0.1456529	-1.91	0.056	-3.25849
Years in spent in school	-0.0045731	0.0252261	-0.18	0.856	-0.05359
Primary occupation	-0.1477107	0.4688742	-0.32	0.753	-1.73109
Years of farm experience	0.1305768 ***	0.0324319	4.03	0.000	1.53029
Farm size owned	-0.0121481	0.0754218	-0.16	0.872	-0.14237
Farm size cultivated	0.2770906***	0.1020192	-2.72	0.007	3.24736
Inherited land	-0.5333546	0.41832	-1.27	0.202	-6.25064
Purchased land	0.3839978	0.7865487	0.49	0.625	4.50025
Member of farmers association	-0.6402635	0.4486345	-1.43	0.154	-7.50355
Credit access	0.1768121	0.5677703	0.31	0.755	2.07214
Crop production	-2.899568	392.6903	-0.01	0.994	-33.98141
Crop and livestock production	-3.335359	392.6902	-0.01	0.993	-39.08866
On-farm income	0.0000436 ***	0.0000163	2.68	0.007	0.000511
Off-farm income	0.0000373***	0.0000122	3.07	0.002	0.000438
Member of cooperative	0.5398817	0.5338296	1.01	0.312	6.32713
Proximity to urban centre	0.0761453**	0.0378626	2.01	0.044	0.89238
No of observation = 240		Pseudo R-squared = 0.6090			
LR chi-square (18) = 155.87		Log likelihood = -50.026267			
Prob > chi-square = 0.0000					

Source: Data Analysis, 2018.
******* = significant at 1% ****** = significant at 5% ***** = significant at 10%

Age and household size is found to negatively and significantly affect food security at 5% and 10% respectively. This indicates that as the age of household head increases by one year the household food security status is likely to reduce by 0.7912. An addition of one more person to the household will reduce the probability of being food secure by 3.2585.

Years of farm experience is found to positively and considerably influence food security status at 1%. This implies that an addition of another year to the farmers' experience will cause a rise in the probability of being food secure by 1.5303.

The coefficient of farm size is positive and significant at 1%. An increase in farm area cultivated by farmers will increase the likelihood of food security by 3.2474.

On-farm and off-farm income is also found to significantly and positively influence food security at 1%. This indicates that a rise in the amount gotten from farm will increase farmers' likelihood of being food secure by 0.0005 and 0.0004 respectively.

Proximity to urban centre has a positive marginal effect on food security and is significant at 5%. This implies that the probability of being food secure is increased by 0.8924 with a km nearness to urban centre.

Therefore, based on the findings of this study, there is a significant relationship between off-farm income of farmers and household food security.

CONCLUSIONS

In this study, only 22.5% were found to be food insecure while 77.5% were food secure. The food security status and off-farm income of households were positively correlated, meaning that food security status of households progresses as off-farm income rises.

Based on the results aforementioned, below are recommendations made:

-Policy makers should supplement agriculture with programs targeted at increasing the off-farm work existing to farming households, taking into consideration the resources and composition of individual households.

-Agricultural extension agents should incorporate the addition of various occupation earning activities into their programmes. This would improve farmers' ability to cope with any shock like food shortage.

REFERENCES

[1]Abdoulaye, T., Olivier, K.K., J.J., Alioune, C., Sidikiba, S., Alexandre, D., Emmanuel, K.Y., Ngbam, K., 2018, Prevelance and determinants of Malnutrition Among School Children in Primary Schools in the Communes of Dixinn, Matam and Matoto, Conakry, Guinea, 2016

[2]Babatunde, R.O., Qaim, M., 2010, Impact of off-farm income on food security and nutrition in Nigeria, The Joint 3rd African Association of Agricultural Economics (AAAe) and 48th Agricultural Economics Association of South Africa, September 19-23, 2010.

[3]Barrett, C.B., Reardon, T., Webb, P., 2001, Non-farm Income Diversification and Household Livelihood Strategies in Rural Africa: Cincepts, dynamics and policy implications. Food policy. 26(4), 315-331.

[4]Davis, B,. Winters, P., Carletto, G., Covarrubias, K., Quinones, E., Zerra, A., Digiuseppe, S., 2010, A cross country comparison of rural income generating activities. World development, 38(1), 48-63.

[5]Ellis, F., Freeman, A. H., 2005, Implications of Livelihood Strategies for Agricultural Research: A Kenya Case Study', in Ellis and Freeman (Eds.), Rural Livelihoods and Poverty Reduction Policies. London and New York: Routledge. pp. 198-212.

[6]Ersado, L., 2003, Income diversification in Zimbabwe: Welfare implication from urban and rural areas. FCND Discussion Paper 152, International Food Policy Research Institute, Washington, DC.

[7]Food and Agriculture Organization, 2011, Global food losses and waste: Extent, causes and prevention. Study conducted for the International congress (FAO) Rome.

[8]Food and Agriculture Organization, 2015, The state of Food insecurity in the world. Meeting the 2015 International hunger targets: taking stock of uneven progress. Vol. 178, Albrecht von Graefes Archiv für Klinische und Experimentelle Ophthalmologie. 1969.

[9]Haggblade, S., Hazell, P., Reardon, T., 2005, The rural non-agricultural economy: pathway out of poverty or pathway in? International Food Policy Research Institute and Michigan State University, proceedings of the research workshop 'The Future of Small-Farms', June 26-29, UK, 2005.

[10]Idowu, A.O, Awoyemi, T.T, Omonona, B.T., Falusi, A.O., 2011, Non-Farm Income Diversification and Poverty among Rural Farm Households in Southwest Nigeria.

[11]Joshi, P. K., Joshi, L., Birthal, P. S., 2006, Diversification and its impact on smallholders: Evidence from a study on vegetable production. Agricultural Economics Research Review, 19(2), 219-236.

[12]Mwaniki, A., 2006, Achieving food security in Africa: Challenges and issues. UN Office of the Special Advisor on Africa. (OSAA).
[13]Pfeiffer, L., Lopez- Feldman, A., Taylor, J. E., 2009, Is off-farm income reforming the farm? Evidence from Mexico. Agricultural economics 40(2), 125-138.
[14]Reardon, T., Delgado, C., Matlon P., 1992, Determinants and effects of Income diversification amongst farm households in Burkina Faso. Journal of development Studies 28(1), 264-196.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

DETERMINATION OF CRITICAL POINT OF CHICKEN FILLET DAMAGE USING POLYETHYLENE PACKAGING AT 4°C STORAGE TEMPERATURE

Rosalina Ilmi AMALIA, Bunayya Rabbika FIRLY, Bella Alfiah SIMAMORA, Nurul SAKINAH, Tita RIALITA, Gemilang Lara UTAMA

University of Padjadjaran, Faculty of Agro-Industrial Technology, Jl. Bandung-Sumedang Km 21, Jatinangor, West Java, Indonesia, 45363, Emails: rosalinailmi@gmail.com, bunayya16001@mail.unpad.ac.id, bellaalfiah16008@mail.unpad.ac.id, nurul16037@mail.unpad.ac.id, trialita1@gmail.com, lugemilang@gmail.com

Corresponding author: lugemilang@gmail.com

Abstract

The use of plastic for packaging fillet chicken meat is known to not significantly inhibit the growth of microbial contaminants. One alternative solution to maintain the freshness of fillet chicken meat at low temperature storage (± 4^{O}C) is to use active packaging based on natural ingredients with the addition of antimicrobials. Based on this, the determination of the critical point of damage to fillet chicken meat during storage is important to know as a basis for comparison to determine the effectiveness of packaging applications in extending the shelf life of fresh chicken meat. This study aims to determine the critical point of damage to fillet chicken meat which is packaged using polyethylene (PE) type plastic and stored at a storage temperature of ± 4 °C. The study was conducted using descriptive methods, where fillet chicken meat was stored until characteristics are not favoured by panellists. Observation parameters consisted of acidity (pH), total number of microbial plate counts (TPC), colour change (ΔE), texture (elasticity), presence of Salmonella, Shigella, and Escherichia coli contamination, and the preference level test for colour, aroma and texture of chicken fillet. The results showed a critical point of damage to fillet chicken meat occurred on the 3rd day marked by a decrease in quality during storage, namely an increase in pH due to decomposition, an increase in the total number of microbes by 2 logs since the first day of storage, lightness on the meat was getting darker, and decreasing the value of the consistency of chicken fillet. Detection of Salmonella, Shigella, and E.coli bacterial contamination was negative on the first day, but was detected positive on the 3rd day. Panellists began rejecting fillet chicken meat on the 3rd day of storage based on the parameters of colour, aroma and texture of chicken meat.

Key words**:** *critical point, chicken fillet, polyethylene plastic, storage*

INTRODUCTION

Chicken broiler is a term commonly used to describe the results of animal husbandry technology cultivation that has economic characteristics with the characteristics of fast growth, as a producer of meat with economical food conversion and ready to cut at a young age of 35 - 45 days with a weight 1.2 - 1.9 kg / head [13]. The color of fresh chicken meat is yellowish with the characteristic aroma of broiler chicken meat that is not fishy, not slimy and does not cause a foul odor [12].

Nowdays, the citizen of Indonesia are more familiar with broiler chicken meat as chicken meat that is commonly consumed because of its advantages such as high content or nutritional value so that it is able to meet nutritional needs in the body, easily obtained, thicker meat, and has a more texture tender compared to free-range chicken meat and easily available on the market and supermarkets at affordable prices. However, due to its high nutritional content, it causes broiler chicken meat to be easily damaged due to the development of spoilage microorganisms which will reduce the quality of the meat so that the impact on the meat becomes easily damaged [12].

Generally, broiler chicken meat sell in the market without packaging, it make easier for spoilage microbes to contaminate broiler chicken meat, so that the broiler chicken meat will be damaged quickly. Some microorganisms that can cause damage and

decay in broiler meat are *Escherichia coli*, *Shigella*, and *Salmonella* [4].

Prevention of damage to chicken fillet is by packaging. the types of plastic packaging commonly applied to broilers are PP (Polyprophylen), PE (polyethylen), and plastic warp [11]. However, packaging of broiler chickens with PP, PE and Warp plastic is not able to protect broiler chickens optimally, because the number of microbes found in broiler chicken meat still exceeded the maximum limit of microbial contamination [19].

Therefore, to extend the shelf life of broiler fillet chicken, packaging is done using active packaging based on natural ingredients with the addition of antimicrobials and stored at refrigerator temperatures (±4 °C).

Active packaging is the incorporation of certain additive compounds into packaging films with the aim of maintaining or increasing the shelf life of the product [8]. The active ingredients in the form of antimicrobial function to delay microbial spoilage, minimize contamination, and maintain the color of the product during the storage process. Meanwhile, refrigerator temperature storage (± 4 °C) can slow down enzymatic performance and prevent the growth of spoilage microbes [17, 14].

Based on this, it is important to determine the critical point of damage to fillet chicken during storage as a basis for comparison to determine the effectiveness of active packaging applications in extending the shelf life of fresh chicken meat. This study aims to determine the critical point of damage to fillet chicken meat which is packaged using polyethylene (PE) type plastic and stored at a storage temperature of ± 4 ° C.

MATERIALS AND METHODS

The purpose of this research is to determine the critical point of chicken meat fillet which is packaged using polyethylene (PE) type plastic and stored at a storage temperature of ± 4 °C

The tools used in this study were stirring rods, beaker cups, petri dishes, colony counters, sensory shapes, scissors, hand chroma, incubators, refrigerators, pH meters, volume pipettes, knives, polyethylene plastic (PE), test tubes, texture analyzers, and vortex.

The materials used in this study were fillet chicken breast originating from Slaughtering house in the Rancaekek District, West Java-Indonesia, distilled water, buffer pH 4 and pH 7, broiler chicken breast fillet, Eosin Methylene Blue (EMB) agar media, Plate Count Agar (PCA) media, Salmonella-Shigella Agar (SSA) Media, and Physiological NaCl 0.85% sterile.

Preparation of Fillet Chicken Meat

Chicken breast fillets are cut into cubes with a size of ± 5 cm x 5 cm x 5 cm. Then, the chicken pieces are put into PE plastic. Samples are stored in the refrigerator at a temperature of ± 4 °C.

Organoleptic Test

Pieces of chicken fillet are tested hedonically every day by semi-trained panelists until the sample is damaged and panelists reject it. The quality parameters tested included color, aroma and texture.

Microbial Test

In microorganism testing, testing is done that is Total Plate Count, detection of Salmonella bacteria, Shigella, and detection of Escherichia coli bacteria contamination. The procedure performed was mashed chicken fillet, dissolved in 0.85% NaCl physiological sterile (1:9) in a test tube. Then the sample was homogenated by vortex, the suspension is a 10^{-1} dilution. Then, dilution is continued until 10^{-7}. Samples contained in 10^{-6} and 10^{-7} dilutions were incubated using SSA (for *Salmonella* and *Shigella* bacterial detection), EMB (*E.coli* bacterial detection and PCA (Total Plate Count for all kind of microorganism) media. SSA and EMB agar are incubation in temperature 37°C and PCA agar is incubation in temperature 30°C for 2 days.

Colour Test

First, the chroma-hand is prepared and calibrated. After being calibrated, a color test was carried out by detecting at 5 points on the surface of the fillet chicken pieces. The results of the hand chroma color test are sets of coordinates such as L *, a * and b *. L * values represent lightness, i.e. 0 for black and

100 for white, axis a * shows 28 intensities in red (+) or green (-), axis b * indicates intensity in yellow (+) or blue (-) [10].

Texture Test

First, a texture analyzer is prepared and a probe type P-36 is selected. After all texture analyzer components are installed, select TPA mode then calibrate it first, both calibration force and calibration height. After calibration, chicken pieces can be placed under the probe, then select Run A Test. The probe will compress the chicken meat. The results will be displayed on a computer display, both hardness, cohesiveness, adhesiveness, gumminess, springiness and chewiness. In this research just using springiness result.

pH Test

First, the pH meter is calibrated first with a buffer of pH 7 and followed by a buffer of pH 4. After the pH meter has been calibrated, chicken samples are prepared. Chicken pieces are weighed as much as 5 g for 25 ml of distilled water (1: 5 w /v). After weighing, the chicken pieces are chopped until fine and 25 ml of distilled water is added.

RESULTS AND DISCUSSIONS

Texture of Chicken Meat Fillet

Chicken meat texture was measured using the Texture Analyzer tool. This texture profile analysis is the most popular method used to predict the texture quality of chicken breast meat. Texture profile analysis (TPA) is a two-cycle compression test to determine texture attributes in food by mimicking the action of biting humans [5]. The texture parameters taken in this study are the Springiness value in chicken meat. Springiness is a value that indicates the extent to which the sample returns to its original form. The results of springiness testing in chicken meat can be seen in Fig. 1.

Broiler chicken meat packaged in polyethylene packages and stored at a storage temperature of ± 4°C has a springiness value that continues to decrease during storage. This decrease in springiness value indicates that chicken meat has changed its texture to become more soft or inelastic.

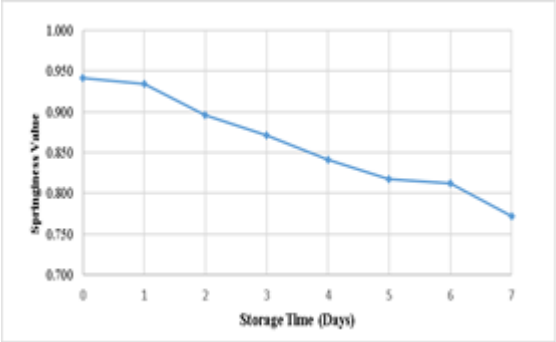

Fig. 1. Texture of Chicken Fillet
Source: Own data.

Changes in texture can also occur due to damage to some of the constituent connective tissue and filament threads in chicken meat as a result of biochemical changes and microbial activity [16]. Damage to these tissues causes loss of power to support the structure of chicken meat so that the texture of the meat has decreased. When the total number of microbes reached 10^8 CFU/g, decomposition of muscle tissue was evidenced by the formation of surface mucus [6].

Value of Acidity (pH)

The average pH of broiler chicken meat packaged with PE plastic packaging, and stored at a storage temperature of ± 4 ° C, is briefly presented in Fig. 2. The results showed a tendency to increase in pH value during storage of broiler chicken meat using PE type plastic.

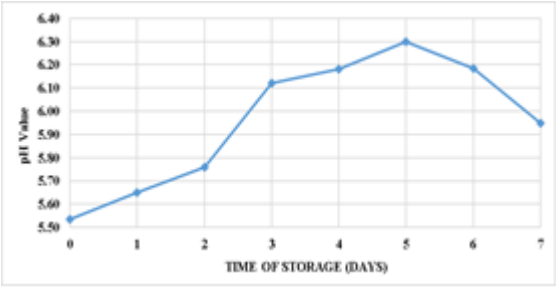

Fig. 2. Observation of pH
Source: Own data.

The increase in pH can be caused by the activity of spoilage microbes that produce ammonia, so that it is detected as OH^- value which can increase the pH value of broiler chickens. In addition, the increase in pH can also be caused by biochemical reactions in the post-mortem process of chicken meat.

Many factors cause an increase in the pH value of chicken meat. After slaughtering

chicken has a pH value that is not constant, the pH will decrease in the first hours of cutting, and will increase after experiencing postmortem [7, 9]. The increase in pH value in chicken meat is still in accordance with the Indonesian National Standard which states if the pH of a good chicken ranges between pH 6-7.

L * Value (*Lightness*)

L * or lightness values indicate the brightness of a sample with values ranging from 0 (black) to 100 (white). The average L * value in chicken meat packed with PE plastic and stored at ± 4 °C storage temperature decreased. The results of observing the L * value are presented in Fig. 3.

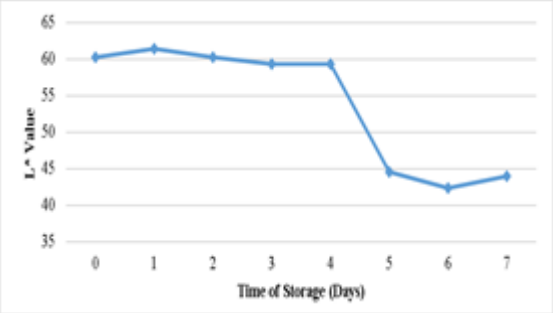

Fig. 3. L* Value
Source: Own data.

Decrease in L * value indicates if the color of the chicken is getting darker, this is due to the influence of the activity of microorganisms that cause the color of the chicken to get darker [2].

Value of a * (*Redness*)

Value of a* or redness values indicate the redness or greenness of a sample with values ranging from -60 (green) to +60 (red). The average value of a * in chicken meat during storage decreased, the results of observations are in Fig. 4.

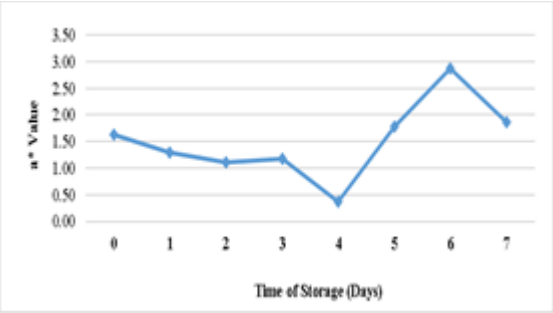

Fig. 4. Value of a*
Source: Own data.

The decrease in the value of a * indicates that the color of chicken meat is getting longer and more greenish storage period, this is due to the presence of hydrogen sulfide (H_2S) compounds produced by bacteria in meat. H_2S will react with air, blood pigment, and tissue pigment to form sulfmioglobin which is green [18].

Value of b * (Yellowness)

A value of b * or yellowness value indicates the yellowish or bluish level of a sample with values ranging from -60 (blue) to +60 (yellow) [3]. The average value of b* decreases during storage. The observations can be seen in Fig. 5.

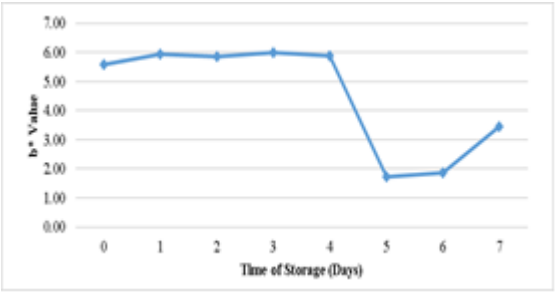

Fig. 5. Value of b*
Source: Own data.

A decrease in the value of b* can be caused by changes in meat pigment during storage. Storage at low temperatures for a long time causes methyoglobin to synthesize, which in general can change the color of meat [15].

Organoleptic Test

Organoleptic test on a product is very necessary to assess how much consumer interest in the food produced. This test was carried out to determine the assessment of the level of consumer preferences in terms of color, aroma, and texture of chicken packed with PE plastic and stored at ± 4 ° C. The observations are presented in Fig. 6.

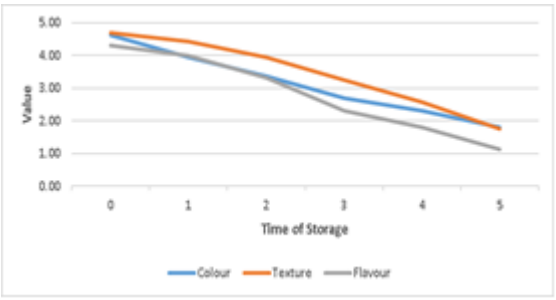

Fig. 6. Results of Organoleptic Test
Source: Own Data.

The observations stated that if the panelists began rejecting samples on the 3rd day of storage, from the test results, the longer the storage time, the more the panelists disliked the color, aroma and texture of the chicken, so the smaller the test value. Panelist dislike of the color, texture, and aroma of chicken meat is supported by other test data.

Amount Total of Microorganisms

Amount total of microorganism has purpose to find out whether the number of microbes in chicken meat is in accordance with the standards adopted by the Indonesian government or not. The test results are in Fig. 7.

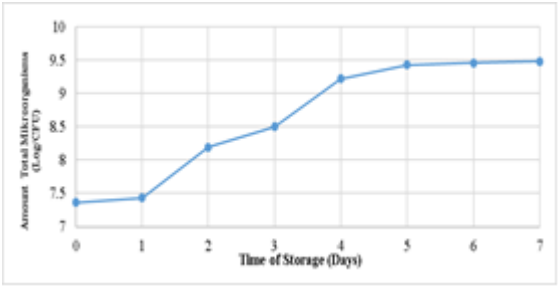

Fig. 7. Total Microorganisms
Source: Own data.

Observation results indicate if on day 0 of chicken meat storage, the number of microbial colonies in chicken meat has exceeded the Indonesian National Standard Agency (BSNI), which is 10^6 or 6 Log cfu/gr [1].

The total number of microbes in meat observed on day 0 was 7 log, and it increased until the 7th day of storage.

The high number of total microorganisms on the first day can be due to poor storage after the cutting process, so when testing the total number of microbes has exceeded the set standards.

***Salmonella, Shigella,* and *Escherichia coli* Bacterial Detection**

Salmonella, Shigella, and E.coli bacteria are three of the many bacteria that are used as indicators of damage to chicken meat.

This study examines the presence or absence of contamination of Salmonella, Shigella, and E.coli bacteria in chickens that are packed with PE packaging and stored at low temperatures.

The observations are presented in Table 1.

Table 1. Result of Bacterial Detection

Bacteria/ Time of Storage	Result	
	10^6	10^7
Salmonella dan Shigella/D0	Negative	Negative
Salmonella dan Shigella/D7	Positive	Positive
Escherichia coli/D0	Negative	Negative
Escherichia coli/D7	Positive	Positive

Source: Own Data.

Observations were obtained if the bacteria Salmonella, Shigella and E.coli were detected in the samples tested on the last day of storage, but were not detected at the beginning of the storage period. The undetectability of the three bacteria can be caused by the amount of dilution that is too large so that when the last day is observed, the results are positive for the three bacteria.

CONCLUSIONS

Chicken fillets that were given a packaging treatment using PE type plastic and stored at a storage temperature of ± 4 ° C only lasted for 3 days of storage. Decrease in quality during 4°C storage shown by the increase of pH and the total number of microbes by 2 logs, lightness on the meat was decrease and followed by decreasing of the chicken fillet consistency. Based on the color, aroma and texture of chicken fillet, panellists began to dislike it since the 3rd day of storage.

REFERENCES

[1]Badan Standardisasi Nasional (National Standardization Agency), 2009, SNI 3924:2009 Mutu Karkas dan Daging Ayam. Dewan Standardisasi Nasional. Jakarta. (SNI 3924: 2009 Quality of Carcass and Chicken Meat. National Standardization Board. Jakarta).
[2]Barbut, S., 2002, Poultry Products Processing. An Industry Guide. CRC Press. Florida.
[3]Barbut, S., 2015, The Science of Poultry and Meat Processing. University of Guelph. Canada.
[4]Bhunia, A.K., 2008, Foodborne Microbial Pathogens: Mechanisms and Pathogenesis.
[5]Bourne, M.C., 1978, Texture Profile Analysis. Food Technology 32(7): 62-67 &72.
[6]Charles, N., Williams, S. K., Rodrick, G. E. 2006, Effect of Packaging System on The Natural Microflora

and Acceptability of Chicken Breast Meat. Poultry Science 85, 1798-1801.

[7]Debut, M., Berri, C., Bae´za, E., Sellier, N., Arnould, C., Guemene, D., Jehl, N., Boutten, B., Jego, Y., Beaumont, C., Le Bihan-Duval, E., 2003, Variation of Chicken Technological Meat Quality in Relation to Genotype and Preslaughter Stress Condition. Poultry Science. Vol. 82:1829–1838. France.

[8]Dobrucka, R., Cierpiszewski, R., 2014, Active and Intelligent Packaging Food-Research And Development: A Review. Polish Journal Food Nutrition Sciences 64(1): 7-15.

[9]Duclos, M. J., Berri, C., Le Bihan-Duval, E., 2007, Muscle growth and meat quality. J. Appl. Poultry Res. 16:107–112.

[10]Fabre, C.E., Goma, G., Blanc, P.J., 1993, Production and Food Applications Of The Red Pigments of *Monascus ruber*. Journal of Food Science 58 (5): 1099-1102.

[11]Irawati, N., Neneng, Y.H., 2014, Penggunaan Kemasan Plastik Jenis PE (*Polythylene*), PP (*Polypropylene*) dan Plastik *Wrap* terhadap Angka Kuman pada Daging Ayam. Jurnal Kesehatan. Universitas Dian Nuswantoro. Semarang. (Use of PE (Polythylene), PP (Polypropylene) and Plastic Wrap Type of Germs on Chicken Meat. Journal of Health. Dian Nuswantoro University. Semarang).

[12]Kasih, N.S., Jaelani, A., Firahmi, N., 2012, Pengaruh Lama Penyimpanan Daging Ayam Segar Dalam Refrigerator Terhadap pH, Susut Masak Dan Organoleptik. Media Sains (Effect of Long Storage of Fresh Chicken Meat in Refrigerator on pH, Shrinkage and Organoleptic Shrinkage. Science Media), 4 (2): 154-159.

[13]Priyatno, M. A., 2003, Mendirikan Usaha Pemotongan Ayam. Penebar Swadaya, Jakarta (Establishing Chicken Slaughtering Business. Penebar Swadaya, Jakarta).

[14]Risnajati, D., 2010, Pengaruh Lama Penyimpanan dalam Lemari Es terhadap pH, Daya Ikat Air, dan Susut Masak Karkas Broiler yang Dikemas Plastik Polyethylen. Jurnal ilmu (Pet Effect of Storage Duration in the Refrigerator on pH, Water Bonding Capacity, and Shrinkage of Broiler Carcass Cooking Packaged by Polyethylene Plastic. Journal of Pet Sciences).13 (6):309-315.

[15]Saucier, L., Gendron, C, Gariepy, C., 2000, Shelf Life of Ground Poultry Meat Stored Under Modified Atmosphere. Poultry Sci. Canada

[16]Soeparno, 2009, Ilmu dan Teknologi Daging. Cetakan V. Gadjah Mada University Press. Yogyakarta (Meat Science and Technology. Matter of V. Gadjah Mada University Press. Yogyakarta)

[17]Wuryanti, 2004, Isolasi dan Penentuan Aktivasi Spesifik Enzim Bromelin dari Buah Nanas (*Ananas comosus* L.). Artikel: JKSA, (Isolation and Determination of Specific Activation of Bromelin Enzyme from Pineapple (Ananas comosus L.). Article: JKSA), 7(3): 83-87

[18]Yulistianti, R., 2010, Studi Daging Ayam Bangkai: Perubahan Organoleptik dan Pola Pertumbuhan Bakteri. Jurnal Teknologi Pertanian (Chicken Carcasses Study: Organoleptic Changes and Bacterial Growth Patterns. Journal of Agricultural Technology). Vol 11, 27-36.

[19]Zhang, Q.Q., Han, Y. Q., Cao, J. X., Xu, X. L. Zhou, G. H., Zhang, W. Y., 2014, The Spoilage Of Air-Packaged Broiler Meat During Storage At Normal and Fluctuating Storage Temperatures. Poultry Science 91:208–214.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE EFFECT OF CORPORATE GOVERNANCE ON COST OF CAPITAL IN AGRICULTURE SECTOR OF ASIAN COUNTRIES

Zeshan ANWAR

University of Sialkot, Sialkot, Pakistan, Phone/Fax: +92-300-4990206; E-mail: zeshananwar58@gmail.com

Corresponding author: zeshananwar58@gmail.com

Abstract

This study has determined connection of governance mechanisms with cost of capital based on Agency and Stewardship theories for companies in agriculture sector in 20 Asian countries from 2009-2018 for 363 agricultural firms as agriculture significantly contributes in growth of Asian economies. The WACC variable is selected as a dependent variable, whereas quality of corporate governance practices (QCG) variable has been used as independent variable. The endogeneity of QCG variable was examined through 2SLS model and results depict that variable of QCG significantly and negatively affect the variable of WACC. Moreover, the variables of leverage, ROA, sales growth and stock's volatility have significant positive connection with WACC, whereas, the firm size has significant negative relationship with the WACC. This research contributes to empirical literature by offering the first empirical support for analysis on association of governance systems and WACC for agricultural firms in Asian countries. These results are consistent with suggestions of Agency and stewardship theories and therefore, policy makers need to improve their corporate governance structures for attracting more investors and creditors around the world in agriculture sector.

Key words**:** *Governance practices, cost of capital, agricultural firms, Asian countries*

INTRODUCTION

This study explores connection of governance mechanisms and cost of capital for Asian agriculture firms. The cost of capital has been measured through WACC because it includes both cost of debt and equity. So, instead of using only equity or debt cost as a proxy for organization's capital cost; it is expected that using WACC will provide more valid results as compared to results by using only cost of equity or debt. Many theories have pointed a connection of governance mechanisms with shareholders' wealth. The empirical literature has given preference to Agency and Stewardship theories in explaining corporate governance association with firms' capital cost [3]. The agency theory argues that stockholders' wealth maximization objective could be accomplished by alignment of managers and shareholders' interests. Conversely, stewardship theory points out that managers implement better corporate governance mechanisms to reflect being the reliable stewards of their controlling assets which results in boosting wealth of stockholders thus indicates the connection of corporate governance with stockholders' wealth. Whereas, the capital cost is a critical element in creation of wealth.

This study observes this matter for Asian agricultural firms due to lesser available literature on this topic for Asian economies and existence of gap in literature for impact of governance mechanisms on organizational performance. So there is a stronger motivation of this study for bridging these literature gaps. The research examined whether improved governance would lower capital cost for Asian agricultural firms of 20 countries from 2009-2018.

This study analyzed connection of governance mechanisms with capital cost along with some control variables. Following are the objectives of this research:

(1)Are there financial benefits for better governance practices in Asian Countries?

(2)Determine whether Better Governance practices Results in Lowering the Cost of Capital.

The rest of the study is organized as following: literature review is described in section 2; research methods is presented in

section 3. Results are discussed in section 4, whereas, the conclusion is provided in section 5.

Literature review

Many researchers have analyzed association of governance activities and capital cost e.g. [8] found that increased managerial ownership results in increasing debt cost at lower levels but reduces debt cost at higher levels. [5] also stated that as purpose of governance practices is decreasing agency costs, they may have an important impact on equity capital cost of the firm; the researchers also described that better quality of company's financial information have negative correlation with equity cost of the business. [14] provided direct evaluation regarding incentives related to disclosure and impact on organizations' capital cost. The authors argued that businesses in industries which require more external financing have more voluntary disclosures in order to differentiate their companies for obtaining external financing at a lower cost. The researchers found that an extended disclosure policies for these corporations results in decreased cost for both debt and equity. [12] determined influence of governance practices on liquidity of equity and described that the organizations with weaker disclosure practices and information transparency have to bear a more cost for liquidity of equity.

[1] analyzed impact of board's size, independent audit committee, managerial ownership, governance score and board independence on equity cost in Pakistan by utilizing data of 2003 to 2007 for 114 KSE firms. The authors used correlation matrix, OLS and fixed effects models for testing this association. The results have shown that board size and managerial ownership significantly and negatively affect on equity cost, whereas, independent auditors, board and governance score have positively affect equity cost in Pakistan. [15] observed interactive influence of financial and legal developments at country level, and governance attributes at organizational level on cost of equity by utilizing a broad sample of 7,380 observations in 22 developed economies for period of 2003 to 2007. The authors demonstrated that governance attributes at firm level have an effect on equity cost just in Common Law nations with higher degree of financial developments.

Furthermore, [10] studied Canadian economy for period of 2002 to 2005 and tested governance levels with corresponding WACC and discovered a strong association among the variables. They measured governance by report on business (ROB) index and suggested that improved governance practices results in decreasing WACC for Canadian businesses. The ROB index comprises large number of governance factors which are considered to be extremely important for the effectiveness of governance practices. It includes board composition, board independence assessment, and also three committees namely nomination, audit and remuneration. [6] conducted same kind of research and found that ownership concentration would result in increasing or decreasing the debt cost. [16] determined influence of governance practices on equity cost and financial decisions for listed companies in Tehran from 2007-2011. The results depicted that the variables of governance practices significantly and positively affect cost of equity, debt and WACC. [27] analyzed 22 countries data and suggested that governance practices at firm level can substitute for protection at country level. They also found that cost of equity has been lesser for organizations in countries having stronger legal systems. These findings are similar to past research that debt and equity cost are lesser for businesses having better governance practices. [22] examined association of governance mechanisms with business performance in India by utilizing a sample of larger companies over 10 years. This study showed that more insider ownership, independent board directors and existence of institutional blockholders reduced the company's perceived risk, thus directing the investors to require lesser return on invested capital. This study highlighted vital role of governance practices in producing value for stockholders by diminishing external financing cost.

[11] examined association of board independence and cost of debt for 2002 to 2006 and reported that independent board

reduces debt cost in presence of stronger credit situations or lower leverage, whereas, it raises debt cost in presence of poor credit situations or higher leverage. They also documented that independent board directors set organizational policies which enhance business risk so independent board directors perform in better interest of stockholders and are more costly for bondholders with increase of agency conflicts between these two groups. [20] investigated relation of governance index and capital cost for the 110 firms listed on Tehran stock market during 2009 to 2013 through the multivariate regression model. In order to estimate effect of governance index with capital cost, the influence of other related variables have been controlled. The researchers have shown that a negative and significant correlation exist between governance index and capital cost. [25] investigated the degree to which governance mechanisms implemented by listed companies in Latin America influence their equity capital cost. The findings of research showed a negative connection of governance quality and equity cost. Particularly, the "Disclosure" variable was most influential in affecting the equity capital cost. [17] analyzed the Australian economy for the period of 1994 to 2003 and reported that more insider ownership, smaller independent boards and presence of more institutional blockholders results in lowering overall capital cost. Other researchers focused on both debt and equity costs.

[2] indicated that larger boards enhances firm value, whereas, the effect of other governance characteristics changes with state of economic conditions for companies in UK. [7] stated that separation of CEO and board chairman roles improves financial performance for businesses in Tanzania. [4] found that board characteristics does significantly affect firm value in Ghana.

We can conclude from the above mentioned literature that very limited research has been performed regarding relation of governance mechanisms with organizations' capital cost for Asian economies generally and Asian agricultural firms particularly. To the best of author's information, very few studies in Asia has determined the association of governance with capital cost, whereas, there is no study which investigated the association of governance with capital cost for Asian agricultural firms. The empirical literature also depicted mixed results as few researchers found positive, whereas, others found a negative association for governance mechanisms and capital cost. Therefore, this study aimed to determine correlation of governance mechanisms with capital cost for Asian businesses for 2009 to 2018. As investors consider that firms with improved governance practices have lesser risk, so they will perceive that investment in those companies would be exposed to decreased risk. Therefore, the investors will demand lesser rate of return for these organizations. Consequently, the following hypothesis is formulated:

H1: Better Governance Practices Results in Lowering the Cost of Capital.

MATERIALS AND METHODS

Based on Agency and Stewardship theories, the theoretical framework of this research has been depicted in Fig. 1 as follows:

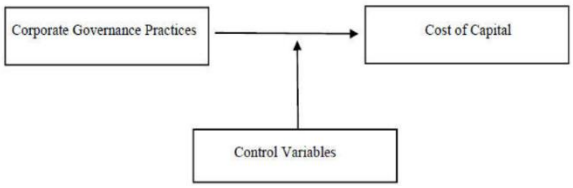

Fig. 1. The Theoretical Framework of the Study
Source: Own Design.

The framework and empirical models for this research has been discussed in this section. The methods employed for determining the relationship between governance mechanisms with capital cost in Asian firms has also presented, whereas, the conceptual framework is described in Fig. 2.

The governance mechanisms variables for Asian firms are depicted on left side which include: Quality of Corporate Governance (QCG), Board Independence (BI), Ownership Concentration (OWN), Audit Committee Independence (AI) and CEO Duality (DUAL). The proxy for organizations' capital cost is

specified on right hand side that is WACC which is measured through combination of equity and debt costs. The control variables include: Firm Leverage (LEV), Firm Size (SIZE), ROA, Sales Growth (SALESGROW) and Firm's leverage (LEV).

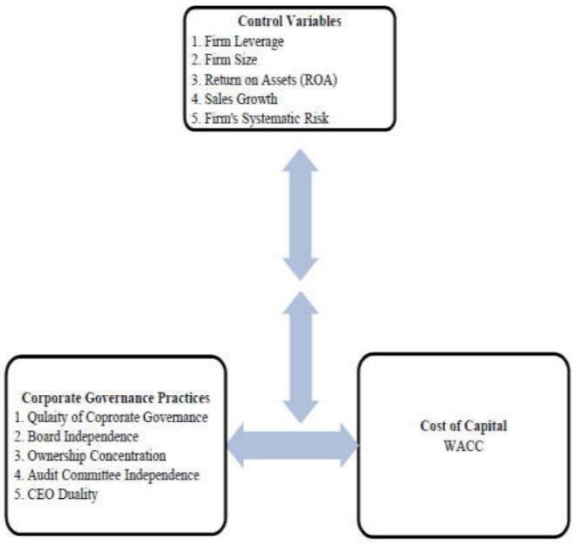

Fig. 2. Potential Association of Characteristics for Governance Practices and Cost of Capital
Source: Own Design.

Data and Selection of Sample

This study employed quantitative technique for examining connection between governance mechanisms and capital cost for Asian businesses. This study have a sample of agriculture firms in 20 Asian economies covering the time period of 2009-2018 and excluded the financial sector firms and the businesses not having complete dataset. The dataset is gathered from audited reports, concerned stock exchanges and websites of concerned firms. A final sample of 363 nonfinancial firms in agriculture sector is used as dataset of this study for representation of agricultural sector in Asian economies.

Variables

According to [19], WACC includes the organizations debt and equity costs, tax rate, capital structure, amount of equity and debt as shown in balance sheet.

The following equation can be formed to calculate WACC:

$$WACC = \frac{Equity}{Total\ Assets} * R_e + \frac{Debt}{Total\ Assets} * R_d * (1 - T_c) \dots (1)$$

where:

Re denotes the equity cost and
Rd signifies the debt cost.

Calculating equity cost can be carried out in many ways but there are most accepted methods which include CAPM [18]; [21] [26], Three Factor Model [13] and Dividend Discount Model [23]. Even though it is yet indefinite about which technique is most effective to use [23], the common method which was utilized in previous studies is CAPM e.g. [10]. The model for CAPM can be described as follows:

$$R_e = R_f + \beta(R_m - R_f) \dots\dots (2)$$

where:
Rf is risk free return,
β is beta, the variability of organization with respect to the overall market, and
Rm is market rate.
(Rm − Rf) is risk premium.

The risk free rate will be calculated based on 10 year Government Treasury bond which is supported by [24]. The coefficient of beta will be calculated manually based on stock price returns as follows:

$$Beta = \frac{COV\,(R_m\,;R_e)}{Var\,(R_m)} \dots\dots (3)$$

This research employs the CAPM model as it the most widely used method employed in the empirical research to calculate equity cost. The techniques of calculating debt cost are much complex as compared to equity cost. The debt cost represents payments a business should pay against debts. The debt cost is calculated as rate on a risk free bond. The commonly used measure for debt cost is yield spread as indicated by the prior studies, which represents average debt yield to maturity above risk free rate e.g. [9]; [11]; [23]. The debt cost can also be measured as interest payments divided by total debt outstanding. This kind of methodology has been applied by [14] and [27]. This research calculates debt cost as annual interest expense divided by debt.

The independent variables employed in this research and the methods of their estimation have been presented in Table 1 as follows:

Table 1. Explanation of Variables

Variables	**Method of Measurement**
Dependent	
WACC	Weighted Average Cost of Capital
Independent	
QCG	Quality of Corporate Governance calculated as: QCG = f (BI, AI, OWN & DUAL)
BI	% of independent directors to total directors
OWN	% of five biggest stockholders to total stock
AI	% of independent directors to total audit committee's directors
DUAL	Value of 1 for CEO duality or zero, otherwise
SIZE	Total assets' natural log
VOLA	Stock Prices' volatility for one year
LEV	% of total debt with total assets
ROA	Net income divided by the total assets
SALESGROW	Log of sales growth

Source: Own Design.

Research Methodology

This study has estimated panel regression models. First of all, the association of the QCG variable with WACC variable has been determined and then robustness of results has been also tested by regressing WACC variable against individual corporate governance variables. The 2SLS Regression has been used for checking problem of endogeneity for independent variables. As the post estimation tests for 2SLS depict that endogeneity issue does exist in data of this research, therefore the results for 2SLS models have been reported accordingly. As the data used in this study comprises of twenty different countries which may vary based on country specific characteristics. Therefore, for controlling country specific effects, twenty dummy variables namely D1, D2, D3……..D20 have been included in 2SLS model. The base regression model for testing this association is stated below.

$$WACC_{i,t} = \beta 0 + \beta 1\ QCG + \beta 2\ LEV + \beta 3\ SIZE + \beta 4\ ROA + \beta 5\ SALEGROW + \beta 6\ VOL + Ut \ldots\ldots\ldots (4)$$

RESULTS AND DISCUSSIONS

In order to examine endogeneity issue in QCG, the 2SLS regression is employed.

Table 2. The 2SLS Regression Model

2 SLS Regression Model		
WACC	**Coef.**	**Std. Err.**
Panel I		
QCG	-0.217***	0.194
LEV	5.585***	0.495
SIZE	-0.398***	0.050
ROA	0.189***	0.011
SALESGROW	0.446***	0.153
VOLA	2.430***	0.196
D1	-3.209**	1.059
D2	-1.689	2.005
D3	-1.321	1.259
D4	-1.345	2.135
D5	-1.653	1.149
D6	-2.349	2.005
D7	-3.237	4.292
D8	0.476	4.495
D9	0.236	1.321
D10	0.479	2.654
D11	0.742	1.987
D12	0.136	2.234
D13	2.635	1.356
D14	2.852	2.114
D15	-2.613	1.163
D16	0.569	2.254
D17	0.472	1.654
D18	0.316	2.786
D19	0.326	1.316
D20	0.749	2.223
_cons	13.360	3.629
Instrumented: QCG		
Instruments: LEV SIZE ROA SALESGROW VOLA D1 D2 …….. D19 D20 BSIZE		
Panel II		
BI	-8.605***	2.333
OWN	-1.179**	0.490
AI	-0.737	0.607
Dual	-0.612*	0.352
LEV	4.676***	0.495
SIZE	-0.486***	0.250
ROA	0.243***	0.021
SALESGROW	0.557***	0.163
VOLA	2.540***	0.186
_cons	7.743	2.336
Instrumented: BI		
Instruments: OWN AI Dual LEV SIZE SALESGROW VOLA BSIZE		
*****Significant at p-value <1%,**		
****Significant at pvalue <5%,**		
***Significant at p-value <10%**		

Source: Own Design.

The QCG is considered as endogenous, whereas, the variable of board size is taken as instrumental variable and results are described in Table 2.

The panel I of Table 2 depicts that the variable of QCG negatively and significantly affect the WACC which means that improved quality of governance mechanisms results in decreased capital cost which is similar to results of [20]. Thus, based on these finding, this study concludes that better governance mechanisms results in lowering the capital cost for Asian agricultural firms which is in accordance to recommendations of agency and stewardship theories. Moreover, the control variables of leverage, ROA, SALESGROW and VOLA significantly and positively influence the WACC variable which means that higher leverage, ROA, sales growth and volatility results in higher capital cost for Asian businesses.

Furthermore, the variable of size significantly and negatively affects the WACC variable which means that agricultural businesses have lesser capital cost in Asian countries.

The results also depict that all the country dummy variables which controlled for country specific characteristics have insignificant values except for D1 which represent Japanese economy has significant and negative value. It means that cost of capital for only Japan is significantly different from other economies, whereas, the capital cost difference for all other countries are insignificant. Based on results for country specific dummy variables, this research concludes that findings of this study are valid and country specific differences in data have insignificant impact on findings of this study.

Robustness of Regression Results:

After accepting the hypothesis 1, the robustness of regression results has been checked by regressing the individual corporate governance factors and control variables against WACC variable and findings are depicted in panel II of Table 2. The panel II depicts that variables of BI, OWN, DUAL and SIZE have negative and significant impact on WACC for Asian countries which means that more independence of boards, ownership concentration, existence of CEO duality and larger size of firms will result in decreased WACC for Asian multinationals. These findings are similar to [9]; [10]; [11]; [22] and [25]. The results have also found that the variable of audit committee independence has insignificant association with WACC. The results also show that the variables of leverage, ROA, sales growth and stock price volatility positively affect WACC for Asian multinational companies. So, this study concludes that improved governance results in lesser cost of capital for Asian multinationals which is in accordance with recommendations of agency and stewardship theories. Thus, based on these results, the decision regarding acceptance of hypothesis 1 has been verified and it is being concluded that improvement in corporate governance practices yields benefits to Asian multinational companies in terms of lessening cost of capital.

For testing the endogeneity of board independence, the Durbin and Wu-Hausman techniques are employed which have p-value of 0.0040 and 0.0040 respectively. Therefore, the alternate hypothesis that variables are not exogenous is accepted. This research concludes that board independence has endogeneity issue and 2SLS regression is more suitable for analyses. The First Stage Regression Summary Statistics is used and finding show that the eigenvalue value is 187.211 which is greater than all the critical values, so the alternate hypothesis that instrumental variables are not weak is accepted.

Then, the test of Overidentifying restrictions is employed. The Sargan Test and Basmann Test have p-values of 0.2278 and 0.2485 respectively, so the null hypothesis that instruments set are valid and model has correct specification is accepted.

CONCLUSIONS

The 2SLS model is used in this study and the QCG variable is considered as endogenous variable, whereas, board size is taken as the instrumental variable and the results depict that the variable of QCG significantly and negatively affect cost of capital for Asian multinationals. Moreover, the findings for

individual corporate governance variables also show that ownership concentration, independent boards and CEO duality have negative correlation with WACC. Specifically, the implementation of better corporate governance mechanisms results in lessening the WACC which ultimately decreases the overall capital cost. These findings are significant for the policy makers and provide evidence that investors and creditors around the world assign higher weight for better governance while taking decisions to invest their capital in terms of equity or debt. This significant also points out that investors and creditors around the world would be more willing to invest in those companies which depict lesser capital cost.

Thus, it is extremely important for the companies to strengthen their corporate governance structures to obtain equity and debt financing at lesser cost. The results have showed that the control variables of leverage, firm size, ROA, sales growth and volatility were found significantly affecting capital cost. The potential researchers can extend this research as follows:

Firstly, this study focused on agricultural firms only, whereas, the future research can also examine this relationship in other sectors. Secondly, conducting the same investigations in other economies would assist in clarifying the precise role of governance practices on capital cost. Therefore, the association of governance practices with capital cost should be determined in other economies also. Thirdly, country wise analyses should be performed. Fourthly, utilization of more specific periods in future research would assist in developing new insights of governance practices. By focusing on the crisis periods and evaluating the board performance and comparing the board performance with other times periods can clarify the board dimensions in a better way.

REFERENCES

[1]Ali Shah, S. Z., Butt, S. A., 2009, The impact of corporate governance on the cost of equity: empirical evidence from Pakistani listed companies. The Lahore Journal of Economics, 14(1), 139-171.

[2]Allam, B. S., 2018, The impact of board characteristics and ownership identity on agency costs and firm performance: UK evidence. Corporate Governance: The International Journal of Business in Society, 18(6), 1147-1176.

[3]Anwar, Z., Aziz, B., Abbas, K., 2019, Corporate governance and firm profitability in agricultural sector: evidence from Asian countries. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(1), 31-39.

[4]Asante-Darko, D., Adu Bonsu, B., Famiyeh, S., Kwarteng, A., Goka, Y., 2018, Governance structures, cash holdings and firm value on the Ghana stock exchange. Corporate Governance: The International Journal of Business in Society, 18(4), 671-685.

[5]Ashbaugh, H., Collins, D. W., LaFond, R., 2004, Corporate governance and the cost of equity capital, Emory, University of Iowa. Retrieved on January, Vol. 26, pp. 2006.

[6]Aslan, H., Kumar, P., 2012, Strategic ownership structure and the cost of debt. The Review of Financial Studies, 25(7), 2257-2299.

[7]Assenga, M. P., Aly, D., Hussainey, K., 2018, The impact of board characteristics on the financial performance of Tanzanian firms. Corporate Governance: The International Journal of Business in Society, 18(6), 1089-1106.

[8]Bagnani, E. S., Milonas, N. T., Saunders, A., Travlos, N. G., 1994, Managers, owners, and the pricing of risky debt: An empirical analysis. The Journal of Finance, 49(2), 453-477.

[9]Blom, J., Schauten, M. B., 2008, Corporate governance and the cost of debt. In New developments in financial modelling, 116(145), 116-145. Cambridge Scholars Publishing in association with GSE Research.

[10]Bozec, Y., Bozec, R., 2011, Corporate governance quality and the cost of capital. International Journal of Corporate Governance, 2(3-4), 217-236.

[11]Bradley, M., Chen, D., 2014, Does board independence reduce the cost of debt?, Financial Management, 44(1), 15-47.

[12]Chen, W. P., Chung, H., Lee, C., Liao, W. L. 2007, Corporate governance and equity liquidity: Analysis of S&P transparency and disclosure rankings. Corporate Governance: An International Review, 15(4), 644-660.

[13]Fama, E. F., French, K. R., 1993, Common risk factors in the returns on stocks and bonds. Journal of financial economics, 33(1), 3-56.

[14]Francis, J., LaFond, R., Olsson, P., Schipper, K., 2005, The market pricing of accruals quality. Journal of accounting and economics, 39(2), 295-327.

[15]Gupta, K., Krishnamurti, C., Tourani-Rad, A., 2010, Financial development, corporate governance and cost of equity capital. In Corporate Governance and Cost of Equity Capital (March 1, 2011). Finance and Corporate Governance Conference.

[16]Keshtavar, A., Moeinaddin, M., Dehnavi, H. D. 2013, Need for Capital Management and Capital Structure in the World Today. International Journal of Modern Management Sciences, 2(2), 67-74.

[17]Kien Pham, P., Suchard, J., Zein, J., 2016, Corporate Governance, Cost of Capital and Performance: Evidence from Australian Firms. Journal of Applied Corporate Finance, 24(4), 84-93.

[18]Lintner, J., 1975, The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. In Stochastic optimization models in finance (131-155). Academic Press.
[19]Miles, J. A., Ezzell, J. R., 1980, The weighted average cost of capital, perfect capital markets, and project life: a clarification. Journal of financial and quantitative analysis, 15(3), 719-730.
[20]Nikkar, B., Azar, M. N., 2015, An Investigation Of The Relationship Between Corporate Governance Score And The Cost Of Capital In Listed Firms On Tehran Stock Exchange. SAUSSUREA, 3(1), 102-119.
[21]Sharpe, W. F., 1964, Capital asset prices: A theory of market equilibrium under conditions of risk. The Journal of Finance, 19(3), 425-442.
[22]Singhal, A., 2014, Corporate Governance, Cost of Capital and Value Creation: Evidence from Indian Firms. IOSR Journal of Economics and Finance, 4(6), 36-54.
[23]Soha, T. M., 2011, Corporate Governance and Cost of Capital. International Journal of Governance, 1(1), 92-111.
[24]Sörensson, T., 2011, The equity risk premium on the Swedish stock market. Royal Institute of Technology, Stockholm, Sweden, Industrial Engineering and Management.
[25]Teti, E., Dell'Acqua, A., Etro, L., Resmini, F., 2016, Corporate governance and cost of equity: empirical evidence from Latin American companies. Corporate Governance: The International Journal of Business in Society, 16(5), 831-848.
[26]Treynor, J. L., 1962, Toward a theory of market value of risky assets, Available at SSRN: http://ssrn.com/abstract=628187.
[27]Zhu, F., 2014, Corporate governance and the cost of capital: an international study. International Review of Finance, 14(3), 393-429.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

POST CONFLICT AGRICULTURAL LAND SHARING BETWEEN THE IFE AND THE MODAKEKE, NIGERIA

Festus AWOYELU[1], Kayode IDOWU[2]

[1]University of Nigeria, Department of Agricultural Economics, Nsukka, Enugu State, Nigeria. Phone: +2348037736661; E-mail: festus.awoyelu@unn.edu.ng; duroawoyelu@yahoo.com
[2]Obafemi Awolowo University, Department of Agricultural Economics, Ile-Ife, Osun State, Nigeria. Phone: +2348037263471; E-mail: eidowu1@yahoo.co.uk

Corresponding author: duroawoyelu@yahoo.com

Abstract

The paper assessed post conflict agricultural land sharing between the Ife and the Modakeke. The broad objective of the study to assess post conflict agricultural land sharing between the two groups of the respondents. Specifically, the study describes the socioeconomic characteristics of the respondents, identifies the causes and outcomes of conflicts in the past between the two sets of land users, examines conflict resolution methods adopted by the two parties to settle past conflicts, evaluates the respondents' perceived benefits of Land Use Act of 1978, and analyses the land rental systems adopted in the study area. The assessment revealed that the respondents were predominantly male, the majority of the tenant farmers were relatively young and in their active years compared to the landowners. The analysis further revealed that the major cause of conflict between the landowners and tenants in the study area is the non-payment of land rent (isakole). Past land conflicts were settled and/or resolved mainly by community leaders without any recourse to government courts. Both categories of respondents perceived the LUA of 1978 as non-beneficial to the South Western agricultural communities in Nigeria. Assessment of the agricultural land sharing and rental payment revealed that two rental regimes exist both before and after the conflict. Before and after the conflict, rental payment was by crop. Landowners collected only 10% of total annual cocoa harvested as rent from the tenants before conflict, but now collect 20% after the conflict. Land rental agreement before the conflict ranged between 5 to 20 years before the conflict, but now it has been reduced to between 5 to 10 years.

Key words**:** *post conflict, agricultural land sharing, Ife, Modakeke*

INTRODUCTION

The importance of agriculture for developing countries and for an adequate functioning of the world economy cannot be denied. First, although declining over time, primary agriculture still represents important percentages of developing countries' overall domestic production, exports, and employment. If agro-industrial, transportation, commercial, and other related activities are also counted, then the economic and social importance of agriculture-based sectors increases significantly. Furthermore, large numbers of the world's poor still live in rural areas and work in agriculture. Through the links via production, trade, employment, and prices, agricultural production is also crucial for national food security. Second, it has been shown that agriculture in developing countries has important growth and employment multipliers for the rest of the economy, and agriculture seems to have larger positive effects in reducing poverty than growth in other sectors. Third, agriculture is not only important for individual developing countries, but it has global significance, considering the large presence of developing countries in world agricultural production and the increasing participation in international trade of those products.

From a global perspective, agriculture provides livelihoods for more people than any other industry and it is the main source of livelihoods for the majority of rural people in developing countries. Growth in agricultural production and productivity is needed to raise rural incomes, to support the increasing numbers dependent on the industry and to meet the food and raw material needs of the faster growing urban population. Researches have shown that agriculture is the foundation of economic growth, development, poverty eradication, and prosperity of many

developing countries of the world. The fight for consistent economic growth can only be lost or won by investing in the agricultural sector [12]. It was also asserted that close to 75% of the world's poor people live in rural areas and many of them depend on agriculture with its related activities. Given its overbearing roles, the world's economic growth process, poverty eradication, and environmental sustainability must, one way or the order, involve agriculture [15]. As an important sector of the world's economy, agriculture is critical in achieving global poverty reduction targets. It is the most single important productive sector in most low-income countries in terms of its share of Gross Domestic Product (GDP) and of the number of people it employs [8]. A larger percentage of the poor people reside in rural areas and are dependent on the returns of agriculture to live a stable life. In Nigeria as the case in most Africa countries, agriculture plays a critical role in reducing poverty as over 40% of Nigeria's GDP comes from the agricultural sector while employing about 60% of the working population [13].

Agricultural production in any country requires an enabling environment to reach its maximum potential, and sustainable development in it, among other things, demands a peaceful co-habitation of producer communities. Agricultural operations such as crop production, animal husbandry, fishery, and forestry demand the use of land resources (land/soil and water). Land is a resource that has a primary consequence on any nation's economy. It is a highly symbolic and fundamental resource that has a special value in an African society and economy. It is a basic and productive resource to the African people and serves as a major avenue for survival for many, particularly the people in the rural communities of the South Western part of Nigeria [1]. Land and its associated resources provide the basic means of livelihood to members of these communities. As a result of the important role it plays in the life of the people in the developing world, there is a very complex relationship between an individual, a family and/or compound, a larger community on one hand, and land on the other hand which requires proper functioning. Smooth relationship of these units is basic to healthy inter-personal, intra- and inter family, and intra-and inter group stability, and for political stability and unhampered economic growth in the developing world. For a unique position land holds in the life of the people of Africa, it is increasingly becoming a major source of conflicts in Sub-Saharan region, where land access has traditionally been characterized as relatively egalitarian [16].

From the beginning of man creation, the land use by man was mainly for agriculture, and till now, agriculture is still the most important use to which land is put in West Africa sub-region. In the context of agricultural economics, agricultural land can be divided into land use for growing food crops or tree crops; land use for growing livestock food and for grazing livestock; land left fallow as part of the shifting agricultural system; and land use for forest reserves, where trees are grown for commercial purposes. Land possession means access to many other important resources like minerals, timber, and animals. These possessions give land a high economic value. Some communities do have symbolic and strong emotional attachments to a land including the resources on it. This clearly shows why a valuable land control is very competitive, including government regulation and authority that causes continuous conflicts. Traditionally, a lot of wars occurred over the ownership of land.

Currently in Nigeria, agricultural production is facing many constraints of which the problem of land tenure is a major one. Generally, the situation of land tenure in Africa has been described as conflict-ridden and confusing [5]. According to [4], limitations and constraints that relate to land tenure insecurity have been discouraging many Africans that want to invest in the agricultural sector. Achievement of food security and sustainable rural development in Africa in general and Nigeria in particular are closely tied to access and rights to land. Access and rights to land are the basic building blocks for the livelihood and sustenance of individuals, families and

communities, especially in agrarian societies. In other to achieve sustainable rural development and food security, access and rights to land must be given priority. Poverty increases as a result of insecure and limited access to land, which in turn has provided the ideal circumstances for conflicts [7]. Lack of assurance of rights to land over a long period of time and unequal land distribution hinder development in agriculture by limiting land access to many needy Africans. This condition has relegated many land users (particularly farmers) to the status of land tenants and therefore opening the door to conflict among people (landowners and tenant farmers). Although these problems exist in many parts of Africa in general and Nigeria in particular, the need for growth in agriculture, food security and poverty reduction requires that indigenous landowners in the country should embrace the reality of sharing their lands with the landless group for the betterment of all and sundry.

Land Tenure and Land Related Conflicts in Nigeria

The land tenure system in Nigeria is based on the Land Use Act (LUA) of 1978. LUA is the principal Nigerian land policy with regards to all land which was, to a great extent unified the laws relating to land in Nigeria. The Act reflects the idea that it is in the public interest that the rights of all Nigerians to the land of Nigeria be asserted and preserved by law. The decree's objectives are: to facilitate the rapid economic and social transformation of the country through a rationalization of land use, to enable state governments to bring about proper control and administration of land for the benefit of their people, to remove a main cause of social and economic inequality, and to provide an incentive to development by providing easy access to land for the state and the people. According to [10], the Land Use Act of 1978 was enacted to usher in a new land reform in the country that would promote greater access and rights to land for the benefits of Nigerians, the Act soon became a clog in the wheel of development over the years. The objectives of the decree remain largely unfulfilled several years after its enactment, and titles to land appear to be more insecure now than ever before. Consequently, land is less available to the ordinary Nigerian today than it was prior to the Decree, thereby relegating most citizens to an inevitable state of perpetual tenancy.

The promulgation of the national land policy as contained in the Land Use Act of 1978 brought disequilibrium into the former balance of rights and privileges enjoyed by landowners and tenants (as is the case between the Ife and the Modakeke). The Act also led to the non-recognition of indigenous bodies for conflict resolution in most agrarian communities in the country. It failed to recognize the continued existence of customary tenancy, both a key feature of customary land tenure and a *de facto* recognition of the ownership rights of landlords by the tenant farmers. The decree transferred landownership in Nigeria from the compound/family to the government without any regard for peculiar local circumstances that pattern the relationship between landowners and tenants in different communities. The resultant and seemingly unending conflicts that result from the failure of the Decree have negatively affected the performance of the agricultural sector in most parts of Nigeria, particularly in South-western Nigeria.

Inconsistency in the land tenure system in Nigeria has severally resulted into conflicts among land users and landowners in many parts of the country. According to [9], land related conflicts in Nigeria are the most evident social manifestations of land insecurity with its nature undefined. Some underlying factors, such as population pressure, agricultural commercialization, the introduction of Land Use Act of 1978 which led to the violation of land tenancy agreement between landowners and tenants, and urbanization helped to increase the number of conflicts arising on lands in several part of the country. These incessant land conflicts have led to several inter-group clashes where lives and properties have been lost and the benefits of peaceful cohabitation of agricultural communities being gradually eroded. Such conflicts are common in most parts of Northern Nigeria between the indigenous crop

farmers (landowner group) and nomadic pastoralists (landless group) over the competing use of land for cropping and grazing and between the indigenous landowners and migrant farmers (tenant farmers) in the Southwestern part of the country (e.g. conflicts between the Ife and the Modakeke) over land ownership rights. Conflicts between croppers and herders keep escalating in Sub-Saharan Africa where large-scale, medium and small conflicts have degenerated into serious violence. According to [3], one central aspect of the national question within the discourse in Nigeria concerns the conflicts and disputes historically driven by struggles over land-based resources. Unless this situation is urgently addressed, the national policy of government to diversify the economy of the country from that of oil dependent to agricultural dependent would be a mirage.

Conflicts between the Ife and the Modakeke

In Ife land, the Ife and the Modakeke communities have engaged in protracted intra-communal conflicts relating to land issues over a long period of time. [3] and [14] asserted that so far, there had been seven major wars between the Ifes and Modakekes, the first was between 1835-1849 while the last was in year 2000. The conflict between the two appears to be the oldest intra-ethic conflict in Nigeria. Since its first outbreak in 1835, there have been a number of causes which have overtime varied or consolidated and culminated into open violent conflict that has on a number of occasions pit both Yoruba sub-groups against one another. The causes are partly economic and partly political and identity issues revolving around landownership, non-payment of land rent (*isakole*), status of Modakeke community, local government creation and location of local government headquarters. The conflict however is depicted as a conflict between landowners (the Ife) and the tenants (the Modakeke). These land conflicts have negatively affected the economy of the two communities, particularly the agricultural communities under the geographical boundary of Ile-Ife. One important aspect of conflicts between the Ife and the Modakeke that is often overlooked is the issue of "non-recognition" of the landowners (the Ife) by the tenants (the Modakeke) as a result of the misinterpretation of the Land Use Act of 1978 (popularly known as Land Use Decree) with its ambiguities that both vested landownership in the government and at the same recognizes compound claim to landownership.

Although land conflicts appear to have pitched the two communities, a sizeable proportion of the population of the people still cohabit peacefully both in town and in the rural areas and they go about with their businesses without any form of molestation to the mutual benefits of the two sides. Factors that lead to the peaceful cohabitation of these two important groups in Ife land form the trust of this study. The landowners (the Ife) still share their agricultural lands with the tenants (the Modakeke) despite the long experiences of conflict. There has been limited research work in terms of agricultural land sharing between these groups of resource users after a protracted period of conflict, hence this study.

Acquisition of land by migrant farmers in South Western Nigeria.

The acquiring of land is one of the most important steps taken by a beginning farmer. The established farmer may have to add land to his farm business several times during his farming career. The way in which a land is acquired and its characteristics will shape many subsequent farming decisions. If the farmer decides to buy land, the price paid and the size of the mortgage will influence his capital position and hence the type of farming organization he can develop. If he decides to rent, the kind of leasing arrangement developed will affect the enterprises selected and the way his labor, capital, and management will be used. In Southwestern Nigeria, the common form of land acquisition by migrant farmers is a rental form which is commonly based on payment of rent to the landowners. This rental arrangement is found in Ife land, the study area. The rent is referred to as '*isakole*'. Agricultural land is not sold to migrant farmers in Southwestern Nigeria in general and in the study area in particular.

Objectives of the study

The broad objective of this study is to assess post conflict agricultural land sharing between the Ife and the Modakeke in Ife land. Specifically, the study describes the socioeconomic characteristics of the respondents, identifies the causes and outcomes of conflicts between the two parties in the past, examines conflict resolution methods adopted by the parties, evaluates the respondents' perceived benefits of LUA of 1978, and analyses the rental systems in the study area.

MATERIALS AND METHODS

Study Area

The study was conducted in six purposively selected agricultural communities under the geographical boundary of Ife land. Ife land is made up of four Local Government Areas (LGAs): Ife Central, Ife East, Ife South and Ife North. Two of these, Ife Central and Ife East are located within Ile-Ife Township. Ile-Ife is located between latitudes 7^0 28^1N and $7^0 45^1$N and longitudes $4^0 30^1$E and $4^0 34^1$. Ile-Ife is surrounded by rural settlements where agriculture is the major occupation.

The climate is tropical with a rainfall of about 1,600mm per year. The rainy season starts April through October while dry season lasts October to March. The soil in Ife land is rich in fertility and suitable for cultivation of tree/cash crops such as cocoa and kola-nut, palm tree. As a result of this, many non-indigenes (including people from Modakeke, Origbo, Ikirun, Iragbiji, and many more) have migrated to the area primarily for farming.

The selected communities for the study include Aba Olodo, Owa village in Ife Central LGA; Ajebamidele Omoniyi, Area 4, Ife South LGA; Esuyare village, Ife East LGA and Ajebamidele Fadehan, Area 4, Ife South LGA. These communities are populated by a large number of migrant farmers, including the Modakekes who migrated to the locations for the purpose of farming as major occupation. The Ife (landowners) either live in the villages or in town, but all of them have tenant farmers operating on their lands. The target population for the study includes only the Ife and Modakeke.

Sampling Techniques

In each community, 25 respondents (10 Ife household heads and 15 Modakeke household heads) were randomly selected for interview via questionnaire guides. The reason is that the number of tenants in each of the villages is usually more than double that of the landowners. In all, a total of 100 respondents were interviewed. To gather relevant information, other people interviewed include village heads/chiefs, landowners living in the villages, absentee landowners and tenants.

Before the commencement of the study, visits were made to the Aafin of the Ooni of Ife and the Aafin Ogunsua of Modakeke, compound heads (Baale and Bale) of notable compounds that own villages where tenants are accommodated, and periodic meetings of the selected farming communities to gather relevant information regarding the operation of tenancy agreement after the settlement of past land conflicts. The data collected were analyzed through the use of descriptive statistics and inferential statistics such as t-test of significance between two means.

RESULTS AND DISCUSSIONS

Socioeconomic Characteristics of the Respondents

Socioeconomic characteristics are important attributes of farmers. They help to shape the entrepreneurial abilities of farmers in rational decision making, particularly those relating to agricultural enterprises [6].

Results in Table 1 show that the respondents were predominantly male (90% landowners and 92% tenants). This is usually the picture of most agricultural communities in Africa. However, the very few female tenants in the study area reported that they hired laborers to work on their farm plots. The majority (79.6%) of the landowners were above age 60 years while the majority (72.6%) of the tenants were in between the age bracket (41-60). These age distributions imply that most of the landowners were relatively old while most of the tenants were relatively young and in their active years. Most of the tenant

farmers are the second generation of the original migrants. This was also the observation of [9].

Table 1. Socioeconomic Characteristics of the Respondents

Variable	Landowners	Tenants
	Percent	Percent
Sex		
Male	90.0	92.0
Female	10.0	18.0
Age (Years)		
41-50	8.0	28.2
51-60	12.4	44.4
61-70	27.4	18.2
>70	52.2	9.2
Mean	66	48
Farm Size (Ha)		
1-4	72.4	12.6
5-8	18.2	24.8
>9	9.4	62.6
Mean	3.8	6.2
Farming Experience (Years)		
1-10	24.6	12.4
11-20	36.2	24.8
>20	29.2	62.6
Primary Occupation		
Farming	32.2	98.0
Others	67.8	2.0
Household Size		
3-6	44.8	12.2
7-10	32.4	24.6
>10	22.8	63.2
Mean	4	8
Residency in the Area (Yrs)		
1-10	N/A	12.2
11-20	N/A	18.6
21-30	N/A	42.2
>30	N/A	27.0

Source: Field Survey, 2018.

The Table 1 further shows that the average farm size of the landowners is 3.4 ha have farm while the mean farm size of the tenants is 6.2 ha. This implies that the tenant farmers in the study area are medium-scale farmers while the landowners are small-scale farmers. This scenario equally suggests that the landowners rely on the periodic rents from their tenants, and hence the reason for them to keep lesser plot of farmlands. From the Table, the majority (98%) of the tenants were full-time farmers while only (32%) of the landowners were full-time farmers. This suggests that the tenant farmers in the study area would be more tolerable to live in peace with their hosts in order to keep the source of their livelihood. Though Focus Group Discussion, the researchers gathered that although the landowners cultivate cocoa, most of their farm plots are devoted to cultivation of food crops like maize, cassava, yam, cocoyam and vegetables. They also have their farm plots very close to the tenant farmers to monitor the performances of their cocoa farms with a view to ascertain payment of rent. Majority (63%) of the tenant farmers have large family sizes. In the traditional agricultural production, family labour plays a significant role in the farm labour supply. An average farmer first uses all sources of labour in his family before hiring labour in order to reduce the cost of production [11]. The Table further shows that majority (69%) of the tenant farmers have been resident in the study area for over twenty years. This implies that they are thoroughly integrated in the communities. Some of the respondent tenants claimed to have been born in the area while some claimed that they took over the management of their farm plots from their parents, but still recognize that the land belongs to their hosts (the Ife).

Causes of conflicts in the past

Although the Ife and the Modakeke had engaged in several communal conflicts for many years and for many reasons, the introduction of the Land Use Act of 1978 marked the beginning of another form of conflict that was primarily based on non-payment of rents by the migrant tenants (the Modakeke) to the landowners (the Ife). Before the introduction of the Land Use Act, there had been agreement and/or negotiation between the two communities over the use of agricultural lands. The negotiation was that the Modakeke farmers would be allowed to work the farmlands belonging to the Ife for agricultural purposes in return for regular payment of rents (*isakole*) payable to the individual landowners and landowning families/compounds. That agreement was in practice until the promulgation of the Land Use Act of 1978 when the Modakeke farmers operating on the farmlands belonging to the Ife decided to stop the payment of rent to their landlords as previously agreed by relying on

the premise of the decree that all land belongs to government. Between 1978 and 2000, there had been series of conflicts between the two communities which resulted into monumental loss of lives and properties. The major cause of these series of conflicts advanced by the respondents is non-payment of rents by the tenant farmers. Results from Table 2 show that majority of the two categories of the respondents (92% and 90%) claimed that non-payment of rents was the major cause of conflict. This finding is in consonant with the finding of [17] who opined that the strong resistance by the people of Ife to the Modakeke's ownership claims to their settlement and farmlands has been the major cause of the conflict between the two groups.

Table 2. Causes of conflicts in the past

Cause	Landowners	Tenants
	Percent	Percent
Non-payment of rent	92.0	90.0
Other reasons	8.0	10.0

Source: Field Survey, 2018.

Effects of conflicts

The year 2000 conflict between the Ife and the Modakeke was particularly intense with enormous negative effects that are still felt in the two communities till date. All the Modakeke farmers in the study area reported that their farm plots and buildings were destroyed during the conflict and they were completely displaced from the communities. The results are shown in Table 3. The results of this work are in consonant with the findings of [2]. However, some 34% of the landowners also reported that their farm plots and buildings were destroyed during the conflict. All the tenant farmers (the Modakeke) claimed that they were completely displaced from the villages.

Table 3. Effects of conflicts

Effects	**Landowners**	**Tenants**
	Percent	Percent
Destruction of farm plots and buildings	34.0	100.0
Displacement from farm land	0.0	100.0

Source: Field Survey, 2018.

Settlement/resolution of last conflict

In times of conflicts between the two communities, the Modakeke farmers who had worked the farmlands in Ife land were completely forbidden by the Ife from entering all the villages where conflicts had taken place. The conflicts of 1981, 1983, 1997 and 2000 were clear evidences of the breakdown of the indigenous institutions for conflict resolution due to the ambiguities in the Land Use Act of 1978. The decree vested landownership in the government and at the same recognizes compound claim to landownership. That development worsened the strain in the relationship between the two communities, eroded the benefits of mutual interaction and peaceful cohabitation of the affected agricultural communities. Indeed, the economy of the entire study area was badly affected.

However, with a view to revamping the economy of the area and restore the mutual relationship between the two communities, the researchers were informed that some prominent elders, chiefs and community leaders came together to find solution to the problem mitigating against the peaceful cohabitations of people of both sides in towns and villages of the affected areas. According to the people interviewed, efforts were made to renegotiate on the issue of agricultural land use by the Modakeke farmers based on regular payment of rents which was the bone of contention in all the fights. Renegotiation began from the palaces of the two communities with the involvement of community leaders, chiefs and Obas. Table 4 shows the means through which the misunderstandings/conflicts were resolved. All the respondents interviewed (both landowners and tenants) reported that they resolved their conflicts through community leaders interventions without recourse to any government courts.

Table 4. Conflict resolution method

Method	**Landowner**	**Tenant**
Settlement by community leaders	100.0	100.0
Govt. courts	0.0	0.0

Source: Field Survey, 2018.

Period of Hostility

Further enquiry was made to know the length of hostility between the two communities after the conflict of 2000 and the results are shown in Table 5. From the Table, majority (86% and 88%) of the two categories of respondents respectively reported that it took them a minimum of about four years before their differences were resolved. However, underground settlements were going on through connections of palace chiefs and community leaders in the two communities.

Table 5. Period of Hostility

Length of Time (Years)	Landowner	Tenant
	Percent	Percent
1 – 3	14.0	12.0
4 – 6	76.0	72.0
>6	10.0	16.0

Source: Field Survey, 2018.

Other interactions (social, economic and cultural) between the Ife and the Modakeke after the year 2000 conflict

Since the settlement of the year 2000 conflict between the Ife and the Modakeke, there have been further interactions (social, economic and cultural) among the people in the study area. From the people interviewed, intermarriages have taken place between the two communities since the coming together of the two groups. Before the conflict, intermarriage was a common social interaction between the Ife and the Modakeke. Almost all compounds in Ife have women from Modakeke as wives. The same is the case in almost all Modakeke compounds. Local traders and people from both sides now buy and sell in local markets in both Ife and Modakeke without any form of molestation. Also, people from Modakeke now freely participate in certain annual festivals (such as "Olojo, Edi, Odun Ifa") taking place in Ife while people from Ife freely go to watch "Egungun" festival in Modakeke

Respondent's perceived benefits of Land Use Act 1978

One of the reasons for promulgating the Land Use Act of 1978 is to make land easily accessible to farmers in all the parts of Nigeria. In view of this belief, the respondent landowner and tenant groups in the study area were asked to express their view of the benefits of the Act to the agricultural communities and the results are shown in Table 6. Majority (88% and 77%) of landowners and tenants respectively specified that the Land Use Act of 1978 is grossly not beneficial to the South-west agricultural communities. This finding is in line with the submission of [10]. According him, although the Land Use Act of 1978 was meant to usher in a new land reform in Nigeria, it soon became a clog in the wheel of development over the years.

Table 6. Benefits of Land Use Act 1978 to Agricultural Communities

Benefit	Landowners	Tenants
	Percent	Percent
Highly Beneficial	0.0	8.0
Fairly Beneficial	12.0	15.0
Not Beneficial	88.0	77.0

Source: Field Survey, 2018

Agricultural land sharing and rental regime in the Study Area

Two-rental regime arrangement exists between the Ife (landowners) and the migrant farmers, the Modakeke (tenants) over agricultural land sharing for agricultural purposes. The first regime starts from the first year a tenant is allotted plot of land mainly for farming purposes until the fifth year when the cultivated cash crop (usually cocoa) is matured to produce fruit. Cocoa is the most cash crop that forms the basis of rent in the study area. Other crops such as kola-nut, orange tree, cashew, and many others may be planted by the migrant farmers. Another important cash crop, palm trees in the study area are usually the wild groove which are assumed to have been planted by the landowners or their parents. In the first regime, a tenant farmer only pays a lump sum for a measured plot of land. The second regime begins after five years by which time the major cash crop (cocoa) is matured to yield fruit. These two regimes are still in operation, but with slight adjustment after the last communal conflict of year 2000. In the second regime, often a share of the crop or a fixed cash sum is paid as rent.

According to the respondents, a tenant farmer only paid ₦2,500/2ha to the landowner to gain access to land. After this once-and-for-all payment, a tenant would only be expected to be of good conduct in the community while doing his farming business. However, he could be generous by giving some proceeds from his farm plots such as cocoyam, plantain, sweet potato and other crops to his landlord with a view to smoothing the relationship.

Land rental before conflict

The results of the second regime of rental system before conflict are shown in Table 7. The majority (66.4%) of the respondents reported that payment for the use of land was in crop while only (33.6%) payment was in cash. Cash rent has certain advantages and disadvantages both to the landlord and the tenant. Paying cash for land rent represents a fixed cost to the tenant which he must meet regardless of the yield or the price of his crop. The tenant therefore bears the risk of these fluctuations. The owner may, because of his guaranteed income, be willing to accept a lower rent than he would if he were receiving a share of the crop and bearing more risk. The tenant who pays cash rent usually has more freedom in making farm management decisions than the crop share renter. The rent is fixed in advance in the form of verbal agreement between landlord and tenant. This method of rent payment is mutually beneficial for both landlord and tenant. Payment is made on an annual basis. The system of payment of cash for land in the study area before the conflict was that a tenant paid ₦2,000/ha/year. The crop share lease was the predominant type of lease in the study area from the tenant's stand point its major advantage is that he does not bear the entire risk of price and yield fluctuations. This suggests its main advantage and disadvantage to the owner. It permits him to share in any extremely good years that occur, but he must also bear some of the risk. This was also the findings of Robertson (1987) and Alarima *et al*., (2012). Because he shares in the product, the owner usually has something to say about the management of the farm. He may be unwilling to permit the planting of some crops or the use of certain chemicals unless they will eventually result in more harvest or unless he receives cash rent in addition to his share of the crop. The volume of the crop accepted as rent was some 10% of the total annual yield from the planted field. To ascertain the total annual yield, the landowners were usually very frequent in the village during the period of harvest. This is for the purpose of monitoring of the tenants with a view to know the performance of the planted field. The option for crop as rent is based on the fact that high prices are usually anticipated for cocoa in the international market. In times of favorable prices in the international market, the landowners benefit. The tenancy agreement is usually verbal and the tenancy could be altered to suit the parties involved or completely revoked should the tenant fail to fulfill his/her obligation. Before the terrible conflict of year 2000, the duration of the agreement ranges from 5 to 20 years, but payment is made on an annual basis.

Table 7: Rental system before conflict

Type of Rent	%	Cost	Contract	Tenancy
Cash	33.6	₦2,000/ 1 ha/year	Verbal	Revocable
Crop (cocoa)	66.4	10% of total annual yield	-ditto-	-ditto-

Source: Field Survey, 2018.

Land rental after conflict

The results of the land rental after the last conflict of year 2000 between the Ife and the Modakeke are shown in Table 8. Majority (72.2%) of the rental agreements are under the payment of crop as rent. In this payment pattern, a tenant farmer pays 20% of the total annual yield of his cocoa to the landowner as against 10% of the annual yield of cocoa in the period before the conflict. A landowner would go for this arrangement because of the usual high price anticipated for cocoa in the international market. Both the landlord and the tenant share both the benefits and risks involved in the use of the land. This finding is in consonant with the finding of Robertson (1987). From the same Table, 27.8% of the rental agreement is under the payment of cash

only as rent. Under this arrangement, a tenant farmer will pay ₦5,000/ha/year to the landlord for the use of his land as against ₦2,000/ha/year in the period before conflict. Rent is usually fixed in advance in contractual written form between the landlord and tenant as against the verbal agreement in the period before conflict. Under the two forms of arrangements, both landowners and tenants benefit because there is peace in the farming communities and everybody can move freely to go about his business. The period of agreement after the conflict is between 5 to 10 years.

Table 8. Second Rental System after conflict

Type of Rent	%	Cost	Contract	Tenancy
Cash	27.8	₦5,000/ 1 ha/year	Written	Revocable
Crop (cocoa)	72.2	20% of total annual yield	-ditto-	-ditto-

Source: Field Survey, 2018.

The result of this finding suggests that the recent land rent system (*isakole*) in the affected agricultural communities is based on two important considerations:
(i) the landowners' sensitivity to the tenant farmers' eagerness to have access to land and their willingness to pay any cost to keep the land, and
(ii) local knowledge of land supply/demand interactions over time and experiences with the production cost and return structure among the people in Ife land. These considerations are germane and aftermath of several land conflicts between the Ife and Modakeke.

CONCLUSIONS

Although land related conflicts had separated the people Ife and Modakeke for a time, some proportions of the population of the two communities who had lived and worked together in some villages have returned to their old ways of mutual and peaceful cohabitation as is found in the study area. The major findings of this study are one, the major cause of conflicts between the two communities is non-payment of land rent (*isakole*) by the tenants (the Modakeke farmers) to the landowners (the Ife people); two, land related conflicts between the two sets of people were resolved/settled through the efforts of community leaders from the two sides without a recourse to government courts; three, the respondents believed that the Land Use Act of 1978 is thoroughly non-beneficial to the agrarian communities in the South Western Nigeria; four, there is reduction in the tenancy agreement between the landowners and tenants from between 5 to 20 years to between 5 to 10 years; and five, there is a general preference for payment of land rent by cash crop as against payment by cash. The results of the study can therefore be used in agricultural policy formulation aiming at enhancing rights and access to land by the Nigerian existing and prospective farmers through amendment of the Nigeria land policy (Land Use Act of 1978).
The Federal government is hereby advised to give room for the recognition of landowners (individuals and family/compound) in the LUA that will allow them have little claims over the usage of land in their possession. This will reduce tension and conflicts between landowners and migrant farmers over payment of land rents. The Federal government should, as a matter of urgency, call for a national conference to address the anomalies in the LUA of 1978 in order to prevent incessant conflicts between landowners and migrant farmers (existing and prospective) and to be able to make land accessible to users for agricultural purposes in all parts of the country.
Since the study area is just a part of the large expanse of agricultural land in Ife, other inhabitants in the two communities who are landowners and tenants should learn from the experience of the people in the study area. The respondents have come together by settling their conflicts through the help of community leaders. Such experience can be copied in other villages and farm communities in Ife. Aside from restoring peace in the community, there will be general improvement in agricultural production in the whole area.

Rental payment before and after conflict was majorly based on payment by crop. The commonly planted cash crop is cocoa in the study area which is a permanent crop. This is a form of contradiction in the rental arrangement because the landowners have complete rights over their land. The rental agreement can be revoked at will by the landlord at any time. This puts the tenants at disadvantage. This calls for a new round of institutional arrangement to ensuring more secure rights and longer tenancies on land for tenants particularly where permanent crops are planted, and which would allow for growth and investment in land.

REFERENCES

[1]Adedeji, A,. Ayo B., 2000, People-Centered Democracy in Nigeria: The Search for Alternative Systems of Governance at the Grassroots. Ibadan: Heinemann Educational Books (Nigeria) Pic.

[2]Adegbite, A., A., Balogun, B., O., Buba, F., N., 2016, Impact of Ife-Modakeke Intra-Communal Conflicts on Spatial Realignment of Ile-Ife City. Global Journal of Science Frontier Research. 1(2), 4-12.

[3]Asiyanbola, A.R. (2007). "Urban-ethno Communal Conflict in Africa: Nigeria", A paper submitted for presentation at the Union for African Population Studies (UAPS) Fifth African Population Conference, Arusha, Tazania, 10 -14.

[4]CAPRI, 2005, Land Rights for African Development from Knowledge to Action, http://www.the-eis.com/data/literature/Land%20rights%20for%20African%20development%20from%20knowledge%20to%20action.pdf, Accessed on 20th September, 2019.

[5]Hart, K., 1982, The Political Economy of West African Agriculture. Cambridge University Press, Cambridge

[6]Haruna, U., Garba, M., Nasiru, M., Sani, M. H., 2010, Economics of Sweet Potato Production in Toro Local Government Area of Bauchi State, Nigeria. In Proceedings of 11th Annual National Conference of National Association of Agricultural Economists (NAAE).

[7]Huggins, C., Pottierl, J., 2011, Land Tenure, Land Reform and Conflict in Sub-Saharan Africa: Towards a Research Agenda. http://www.iss.co.za/pubs/Books/GroundUp/Conclu.pdf, Accessed on December 22nd 2011.

[8]IDA (International Development Association), 2009, Agriculture: An Engine for Growth and Poverty Reduction. http://www.worldbank.org/ida, Accessed on 20th October, 2016.

[9]Idowu, E. O., 2006, Land conflict management under a tree cropping system: The case of theobroma cacao in South-Western Nigeria. Journal of Conflict Resolution, 8: 143–158.

[10]Mabogunje, A. L., 2010, Land reform in Nigeria: progress, problems and prospects. In Annual Conference on Land Policy and Administration, World Bank.

[11]Muhammad-Lawal, A., Omotesho, O. A., Falola, A., 2009, Technical Efficiency of youth participation in agriculture: A Case Study of the Youth-in- Agriculture Programme in Ondo State, Southwestern Nigeria. Nigerian Journal of Agriculture, Food and Environment, 5(1):20-26.

[12]Myrdal, G., 1984, International inequality and foreign aid in retrospect. Pioneers in development, 151-165

[13]Nwafor, M., Ehor, E. C., Chukwu, O. J., Amuka J. I., 2011, Cost-Effective Agriculture Growth Options for Poverty Reduction in Nigeria: Evidence and Policy Implications. AIAE Research Paper 6. African Institute for Applied Economics, Enugu.

[14]Olayiwola, S., Okorie, N., 2010, Integrated education: An instrument for resolving Ife-Modakeke conflict in Osun state, Nigeria. Journal of Alternative Perspectives in the Social Sciences, 2(2), 953-965.

[15]Undp, A., 2012, Africa Human Development Report 2012 Towards a Food Secure Future. United Nations Development Programme (UNDP).

[16]Yamano, T., Deininger, K., 2005, Land conflicts in Kenya: causes, impacts, and resolutions. Foundation for Advanced Studies on International Development/National Graduate Institute for Policy Studies. The World Bank, 28.

[17]Ekpeyong, E. O., 2011, The Social and Political Roots of Conflict in Nigeria: The Role of the Church. American Journal of Social Issues and Humanities. 1(2): 117-136.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

MANAGEMENT OF *HIBISCUS ROSA SIENSIS* L. PROPAGATION BY OPTIMIZING THE GROWTH SUBSTRATES AND BIOSTIMULATORS COMBINATION

Maria BĂLA[1], Florin SALA[2]

[1]Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Horticulture, Timișoara, 300645, Romania; Email: mariabalamonicabala@yahoo.com
[2]Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Soil Science and Plant Nutrition, Timișoara, 300645, Romania; Email: florin_sala@usab-tm.ro

Corresponding author: florin_sala@usab-tm.ro

Abstract

The aim of the study was to evaluate the influence of biostimulators and growth substrates on rooting of cuttings, in order to improve the vegetative propagation through cuttings in Hibiscus rosa sinensis L.. Three varieties of Hibiscus (red flowers - R, yellow flowers - Y, and orange flowers - O), two growth biostimulators (Radistim - R, and Atonic - A) and four rooting substrates were used (sand - S1, sand:perlite - S2, sand:peat - S3, sand:peat: perlite - S4). From the combination of the three variables (biological material, biostimulators, and rooting substrates) resulted in 24 experimental variants. Cluster analysis facilitated for each studied hibiscus genotype obtaining a dendrogram in statistical safety conditions, depending on the favorable response given in quality indices of vegetative propagation, as rooting and root length. In the case of the red hibiscus variety, there was a high affinity between R.S2.R (LSD0.5%) and R.S4.A (LSD5%), and between R.S3.R (LSD5%) and R.S3.A (LSD5%) variants, under conditions of Coph.corr = 0.899. In the case of the yellow hibiscus variety, a high affinity was found between Y.S4.R (LSD5%) and Y.S4.A (0.1%), and between Y.S2.R (LSD0.5%) and Y.S2.A (LSD5%) variants, in conditions of Coph.corr = 0.809. In the case of the orange hibiscus variety, there was a high affinity between O.S4.R (LSD0.5%) and O.S4.A (0.5%), respectively between O.S2.R ad O.S2.A (LSD0.5%) variants, under conditions of Coph.corr = 0.859. By PCA analisys, PC1 explained 76.122% of variance and PC2 explained 23.878% of variance, and was obtained a distribution chart and a breakdown of variants in relation to the quality indices of the rooting process.

Key words**:** *biostimulator, cluster analysis, hibiscus, PCA, vegetative propagation*

INTRODUCTION

The species *Hibiscus rosa sinensis* L. belongs to the genus *Hibiscus* L., Family Malvaceae, order Malvales. It is a perennial species and grows widely as a shrub in tropical areas and warm climate [31]. Taxonomy studies [6] and recent genomic sequencing studies in Hibiscus have aimed to clarify of some phylogenetic discrepancies, and have also evaluated the genetic diversity and variability of different cultivars in relation to their importance [26], [1].

Due to its high content of substances and active principles (alkaloids, anthraquinones, carbohydrates, cardiac glycosides, essential oils, flavanoides, free amino acids, mucilage, protein, phenols, quinines, reducing sugars, saponins, steroids, tannins, terpenoids), *Hibiscus rosa sinensis* L. are multiple pharmaceutical and medicinal uses [49], [5], [32, 35]. Red-flowered hibiscus varieties are most commonly used in the medical and pharmaceutical fields, due to the high content of active principles contained therein [25], [33], [7].

Based on the antioxidant, antibacterial properties, the content of pigments and minerals in flowers, but also of some important active principles in the herb, hibiscus has found utility and in the food industry for different functional foods [42], [31], [12]. Different cultivars have been studied in relation to biomass active principles content, the antioxidant capacity [50], and *H. rosa sinensis* flowers are used in some areas for the treatment of diabetes; some studies has evaluated the potential for secondary,

toxicological effects [3].

Hibiscus rosa sinensis L. occupies an important position within the species of ornamental plants, being studied in relation to the area and the pedo-climatic conditions. Various studies and researches have evaluated horticultural characteristics as ornamental and functional role, and also studied different Hibiscus cultivated genotypes, and their growing conditions [28], [30], [36], [54].

Anatomical and morphological studies were performed on numerous spontaneous and cultivated genotypes for the characterization and evaluation of diversity in Hibiscus [2], [40], [17], [51].

Studies on the plant leaves have been performed in different species in relation to the nutrients, the chlorophyll content and the quantitative and qualitative modeling of the useful biomass [23], [41], the leaf surface and models for its determination [44], [15], classification of genotypes based on the fractal geometry of the leaves [46], or to determining the degree of attack at foliar level of some pathogens [16]. Such researches can also be adapted and extended to Hibiscus.

Various factors have been studied and tested to stimulate propagation, in relation to the species, the base material, the propagation methods and techniques, such as: magnetic nanoparticles treatments [43], mechanical r chemical scarification [13], [18], stimulation by microwave or electromagnetic field [4], [52], ultrasound treatments [27], and bio-stimulatory substances [34], [56].

Propagation of hibiscus genotypes, as ornamental plants, has been approached by different methods, vegetative, generative, germination of pollen in vitro, but more common is the vegetative method [29], [47]. Some research has focused on the evaluation of the quality of the biological material source (cuttings) and of biostimulatory substances or rooting media in the vegetative propagation in Hibiscus [48], [22].

Even though most studies have aimed at optimizing cereal production and the agri-food market [14], [20], [21], [45], [11], [37], [38], [39], the market of the ornamental plant is just as important in the economic balance of a country [9], [53], [57], [24].

In the presented context, this study evaluated the influence of biostimulators and rooting substrates on vegetative propagation in *Hibiscus rosa sinensis* L.

MATERIALS AND METHODS

The objective of the study was to optimize the combination of biological material, growth biostimulators and rooting substrate for vegetative propagation in *Hibiscus rosa sinensis* L.

Three varieties of *Hibiscus rosa sinensis* L. (H.rs) were used: red - R, yellow - Y, and orange - O (R, Y and O symbols are used in experimental variant codes). Substrates for rooting were represented by: sand, as substrate 1 – S1; sand:perlite as substrate 2 – S2; sand:peat, as substrate 3 – S3; sand:peat:perlite, as substrate 4 – S4, (S1, S2, S3 and S4 symbols are used in experimental variant codes). Two biostimulators were used to treat cuttings for rooting stimulation, Radistim - R, and Atonik - A (R and A symbols were used for experimental variant code).

From the combination of the three varieties of hibiscus (R, Y, O), four rooting substrates (S1, S2, S3 and S4) and two biostimulators (R and A) resulted 24 experimental variants: R.S1.R; R.S2.R; R.S3.R; R.S4.R; R.S1.A; R.S2.A; R.S3.A; R.S4.A; Y.S1.R; Y.S2.R; Y.S3.R; Y.S4.R; Y.S1.A; Y.S2.A; Y.S3.A; Y.S4.A; O.S1.R; O.S2.R; O.S3.R; O.S4.R; O.S1.A; O.S2.A; O.S3.A; O.S4.A.

The degree of rooting of the cuttings and the length of the roots in the rooted cuttings were evaluated, under the influence of biostimulators and of the rooting and growth substrate. The experimental data set was analyzed by analysis of variance, cluster analysis and PCA [19].

RESULTS AND DISCUSSIONS

Radistim and Atonic biostimulators, and rooting substrates (S1, S2, S3 and S4) differentially influenced the rooting of cuttings in the three varieties of *Hibiscus rosa sinensis* L., Tables 1 - 6.

For *Hibiscus rosa sinensis* L., red variety,

positive results were obtained, with statistically significant differences for R.S2.R (LSD0.5%), R.S4.A (LSD5%) for rooting cuttings, and R.S3.R (LSD5%), respectively R.S3.A (LSD5%) and R.S4.A (LSD5%) for the root length, the results being presented in tables 1 and 2.

Table 1. Effect of rooting substrates, Radistim and Atonic biostimulators on the rooting at *Hybiscus rosa sinensis* L., red variety

Experimental variants	Mean values	Relative values (%)	Differences and significance
R.S1.R	5.66	74.72	-1.91
R.S2.R	11.33	149.45	3.75**
R.S3.R	3.66	48.35	-3.91^{00}
R.S4.R	9.66	127.47	2.08
Average of experience	7.58	100.00	-
LSD values	$LSD_{5\%}$=2.53; $LSD_{1\%}$=3.69; $LSD_{0.1\%}$=5.54		
R.S1.A	5.66	64.76	-3.08
R.S2.A	11.00	125.71	2.25
R.S3.A	5.66	64.76	-3.08
R.S4.A	12.66	144.76	3.91*
Average of experience	8.75	100.00	-
LSD values	$LSD_{5\%}$=3.36; $LSD_{1\%}$=4.89; $LSD_{0.1\%}$=7.34		

Source: original data, the 2018 experiment.

Table 2. Effect of rooting substrates, Radistim and Atonic biostimulators on root length at *Hybiscus rosa sinensis* L., red variety

Experimental variants	Mean values	Relative values (%)	Differences and significance
R.S1.R	16.60	89.83	-1.88
R.S2.R	17.00	91.99	-1.48
R.S3.R	21.00	113.64	2.52*
R.S4.R	19.33	104.60	0.85
Average of experience	18.48	100.00	-
LSD values	$LSD_{5\%}$=2.47; $LSD_{1\%}$=3.43; $LSD_{0.1\%}$=5.49		
R.S1.A	7.33	48.67	-7.73^{000}
R.S2.A	14.33	95.15	-0.73
R.S3.A	19.60	130.14	4.54*
R.S4.A	19.00	126.16	3.94*
Average of experience	15.06	100.00	-
LSD values	$LSD_{5\%}$=3.69; $LSD_{1\%}$=4.82; $LSD_{0.1\%}$=6.28		

Source: original data, the 2018 experiment.

Cluster analysis of the experimental data set regarding rooting of the cuttings and the root length, of the red variety of *Hibiscus rosa sinensis*, led to the grouping of variants into two distinct clusters, under statistical safety conditions (Coph.corr = 0.899), as presented in Fig.1.

There was a high affinity between the variants R.S2.R with R.S4.A, respectively R.S3.R with R.S3.A, and on the separate position was placed the variant R.S1.A, with the lowest values for evaluated parameters.

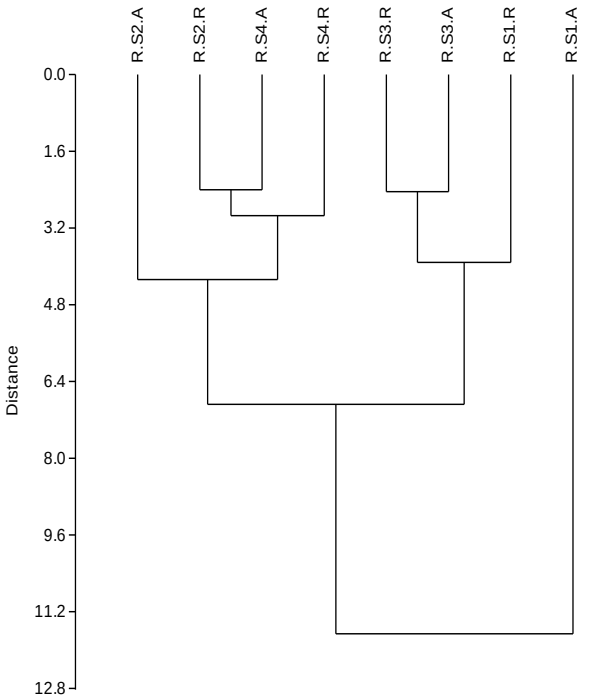

Fig. 1. Clustering of variants in the case of *Hibiscus rosa sinensis* L. - red variety
Source: original graph, based on own experimental data.

Table 3. Effect of rooting substrates and Radistim and Atonic biostimulators on the rooting at *Hybiscus rosa sinensis* L., yellow variety

Experimental variants	Mean values	Relative values (%)	Differences and significance
Y.S1.R	7.00	83.16	-1.41
Y.S2.R	11.33	134.65	2.92**
Y.S3.R	4.33	51.48	-4.08^{00}
Y.S4.R	11.00	130.69	2.59*
Average of experience	8.41	100.00	-
LSD values	$DL_{5\%}$=1.96; $DL_{1\%}$=2.85; $DL_{0.1\%}$=4.28		
Y.S1.A	6.00	59.01	-4.36^{0}
Y.S2.A	13.66	134.42	3.5*
Y.S3.A	10.00	98.36	-0.16
Y.S4.A	11.00	108.19	0.83
Average of experience	10.16	100.00	-
LSD values	$LSD_{5\%}$=2.92; $LSD_{1\%}$=4.28; $LSD_{0.1\%}$=6.42		

Source: original data, the 2018 experiment.

In the case of *H. rosa sinensis*, yellow variety, positive results were obtained, with statistically significant differences for variants

Y.S2.R (LSD0.5%), Y.S4.R (LSD5%) and Y.S2.A (LSD5%) for rootings, and Y.S4.R (LSD5%), respectively Y.S4.A (LSD0.1%) for root length (Tables 3 and 4).

Table 4. Effect of rooting substrates, Radistim and Atonic biostimulators on root length at *Hybiscus rosa sinensis* L., yellow variety

Experimental variants	Mean values	Relative values (%)	Differences and significance
Y.S1.R	5.33	63.98	-3.00
Y.S2.R	7.33	87.99	-1.00
Y.S3.R	9.00	108.04	0.67
Y.S4.R	11.66	139.97	3.33*
Average of experience	8.33	100.00	-
LSD values	$LSD_{5\%}$=3.11; $LSD_{1\%}$=4.53; $LSD_{0.1\%}$=6.79		
Y.S1.A	4.66	58.94	-3.25^{0}
Y.S2.A	9.33	117.89	1.41
Y.S3.A	4.33	54.73	-3.58^{00}
Y.S4.A	13.33	168.42	5.41***
Average of experience	7.91	100.00	-
LSD values	$LSD_{5\%}$=2.31; $LSD_{1\%}$=3.36; $LSD_{0.1\%}$=5.04		

Source: original data, the 2018 experiment.

Cluster analysis led to the grouping of variants, based on Euclidean distances, under statistical safety conditions, Coph.corr = 0.809, (Fig. 2).

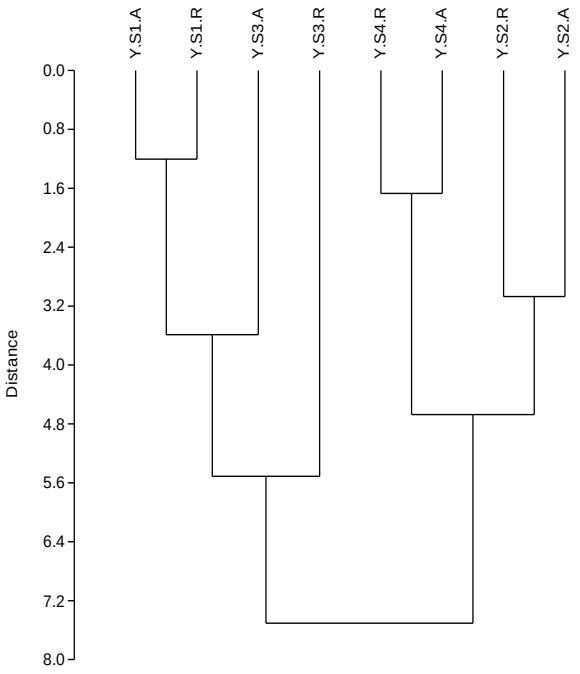

Fig. 2. Clustering of variants in the case of *Hibiscus rosa sinensis* L., yellow variety
Source: original graph, based on own experimental data.

From the analysis of the formed clusters, we found a high affinity between the variants Y.S4.R and Y.S4.A, respectively YS2R and Y.S2.A, with favorable results, and between Y.S1.R and Y.S1.A variants, with low results.
In the case of *H. rosa sinensis*, the orange variety, positive results were obtained, with statistically significant differences for O.S4.R (LSD0.5%), O.S4.A (LSD0.5%) for rootings, and O.S4.R (LSD0.5%), respectively O.S2.A (LSD0.5%) and O.S4.A (LSD0.5%) for root length (Tables 5 and 6).

Table 5. Effect of rooting substrates and Radistim and Atonic biostimulators on the rooting at *Hybiscus rosa sinensis* L., orange variety

Experimental variants	Mean values	Relative values (%)	Differences and significance
O.S1.R.	9.66	119.58	1.58
O.S2.R	4.66	57.73	-3.41^{0}
O.S3.R	5.33	65.97	-2.75^{0}
O.S4.R	12.66	156.70	4.58**
Average of experience	8.08	100.00	-
LSD values	$DL_{5\%}$=2.49; $DL_{1\%}$=3.62; $DL_{0.1\%}$=5.44		
O.S1.A	8.00	101.05	0.09
O.S2.A	4.66	58.94	-3.25^{0}
O.S3.A	6.33	80.00	-1.58
O.S4.A	12.66	160.00	4.75**
Average of experience	7.91	100.00	-
LSD values	$LSD_{5\%}$=2.43; $LSD_{1\%}$=3.54; $LSD_{0.1\%}$=5.31		

Source: original data, the 2018 experiment.

Table 6. Effect of rooting substrates, Radistim and Atonic biostimulators on root length at *Hybiscus rosa sinensis* L., orange variety

Experimental variants	Mean values	Relative values (%)	Differences and significance
O.S1.R.	6.00	75.00	-2.25
O.S2.R	10.66	125.00	2.41
O.S3.R	3.33	41.66	-4.92^{00}
O.S4.R	12.99	158.33	4.74**
Average of experience	8.25	100.00	-
LSD values	$LSD_{5\%}$=3.18; $LSD_{1\%}$=4.63; $LSD_{0.1\%}$=6.95		
O.S1.A	4.66	45.82	-5.51^{00}
O.S2.A	15.63	153.69	5.46**
O.S3.A	5.33	52.41	-4.84^{0}
O.S4.A	15.06	148.08	4.89**
Average of experience	10.17	100.00	-
LSD values	$LSD_{5\%}$=3.32; $LSD_{1\%}$=4.85; $LSD_{0.1\%}$=7.25		

Source: original data, the 2018 experiment.

Cluster analysis led to the grouping of variants based on Euclidean distances into two distinct clusters, each with several sub-clusters, under statistical safety conditions, Coph.corr = 0.859 (Fig. 3). From the analysis of the formed clusters, it was found a high affinity between the variants O.S4.R with O.S4.A, and O.S2.R with O.S2.A, in conditions of favorable results, respectively O.S1.A with O.S3.A, to which O.S3.R and O.S1.R are affiliated, with weaker results.

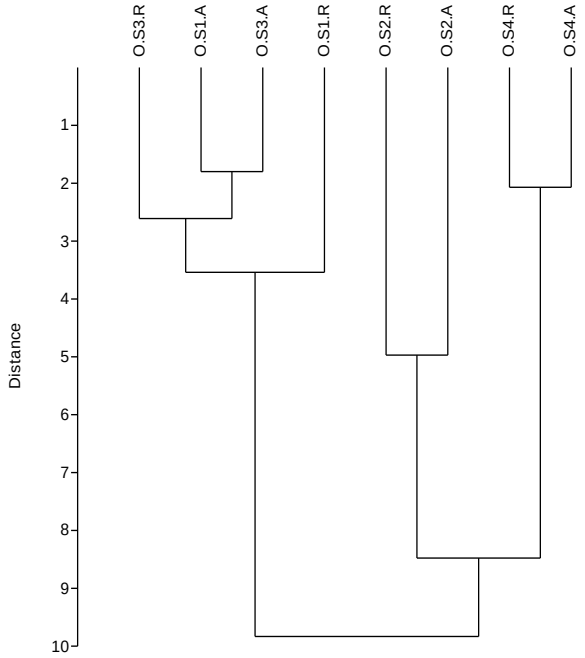

Fig. 3. Clustering of variants in the case of *Hibiscus rosa sinensis* – orange variety
Source: original graph, based on own experimental data.

PCA test, over the entire experimental data set, led to the graphical distribution in Figure 4. PC1 explained 76.122% of variance, and PC2 explained 23.878% of variance.
From the analysis of the distribution of variants in relation to biplots Rooting and Root length, it was found that the grouping of variants with respect to the response given from the combination of biological material x biostimulator x substrate.
Wang and Andersen (1989) [55] identified a number of interdependence relationships between seedlings, their age, treatment with bioregulatory substances and rooting environment in *Hibiscus rosa sinensis* L. Shadparvar et al. (2011) [48] found the favorable influence of higher concentrations of IBA (Indole Butyric Acid), in the range 0 - 4,000 mg l^{-1} tested, on the vegetative propagation through cuttings in *Hibiscus rosa sinensis* 'yellow double hybrid' variety. They evaluated the callus time of cuttings, beginning of rooting, and percentage of rooting, number of root at cuttings, root length and number of buds, in relation to IBA concentrations.

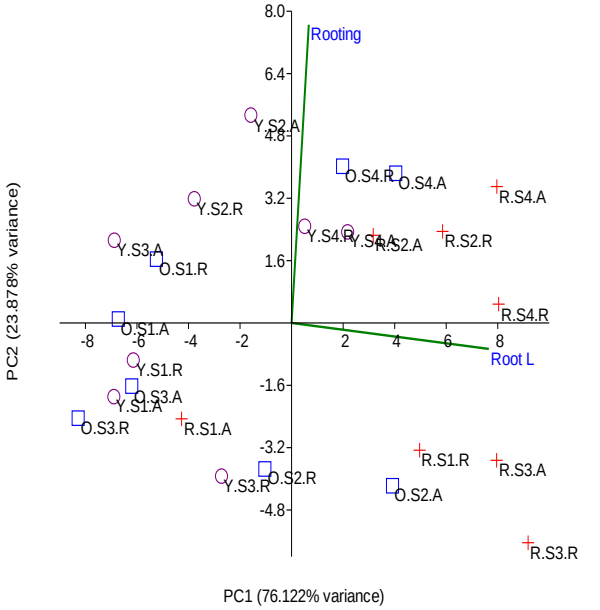

Fig. 4. PCA - grouping of variants as a result of the interaction [genotype x biostimulator x substrate]; R – root, Y – yellow, O – orange; S1, S2, S3, S4 – substrates; R, A – biostimulators
Source: original graph, based on own experimental data.

Baldotto et al. (2012) [8] reported favorable results on the propagation by cuttings in Hibiscus using the biostimulators IBA (indolbutyric acid) and HA (humic acid). Similar results were reported by Izadi and Zarei (2014) [22] in Hibiscus, 'Blue Stain' and 'Jeanne d'Arc' cultivars, in which high concentrations of IBA had favorable effects on vegetative propagation through seedlings. Chowdhuri et al. (2017) [10] reported favorable results by testing three root and growth biostimulators (IAA, IBA, NAA) in *Hibiscus rosa sinensis*, China rose.
The objectives of the present study are in the context of the research and studies to which it was referred. The results were obtained by using biostimulatory substances, accessible to

flower producers, Hibiscus species, in conditions of statistical certainty of the differences identified between the experimental variants.

CONCLUSIONS

The independent variables used, such as growth biostimulators (Radistim, Atonic) and rooting media (sand, sand:perlite, sand:peat, sand:peat:perlite) differentially influenced the vegetative propagation, through cuttings, in *Hibiscus rosa sinensis* L., varieties red, yellow, and orange.

Cluster analysis and PCA led to obtaining cluster groups and PCA distribution, under statistical safety conditions, based on which the best variants for obtaining vigorous plants were found, in order to optimize vegetative propagation in Hibiscus.

ACKNOWLEDGMENTS

The authors thank to the staff of the Didactic and Research Base of the Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Romania to facilitate this research.

REFERENCES

[1]Abdullah, Mehmood, F., Shahzadi, I., Waseem, S., Mirza, B., Ahmed, I., Waheed, M.T., 2020, Chloroplast genome of *Hibiscus rosa-sinensis* (Malvaceae): Comparative analyses and identification of mutational hotspots, Genomics, 112(1):581-591.

[2]Adedeji, O., Illoh, H.C., 2004, Comparative foliar anatomy of ten species in the genus Hibiscus Linn. in Nigeria, New Bot., 31:47-180.

[3]Afiune, L.A.F., Leal-Silva, T., Sinzato, Y.K., Moraes-Souza, R.Q., Soares, T.S., Campos, K.E., Fujiwara, R.T., Herrera, E., Damasceno, D.C., Volpato, G.T., 2017, Beneficial effects of *Hibiscus rosa-sinensis* L. flower aqueous extract in pregnant rats with diabetes. PLoS ONE, 12(6):e0179785.

[4]Afzal, I., Mukhtar, K., Qasim, M., Basra, S., Shahid, M., Haq, Z., 2012, Magnetic stimulation of marigold seed. Int. Agrophys., 26(4):335-339.

[5]Al-Snafi, A.E., 2018, Chemical constituents, pharmacological effects and therapeutic importance of Hibiscus rosa-sinensis - A review, IOSR J. Pharm., 8(7):101-119.

[6]Ayanbamiji, T.A., Ogundipe, O.T., Olowokudejo, J.D., 2012, Taxonomic significance of the epicalix in the genus Hibiscus (Malvaceae), Phytol. Balc., 18(2):135-140.

[7]Bahuguna, A., Vijayalaxmi, K.G., Suvarna, V.C., 2018, Formulation and evaluation of fresh red Hawaiian hibiscus (*Hibiscus rosa-sinensis*) incorporated valued added products Int. J. Curr. Microbiol. App. Sci., 7(8):4282-4290.

[8]Baldotto, L.E.B., Baldotto, M.A., Soares, R.R., Martinez, H.E.P., Venegas, V.H.A., 2012, Adventitious rooting in cuttings of croton and hibiscus in response to indolbutyric acid and humic acid, Rev. Ceres, 59(4):476-483.

[9]Çelik, Y., Arisoy, H., 2013, Competitive analysis of outdoor ornamental plants sector: A case study of Konya Province, Turkey, J. Hort. Res., 21(2):5-16.

[10] Chowdhuri, T.K., Sadhukhan, R., Mondal, T., Das, S., 2017, Effect of different growth regulators on propagation of China rose (*Hibiscus rosa-sinensis*) in Subtropical zone of West Bengal, Int. J. Dev. Res., 07(09):1512215125.

[11] Cimpoies, L., Coser, C., 2017. Intra-industry trade in agricultural and food products: the case of Moldova, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 17(2):43-50.

[12]Dahiya, B., Kaur, P., 2019, Nutritional and therapeutic uses of Hibiscus Rosasinensis, Int. J. Food Sci. Nutr., 4(5):94-98.

[13]Dewir, Y.H., El-Mahrouk, M.E., Noidoo, Y., 2011, Effects of some mechanical and chemical treatments on seed germination of *Sabal palmetto* and *Thrinax morrisii* palms, Aust. J. Crop Sci., 5(3):248-253.

[14]Dobrei, A., Poiana, M.A., Sala, F., Ghita, A., Gergen, I., 2010, Changes in the chromatic properties of red vines from *Vitis vinifera* L. cv. Merlot and Pinot Noir during the course of aging in bottle, J. Food, Agri. Environ., 8(2): 20-24.

[15]Drienovsky, R., Nicolin, A.L., Rujescu, C., Sala, F., 2017a, Scan LeafArea – A software application used in the determination of the foliar surface of plants, Res. J. Agric. Sci., 49(4):215-224.

[16]Drienovsky, R., Nicolin, A.L., Rujescu, C., Sala, F., 2017b, Scan Sick & Healthy Leaf – A software application for the determination of the degree of the leaves attack, Res. J. Agric. Sci., 49(4):225-233.

[17]Essiett, U.A., Iwok, E.S., 2014, Floral and leaf anatomy of Hibiscus species, Am. J. Med. Biol. Res., 2(5):101-117.

[18]Fredrick, C., Muthuri, C., Ngamau, K., Sinclair, F., 2017, Provenance and pretreatment effect on seed germination of six provenances of *Faidherbia albida* (Delile) A. Chev., Agrofor. Syst., 91(6):1007-1017.

[19]Hammer, Ø., Harper, D.A.T., Ryan, P.D., 2001, PAST: Paleontological statistics software package for education and data analysis, Palaeontol. Electron., 4(1):1-9.

[20]Herbei, M.V., Sala, F., 2015, Use Landsat image to evaluate vegetation stage in sunflower crops. AgroLife Sci. J., 4(1):79-86.

[21]Herbei, M., Sala, F., 2016, Biomass prediction model in maize based on satellite images, AIP Conf. Proc., 1738:350009-1 – 350009-4.

[22]Izadi, Z., Zarei, H., 2014, Evaluation of propagation of Chinese hibiscus (*Hibiscus rosa-sinensis*) through stenting method in response to different IBA concentrations and rootstocks, Am. J. Plant Sci., 5:1836-1841.
[23] Jivan, C., Sala, F., 2014, Relationship between tree nutritional status and apple quality, Hort. Sci., 41(1):1-9.
[24]Junqueira, A.H., Peety, M.D.S., 2018, Sustainability in Brazilian floriculture: introductory notes to a systemic approach, Ornam. Hortic., 24(2):155-162.
[25]Khristi, V., Patel, V.H., 2016, Therapeutic potential of *Hibiscus rosa sinensis*: A review, Int. J. Nutr. Diet., 4(2):105-123.
[26]Kim, Y., Oh, Y.J., Han, K.Y., Kim, G.H., Ko, J., Park, J., 2019, The complete chloroplast genome sequence of *Hibicus syriacus* L. 'Mamonde' (Malvaceae), Mitochondrial DNA Part B, 4:558-559.
[27]López-Ribera, I., Vicient, C.M., 2017, Use of ultrasonication to increase germination rates of Arabidopsis seeds, Plant Methods, 13(31):1-6.
[28]Magdalita, P.M., Gonzales-Lee, V.R.C., Pimentel, R.B., 2011, Development and horticultural characteristics of Hibiscus hybrids 'Women in Public Service Series', Philipp. J. Crop. Sci., 32(2):56-62.
[29]Magdalita, P.M., Pimentel, R.B., 2013, Development of Hibiscus hybrids "Women in Public Service Series II" and propagation studies on *Hibiscus rosa-sinensis* 'Cynthia A. Villar', Philipp. Sci. Lett., 6(1):39-56.
[30]Magdalita, P.M., Cayaban, M.F.H., Gregorio, M.T., Silverio, J.V. 2016. Development and characterization of nine new Hibiscus hybrids, Philipp. J. Crop. Sci., 41(2):31-34.
[31]Mak, Y.W., Chuah, L.O., Ahmad, R., Bhat, R., 2013, Antioxidant and antibacterial activities of hibiscus (*Hibiscus rosa-sinensis* L.) and *Cassia* (*Senna bicapsularis* L.) flower extracts, J. King Saud Univ. Sci., 25(4):275-282.
[32]Missoum, A., 2018, An update review on *Hibiscus rosa sinensis* phytochemistry and medicinal uses, J. Ayu. Herb. Med. 4(3):135-146.
[33]Mondal, S., Ghosh, D., Sagar, N., Ganapaty, S., 2016, Evaluation of antioxidant, toxicological and wound healing properties of Hibiscus rosa-sinensis L. (Malvaceae) ethanolic leaves extract on different experimental animal models, Indian J. Pharm. Educ. Res., 50:620-637.
[34] Pacholczak, A., Jędrzejuk, A., Sobczak, M., 2017, Shading and natural rooting biostimulator enhance potential for vegetative propagation of dogwood plants (*Cornus alba* L.) *via* stem cuttings, S. Afr. J. Bot., 109:34-41.
[35]Patel, S., Adhav, M., 2018, IR spectroscopy and antimicrobial activity of ethanolic flower extract of *Hibiscus rosa sinensis* Linn. (Hibiscus Red), Int. J. Botany Stud., 3(2):161-163.
[36]Pekamwar, S.S., Kalyankar, T.U., Jadhaya, A.C. 2013. *Hibiscus rosa-sinensis*: A review on ornamental plant, World. J. Pharm. Pharm. Sci. 2(6):4719-4727.
[37]Popescu A., 2018a, Maize and wheat - top agricultural products produced, exported and imported by Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18(3):339-352.
[38]Popescu A., 2018b, Romania's sunflower seeds production, export and import- analysis of the 2007-2017 period and forecast for 2018-2022 horizon, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18(4):261-270.
[39]Popescu, A., Dinu, T.A., Stoian E., 2018, Sorghum - an important cereal in the world, in the European Union and Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18(4):271-284.
[40]Priya, V.D., Ninan, C.A., Kothari, N.M., 2008. Stomatal variations in cultivars of *Hibiscus rosa-sinensis* L., Biodivers. Conserv., 9:129-134.
[41]Rawashdeh, H.M., Sala, F., 2016, Effect of iron and boron foliar fertilization on yield and yield components of wheat, Rom. Agric. Res., 33:241-249.
[42]Rymbai, H., Sharma, R.R., Srivasta, M., 2011, Biocolorants and its implications in health and food industry – A review, Int. J. Pharmtech Res., 3(4):2228-2244.
[43]Sala, F., 1999, Magnetic fluids effect upon growth processes in plants, J. Mag. Mag. Mater., 201(1-3):440-442.
[44]Sala, F., Arsene, G.-G., Iordănescu, O., Boldea, M., 2015, Leaf area constant model in optimizing foliar area measurement in plants: A case study in apple tree, Sci. Hortic (Amsterdam), 193:218-224.
[45]Sala, F., Rujescu, C., Constantinescu, C., 2016, Causes and solutions for the remediation of the poor allocation of P and K to wheat crops in Romania, AgroLife Sci. J., 5(1):184-193.
[46]Sala, F., Iordănescu, O., Dobrei, A., 2017. Fractal analysis as a tool for pomology studies: Case study in apple, AgroLife Sci. J., 6(1):224-233.
[47]San Pascual, A.O., Magdalita, P.M., Medina, N.G., Apacionado, B.V., 2017, Characterization, pollen behavior and propagation of five selected Hibiscus hybrids (*Hibiscus rosa-sinensis* Linn.), Aust. J. Crop Sci., 11(12):1508-1519.
[48]Shadparvar, V., Mohammadi Torkashvand, A., Alinejad Alamshiri, H., 2011, Effect of IBA and soil mixture on rooting of (*Hibiscus rosa-sinensis*), Eur. J. Exp. Biol., 1:142-146.
[49]Sharma, K., Pareek, A., Chauhan, E.S., 2016, Evaluation of hyperglycemic and hyperlipidemic mitigating impact of *Hibiscus rosa-sinensis* (Gudhal) flower in type II diabetes mellitus subjects, Int. J. Appl. Biol. Pharm. Technol., 7(2):223-228.
[50] Sheth, F., De, S., 2012, Evaluation of comparative antioxidant potential of four cultivars of *Hibiscus rosa-sinensis* L. by HPLC-DPPH method, Free Radicals and Antioxidants, 2(4):73-78.
[51] Slamet, A., 2018, The diversity of Hibiscus rosa-sinensis based on morphological approach, Scientiae Educatia: Jurnal Pendidikan Sains, 7(1):33-41.

[52]Sudsiri, C.J., Jumpa, N., Kongchana, P., Ritchie, R.J., 2017, Stimulation of oil palm (*Elaeis guineensis*) seed germination by exposure to electromagnetic fields, Sci. Hortic. (Amsterdam), 220:66-77.
[53]Verdouw, C.N., Beulens, A.J.M., van der Vorst, J.G.A.J., 2013. Virtualisation of floricultural supply chains: A review from an internet of things perspective, Comput. Electron. Agr., 99:160-175.
[54]Verma, S., 2016, *Hibiscus rosa-sinensis* L. (Malvaceae): A multipurpose ornamental plant. Int. J. of Res. in Pharmacology & Pharmacotherapeutics 6(1):61-64.
[55]Wang, Q., Andersen, A.S., 1989, Propagation of *Hibiscus rosa-sinensis*: Relations between stock plant cultivar, age, environment and growth regulator treatments, Acta Hortic. 251:289-310.
[56]Yakhin, O.I., Lubyanov, A.A., Yakhin, I.A., Brown, P.H., 2017, Biostimulants in plant science: A global perspective, Front. Plant Sci. 7:2049.
[57]Zarbà, A.S., Di Vita, G., Pecorino, B., 2015, Business performance in the ornamental plants industry: A supply chain approach, Quality – Access to Success, 16:9-16.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

DID THE PORK SECTOR IN ROMANIA REACHED THE MAXIMUM DECLINE?

Silviu BECIU[1,2], Georgiana Armenița ARGHIROIU [2], Răzvan PANAIT[2]

[1]The Bucharest University of Economic Studies, 6 Piaţa Romană, 6, 010374, Bucharest, Romania, Phone: 004 0723165907, Email: beciu.silviu@gmail.com
[2]University of Agronomic Sciences and Veterinary Medicine, Bucharest 59 Marasti, District 1, 011464, Bucharest, Romania, E-mails: beciu.silviu@gmail.com, armenitaarghiroiu@gmail.com, razvanpan2@yahoo.com

Corresponding author: armenitaarghiroiu@gmail.com

Abstract

This paper aimed to analyse the evolution of the pork sector in Romania which continue to fall under the African Swine Fever dramatic effects on Romanian pig livestock. While the last decade was related with a continuous decline of pigs effective in Romania, in 2018 the livestock went down for the first time under 4 million heads. The paper tried to find how was Romania affected at the county and region level, taking into account a five-year trend, from which, the last two were directly influenced by this contagious viral disease. The research method is based on a quantitative approach, based on regional and national time data series for pig livestock. The results indicated that Romania has reached a maximum trend of decreasing of its pig livestock in 2019, but the veterinary safety measures conducted to a decrease in the incidence of AFS within the commercial pig enterprises, and the danger is focused now in the vicinity of households with the wild boar populations.

***Key words*:** *pig livestock, African Swine Fever, Romania, regions*

INTRODUCTION

Romania was highly affected by the ASF (African Swine Fever) in 2018 and 2019. The pig livestock decreased from the last decade in Romania was correlated with a change in the top of the regions with the highest livestock, the West Region of Development replacing the South Region [1]. All the pork supply chain in Romania is still hardly affected and the market continued to be under pressure of the import pork products from the EU countries. Due its specific epizootic type [2], which affected more the domestic pigs than the wild boar herds, which was not the case in rest of the EU affected countries, the cause of its spread was related with the fail of persons in charge to implement safety biosecurity procedures in order to avoid disease spreading in other farms. Since there is no vaccine against ASF, which limits the options for disease control many studies were toward to the possibilities for limiting the transmission of this disease within the wildlife and domestic pig populations [3]. While some specialists consider that we face a constant, but relatively slow spread of AFS, and its evolution is related with factors as the host, the virus pathogenesis, and also the environment [4] the recent facts indicates that only in one year close to 5 million pigs were lost due to Asia's swine fever outbreak [5]. After its first landing in Europe in 2007 through a Georgia Black Sea port from East Africa, and its signalling in EU in 2014 [6], the ASF spread rapidly in all the Baltic states and Poland, following its course in countries with significant pig livestock as Czech Republic, Hungary, Romania (since 2017) [7] or Bulgaria. This paper aimed to evaluate the recent evolution of pigs heard in Romania at the level of its regions of development and in relation with the spread of ASF.

MATERIALS AND METHODS

For this paper was first analysed the overall evolution of the Romanian pig livestock, then we developed the analyse at the regions of development level and also at the counties level, in relation with the spread of AFS between 2017 and 2019 in many of Romanian

counties with tradition in pig livestock production. Most of the data were provided by Romanian Authority for Food Safety and Veterinary Health (ANSVSA), the National Institute of Statistic from Romania and FAO.

RESULTS AND DISCUSSIONS

During the 2015-2019 period the pig livestock in Romania decreased with 20% from 4.65 million heads in 2015 to 3.72 million in 2019.

According to Romanian Authority for Food Safety and Veterinary Health (ANSVSA), since the first report of the presence of AFS in Romania at end of July 2017, until the end of January 2020, over 570 thousand pigs and around 2,765 boars were affected in most part of the country. While 2,347 infested areas have been neutralized, the epidemic was still active in 619 outbreaks at the beginning of 2020 [8].

Table 1. The number of existing pigs, by development regions (heads)

	North-East	South-East	South Muntenia	South-West Oltenia	West	North-West	Centre	Bucureşti-Ilfov	TOTAL
2015	517,015	769,467	792,914	587,286	875,522	646,028	450,590	20,589	**4,659,411**
2016	489,985	657,258	743,468	569,940	959,956	669,586	465,904	18,593	**4,574,690**
2017	489,083	733,707	650,914	643,310	930,006	593,525	428,002	18,016	**4,486,563**
2018	432,513	698,725	656,923	523,420	834,654	612,086	349,750	21,222	**4,129,293**
2019	436,573	434,503	574,530	494,051	846,880	558,025	362,751	18,969	**3,726,282**

Source: National Institute of Statistics, 2020.

In the North East Region of Development, the pig livestock decreased with 15,5% between 2015 and 2019, from 517 thousand to 436 thousands pigs. The share of the pig livestock of this region in the Romanian total of pigs herds increased during this period up to 11.72% in 2019, from a minim of 10.47% in 2018, which might mean that this region started to recover from the AFS crises.

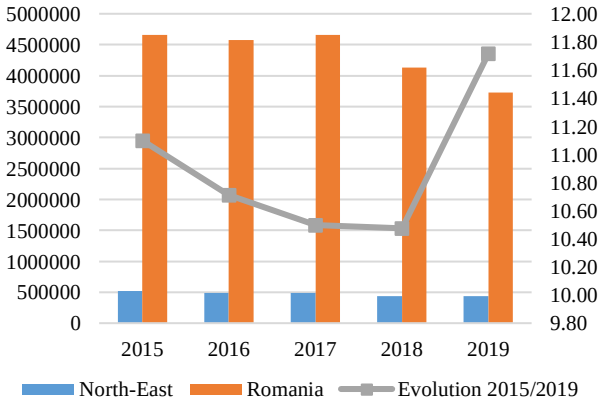

Fig.1. Evolution of pig herds in the North-East Region of Romania
Source: Own determination based on NIS data.

In this region most of the outbreaks that have been closed were recorded in Botoșani county (19 outbreaks). This county faced recently 100 outbreaks in boars, which were still active at the end of January 2020.

In the South East Region of Development, the pig livestock decreased dramatically with 43.5% between 2015 and 2019, from 769 thousand to 434 million pigs.

The share of the pig livestock of this region in the Romanian total of pigs herds decreased during this period from 16.51 % in 2015 to a minim of 11.66% in 2019.

The most affected county by the AFS from the pointed view of number of outbreaks, in the South East Region was Tulcea county, with 586 already closed outbreaks and still 5 active outbreaks in pig livestock and 179 active cases in boars at the end of January 2020. In Brăila county, also situated in this region were recorded 210 outbreaks from which 207 are now closed. Over 4,000 farms from this county were affected from which 17 were specialized large enterprises and one of them was still active outbreak at the end of January 2020. Brăila county recorded the largest amount of slaughtered pigs from Romania due to AFS, almost half of the value of the compensation offered by the authorities (204 million lei from a total at

national level of 403 million lei) being granted in this county.

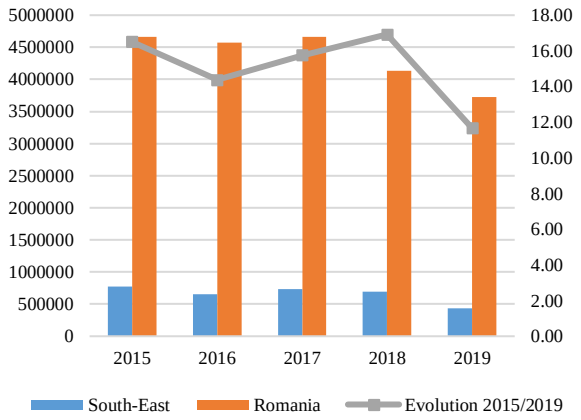

Fig.2. Evolution of pig herds in the South-East Region of Romania
Source: Own determination based on NIS data .

The South– Muntenia Region is the second region after the South East Region significant affected by the ASF in Romania. In this region the pig livestock decreased with 27.5% between 2015 and 2019, from 792 thousand 2015 to 574 thousand pig herds in 2019.

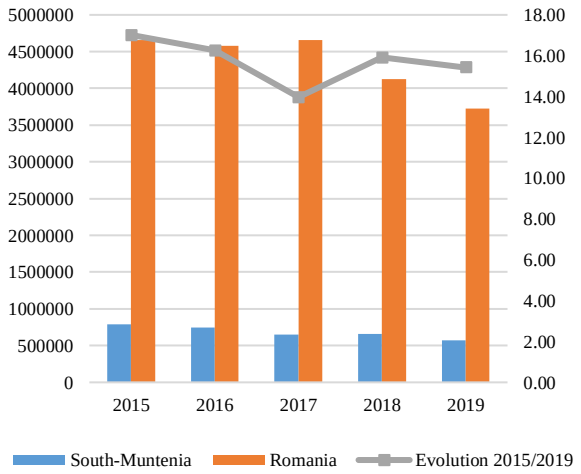

Fig. 3. Evolution of pig herds in the South Muntenia Region of Romania
Source: Own determination based on NIS data.

The region decreased its share in total pig livestock from Romania from 17% in 2015 to 15.42% in 2019. In the South – Muntenia region, Teleorman county was the most affected by the ASF from the point of view of outbreaks number, with 401 outbreaks, from which 198 were still active at the end of January 2020, but the Călărași county recorded the ASF outbreaks in pig production specialized enterprises, which conducted to a large number of slaughtered pigs, and a high level of the compensation value offered by the authorities (34 million lei). Also in the Argeș county the large number of slaughtered pigs in two large enterprises specialized in pig livestock generated a level of 21 million lei compensation by the authorities.

In the South West Region of Romania, the pig livestock decreased by 15.87 from 2015 to 2019, respectively from 587 thousand pigs in 2015 to 494 thousand pigs in 2019, but the region increased its share in total pig livestock in Romania from 12.6% in 2015 to 13.26% in 2019, having even a large share, of 13.81% in 2017, before the ASF crises started to manifest its effects in the region.

Dolj and Olt were the most affected counties in the South West Region, with 190 respectively 71 closed outbreaks and 79 respectively 68 still open outbreaks at the end of January 2020.

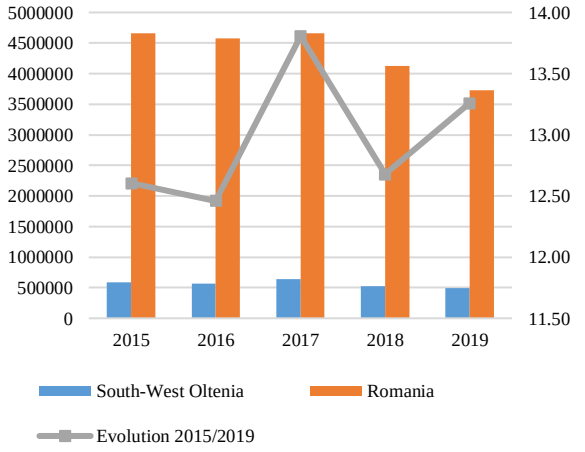

Fig. 4. Evolution of pig herds in the South-West Oltenia Region of Romania
Source: Own determination based on NIS data.

In the West Region of Romania, the pig livestock decreased only by 3.27 % between 2015 and 2019, from 875 thousand pigs in 2015 to 846 thousands pigs in 2019.

The share of the pig livestock of this region in the Romanian total of pigs herds increased during this period to 22.73 % in 2019, from 18.79 % in 2015, this region being the best protected against ASF.

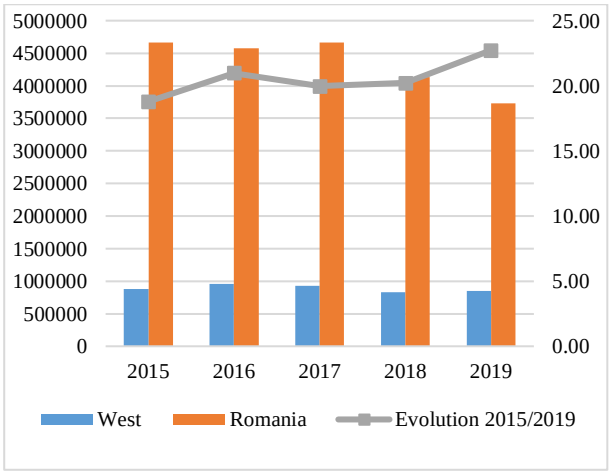

Fig. 5. Evolution of pig herds in the West Region of Romania
Source: Own determination based on NIS data.

Only the Arad county recorded a significant number of outbreaks: 35, but all of them were closed. Some active cases at the end of January 2020 (59) were recorded in Arad county within the wild boar population.

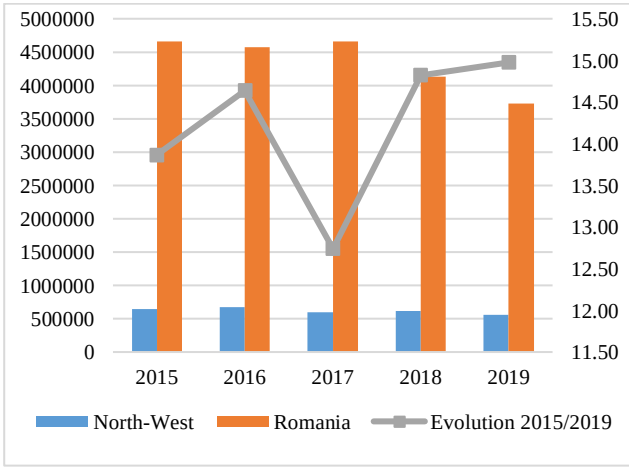

Fig. 6. Evolution of pig herds in the North-West Region of Romania
Source: Own determination based on NIS data.

In the North West Region of Romania, the pig livestock decreased by 13.62 % between 2015 and 2019, from 646 thousand pigs in 2015 to 558 thousands pigs in 2019, but the share of the pig livestock of this region in the Romanian total of pigs herds increased during this period from 13.87 % in 2015 to 14.98 % in 2019.
Bihor and Satu Mare were the most affected counties in the North West Region of Romania, with 97 and 56 outbreaks that have been closed. In this counties were still active at the end of January 2020, 227 respectively 174 cases of AFS in the wild boar population.
In the Centre Region of Romania, the pig livestock decreased by 19.49 % between 2015 and 2019, from 450 thousand pigs in 2015 to 362 thousands pigs in 2019, but the share of the pig livestock of this region in the Romanian total of pigs herds slightly increased during this period from 9.67 % in 2015 to 9.73 % in 2019.
Few cases of AFS have been recorded in the Centre Region, the evolution of the pig livestock in this part of the country being related only with the production and the market conditions.

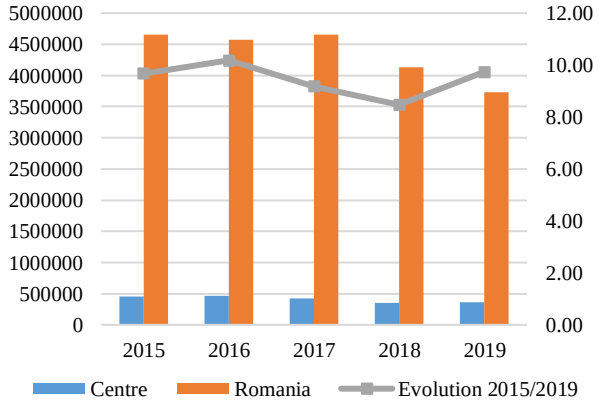

Fig. 7. Evolution of pig herds in the Centre Region of Romania
Source: Own determination based on NIS data.

In the Centre Region of Romania, the pig livestock decreased by 7.86 % between 2015 and 2019, from 20.5 thousand pigs in 2015 to 18.9 thousands pigs in 2019, but the share of the pig livestock of this region in the Romanian total of pigs herds slightly increased during this period from 0.44 % in 2015 to 0.51 % in 2019.
Two important enterprises specialized in pig livestock were affected by the AFS, generating, besides other 46 farms a compensation value, offered by the authorities of 37 million lei. A significant number of 171 AFS cases were still active at the end of January 2020 within the wild boar population.

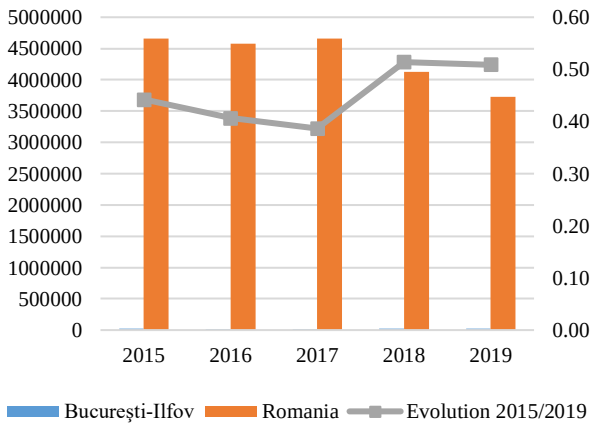

Fig. 8. Evolution of pig herds in the București-Ilfov Region of Romania
Source: Own determination based on NIS data.

CONCLUSIONS

Romania continued to be affected by the African Swine Fever, but the spread of the diseases seems to reduce at the beginning of 2020. While the enterprises specialized in pig livestock took measures to avoid the spreading within their herds, the households are still vulnerable and the major danger comes now mostly in relation with the wild boar population.

The increased security of the farms and the improved reaction of the factors involved in veterinary security started to limit the impact of this crisis on the internal pork market, but the loss of significant swine breading herds will hardly be recovered.

The deficient in Romanian trade balance with pork products will become higher since exports from 25 counties are forbidden now in the EU.

The West Region is the least affected region in terms of pig livestock from Romania, and the few cases of AFS within the enterprises from this region is a hint that safety measures can be efficient even if spreading of this diseases seems hard to stop since there is no vaccine to stop it yet.

REFERENCES

[1]ANSVA, 2017, Press release (Informare de presă) A fost confirmat primul focar de pestă porcină africană în România la porcii din gospodării în județul Satu – Mare (The first outbreak of African swine fever in Romania was confirmed in pigs from households in Satu - Mare county), August 1, 2017, http://www.ansvsa.ro/blog/a-fost-confirmat-primul-focar-de-pesta-porcina-africana-in-romania-la-porcii-din-gospodarii-in-judetul-satu-mare, Accessed on 3 Jan 2020.

[2]ANSVA, 2020, Press release (Informare de presă) Actualizarea situației privind evoluția Pestei Porcine Africane (Updating of the situation regarding the evolution of the African Swine fever), January 28, 2020, http://www.ansvsa.ro/blog/actualizarea-situatiei-privind-evolutia-pestei-porcine-africane-50/, Accessed on 5 Jan 2020.

[3]Beciu, S., Arghiroiu, A.G., 2019, Challenges for the pork sector in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 19(1): 71-76.

[4]Chenais, E., Depner, K., Guberti, V., Dietze, K., Viltrop, A., Ståhl, K, 2019, Epidemiological considerations on African swine fever in Europe 2014–2018, Porcine Health Management, Vol 2019, 1:10L.K.

[5]Costard, S., Wieland, B., de Glanville, W., Jori, F., Rowlands, R., Vosloo, W., Roger, F., Pfeiffer Dirk, U., Dixon, L. K. African swine fever: how can global spread be prevented? 364 Phil. Trans. Royal Society http://doi.org/10.1098/rstb.2009.0098, Accessed on 5 Jan 2020.

[6]Dixon, H. Sun, H. Roberts, 2019, African swine fever, Antiviral Research, Volume 165, 34-41.

[7]FAO, One year on, close to 5 million pigs lost to Asia's swine fever outbreak, http://www.fao.org/news/story/en/item/1204563/icode/, Accessed on 12 Jan 2020.

[8]Schulz, K., Conraths, F.J., Blome, S., Staubach, C., Sauter-Louis, C., African Swine Fever: Fast and Furious or Slow and Steady?, Viruses 2019, 11(9), 866.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

HOW IS THE REGIONAL OPERATIONAL PROGRAM 2014-2020 PERFORMING WITHIN ROMANIAN REGIONS OF DEVELOPMENT?

Silviu BECIU[1,2], Georgiana Armenița ARGHIROIU[2], Răzvan PANAIT[2]

[1]The Bucharest University of Economic Studies, Piaţa Romană, 6, 010374, Bucharest, Romania
Phone: 004 0723165907, Email: beciu.silviu@gmail.com
[2]University of Agronomic Sciences and Veterinary Medicine, Bucharest 59 Marasti, sector 1, 011464, Bucharest, Romania, E-mail: beciu.silviu@gmail.com, armenitaarghiroiu@gmail.com, razvanpan2@yahoo.com

Corresponding author: armenitaarghiroiu@gmail.com

Abstract

This paper was focused on the study of one of the main driver of Regional Development in Romania, the REGIO program, being analysed the efficiency of its implementation in all the Romanian Regions of Development. The study was made from the point of view of the projects that were accessed within the Romanian counties that belongs to one region or another. The method was based on REGIO data analysis, and the results indicated significant regional disparities and various mobilization at the county and regional level in EU fund accessing which justify the GDP growing trends within the regions.

Key words: *program, projects, REGIO, Romania, regions of development*

INTRODUCTION

Regional development was conceptualized as *a dynamic outcome of the complex interaction between two types of networks: territorialized relational networks and global production networks that are acting in relation with variable regional governance structures*[4]. While some studies debated the nature of regional problems [7], other were focused on the key role of the labour flexibility within regions or were targeted on the role of the local [5] and foreign [8] SMEs within regions. The Ministry of Regional Development and Public Administration from Romania is the institution that we considered professionally in charge [6] with regional planning and allocating resources at the national level, which must act in the direction of a sustainable development of the all [2, 3] regions existing at national level. Considering that the institutions are essential for economic development, and have the capability to generate various institution-based regional development strategies, the efficiency of the institutions that are implementing the regional programs in Romania vary and the effects can be seen also within the Romania Operational Program (REGIO), which was developed within the regional development agencies [8]. If the economic growth can be achieved more easily in regions with a high level of workforce qualification, the increase of the level of capitalization does not depend solely on the characteristics of the region and can be achieved by increasing the level of investments in the region [1]. The main instrument used in the last years by this minister, the REGIO program, was target to reduce large disparities between regions, highly underlined by indicators as GDP per inhabitant or average monthly nominal gross earning [7]. This paper aimed to identify how REGIO performed in the recent period within the Romanian Regions of Development, taking in to account the projects that were implemented at the regions level and within regions at the county level.

MATERIALS AND METHODS

For this paper we determined the evolution of the population and the GDP progress in each Romanian region of development, then we analysed the implementation level of the Romanian Operational Program - REGIO, from the point of view of: the total number of projects that were ongoing or implemented in

each Romanian region of development and also in each county from a region of development; the total value of the projects in each region; the top projects from the point of value at the national level. In order to have a better picture of the impact of the implementation of REGIO in each region we have calculated the value of the projects per person for each region population. Most of the data were provided by the National Institute of Statistic and the Romanian Operational Program – REGIO.

RESULTS AND DISCUSSIONS

During the 2015-2019 period all the Romanian regions of development, excepting Bucharest- Ilfov, followed a negative trend in terms of resident population. The Bucharest-Ilfov Region of Development was the only region in 2018 - the last year with available data - which recorded a positive natural increase of the population, of 124 persons, while the South Muntenia Region had the highest negative decrease, of 16,261 persons. The North – East Region of Development had the largest population (Table 1), of 3.1 million people in 2019, while at the opposite pole was the West Region of Development with only 1.7 million people.

Table 1. Usually resident population by development regions at January 1st

Development regions	2015	2016	2017	2018	2019
Total	19,875,542	19,760,585	19,643,949	19,530,631	19,414,458
North - West	2,586,034	2,576,567	2,568,392	2,560,822	2,552,112
Centre	2,350,539	2,341,964	2,332,791	2,325,747	2,318,272
North - East	3,272,210	3,256,734	3,239,573	3,221,183	3,198,564
South - East	2,492,582	2,469,868	2,447,305	2,421,957	2,396,171
South - Muntenia	3,061,759	3,031,555	3,003,333	2,965,205	2,929,832
Bucharest - Ilfov	2,284,443	2,288,203	2,287,065	2,301,255	2,315,173
South - West Oltenia	2,015,792	1,993,482	1,972,940	1,949,940	1,926,860
West	1,812,183	1,802,212	1,792,550	1,784,522	1,777,474

Source: NIS, 2020.

While, the GDP recorded a positive trend between 2013 and 2017 at national and regional level (Table 2), the contribution of each region to the total GDP varied between 27.15 % for Bucharest - Ilfov and 10.25% for South East Region of Development, at the level of the year 2017. We noticed that in 2017 the lowest GDP contribution at regional level, excepting extra regions (the continental platform from the Black Sea and territorial enclaves) was recorded in South West Oltenia, of only 7.4 %.

The highest value of the project funded by REGIO 2014-2020 was recorded in the North West Region of Development, of 8.7 million lei, followed by the South East Region with 7.4 million lei. In relation with direct or indirect beneficiary population of each region, the highest value calculated by person for the REGIO program was also recorded in North - West Region with 3.4 thousand by person, followed by the South – East Region of Development with 3.1 thousand per person (Table 3).

At the national level, REGIO 2014-2020 financed in the period 2017-2019 a total number of 4,600 projects, from which 3,301 were in implementation at the end of September 2019, and 1,299 were finished.

In the North West Region, at the mentioned time, from the total of 877 projects, 746 were in implementation phase while 131 were finished (Table 4).

The South East Region recorded in the same period 837 projects, from which 635 were in implementation and 202 were finished.

Table 2. GDP by development regions - calculated according CANE Rev.2 - ESA 2010

Development regions	2013	2014	2015	2016	2017
Total	635,459.4	668,590.1	712,587.8	765,135.4	857,895.7
North - West	71,248	76,654.7	81,580.5	90,039	104,848.9
% NW in Total	**11.21**	**11.47**	**11.45**	**11.77**	**12.22**
Centre	70,163.1	73,374.8	78,706.6	86,532.8	96,984.1
% C in Total	**11.04**	**10.97**	**11.05**	**11.31**	**11.30**
North - East	65,222.2	67,636.7	71,626.9	77,337.4	88,847.7
% NE in Total	**10.26**	**10.12**	**10.05**	**10.11**	**10.36**
South - East	71,597.9	75,316.1	76,154.9	79,884.4	87,914.5
% SE in Total	**11.27**	**11.26**	**10.69**	**10.44**	**10.25**
South - Muntenia	77,341.8	86,980	86,622	93,655.7	100,917.7
% SM in Total	**12.17**	**13.01**	**12.16**	**12.24**	**11.76**
Bucharest - Ilfov	171,307.9	178,134.2	197,800	207,575.2	232,876.2
% BI in Total	**26.96**	**26.64**	**27.76**	**27.13**	**27.15**
South - West Oltenia	47,848.5	48,504.6	52,068.7	55,344.2	63,927.8
% SWO in Total	**7.53**	**7.25**	**7.31**	**7.23**	**7.45**
West	60,215	61,516.8	67,458	74,234.5	80,895.3
%W in Total	**9.48**	**9.20**	**9.47**	**9.70**	**9.43**
Extra-regions	515	472.2	570.2	532.2	683.5
% Extra-regions in Total	**0.08**	**0.07**	**0.08**	**0.07**	**0.08**

Source: NIS and own determination based on NIS data.

Table 3. Value of the project per person (lei/person)

Development regions	Total value of the projects	Population in 2019	Value of the project / person
Total	**41,577,671,775**	19,414,458	2,141.58
North - West	**8,719,012,011**	2,552,112	3,416.39
Centre	**4,357,863,510**	2,318,272	1,879.79
North - East	**4,910,747,062**	3,198,564	1,535.30
South - East	**7,463,521,287**	2,396,171	3,114.77
South - Muntenia	**4,159,529,168**	2,929,832	1,419.72
Bucharest - Ilfov	**3,518,752,826**	2,315,173	1,519.87
South - West Oltenia	**4,243,598,733**	1,926,860	2,202.34
West	**4,204,647,175**	1,777,474	2,365.52

Source: Own determination based on NIS and REGIO data.

In the third place was situated the South Muntenia Region with 596 projects, from which 370 were ongoing and 226 completed. Only 159 projects were funded in the Bucharest – Ilfov region, from which 124 were ongoing and 35 were finished.

Table 4. Number and project status in the development regions

Development regions	Project numbers	Project status	
		In implementation	Finished
North - West	**877**	**746**	**131**
Centre	584	385	199
North - East	547	409	138
South - East	837	635	202
South- Muntenia	596	370	226
Bucharest - Ilfov	159	124	35
South-West Oltenia	487	315	172
West	513	317	196
Total	**4,600**	**3,301**	**1,299**

Source: Own determination based on REGIO data.

In the North West Region (Table 5), the county with highest number of projects developed through REGIO program was Cluj, where from 292 projects, 228 were in implementation and 64 were finished, followed by Bihor County, where from 192 projects, 185 were in implementation and 7 were finished.

Table 5. Number and project status in the North - West region

Counties	Project numbers	Project status	
		In implementation	Finished
North - West	877	746	131
Bihor	192	185	7
Bistrita Nasaud	103	93	10
Cluj	292	228	64
Maramures	126	97	29
Salaj	67	61	6
Satu Mare	93	79	14
Regional projects	4	3	1

Source: Own determination based on REGIO data.

A significant number of projects were developed in Maramures County – 126 projects and also in Bistrita Nasaud County with 103 projects.

In the Centre Region (Table 6), the county with the highest number of projects developed through REGIO program was Brasov, where from 133 projects, 73 were in implementation and 60 were finished, followed by Harghita County, where from 124 projects, 92 were in implementation and 32 were finished.

A significant number of projects were developed in Mures County – 110 projects and also in Alba County with 84 projects.

Table 6. Number and project status in the Centre region

Counties	Project numbers	Project status	
		In implementation	Finished
Centre	**584**	**385**	**199**
Alba	84	55	29
Brasov	133	73	60
Covasna	46	38	8
Harghita	124	92	32
Mures	110	69	41
Sibiu	81	53	28
Regional projects	6	5	1

Source: Own determination based on REGIO data.

In the North East Region (Table 7), the county with the highest number of projects developed through REGIO program was Suceava, where from 134 projects, 107 were in implementation and 27 were finished, followed by Iasi County, where from 125 projects, 89 were in implementation and 36 were finished. A significant number of projects were developed in Bacau County – 122 projects and also in Neamt County with 79 projects.

Table 7. Number and project status in the North - East region

Counties	Project numbers	Project status	
		In implementation	Finished
North - East	**547**	**409**	**138**
Bacau	122	82	40
Botosani	47	39	8
Iasi	125	89	36
Neamt	79	58	21
Suceava	134	107	27
Vaslui	36	31	5
Regional projects	4	3	1

Source: Own determination based on REGIO data.

In the South East Region (Table 8), the county with the highest number of projects developed through REGIO program was Tulcea, where from 276 projects, 242 were in implementation and 34 were finished, followed by Constanta County, where from 203 projects, 150 were in implementation and 53 were finished. A significant number of projects were developed in Buzau County – 114 projects and also in Galati County with 113 projects.

Table 8. Number and project status in the South - East region

Counties	Project numbers	Project status	
		In implementation	Finished
South - East	**837**	**635**	**202**
Braila	33	20	13
Buzau	114	66	48
Constanta	203	150	53
Galati	113	74	39
Tulcea	276	242	34
Vrancea	96	82	14
Regional projects	2	1	1

Source: Own determination based on REGIO data.

In the South Muntenia Region (Table 9), the county with the highest number of projects developed through REGIO program was Arges, where from 155 projects, 74 were in implementation and 81 were finished, followed by Prahova County, where from 153 projects, 100 were in implementation and 53 were finished. A significant number of projects were developed in Dambovita County – 112 projects.

Table 9. Number and project status in the South - Muntenia region

Counties	Project numbers	Project status	
		In implementation	Finished
South - Muntenia	**596**	**370**	**226**
Arges	155	74	81
Calarasi	41	25	16
Dambovita	112	80	32
Giurgiu	58	42	16
Ialomita	32	22	10
Prahova	153	100	53
Teleorman	37	20	17
Regional projects	8	7	1

Source: Own determination based on REGIO data.

The Bucharest – Ilfov (Table 10) developed 159 projects within REGIO program, from which 124 were in implementation and 35 were finished. While 125 projects were applied in Bucharest and 28 in Ilfov, 6 covered the whole region.

Table 10. Number and project status in the Bucharest - Ilfov region

Counties	Project numbers	Project status	
		In implementation	Finished
Bucharest - Ilfov	**159**	**124**	**35**
Bucharest	125	92	33
Ilfov	28	28	0
Regional projects	6	4	2

Source: Own determination based on REGIO data.

In the South West Oltenia Region (Table 11), the county with the highest number of projects developed through REGIO program was Dolj, where from 153 projects, 83 were in implementation and 70 were finished, followed by Valcea County, where from 125 projects, 86 were in implementation and 39 were finished. A significant number of projects were developed in Olt County – 84 projects, from which 28 were finished.

Table 11. Number and project status in the South – West Oltenia region

Counties	Project numbers	Project status	
		In implementation	Finished
South - West Oltenia	**487**	**315**	**172**
Dolj	153	83	70
Gorj	65	49	16
Mehedinti	53	36	17
Olt	84	56	28
Valcea	125	86	39
Regional projects	7	5	2

Source: Own determination based on REGIO data.

In the West Region (Table 12), the county with the highest number of projects developed through REGIO program was Timis, where from 191 projects, 92 were in implementation and 99 were finished, followed by Hunedoara County, where from 171 projects, 124 were in implementation and 47 were finished.

Table 12. Number and project status in the West region

Counties	Project numbers	Project status	
		In implementation	Finished
West	**513**	**317**	**196**
Arad	81	51	30
Caras Severin	68	49	19
Hunedoara	171	124	47
Timis	191	92	99
Regional projects	2	1	1

Source: Own determination based on REGIO data.

Table 13. Total value of the projects by development region (lei)

Development regions	Total value of the projects	% Total value
Total	**41,577,671,775.73**	**100**
North - West	8,719,012,011.64	20.97
Centre	4,357,863,510.61	10.48
North - East	4,910,747,062.35	11.81
South - East	7,463,521,287.73	17.95
South - Muntenia	4,159,529,168.27	10.00
Bucharest - Ilfov	3,518,752,826.06	8.46
South - West Oltenia	4,243,598,733.12	10.21
West	4,204,647,175.94	10.11

Source: Own determination based on REGIO data.

In terms of value, the projects developed in the North West Region had a share of 20.9 % from the total national value (Tabel 13) of the REGIO 2014-2020 projects, while the projects from the South East region had a share of 17.9 %.

In the North West Region (Table 14), the county with the biggest value of the projects developed through REGIO 2014-2020 program was also Cluj, followed by Bihor, both of them accounting together more than half of the total value of the projects accessed in this region. The Bistrita Nasaud had also a significant share of 18.15 % from the total value accessed at the region level.

Table 14. Total value of the projects by counties in the North – West region (lei)

Counties	Total value of the projects	% Total value
North - West	**8,719,012,011.64**	**100**
Bihor	1,770,510,369.44	20.31
Bistrita Nasaud	1,582,581,477.00	18.15
Cluj	2,912,718,734.74	33.41
Maramures	821,035,256.34	9.42
Salaj	857,711,736.89	9.84
Satu Mare	545,696,179.30	6.26
Regional projects	228,758,257.94	2.62

Source: Own determination based on REGIO data.

In the Centre Region (Table 15), the county with the biggest value of the projects developed through REGIO 2014-2020 program was Brasov, followed by Sibiu, both of them accounting together around 40 % of the total value of the projects accessed in this region. Alba, Harghita and Mures counties had also a significant share, each of them covering around 15 % from the total value accessed at the region level.

Table 15. Total value of the projects by counties in the Centre region (lei)

Counties	Total value of the projects	% Total value
Centre	**4,357,863,510.61**	**100**
Alba	673,807,210.64	15.46
Brasov	963,946,191.45	22.12
Covasna	329,218,622.97	7.55
Harghita	657,032,697.66	15.08
Mures	636,511,912.80	14.61
Sibiu	812,275,701.90	18.64
Regional projects	285,071,173.19	6.54

Source: Own determination based on REGIO data.

In the North East Region (Table 16), the county with the biggest value of the projects developed through REGIO 2014-2020 program was by far Iasi, followed by Suceava and Bacau counties, all of them accounting together over 60 % from the total value of the projects accessed in this region.

Table 16. Total value of the projects by counties in the North – East region (lei)

Counties	Total value of the projects	% Total value
North - East	**4,910,747,062.35**	**100**
Bacau	827,056,316.00	16.84
Botosani	564,637,140.15	11.50
Iasi	1,408,837,735.56	28.69
Neamt	498,186,085.44	10.14
Suceava	846,999,040.59	17.25
Vaslui	453,970,004.22	9.24
Regional projects	311,060,740.39	6.33

Source: Own determination based on REGIO data.

In the South East Region (Table 17), the county with the biggest value of the projects developed through REGIO 2014-2020 program was Vrancea, followed by Tulcea, and Constanta, all of them accounting together over 65 % of the total value of the projects accessed in this region. Even if Tulcea County had the highest number of projects developed in the Region, the Vrancea county had fewer project with much greater value per project.

Table 17. Total value of the projects by counties in the South – East region (lei)

Counties	Total value of the projects	% Total value
South - East	**7,463,521,287.73**	**100**
Braila	470,030,260.39	6.30
Buzau	772,143,635.99	10.35
Constanta	1,361,184,831.10	18.24
Galati	1,172,757,369.56	15.71
Tulcea	1,619,478,732.59	21.70
Vrancea	2,004,209,893.56	26.85
Regional projects	63,716,564.54	0.85

Source: Own determination based on REGIO data.

In the South Muntenia Region (Table 18), the county with the biggest value of the projects developed through REGIO 2014-2020 program was Prahova, followed by Dambovita, both of them accounting together close to the half from the total value of the projects accessed in this region. The Arges county had also a significant share of 19.27 % from the total value accessed at the region level, but have to be mentioned that even this county had the highest number of project, their individual value was lower.

Table 18. Total value of the projects by counties in the South - Muntenia region (lei)

Counties	Total value of the projects	% Total value
South - Muntenia	**4,159,529,168.27**	**100**
Arges	801,503,658.88	19.27
Calarasi	258,738,696.69	6.22
Dambovita	896,507,335.58	21.55
Giurgiu	282,630,033.28	6.79
Ialomita	401,148,737.96	9.64
Prahova	1,010,027,627.02	24.28
Teleorman	218,654,837.81	5.26
Regional projects	290,318,241.05	6.98

Source: Own determination based on REGIO data.

Table 19. Total value of the projects by counties in the Bucharest - Ilfov region (lei)

Counties	Total value of the projects	% Total value
Bucharest - Ilfov	**3,518,752,826**	**100**
Bucharest	3,031,937,557	86.17
Ilfov	399,351,693	11.35
Regional projects	87,463,576	2.48

Source: Own determination based on REGIO data.

In the Bucharest – Ilfov Region, the highest value of the regional projects (Table 19) was

attracted by Bucharest, which had a share of 86.7 % from the total value of the projects from this region.

In the South West Oltenia Region (Table 20), the county with the biggest value of the projects developed through REGIO 2014-2020 program was also Dolj, followed by Valcea, both of them accounting together more than half of the total value of the projects accessed in this region. The Mehedinti county had also a significant share of 15.38 % from the total value accessed at the region level.

Table 20. Total value of the projects by counties in the South – West Oltenia region (lei)

Counties	Total value of the projects	% Total value
South - West Oltenia	**4,243,598,733.12**	**100**
Dolj	1,112,598,274.53	26.22
Gorj	563,141,517.67	13.27
Mehedinti	652,841,439.45	15.38
Olt	586,182,695.35	13.81
Valcea	1,073,224,885.05	25.29
Regional projects	255,609,921.07	6.02

Source: Own determination based on REGIO data.

In the West Oltenia Region, the county with the biggest value of the projects developed through REGIO 2014-2020 program was also Timis, followed by Hunedoara, both of them accounting together almost 65 % the total value of the projects accessed in this region (Table 21).

Table 21. Total value of the projects by counties in the West region (lei)

Counties	Total value of the projects	% Total value
West	**4,204,647,175.94**	**100**
Arad	757,783,329.33	18.02
Caras Severin	651,084,088.08	15.48
Hunedoara	1,308,257,936.54	31.11
Timis	1,421,968,003.05	33.82
Regional projects	65,553,818.94	1.56

Source: Own determination based on REGIO data.

At the national level, Cluj County had the highest number of projects developed within the REGIO 2014-2020, followed by Tulcea and Constanta counties.

The lowest number of projects, accounting for 125, was registered in the following counties: Iasi, Bucharest and Valcea as presented in Table 22.

Table 22. Ranking of counties after the project numbers developed within REGIO program at the national level

No. Crt.	Counties	Project numbers	% in total number of projects
1	Cluj	292	6.40
2	Tulcea	276	6.05
3	Constanta	203	4.45
4	Bihor	192	4.21
5	Timis	191	4.19
6	Hunedoara	171	3.75
7	Arges	155	3.40
8	Prahova	153	3.35
9	Dolj	153	3.35
10	Suceava	134	2.94
11	Brasov	133	2.92
12	Maramures	126	2.76
13	Iasi	125	2.74
14	Bucharest	125	2.74
15	Valcea	125	2.74

Source: Own determination based on REGIO data.

While Bucharest was placed in the 14th position in terms of project numbers accessed within REGIO 2014-2020, this region was in the top of regions in terms of the value of these projects, followed by Cluj and Vrancea counties.

The lowest value of the projects was registered in Brasov county, whose share in the total value of the projects was 2.32% (Table 23).

Table 23. Ranking of counties after the total projects value within REGIO 2014-2020 program at the national level (lei)

No. Crt.	Counties	Total value of the projects	% value projects per county in national value projects
1	Bucharest	3,031,937,556	7.29
2	Cluj	2,912,718,734	7.01
3	Vrancea	2,004,209,893	4.82
4	Bihor	1,770,510,369	4.26
5	Tulcea	1,619,478,732	3.90
6	Bistrita Nasaud	1,582,581,477	3.81
7	Timis	1,421,968,003	3.42
8	Iasi	1,408,837,735	3.39
9	Constanta	1,361,184,831	3.27
10	Hunedoara	1,308,257,936	3.15
11	Galati	1,172,757,369	2.82
12	Dolj	1,112,598,274	2.68
13	Valcea	1,073,224,885	2.58
14	Prahova	1,010,027,627	2.43
15	Brasov	963,946,191	2.32

Source: Own determination based on REGIO data.

CONCLUSIONS

REGIO program is by far the most important financial tool for supporting the regional development in Romania. Its second phase, named REGIO 2014-2020 started to produce its effect since 2017. There are still many regions with significant socio-economic potential that accessed less than 100 project per county and regions that are situated above the regional average in terms of project numbers, but have a smaller value of the projects. While all the Romanian regions, excepting Bucharest – Ilfov region, suffered in the last years in terms of population trends, and recorded a slow increase of the GDP at region level, their development through large infrastructure projects is a condition for reducing the negative trends.

REFERENCES

[1]Beciu, S., 2013, Sustainable rural development. Current trends and perspectives of the North-Eastern Region of Romania, Ceres Printing House, Bucharest, pp.15-22.
[2]Beciu, S., Lădaru, R. G., 2013, Trends and Actual Issues Concerning Sustainable Regional Development in Romania, Study Case: The North East Region of Development, Scientific Papers Series Management, Economic Engineering in Agriculture and rural development, Vol. 13(2):27-30.
[3]Chew, Y.-T., Wai-Chung Yeung, H., 2001, The SME Advantage: Adding Local Touch to Foreign Transnational Corporations in Singapore, Regional Studies, 35:5, 431-448.
[4]Coe, N.M., Hess, M., Wai-Chung Yeung, H., Dicken, P., Henderson, J., 2004, Globalizing' regional development: a global production networks perspective, Transactions of the Institute of British Geographers, New Series, Vol. 29, No. 4 (Dec., 2004), pp. 468-484.
[5]Lădaru, R. G., Beciu, S., 2013, The SMEs sector in Romania: comparative study by economic sectors and regional level, International Scientific Meeting. Sustainable Agriculture and Rural Development in Terms of the Republic of Serbia. Strategic Goals Realization within the Danube Region, Preservation of Rural Values. Thematic Proceedings, December 6-8, 2012, 1273-1288.
[6] Lentz, S., 2020, Towards a Sustainable Future? Challenges for Regional Development and Innovation, Frühauf M., Guggenberger G., Meinel T., Theesfeld I., Lentz S. (eds) KULUNDA: Climate Smart Agriculture. Innovations in Landscape Research. Springer, Cham Switzerland, Seite 433-434, https://link.springer.com/chapter/10.1007/978-3-030-15927-6_31, Accessed on 17 Jan 2020.
[7]Massey, D., 1978, In what sense a regional problem?, Regional Studies 13, 233– 243, https://www.tandfonline.com/doi/abs/10.1080/09595237900185191, Accessed on 18 Jan 2020.
[8]Rodríguez-Pose, A., 2013, Do Institutions Matter for Regional Development?, Regional Studies, 47:7, 1034-1047.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

IMPLICATIONS OF THE NATIONAL AND EU LAWS CONCERNING THE AFRICAN SWINE FEVER ON THE ROMANIAN RURAL ECONOMY

Silviu Ionuţ BEIA[1], Mariana BRAN[2], Romeo Catalin Creţu[1], Iulian ALECU[1], Violeta Elena BEIA[3], Silviu Viorel ANDREI[1]

[1]The University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Mărăşti Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax:+40213182888, Mobile: +40 723 468 301, Email: beiaionut@yahoo.com, creturomeocatalin@yahoo.com, iulian_alecu_2000@yahoo.com, andreisilviuviorel@yahoo.com.
[2]The Academy of Economic Sciences, Bucharest, Romania, 6 Romana Square, Bucharest, Romania, Email: mariana_bran2004@yahoo.com
[3]The National Sanitary Veterinary and Food Safety Authority, Bucharest, Romania, Email: beia.violeta@ansvsa.ro

Corresponding author: beiaionut@yahoo.com

Abstract

The African swine fever (ASF) represents one of the most dangerous infectious diseases of swines, with often acute manifestations and high morbidity. It is widely known that the disease has become common among domestic pigs and also that there are no effective vaccines or treatments to fight the virus. Despite the fact that this issue benefits from an increased interest in the established international literature, as well as at the level of the European Union legislation, in Romania there is a reduced degree of academic, as well as legislative attention in this regard. Especially in the context of the outbreaks in Romania and in Bulgaria in the current year, there is a need for increased awareness at both levels, which should be reflected in new, substantive legislative measures to keep the phenomenon under control. The paper considers a comparative analysis between the EU legislation on the ASFV and that of Romania, in order to outline both the areas of improvement of the Romanian legislation and the influences on the rural economy. The present undertaking concludes with a series of personal reflections in this regard, pointing to future prospects for public policies in order to limit the spread of African swine fever virus.

Key words**:** *African swine fever, outbreaks in Romania, comparative legislative analysis*

INTRODUCTION

The African swine fever is known for being an acute, highly contagious and deadly disease of domestic pigs, wild boars and other members of the family Suidae [6]. According to the virulence of the virus, the disease can vary from peracute to chronic forms. In the peracute form, sudden death with unrelevant symptoms can be observed can be observed. The acute forms illustrate the following symptoms: high fever – ranging from 40.5- to 42°C-, depression and inappetence, coughing and increased respiratory rate, abortions, discharges from the eyes and nose, hyperaemia, cyanosis of the skin, particularly of the ears and snout (usually observed in white-coloured swines), vomiting and diarrhoea. Mortality usually occurs after 3 to 7 days and can reach 100%. The survivors will be life carriers of the virus. In the subacute forms, the same symptoms can be observed, however to lower extent and gravity, with abortions standing out as a constant, and mortality occuring within 2 to 7 weeks [6, 8]. In the chronic forms, the following symptoms can be observed: irregular fever, loss of weight, symptoms similar to pneumonia, pericarditis, necrosis and ulcers of the skin [9].

In terms of differential diagnosis with the classical swine fever, hemorrhagic lesions in ASF are much more severe than in classical swine fever. The appetite and general good condition tend not to be affected visibly in ASF until near the death of the animal, as opposed to the classical swine fever [2].

The paths of virus transmission can be either direct, through skin to skin contact between sick and healthy animals, or indirect, by feeding with domestic waste containing infected meat. The virus lasts 3-6 months in non-heat-treated infected meat products, as well as vehicles were the meat was stored, clothes that went in direct contact with such meat products. The sources of viruses are the blood, tissues, secretions or excretions of sick or dead animals; the animals that have gone through the disease (acute or chronic form) that remain virus-carrying; as well as ticks of the genus *Ornithodoros* [9].

Although it is widely known that no treatment or vaccine is available for the African swine fever, there are a series of prophylactic measures that help diminish the spread of the virus, such as: boiling the domestic wastes for an hour and a half –measure which results in the actual killing of virus (Trevor Drew cited in [7]), following the national and international guidelines concerning the use of biosecurity protocols, hygiene rules (use of showers and different clothing whenever in contact with any potentially infected animals), as well as end-to-end transportation and isolation measures to insure the lack of spread [6].

The international literature concerning the ASF has flourished in the last years, both in what concerns its epidemiological dimension and its essential economic impact [1, 3, 4, 10]. Although our country has been and still represents the subject of numerous outbreaks of the ASF, very few pieces of research have considered this topic particularly in the recent literature in Romania (for instance [14]) and virtually none in terms of a broad legislative analysis focused on diminishing the phenomenon.

On January 14th of this year, the African Swine fever was currently evolving in 246 localities in 25 counties in Romania, with 585 outbreaks (of which 8 outbreaks in commercial holdings and 2 outbreaks in type A holdings) [18]. The latest outbreaks were reported on January 11, 36 in number, according to the European Commission. The quantity of dynamic post-holes diminished by 24 from the past update. In other 11 regions, just instances of wild pig were analyzed. Since the foremost report of the nearness of the PPA infection in Romania, on July 31, 2017, 551 799 pigs influenced by the ailment have been yielded and 2 558 cases have been recognised as such in wild hogs. Altogether, 2334 episodes were stifled [16].

MATERIALS AND METHODS

The present paper looks at the general recommendations provided by the current EU legislation in force in regards to the African swine fever and the Romanian legislation in this direction, in order to identify the following:

-the main key points of action in terms of legislative initiatives to be taken both in our country and at the level of the EU

-the broad economical implications of the existing EU and Romanian legislation.

This undertaking only considers the recent developments in regards to the ASFV legislation and, thus, is not centered on a historical approach, but rather on a conceptual one.

RESULTS AND DISCUSSIONS

The most encompassing piece of legislation in regards to the African swine fever in the EU is the Council Directive 2002/60/EC of 27 June 2002 [5].

In this framework, the latest specific regionalization measures that have been taken with respect to evolution of the ASF situation in the EU are included in Commission Implementing Decision of 9 October 2014 (2014/709/EU) (as latest amended by Commission Implementing Decision (EU) 2020/15 of 9 January 2020) along with Commission Implementing Decision (EU) 2019/1334 of 7 August 2019 [5].

The document SANTE/7112/2015 has been created to set out the standards and criteria for the geographical and temporal characterization of the ASF, consisting in a regionalization tool. The document outlines the key procedures in the management of the African Swine Fever in the EU. The ASF strategic approach is intended to the EU

member states touched by the illness, as well as the member states which are considered far from the ailment, however with a minimum danger of come-back. It is proposed to forestall the spread of the illness and in the end to take out the sickness in the affected regions. The strategic approach which forms the basis of SANTE/7112/2015 was formed and renewed considering the most recent developments from EFSA and its acquired experience. These guidelines of the document are based upon:

-The provisions of Council Directive 2002/60/EC, and specifically of Articles 15 and 16 [5].

-Commission Implementing Decision (EU) 2018/1512 of 10 October 2018 amending the Annex to Implementing Decision 2014/709 / EU on zoosanitary measures on zoosanitary measures to fight the African swine fever in certain member states [5];

- Council Directive 90/667/EEC of 27 November 1990 laying down the veterinary rules for the disposal and processing of animal waste, for its placing on the market and for the prevention of pathogens in feedstuffs of animal or fish origin and amending Directive 90/425/EEC [5];

-Chapter IV(H) of the Annex to Commission Decision 2003/422/EC [5];

-the EFSA Scientific Opinion of the Panel on AHAW on the control and eradication of Classic Swine Fever in wild boar;

-the EFSA Scientific Opinion of the Panel on AHAW on African swine fever [5].

The EU enactment referenced here is completely in accordance with the OIE universal benchmarks. In any case, so as to guarantee a more elevated level of creature wellbeing assurance, the EU goes past the OIE necessities and applies stricter guidelines.

In Romania, the following laws are in force in what concerns the issue of ASFV:

-Government Decision no. 830/2016 for the approval of the National Program for surveillance, prevention and control of African swine fever, as well as for the completion of some normative acts and for the modification of the annex no. 3 to the Government Decision no. 1156/2013 for the approval of the sanitary-veterinary actions included in the Program of actions for the surveillance, prevention, control and eradication of diseases in animals, those transmitted from animals to humans, animal protection and environmental protection, identification and registration of cattle, pigs, sheep, goats and equidae, the actions provided for in the Food Safety Supervision and Control Program, as well as their tariffs [8].

- the Veterinary sanitary norm regarding the diagnostic procedures, the methods of sampling and the criteria for evaluating the results of the laboratory tests, for the confirmation of the classical swine fever from 04.12.2002 [19];

- Order no. 77 of August 15, 2005 (updated) for the approval of the Veterinary Sanitary Rule regarding the notification of animal diseases [11];

- Order no. 79 of September 18, 2008 for the approval of the Veterinary Sanitary Norm regarding the internal notification and the official declaration of transmissible diseases of the animals [12];

- Order no. 99 of April 26, 2006 (updated) for the approval of the Veterinary Sanitary Rule regarding the control of African swine fever [13];

- Romania's contingency plan for African swine fever; Foundation Note - GD no. 583/ 09.08.2017 [15];

- the National program for surveillance, prevention and control of African swine fever since 09.11.2016 [8];

- the project to modify the Order of the Ministry of Agriculture and Rural Development for establishing the size of pig farms on the territory of Romania [16];

- the draft amendment of N.S.V.F.S.A. and Ministry of Agriculture and Rural Development Order regarding biosecurity norms in pig holdings -will be adopted after the adoption of the MARD Order for establishing the sizing of pig farms. - Transitional period 4 months -implementation estimated on April, 2020 [16];

- the draft amendment of Government Decision for increasing the amount of fines for breaching the rules imposed by veterinary legislation [16];

- The National Disease Control Centre Decision no. 1/2019. Portable disinfection devices are installed at the entrance and exit of markets, vegetable and fruit fairs. Pig raising is prohibited in isolated areas like sheepfolds, forest cantons, etc. Traffic controls are being intensified. These checks are carried out by joint teams of three institutions: IPJ (police), IJJ (gendarmes), and DSVSA (local veterinary authority) [16].
- the draft of the Government Decision to approve measures for the surveillance, prevention and control of African swine fever among the wild boar population;
- Order for the approval of the sanitary-veterinary norm and for the food safety regarding the authorization, registration and control of the sanitary-veterinary laboratories and for the food safety in which laboratory testing and analysis activities are conducted (20.01.2020).
- Government Decision no. 830/2016 for the approval of the National Program for surveillance, prevention and control of African swine fever [8];
- Project of Government Decision for the completion of the annex to the Government Decision no. 830/2016 for the approval of the National Program for surveillance, prevention and control of African swine fever, as well as for the completion of some normative acts and for the modification of the appendix no. 3 to the Government Decision no. 1156/2013 for the approval of the sanitary-veterinary actions included in the Program of actions for surveillance, prevention, control and eradication of diseases in animals, those transmissible from animals to humans, animal protection and environmental protection, identification and registration of cattle, pigs, sheep, goats and equidae, the actions provided for in the Food Safety Supervision and Control Program, as well as their tariffs;
- the draft amendment of the Ministry of Agriculture and Rural Development Order for establishing the sizing of pig farms in the territory of Romania.

From its inception, the European legislation has focused on in-depth measures to narrow down and combat the African swine fever virus in its most detailed features, consisting of:

-enhanced traceability of both infected and clear of infection meats throughout the member states, especially in countries with high numbers of outbreaks – understood as end-to-end safety of transportation, real-time location of all vehicles carrying pork, as well as fixed routes, without any stops (Council Directive 2002/60/EC, and amending Directive 92/119/EEC as regards Teschen disease and African swine fever, curently updated with all the areas with outbreaks in Romania, as well as the other member states) – all of which have been approached by the Romanian legislation

-thorough hygiene and biosecurity norms (SANCO/7138/2013), understood as the following: introducing pigs only from certified sources in farms; training of all personnel regarding the importance of bodily hygiene, disinfection (showering prior and after farm entrance) and clothes' changing; perimeter fencing preventing contact with feral pigs (double fences preferable)

-ASF regionalization tools laying down the rules for classifying countries with different degrees of infection (SANTE/7112/2015), and currently updated through Commission Implementing Decision (EU) 2020/15 of 9 January 2020- making Romania a Part III country of the Appendix, thus with a high number of outbreaks

- financial support to countries affected by the ASFV - European Commission, Regulation (EU) No 652/2014
- forbiddance of pig entry or exit in farms where suspicions of ASFV cannot be infirmed, along with the possibility to further expand the interdiction to exit and to destroy rodents and insects that can spread the virus [Article 4, paragraph 4, letter c) of Council Directive 2002/60/CE]
- establishing a temporary control area around the holdings, where needed [Article 4, paragraph 3, letter b) of Council Directive 2002/60/CE]. In Romania, the protection area around outbreaks is of 3 kilometers, where the surveillance area is of 10 km [12]. This means that on a range of 3 kilometers all swines are to be sacrificed, and that none are allowed to

enter or exit for a range of 10 kilometers. The alert is lifted after 3 months if no other outbreak is observed [17].

As it appears, the Romanian legislation has developed many legislative initiatives and has managed to align itself with the European legislation in force in most key-points: enforcing strict hygiene and transportation norms, thorough quarantine rules in all areas with outbreaks and reimbursement of pig owners where needed. However, one aspect remains unaddressed by our country's legislation.

Raising pigs in non-professional establishments is a typical and conventional practice for the most part of the rural areas in Romania and this remains largely unregulated. This kind of raising has a significant place in the local rural practices, both cultural and economical. It offers significant amounts of meat supplies for people and it produces important earnings. Aside from that, countryside pigs are as often as possible sustained with scraps from the kitchen, just as with crisp grains and grass in summer. Be that as it may, swill nourishing is illegal in Romania and upheld by the national enactment. In any case, regardless of whether this is anticipated by the enactments, it is hard to control. Countryside pigs are not butchered in abattoirs, yet are butchered at home. This home butchering is normally performed around Christmas time or at whatever point new meat supplies are required. Customarily, pigs are exchanged either on free markets or by direct contact of the proprietor with potential clients. In this regard, there are no legislative measures to control or at least to influence the feeding practices of swines, as well as their slaughtering and commercialization. While any political measures in this regard will be highly unpopular, we consider them important in order to further limit the spread of the ASFV, as backyard pigs have been deemed as important sources of the virus.

Spain and Portugal are often mentioned as success stories of countries having overcome the ASFV. Both pride themselves with an intense indemnification of farmers –paying high amounts so that cases of ASFV are reported, swines are turned in and that the news is spread- and an equally intense collaboration with the EU and its member states. However, coincidentally or not, Spain is currently one of the countries whose swine population has been mostly auctioned or directly sold to meat producers. The fact that the country is considered reasonably far from serious outbreaks can be attributed to the fact that farmers have been determined formally or informally not to rear pings in non-commercial holdings.

In Romania, there would be a number of measures to be imposed to non-commercial or individual holdings like: following minimum biosecurity standards, acquiring swines only from authorized units, requiring documents for the buying and transportation of each swine, along with registration; and a closer collaboration with the local veterinary medical doctor.

All of these rules are thoroughly followed by commercial farms, but not in the least by non-commercial holdings.

However, as enforcing the abovementioned rules by law would be virtually impossible to track empirically, perhaps the legislators should consider the even more unpopular measure of forbidding pig rearing altogether.

In what concerns the very thorough quarantine norms imposed by our legislation and that of the EU, we consider them highly influential in what concerns the future of the pork industry in Romania. Since no animal passing is allowed in a range of 10 kilometers in surveillance areas, farms are equally confined on a range of 3 kilometers from an outbreak and birth rates remain equally high, the overpopulation of farms is inevitable. This has very important costs on the pork industry in Romania, as the meat in these farms remains uncapitalized.

Furthermore, the fact that Romania is on the Part III of the Appendix pertaining to Decision (EU) 2020/15 of 9 January 2020 has important consequences on our country's national brand, and does not enhance public knowledge of the phenomenon. Most importantly, it does not bring about direct benefits such as, for instance, a by-default right to funds for swine restocking. However,

since the European Commission Regulation (EU) No. 652/2014 is based on a thorough a system of cost reimbursements, seeking to streamline EU co-financing in this policy area up to 100% in case of activities countering serious human, plant and animal health risks, what our country could do is to further continue the efforts to restock the pig populations after the infection alert is lifted.
Naturally, this would imply a great financial effort from the authorities until the costs are being reimbursed under the European Commission Regulation (EU) No. 652/2014. However, it would be an important step in the repopulation of pigs after the powerful effect of the ASFV in Romania.

CONCLUSIONS

Our analysis has shown that while our country's legislation is well aligned to that of the EU in what concerns the spread of the ASFV, not the same can be said about the practice of non-commercial, individual holdings. Most likely, until pig rearing in private farms becomes either very strictly regulated or ultimately eliminated, the rapid evolution of the ASFV and decrease of the pig population remains imminent.
Additionally, further legislative efforts are needed to combat the overpopulation of farms and the diminishing quantities of pork reaching the markets as a result of restraining the access in and out of farms.
Romania's presence on Part III of the Appendix pertaining to the European Commission Regulation No. 652/2014 does not help our country in this regard, nor does it raise awareness around this issue, but is rather influential on our country's brand and access of local meats on the European markets in the future.
Last but not least, the opportunities offered by the European Commission Regulation No. 652/2014 provide for a framework of pig restocking, provided that the local authorities assume a significant indemnification of owners based on replacement after the alert is lifted.

REFERENCES

[1]Alvarez, J., Bicout, D., Boklund, A., Bøtner, A., Depner, K., More, S. J., Roberts, H., Stahl, K., Thulke, H.-H., Viltrop, A., Antoniou, S. E., Abrahantes, J. S., Dhollander, S., Gogin, A., Papanikolaou, A., Van der Stede, Y., Gonzalez Villeta, L. C., Gortazar Schmidt, C., 2019, Research gap analysis on African swine fever. EFSA Journal, 17(8): 1-60.
[2]Beltrán-Alcrudo, D., Arias, M., Gallardo, C., Kramer, S. A., Penrith, M. -L., 2017, African Swine Fever: Detection and Diagnosis. A manual for veterinarians. FAO Animal Production and Health Manual No. 19. Rome. Food and Agriculture Organization of the United Nations.
[3]Dixon, L. K., Sun, H., Roberts, H., 2019, African swine fever. Antiviral Research, 165: 34-41.
[4]Dixon, L. K., Escribano, J.M., Martins, C., Rock, D. L., Salas, M.L., Wilkinson, P.J., 2005, Asfarviridae, in Fauquet C. M., Mayo M.A., Maniloff J., Desselberger U., Ball L. A. (Eds.) Virus Taxonomy. VIII th Report of the ICTV. Elsevier/Academic Press, London, 135–143.
[5]European Commission, 2020a, African swine fever, https://ec.europa.eu/food/animals/animal-diseases/control-measures/asf_en. Accessed February 17th, 2020.
[6]European Commission, 2020b, Animal Disease Notification System (ADNS). Overview report from 01/01/2020 (updated frequently), https://ec.europa.eu/food/sites/food/files/animals/docs/ad_adns_outbreaks-per-disease.pdf, Accessed on Feb 1st, 2020
[7]Evans, I., 2020, African swine fever poses a serious threat to global food security, experts say, Elsevier online, https://www.elsevier.com/connect/african-swine-fever-poses-a-serious-threat-to-global-food-security-experts-say, Accessed on Feb, 1st, 2020.
[8]Government Decision no. 830/2016 for the approval of the National Program for surveillance, prevention and control of African swine fever, as well as for the completion of some normative acts and for the modification of the annex no. 3 to the Government Decision no. 1156/2013 for the approval of the sanitary-veterinary actions included in the Program of actions for the surveillance, prevention, control and eradication of diseases in animals, those transmitted from animals to humans, animal protection and environmental protection, identification and registration of cattle, pigs, sheep, goats and equidae, the actions provided for in the Food Safety Supervision and Control Program, as well as their tariffs (translated from Romanian in English). Available in Romanian at: https://cmvro.ro/files/download/legislatie/pesta-porcina-africana/HG-830-2016.pdf. Accessed February 17th 2020.
[9]Manolescu, N., Gherman, N., Drăgan, N., Mazdrag, F., Grigore, M., 2010, Practical diagnostic guide for veterinary practitioners - African swine fever (Ghid practic de diagnostic pentru medicii veterinari practicieni – Pesta porcină africană),

http://www.ansvsa.ro/download/ghiduri_-_toate/ghid_sanatate_animala/Animale-GHID-practic-de-diagnostic-pentru-medicii-veterinari-practicieni-pentru-Pesta-porcina-africana.pdf, Accessed on Feb, 1st, 2020.
[10]Miller, L. M., Gal, A., 2017, Cardiovascular System and Lymphatic Vessels, in Pathologic Basis of Veterinary Disease (Sixth Edition), Elsevier Saint Louis, 561-616.
[11]Order no. 77 of August 15, 2005 (updated) for the approval of the Veterinary Sanitary Rule regarding the notification of animal diseases (translated from Romanian in English). Available in Romanian at: http://www.ansvsa.ro/download/legislatie/legislatie_sanatate_animala/ordin-77-din-2005-notificare-boli_12870ro.pdf
[12]Order no. 79 of September 18, 2008 for the approval of the Veterinary Sanitary Norm regarding the internal notification and the official declaration of transmissible diseases of the animals. Available in Romanian at: http://www.ansvsa.ro/download/legislatie/legislatie_sanatate_animala/ordin-79-din-2008-notif-int_12876ro.pdf
[13]Order no. 99 of April 26, 2006 (updated) for the approval of the Veterinary Sanitary Rule regarding the control of African swine fever (translated from Romanian in English). Available in Romanian at: https://cmvro.ro/files/download/legislatie/pesta-porcina-africana/Ordin-ANSVSA%2099-2006.pdf.
[14]Petrovan, V., Turcitu, M., Matei, L., Constantinescu, V., Zaulet M., 2019, Genetic characterization of African swine fever virus in Romania during 2018-2019 outbreak, https://www.biorxiv.org/content/10.1101/2019.12.15.876938v1.full.pdf, Accessed on Feb, 1st, 2020.
[15]Romania's contingency plan for African swine fever; Foundation Note - GD no. 583/ 09.08.2017. (translated from Romanian in English). Available in Romanian at: https://www.gov.ro/ro/print?modul=subpagina&link=nota-de-fundamentare-hg-nr-583-09-08-2017.
[16]The National Sanitary Veterinary and Food Safety Authority of Romania, 2019, Epidemiological situation of ASF in Romania, SCOPAFF meeting 24-25.10.2019, https://ec.europa.eu/food/sites/food/files/animals/docs/reg-com_ahw_20191024_asf_rou.pdf, Accessed on Feb, 1st, 2020.
[17]The National Sanitary Veterinary and Food Safety Authority, 2019, Operational manual for intervention in African swine fever outbreaks (Manual operațional pentru interventia in focarele de pesta porcina africana), http://www.ansvsa.ro/download/man.oper_.plan_.contingenta/Manual-Operational-Pentru-Interventia-in-Focarele-De-Pesta-Porcina-Africana-Editia-4-2019.pdf, Accessed on Feb, 1st, 2020.
[18]The National Sanitary Veterinary and Food Safety Authority, 2020, Actualizarea situației privind evoluția Pestei Porcine Africane 14.01.2020 („Update of the situation regarding the evolution of the African swine fever 14.01.2020"), http://www.ansvsa.ro/blog/actualizarea-situatiei-privind-evolutia-pestei-porcine-africane-14-01-2020/, Accessed on Feb, 1st, 2020.
[19]The Veterinary sanitary norm regarding the diagnostic procedures, the methods of sampling and the criteria for evaluating the results of the laboratory tests, for the confirmation of the classical swine fever from 04.12.2002. (translated from Romanian in English). Available in Romanian at: https://lege5.ro/Gratuit/gqydimbs/norma-sanitara-veterinara-privind-procedurile-de-diagnostic-metodele-de-prelevare-de-probe-si-criteriile-pentru-evaluarea-rezultatelor-testelor-de-laborator-pentru-confirmarea-si-diagnosticul-diferent.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ENTREPRENEURIAL SKILLS EVALUATION OF SOCIAL BUSINESS ADVISORS IN THE EUROPEAN UNION

Nelly BENCHEVA, Teodora STOEVA

Agricultural University -Plovdiv, „Mendeleev”12, str., Plovdiv, 4000, Bulgaria, Emails: bencheva@gmail.com, teodorastoeva@gmail.com

Corresponding author: teodorastoeva@gmail.com

Abstract

Social entrepreneurship and social enterprises in the EU, as part of the social economy, are still an untapped business model, with its own specific features and characteristics. Social enterprises seek mainly support and consultations from experienced practicing business consultants and advisors who not only understand the social sector but also possess the necessary skills, qualifications and competencies to provide quality advice. The development of social entrepreneurship and social enterprises, led by entrepreneurial intentions but focused on social objectives, is a trend which is observed in the EU countries with a different level of economic development and specificity in legal systems. The development of the skills and competencies of business advisors aim to improve awareness and partnership relations with social enterprises. This development is based on the personal experience and achievements of business advisors, which it provides in the form of professional advice on a range of topics related to the social enterprises. The aim of this article is to explore the entrepreneurial skills evaluation, competencies, additional qualifications and training needs in terms of the gap between the current and the desired state of knowledge, skills and qualifications of the social business advisors in EU.

Key words**:** *social entrepreneurship, social enterprise, development*

INTRODUCTION

Social entrepreneurship is identified at European Union (EU) as a key instrument for regional cohesion and overcoming the problems of poverty and social exclusion. As part of its policy to promote the social economy and social innovation, social entrepreneurship contribute to achieving the strategic goals set in 2020 [6].

The promoting of the concept of social entrepreneurship is of a business activity, oriented not only to maximizing profit, but to achieving results related to the welfare of the whole community and to certain socially disadvantaged groups [4].

Social enterprises are created to achieve social objectives (overcoming social injustice and social inequalities of vulnerable groups of people or achieve important public goals in the fields of ecology and sustainable development) and subject its economic activity, in contrast goals of profit in favor of individuals. Social enterprises pursue a direct leading goal to create social benefits in the public interest or for their members. For the conditions in Bulgaria the investment in social entrepreneurship may become a key factor in providing employment and development of entrepreneurial initiatives leading to sustainable rural development. Social entrepreneurship is a paradigm that can be seen as one of the solutions to reduce poverty, migration, depopulation and retention of the working population in rural areas [3].

The research presents the results of a pilot study held in EU under the SESBA Project - Social Enterprise Skills for Business advisors.

MATERIALS AND METHODS

The current research is based on analyses of existing regulations, strategic documents and analysis of the development of social entrepreneurship in Bulgaria. The results of a pilot study under the Erasmus+ project "Social enterprise skills for business advisors" are used. The latter embrace a survey of opinions, evaluations and expert analyzes of representatives of various categories of organizations in expert and managerial positions. The collection of the primary data included a questionnaire survey to collect

information and data by using a face-to-face interview. 104 representatives of different types of organizations from the South Central Region, administrative district of Plovdiv were interviewed. The survey included representatives of small and medium-sized enterprises, social enterprises, training and non-governmental organizations which support social entrepreneurs or provide consultancy services on the following issues:

1.Types of organizations providing consulting to social entrepreneurs

2.Business advisory offered to social entrepreneurs

3.Supporting frame for social entrepreneurship start up

4. Social entrepreneurs needs for advisory.

The secondary data were extracted from official data, reports and official websites, etc.

RESULTS AND DISCUSSIONS

Assessing the need for training in different areas the respondents' answers emphasize management, strategic management, business planning, participation in funding programs, finances, fundraising, legal services and access to markets. The need for training in the field of marketing analysis, technology and participatory leadership is valued lower by respondents. The additions are oriented towards the need of training on the very essence of social entrepreneurship, social services, soft skills, ICT and communication skills, psychological trainings [1].

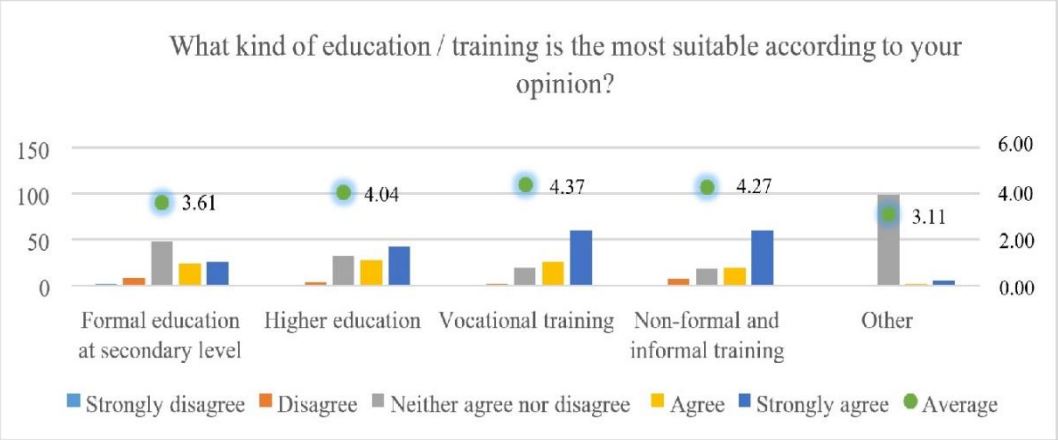

Fig. 1. Respondents' answer at the question: "What kind of education/training is the most suitable according to your opinion ?"
Source: Own calculation.

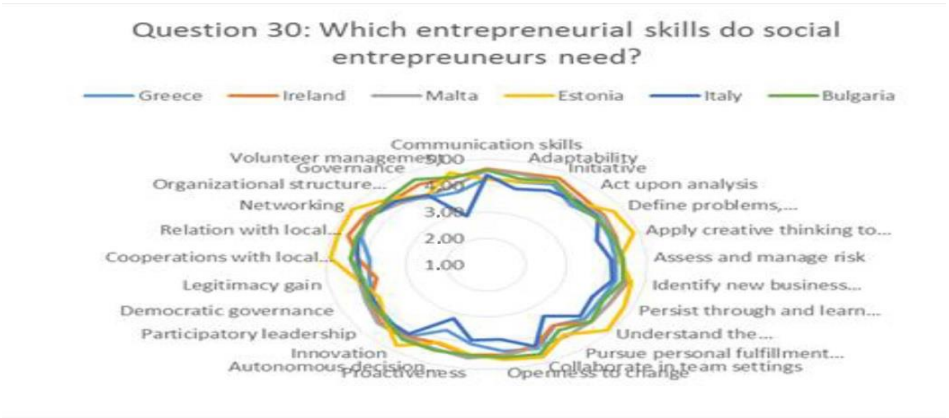

Fig. 2. Respondents' answer at the question: "Which entrepreneurial skills do social entrepreneurs need?"
Source: Own calculation.

Developing the entrepreneurial skills and competencies of social business advisors aim to improve awareness and partnership relations with social entreprises. This

development is based on the personal experience and achievements of business advisors, which it provides in the form of professional advice on a range of topics related to the social enterprises. The knowledge, competence, and awareness of the business advisors is the ability to understand the expectations of social entrepreneurs and to decide how these expectations should be met.

The main role of social business advisors in advising social entrepreneurs is an advisory role. Business advisors have responsibility for decision-making and management within the framework of their joint work. The main skills of social advisors targeted at social entrepreneurship could be presented as follows in Table 1 (SESBA O2, 2016) [1].

Table 1. The entrepreneurial skills and competencies of social business advisors in EU

Fields of knowledge	Specific knowledge of social entrepreneurship
Various types of advice	Advisory skills in social entrepreneurship
Business Management	Knowledge of business and management principles involved in strategic planning, human, material and financial resources allocation, leadership technique, coordination of people and resources.
Economics and Accounting	Knowledge of economic and accounting principles and practices, financial and banking markets, analysis and reporting of financial data, managing financial flows and budgets.
Customer and Personal Service	Knowledge of principles and practices needs assessment and customer satisfaction, achievement of quality standards.
Personal competences, interpersonal skills, digital skills	Active listening and listening ability, understanding of key issues, ability to ask questions; ability to use modern digital technologies for communication and interpersonal contacts and understanding; avoiding conflicts and inconsistencies.
Problem solving	Ability to identify complex social issues, evaluate options and implement solutions.
Analysis skills	Knowledge and skills to analyse the characteristics and requirements of the services or products needed to implement social projects and analyse the needs of the client / social enterprises. IT literacy.
Educational background and training	Social business advisors in the field of social entrepreneurship are highly qualified specialists from different business sectors. Their education and experience allows them to engage in advisory activities such as attorneys, accountants, marketing and management experts of social activities and others.

Source: Own research.

Social business advisors face a number of obligations and tasks when providing services to social enterprises. They should be aware of their role and scope within the social enterprise. A set of skills and qualifications are needed to enable the advisors to provide their services most effectively. The required skills and competencies vary depending on the nature of the consultancy services, but they are mainly focused on business management and business development [4].

The entrepreneurial skills and competencies of social business advisors intended for social entrepreneurs are focused on the effective management of a portfolio of clients participating in a variety of funded/sponsored schemes, programs and initiatives in order to help them and to support the creation and sustainability of their own business, assistance of business planning, business development and management, project management, training or mentoring.

The assessment of entrepreneurial skills in social enterprises ranges from good to very good for all of the skills listed in the following descending gradation: management; teamwork; initiative; communication skills; openness to change; innovation; organizational structure and culture; independent decision making; identifying new business opportunities; pro-activity; volunteer management; risk assessment and management; understanding the motivation and views of stakeholders; relation to local communities; cooperation with local authorities and institutions; networking; adaptability; creative thinking in vague problems; problem definition, opportunities

and solutions to create value; participatory leadership; resistance to and learning through mistakes; action after analysis; democratic governance; obtaining legitimacy; pursuit of personal realization as a member of a value-creating profession (Fig. 3).

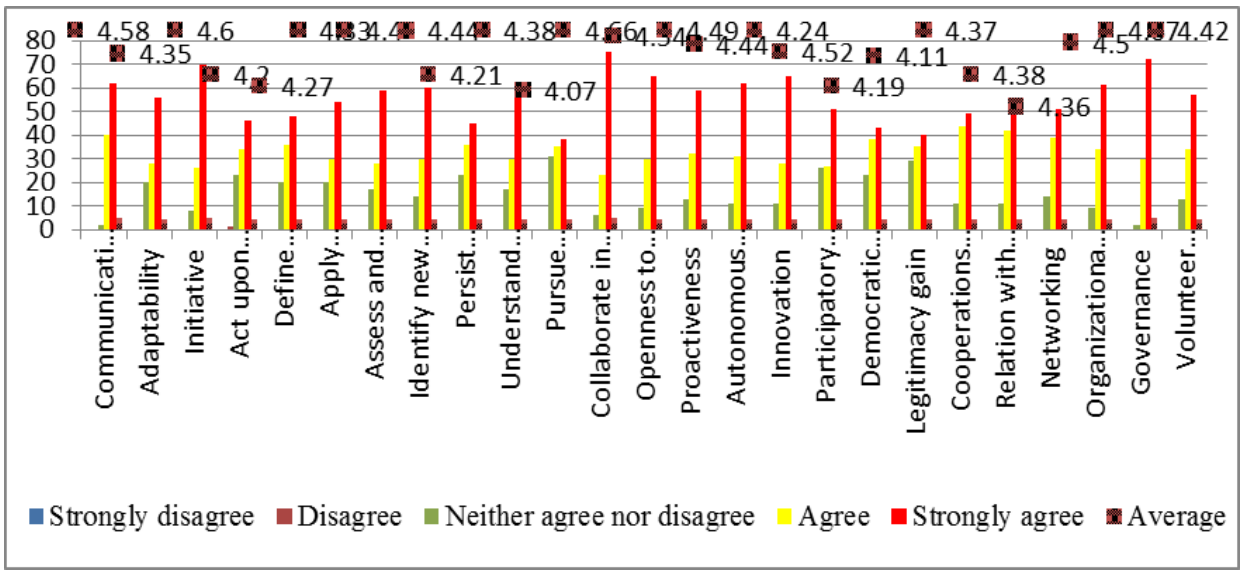

Fig.3. Need for entrepreneurial skills
Source: Own calculation.

The respondents stated that all forms of education (formal, informal and non-formal) are essential for developing entrepreneurial competencies [4].

In addition, the study set out the role of advisors in the training of employees in social enterprises, the realization of contacts and lasting relationships with social partners as well as the opportunities for development of social activities and communication. 66% of the respondents stated that they fully agree with specialized trainings in the field of social entrepreneurship. Vocational/professional training was the most appropriate according to the average assessments given by the respondents, followed by non-formal and informal education. In terms of higher and secondary education the fluctuations were greater [4].

The main content of the training is to understand the role of the business advisor in identifying the opportunities for improvement of services for social enterprises, development of professional networks in the field of social entrepreneurship. This will contribute to a better understanding of the expectations of social enterprises and will decide how these expectations need to be met [2].

CONCLUSIONS

In the European Union the majority of the social enterprises are of social enterprises for work and integration type. They aim to create employment and integration into the labor market of people with disabilities. The existence of long-term unemployment of certain social groups, the limitations of traditional policies on the labor market and the need for more active and innovative integration policy raise questions about the place of the social enterprises and the important role to play in tackling unemployment and promoting growth employment. In this way, the social enterprises promote the sustainable integration into employment of low-skilled unemployed who are at risk of long-term exclusion from the labor market [9].

Social enterprises have a key role in regeneration and economic development and in the promotion of social inclusion. Social enterprises operate in EU and developed traditionally as a means of providing employment and in the fields of education, social services and in rare cases, education, health and culture [10].

The social enterprises need additional capacity, as well as in the development of projects to bring additional funding, and the development of organizational capacity and strategic business planning. Further training in business planning, accounting, financial management, marketing, building partnerships and coalitions so on. Moreover, they need specialized advice in those areas.

Social enterprises need mainly support and advice provided by well-trained practicing business advisors who possess the necessary key skills, qualifications and competencies to provide quality advice for the development of social enterprises [8]. There is a strong need for trainings focusing on the acquisition of knowledge and entrepreneurial skills for social entrepreneurship, consultancy techniques and acquisition of soft skills. The problems in providing consultancy services to social enterprises are mainly due to the lack of information, knowledge and lack of adequate, timely and sufficient support, which, again, draws the attention to the need for specialized training for business advisors that covers a number of issues in the area of law, governance, economy and finance of social enterprise [5].

The support and promotion of social enterprises can contribute to maximizing their growth potential and capacity to create social added value, expressed in terms of job creation, creative approaches to small business, new opportunities for social inclusion [7].

ACKNOWLEDGEMENTS

This paper is prepared under the Erasmus+ Strategic Partnerships Project entitled SESBA: Social Enterprise Skills for Business Advisers, funded with the support from the European Commission. The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

REFERENCES

[1]Bencheva, N., Stoeva, T., 2019, The role of entrepreneurial skills in the development of social enterprises, KNOWLEDGE - International Journal Scientific Papers, Vol. 35.1. pp.289-292.

[2]Bencheva, N., Terziev, V., Stoeva, T., Arabska, E., 2016, Policies for encouraging social enterprises and improving skills for social entrepreneurship development in rural regions, Bulgarian Journal of Agricultural Economics and Management, Vol.2-4, p.116-129.

[3]Bencheva, N., Stoeva, T. Terziev, V., Tepavicharova, M., Arabska, E., 2017, The role of social entrepreneurship for rural development, Agricultural sciences, Vol.IX, Issue 21, pp.89-98.

[4]Bencheva, N., Stoeva, T., Todorova, S., 2018, Key Skills and Competences for Social Business Advisors: Views from Experts, International Journal of Organizational Leadership, 7, pp.413-425.

[5]Brutian, M.M., Vahromeeva, M.P., Bencheva, N., Stoeva,T. Terziev, V., et al, 2016,Problems of the modern economy, Monography, pp. 262.

[6]SESBA, 2013, IO1: Research Report about the status and reinforcement of social entrepreneurship in Europe. Final Report, http://sesbaproject.eu/images/sesbaproject/files/IO_1_FinalReport.pdf, Accessed on October 10, 2017.

[7]Terziev, V., Bencheva, N., Stoeva, T., Arabska, E., 2016, Social enterprises in Bulgaria. International Scientific Conference “Prospects of economic development in the global crisis”, Plovdiv, 27 June 2016, Scientific journal “Economics and finance”, pp. 63-74.

[8]Terziev, V., Bencheva, N. Arabska, E., Stoeva, T., Tepavicharova, M., Nichev, N., 2016a, Social Entrepreneurship in Bulgaria: barriers to growth. Ninth International Scientific Conference "The Teacher of the Future", 17-19 June 2016, Albania. KNOWLEDGE International Journal Scientific Papers Vol. 13.1. pp. 197-202.

[9]Terziev, V., Bencheva, N., Arabska, E., Stoeva, T., Tepavicharova, M., Nichev, N., 2016b, Implications on social entrepreneurship development in Bulgaria. Ninth International Scientific Conference "The teacher of the Future", 17-19 June 2016, Albania. Knowledge International Journal Scientific Papers, Institute for knowledge management, 13, N 1, pp.203-208.

[10]Terziev, V., Bencheva, N., Stoeva, T., Georgiev, M., 2020, Developing social entrepreneurship in the EU: A cress-country analysis, Proceedings of INTCESS 2020- 7th International Conference on Education and Social Sciences 20-22 January, 2020 - Dubai (UAE), pp. 746-753.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

MANAGEMENT OF THE GREEN WORLD BY PHOTOSYNTHESIS MODELING (REPORT OF THINKING AND COMPARATIVE SYNTHESIS)

Mihai BERCA

University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax:+40213182888, Mobile:+40722500620, Email: prof.mihai.berca@gmail.com

Corresponding author: prof.mihai.berca@gmail.com

Abstract

Photosynthesis is that primary reaction by which the first molecule of organic matter (glucose) from carbon dioxide and water is produced, in the presence of solar energy, in the form of photons, respectively electrons and protons (light wavelengths). Within 3 billion years, the mineral world has been partially transformed into the living world, including in green world, which works on biochemical synthesis using chlorophyll pigments, carotenoids and others. Today's biochemistry considers photosynthesis as a deterministic process, in which the chemical-mathematical equations of processes are well known, as a result of the thousands of researchers working in some of the most modern laboratories. In this paper, data are given on both the chemistry and the mathematics of the photosynthesis algorithm. Data are also presented on the efficiency of the first process of natural biochemical production at the Earth level, from which it results that the energy entered in the process of biosynthesis of photosynthesis through its acceptors is used in 100% percent, which doesn't happen with any other energy system. Researchers in quantum physics have observed this anomaly and have come to the conclusion that both the "photosynthesis" form, as well as other biochemical forms take place after a quantum morphogenesis whereby photons enter through the mass of the antenna on multiple paths, depositing as much energy as the system accepts.

Key words**:** *photosynthesis, chlorophyll, photons, antenna, quantum physics*

INTRODUCTION

Life forms of the different segments of life are almost identical, although they are found in systems and subsystems of distant life, distant from an evolutionary point of view.

We can see from Fig. 1 that human blood, plant chlorophyll, myoglobin and vitamin B12 possess almost identical chemical formulas, based on structural Heme-type skeletons, consisting of 5 pyrroles and centrally bound by a metal ion, which is usually Fe^{+++} for hemoglobin, myoglobin, vitamin B12 and Mg^{++} for chlorophyll. The plant and animal world are characterized by a magnificent unit. Porphyrin molecules give rise to magnesium leghemoglobin and iron hemoglobin. They are metallic multiprotein with very well-known functions, except for leghemoglobin from non-legumes. The almost identical form of the molecules structure, as well as their chemical and functional content, shows that the biological roots from which the evolution of life started were the same, identical, and also the way of using energy was almost identical.

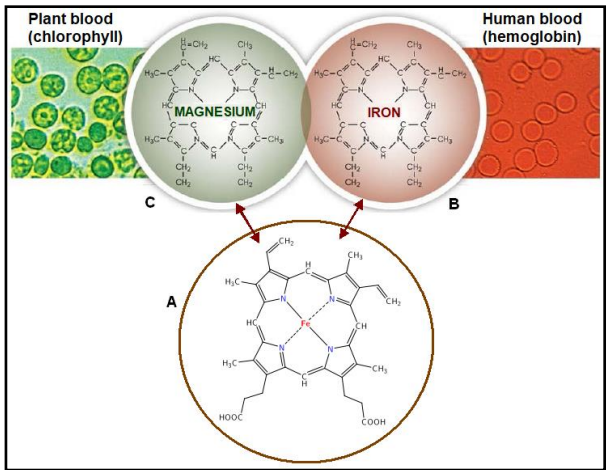

Fig. 1. Heme structural formula, expressing hemoglobin, myoglobin and leghemoglobin
Source: [8], [10].

Fig. 2 shows the transformation of the heme into hemoglobin, by adding on the radical from 2nd position of the "globin" protein complex, with the function of binding oxygen

to the lung area and transporting it into the body. Chlorophyll comes in several forms, the most important being chlorophyll a and b.

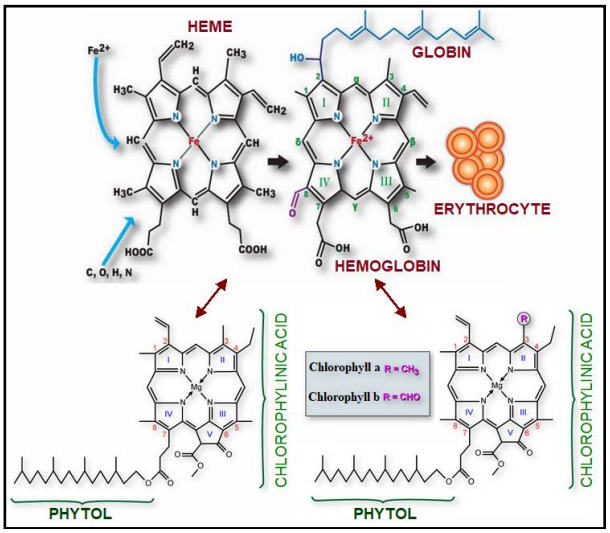

Fig. 2. Comparison between the forms of hemoglobin and those of chlorophyll
Source: [3], [9].

On the other side, an "O" radical is linked to a diterpene-alcoholic derivative product, called phytol (Fig. 3).

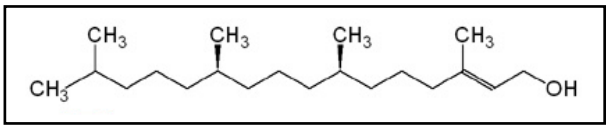

Fig. 3. Structural formula of phytol
Source: [9].

Phytol may have a longer chain, in which case it serves to stabilize the chlorophyll molecule and to facilitate the binding of H (H^+) protons, becoming an accelerator of this energy phenomenon in the reaction center of the antenna – the chlorophyll.

MATERIALS AND METHODS

This is a synthesis paper, which aims to show the important role of photosynthesis for life on Earth. In this regard, a series of recent scientific studies were used, in order to emphasize all the main characteristics of chlorophyll.
Quantum physics is in the middle of everything nowadays, so it has to be extended to this area of interest.

RESULTS AND DISCUSSIONS

It is important to know how chlorophyll is formed and which is the mathematical algorithm that supports it. Pyrroles are heterocyclic organic compounds, consisting of a ring formed by 5 elements or, mathematically, 5 forms which, together, lead to a macroform of type $C_4H_4NCH_3$, which we can call C1 (component 1). Geometrically, the mathematical macroform is distributed in space according to Fig. 4.

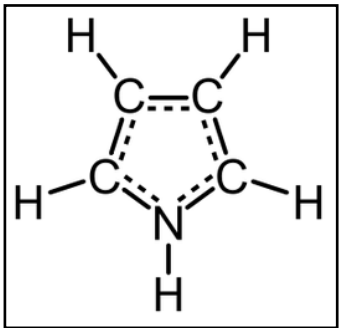

Fig. 4. Structural formula of pyrroles
Source: [14].

Pyrroles can be found in a variety of biological contexts, as parts or sub-forms of natural products. Pyrroles are in vitamin B12, in bile pigments (bilirubin and biliverdin), in the porphyrins of heme, in chlorophyll, in chlorine, bacteriochlorin (Wikipedia) and in many more. The synthesis of chlorophyll begins with this assembly of pyrol rings, which are formed from an organic acid, δ-aminolevulinic (ALA). ALA is synthesized from glycine and succinyl (CoA), by the process Knorr ALA (2 molecules) ring of hydrogenase by catalysis.
If we think mathematically, we find that the dynamic fragments that form the biochemical reactions lead to stable intermediate forms. These, under special catalytic conditions, evolve towards the heme and the chlorophyll complexes or, on the contrary, towards hemoglobin.
In its present form, except for the geometry that describes the structures of molecules in two- or three-dimensional space, any other branch of the present mathematics can't describe the nonlinear dynamics of heme and chlorophyll formation. At most, an algorithm

can be described. Chlorophyll formation has the following mathematical algorithm, simplified into a new form, called porphobilinogen (PBG) – Fig. 5.

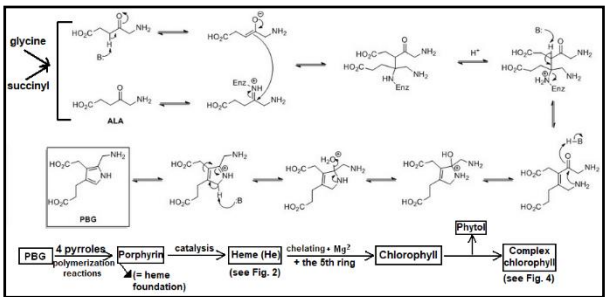

Fig. 5. Synthesis of chlorophyll and porphobilinogen (PBG)
Source: own processing [1].

The mathematical algorithm of the formation of chlorophyll (Ch) is a function of some nonlinear (chaotic) dynamic transformations – see chaos theory of Daniel Kahneman, in which the ordering is done through the intervention of quantum form theory.

$$Ch = f\left(\begin{matrix} glycine \\ \& \\ succinyl \end{matrix}\right) \xrightarrow{reaction} \underset{molecule}{ALA} \xrightarrow{DH\ (dehydrogenation)} + Enzyme \xleftrightarrow{H^+} Enzyme \rightarrow$$

$$\rightarrow Other\ nonlinear\ dynamics \rightarrow PBG\ (porphobilinogen) \xrightarrow{enzyme} Linear\ tetrapyrol \rightarrow$$

$$\rightarrow Uroporfirinogen \rightarrow Coproporfirinogen\ III \rightarrow Protoporphyrin \xrightarrow{chlorine} Protoclorofilide$$

It's all we know today. It is necessary for morphometrics, a new branch of modern mathematics or another mathematical science, which will develop soon, to be explained to us:

- → Why the starting substances in the biological synthesis of chlorophyll are succinyl glycine? Glycine is the lowest known amino acid, and succinyl is A coenzyme (succinyl - CoA).
- → Why is the citric cycle involved only for the extraction of succinyl CoA or there are other causes?
- → Why is the onset and progress of the reactions unpredictable?
- → Why the description of chlorophyll synthesis in plant chloroplasts hasn't been completely made so far? There are still many fractures in the process of biosynthesis not covered by experience and unexplained.

There are still numerous fragments, insufficiently studied forms, which correlate with thousands of environmental factors, biotic or abiotic, which modify biological reactions precisely because we lack a mathematically calculated confidence interval. The effect of chlorophyll is the photosynthesis, the greatest and most useful reaction of life [2], but it is not well known. First of all, it's impossible to explain why photosynthesis, respectively the chlorophyll, have such a high efficiency inside the system. Physicist Paul Davies [4] is very interested in the role of quantum in the living environment. In an article published in 2009 in "Physics World", based on the laws of nature, he considers that life is a miracle that cannot be conducted only after the known natural laws and that the sciences of life cannot be separated from quantum physics. Several physicists have accepted the same view, which is why:

- → It is required to be explained by contemporary biology in how and according to which mystery the prebiotic world could be transformed into life or made life over a 3-billion-year history in the absence of quantum hypothesis. Biological researchers can't explain why the enzymatic activity of cells is sometimes "down," and this phenomenon is not due to chemistry, although chemistry did not say the last word. Life is not only chemical, it is also quantum.
- → It is assumed that at the origin of life there is less or no chance, and that the miracle is in fact the permanent intervention of quantum processes, which allow molecules the possibility to find their way to life. Exit from the initial chaos to life is a quantum process.
- → It has been proven for a century that contemporary biology is a chemical biology. Huge and modern laboratories deal with biochemistry. Only a few researchers, called "dissidents", found the involvement of physics in the living environment.
- → They were marginalized.
- → The basic law with which quantum physics operates is the "law of quantum

coherence", discovered by Graham Fleming and ordered, at the level of living systems, by Gregory Scholes. Consistency is achieved when a photon interacts with at least 2 atoms in a very short interval, which limits the possibility of observing it. In this short period of time, the quantum system is in two states:

- ✓ If decoherence occurs, a real energy transfer takes place.
- ✓ If not, the proton and energy are lost.

Scholes et al. (1997) [11] used a particular protein called "antenna", extracted from cryptophytes, that is not independent of the chlorophyll universe. The antenna complex is, in fact, a protein chemical form, consisting of chlorophyll and carotenoid molecules, more developed in algae than in spinach, for example.

Protein plays a major role in chlorophyll, allowing the transfer of light energy to carboxynthesis devices. In a fraction of a second, marine algae containing the antenna can capture at least negligible and, at any rate, higher energy than standard chlorophyll and transmit it to biological forms of carbosynthesis.

To perform the operation, we can imagine that the photon needs to find its way to atoms very quickly. Otherwise, he and his energy are wasted in the environment. In conclusion, quantum coherence allows a new biological, ecological and economic horizon in capturing solar energy and introducing it into the system to increase the efficiency of photosynthesis.

Science Magazine, no. 1123/2011, argues that the significant improvement of the reactions in the chlorophyll formation process is due to the quantic, in which the catalytic enzymes are involved.

The photosynthetic capture of solar energy, its conservation and transformation at almost 100% would not be possible without quantum laws. The best solar collectors work in 20% efficiency (Fig. 6). It's about the energy coming into the system.

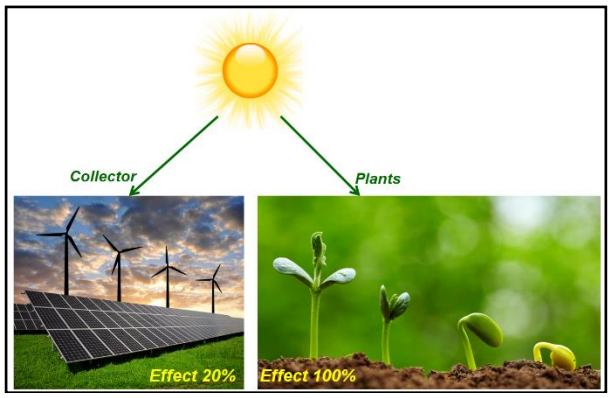

Fig. 6. Different energy effect at physical and biological collectors
Source: own processing.

Quantum laws allow the knowledge of a quantum form to have the ability to use multiple pathways at the same time, in order to optimize the transfer of light energy to cellular plants. In the quantum world an object, a form can be in several places at the same time, a superposition that allows it to use two paths at the same time. Applied to photosynthesis, it offers the faculty of excited electrons to be everywhere and to propagate in plants, using all possible pathways at the same time and without loss (Fig. 7).

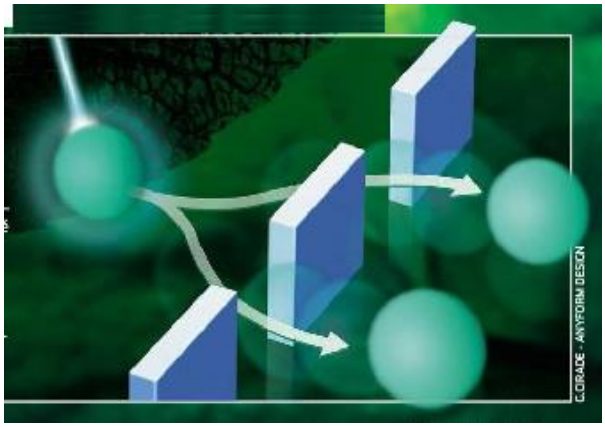

Fig. 7. Superposition of the doubling state of photosynthetic electrons
Source: Grousson M., 2011 [7].

When a photon repeats, it strikes a molecule, transmits its energy in the form of an electronic excitation and circulates transversely on and through the antenna, to a location where the reaction takes place, where 2 electrons are released to feed the chemistry of life. Chemists and biologists could not explain why, in its entirety, the photon energy comes to the reaction site, transforming the

photosynthetic system into the most efficient energy converter in the world.

In standard vision, the electronic excitation should propagate randomly into the antenna, each step being a danger of seeing a part evaporate in the form of heat or vibration. Not at all, and it has been demonstrated above. The difference between the standard knowledge and the quantum of the coherence is realized instead of the solar energy capture. This difference lies in the fact that the electronic excitation behaves as if it were using all the access paths at the same time. It is not magic, but simply quantum physics.

Due to very precise methodologies, physicists can make such overlays. It is not always certain that any plant or leaf or perhaps algae exploits this quantum magic perfectly. Experiences by Gregory Scholes suggest that this effect lasts abnormally long, namely 10-15 seconds, which is 4 times more than the coherence time observed for a single molecule. The system, however, works on the coherence model. Quantum effects are not felt on a macroscopic scale.

This intelligence of plants is one naturally accumulated by evolution, which the scientific society has only discovered in this decade of the 21st century. Practically thinking, the researchers consider it an algorithmic achievement, called the "quantum hazard market". Here is the key to the record yield of photosynthesis.

The next step after stabilizing the results is to convert the results to solar panels or other similar forms of solar energy retention and use. We note that Dugué B. (2012) [5] considers life as being described by 2 mechanisms: the process of chemical and molecular forms developed by mechanistic methodologies - which lead to good results, but cannot correctly explain the evolution of phenomena in their very small dimensions. Sheldrake R. (2007) [12] considers that these new forms appear in the morphogenetic fields and their explanation is done through a special mathematics, not yet elaborated as a way of working.

Mathematics is the science of forms, but in this case the forms become fractals and chaos [13] and they need the mathematics of quantum physics to be able to explain them. The observation and study of quantum forms uses first the theoretical thinking and only then the experimentation and results such as the existence of coherence, non-separability, tunnelling effect and interfaces. As a result, a new scientific hybrid emerges between chemists and physicists, which cannot be ignored.

In the case of photosynthesis, the antenna that purchases the photons takes care to send energy in the form of electrons ($2e^-$) or protons (H^+), where it is needed, either for organic synthesis or for energy conservation.

In the quantum vision, both photons and electrons are present on several pathways and on all acceptance sites, forming a cloud in which the energy utilization bodies are located. Let us not forget that the deconvolution of the proton in its energy forms takes place in chlorophyll (the reaction center) – Fig. 8.

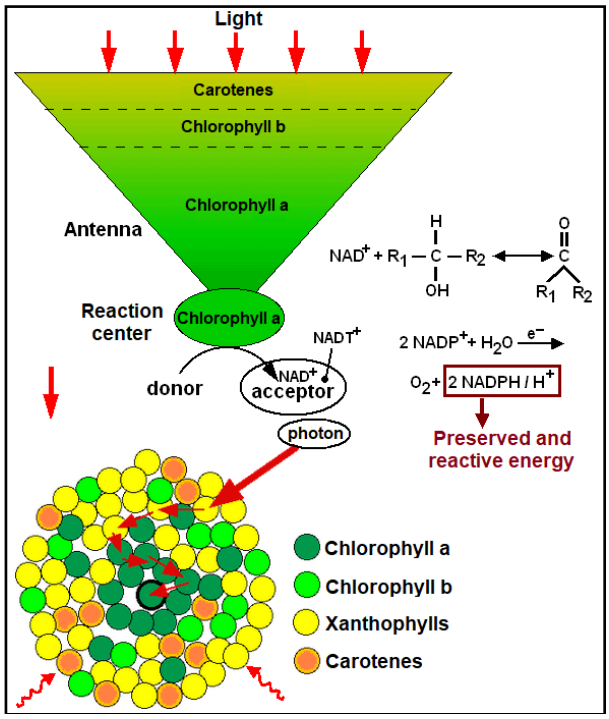

Fig. 8. Micro photosynthesis
Source: processing by CannaWeed [6].

The figure shows the role of the antenna, this mixture of various proteins and pigments to drain, through morphic resonance [12], the energy brought by the proton flow and received by several pigments, depending on the lengths of wave, and transmitted to the

chlorophyll molecule in the reaction center. In quantum interpretation, photons have several penetration pathways and therefore the efficiency of photosynthesis is 100%. The chemical form of photosynthesis is not deterministic.

CONCLUSIONS

1.Simple stringing of photosynthesis equations according to the models of biology textbooks is a good but insufficient didactic solution.

Partial equation, reaction to light:

$$12\ H_2O \rightarrow 24\ (H) + 6O_2$$

$$6\ CO_2 + 24\ (H) \rightarrow C_6H_{12}O_6 + 6\ H_2O$$

Partial equation, reaction to darkness:

$$12\ H_2O + 6\ CO_2 + 24\ (H) \rightarrow 24\ (H) + 6O_2 + C_6H_{12}O_6 + 6\ H_2O$$

$$= 6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$$

Concentrated equation:

$$= 6\ CO_2 + 12\ H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6\ H_2O$$

The equations presented and many other similar ones do not explain why things happen this way and if they happen this way.

2.Starting from the high energy efficiency inside the system, the mechanistic deterministic method of research and description, as well as the acquisition of photosynthesis, becomes insufficient.

3.Quantum physics, quantum morphogenesis of the photonic superposition explains the high speed with which the operations are carried out and their high efficiency in the system. Photons circulate in different planes and so do electrons and protons. In quantum physics no one stands in line to waste time. Therefore, it is said that nature is the best engineer, mathematician, physicist and chemist. Nothing that happens in human society resembles the perfection of nature and the simpler the organisms, the greater the stability of quantum systems.

REFERENCES

[1]Anonymous, Teorii moderne ale legăturii covalente (Modern theories of the covalent bonding), http://www.creeaza.com/referate/chimie/Teorii-moderne-ale-legaturii-c313.php, Accessed on 14th of January 2020.

[2]Anonymous, 2020, Ce este fotosinteza si cum se realizeaza aceasta?, Cultură generală, http://destepti.ro/ce-este-fotosinteza, Accessed on 14th of January 2020.

[3]Biodumbrava, 2017, Despre clorofila, avere si ignoranta (About Chlorophyll, Wealth and Ignorance), www.bioterapi.ro – Clorofila, https://biodumbrava.ro/blog-biodumbrava/DESPRE%20CLOROFILA%20-%20AVERE%20SI%20IGNORANTA, Accessed on 15th of January 2020.

[4]Davies, P., 2009, The quantum life, Physics World, Vol. 22, Issue 7, Iuly 2009, pag. 24-29.

[5]Dugué, B., 2012, La physique quantique appliquée à la biologie (et bientôt au biomagnétisme?), http://www.agoravox.fr/actualites/technologies/article/la-physique-quantique-appliquee-a-124767, Accessed on 13th of January 2020.

[6]Evergreen, 2007, La culture sous led ou l'avenir des ampoules économiques, www.cannaweed.com, 27.05.2007, https://www.cannaweed.com/forums/topic/55961-la-culture-sous-led-ou-lavenir-des-ampoules-économiques/, Accessed on 15th of January 2020.

[7]Grousson, M., 2011, La vie serait quantique!, Science & Vie, no. 1123, 04/2011, Paris, pag. 54-73.

[8]Legendre, P., Legendre, L., 1998, Numerical Ecology, 2nd English Edition, Elsevier Science B.V., Amsterdam, Netherlands.

[9]Marengo-Rowe, A.J., 2006, Structur-functions relations of human hemoglobins, Baylor University Medical Center Proceedings, Vol. 19, Issue 3, pag. 239-245.

[10]Padalia, S., Drabu, S., Raheja, I., Gupta, A., Dhamija, M., 2010, Multitude potential of wheatgrass juice (Green Blood): An overview, Journal of Postgraduate Medicine, Vol. 1(2):23-28.

[11]Scholes, G.D., Harcourt, R.D., Fleming, G.R., 1997, Electronic Interactions in Photosynthetic Light-Harvesting Complexes: The Role of Carotenoids, J. Phys. Chem. B., Vol.101, Issue 37, pag. 7302-7312.

[12]Sheldrake, R., 2007, Rezonanta morfică. O nouă ştiinţă a vieţii, Ed. Firul Ariadnei, Bucureşti (Morphic resonance. A new science of life. Firul Ariadnei Publishing House, Bucharest).

[13]Stewart, I., 1999, Numerele naturii: Ireala realitate a imaginaţiei matematice, Ed. Humanitas, Bucureşti (Nature's numbers: The unreal reality of mathematical imagination, Humanitas Publishing House, Bucharest).

[14]Wikipedia the free encyclopedia, Pyrrole, http://en.wikipedia.org/wiki/Pyrrole, Accessed on 14th of January 2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

VARIABILITY OF YIELD TRAITS IN A GERMOPLASM OF BARLEY CULTIVARS, STUDIED AT TURDA AGRICULTURAL RESEARCH AND DEVELOPMENT STATION, CLUJ COUNTY, ROMANIA

Emilia-Ancuța BOANTA[1], Leon MUNTEAN[1], Florin RUSSU[2], Ioana PORUMB[2], Raluca-Maria PARLICI[1], Andreea-Daniela ONA[1]

[1]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania, 3-5 Manastur, Cluj-Napoca, 400372, Romania, Emails: ancuta.boanta@usamvcluj.ro, lmuntean@usamvcluj.ro, andreea.ona@usamvcluj.ro
[2]Turda Agricultural Research and Development Station, 27 Agriculture Street, Cluj County, Romania, Phone: +40 0264 311 680, Emails: florin.russu@scdaturda.ro, ioanaporumb18@yahoo.com

Corresponding author: andreea.ona@usamvcluj.ro

Abstract

Barley (Hordeum vulgare) is one of the essential cereal crops for humankind, the harvested area with barley ranks the 3rd place regarding grains cereals, after wheat and rice. The yield potential of barley, trait with complex genetic determinism, represents the maximum level of biomass which a genotype can realize under optimal conditions of growth and development as well as in an environment free of diseases, pests and weeds. The inheritance of quantitative traits involves a large number of genes which act additively in determining the character. To increase the yield potential of barley varieties, the present paper studied three traits which are involved in yield: spike length, grain weight/spike and grain number/spike that on 22 cultivars of barley, in ecological condition of ARDS Turda. Significance of the sample F for the genetic factor and interaction between the year and the genotype, for all three studied traits, reflects the fact that between those the 22 distinct genotypes there are very significant differences, which can be used in breeding programmes. As genitors for breeding programmes we can use cultivars Daciana, Romaniţa and To 2170/01 for spike lenght, cultivars Turdeana, Aura, Daciana and Xanadou for grain weight/spike and cultivars Turdeana and Adina for grain number/spike. The correlations between the three studied traits, which influence the barley yield, were positive, statistically assured, allowing their simultaneous improvement in the breeding programs.

Key words**:** *barley, yield traits, cultivars, spike, correlations, variance, genotype, interaction genotype year*

INTRODUCTION

Among the oldest cultivated plants [2], [9], [15], barley (*Hordeum vulgare*) is one of the essential cereal crops for humankind [5], [12]. Worldwide, the harvested area with barley ranks the 3rd place regarding grains cereals, after wheat and rice, reaching 47 million hectares. In Europe, barley is the 2nd most widespread cereal crop following wheat, exceeding 2 million hectares. Barley in Romania is the 2nd most cultivated grain cereal after wheat, with a harvested area of 455 thousand hectares and total grain production of 1.9 million tonnes [4].

Barley has wider uses in animal feed and beer industry, but also in human nutrition where it can be consumed in the form of crumps, flour, and malt [16]. In addition to these achievements, another important use of this crop is in agriculture, because it liberates the field early, it contributes to the reduction of the weeds, allows the sowing of successive crops and is a good precursor for most spring crops [2]. Winter barley is superior yielding than spring barley, but the latest is better for malting and brewing quality. Nevertheless lately, also the winter barley crops are encouraged to be use for brewing industry because of their yield stability under the global warming effects [3], [7].

On the global scale, the average yield for barley crops was 3,136 kg ha-1 [4], but the world record of 13,800 kg ha-1 was set by a New Zealand farmer in 2015 [8]. The yield potential, trait with complex genetic determinism, represents the maximum level of biomass which a genotype can realize under optimal conditions of growth and development as well as in an environment free of diseases, pests and weeds [14]. The inheritance of quantitative traits involves a

large number of genes which act additively in determining the character. Quoting [10], the main aims in barley's breeding are represented both by the increase of the quality assumptions concomitant with the high production of grains, as well as of other qualities related to the variety [1].

In major barley-growing countries like Germany, grain yield of winter barley has been increased in the last decades by ca. 70 kg ha^{-1} each year. This progress recorded due to the use of haploid method in lines breeding. Besides this, more recently, the marker-assisted selection allows an efficient association of genes or loci for improving varieties quality and enhancing resistance to different pathogens. Nowadays, the exploitation of the heterosis phenomenon using hybrid breeding, leads to a higher yield potential in barley hybrid varieties [6]. Together, breeding and crops technologies are able to fulfil the requirements of barley growers and beer industry [11].

The present paper presents some of the yield components that can be improved by breeding techniques to increase the yield potential of varieties.

MATERIALS AND METHODS

In plant breeding programs, both variability and stability of morpho-productive traits are important requirements in choosing the most accurate genitors. In order to identify barley parents, useful for the future breeding programs, in this study we proposed the evaluation of some agronomic traits of the yield in a series of Romanian and foreign barley genotypes, in two experimental years 2017 and 2018. The experience was placed at ARDS Turda, according to the randomized blocks method in three repetitions, each experimental plot had an area of 14 m^2 and the harvestable area of 10 m^2. For this experience we have chosen 22 cultivars, and the main biometric features were the length of the spike, the weight and the number of grains per spike. Polifact and Excel were used for the processing of the experimental data, and the standard formulas for statistical calculation were used for the variability parameters.

RESULTS AND DISCUSSIONS

The length of the spike is an important feature of a barley yield, which is less affected by the climatic factors, as is proved by F sample, not statistically assured for this factor. Significance of the sample F for the genetic factor reflects the fact that between those the 22 distinct genotypes there are very significant differences, which can be used in breeding programmes. Also, the interaction between the two years of culture and genotypes are very important, as evidenced by the significance of the sample F for the interaction between the two factors (Table 1).

Table 1. Analysis of variance for spike length, grain weight/spike (g) and grain number/spike (Turda 2017 - 2018)

No.	Source of variability	SS	DF	s^2	F	SS	DF	s^2	F	SS	DF	s^2	F
	Trait	Spike length (cm)				Grain weight/spike (g)				Grain number/spike			
1	Total	75.44	129			5.61	131			1,859.24	131		
2	Years (Y)	17.45	1	17.45	10.11	1.97	1	1.97	24.99*	400.75	1	400.75	45.76 *
3	Genotype (G)	27.85	21	1.33	6.76***	1.74	21	0.08	8.62***	664.57	21	31.64	5.02 ***
4	Y x G	10.21	21	0.49	2.48***	0.91	21	0.04	4.51***	241.24	21	11.48	1.82 *
5	Error (A)	3.45	2	1.73		0.15	2	0.07		17.51	2	8.75	
6	Error (G)	16.48	84	0.20		0.80	84	0.00		529.09	84	6.29	

Source:original, obtained through the statistical program.

Earlier, we mentioned that the climatic factors show a less eloquent influence on the spike length, but if we analyse the data presented in Table 2, it can be observed that almost all genotypes recorded higher values of this trait in 2018 compared to 2019, excepting Capriana cultivar. In fact, in 2017, the only genotype that registered statistically assured differences was the Romanian cultivar Daciana. This cultivar is also distinguished by a high stability of this trait, recording the same values in both experimental years, the

values being above the average of the years. The Romanian Romaniţa cultivar, can be considered a good genitor for improving this trait, because it has registered the highest average value for this trait. Alongside this cultivar, the To 2170/01 line is noted, which ranks second on the average of this trait. From the values of the coefficients of variation for this trait it is noted that between the analysed variants there is a small to medium variability, the useful part of this variability lies between the values medium and maximum (Table 2).

Table 2. Behaviour of genotypes in the two experimental years and indicators of variability for spike length

Genotype	Spike length (cm)		Spike length (cm)		Variability indicators
	2017	2018	2017	2018	
Control	8.03	8.76	0.00	0.00	Year 2017 The coefficient of variation = 5.5% Minimum = 7.33 Maximum = 9 Sample variance = 0.20
Turdeana	8.33	9.33	0.30	0.58	
Aura	8.00	9.00	-0.03	0.24	
Daciana	9.00	9.00	0.97**	0.24	
Romaniţa	8.67	10.00	0.64	1.24***	
Capriana	8.67	8.33	0.64	-0.42	
Jubileu	8.33	9.00	0.30	0.24	
To 2027/10	8.00	9.00	-0.03	0.24	
To 2172/01	7.33	8.00	-0.70	-0.76^{0}	
To 2170/01	8.33	10.00	0.30	1.24***	
Marthe	7.33	7.67	-0.70	-1.09^{00}	
Vienna	7.67	9.00	-0.36	0.24	Year 2018 The coefficient of variation = 7.25% Minimum = 7.67 Maximum = 10 Sample variance = 0.40
Sulilly	7.67	8.67	-0.36	-0.09	
Tatum	8.00	9.33	-0.03	0.58	
Odyssey	7.67	9.00	-0.36	0.24	
Chronicle	7.67	8.00	-0.36	-0.76^{0}	
Concerto	8.00	8.67	-0.03	-0.09	
Sidney	7.67	8.00	-0.36	-0.76^{0}	
Steward	8.00	9.00	-0.03	-0.24	
Belgravia	8.00	8.00	-0.03	0.76^{0}	
Xanadou	8.67	8.67	0.64	-0.09	
Armada	8.00	8.00	-0.03	-0.76^{0}	
Salome	7.67	9.00	-0.36	0.24	
LSD (5%)0.72 LSD (1%) 0.95 LSD (0.1%) 1.23					

Source:original, obtained through the statistical program.

Along with the number of spike per unit area, the weight of the grains/spike is a trait that greatly determines the level of yield. By the fact that the process of formation and filling of the grains lasts a considerable period of time, respectively from a few days from the anthesis to the physiological maturity, it is very much influenced by the climatic conditions. Also, the expression of this trait is closely related to the technological factors (fertilization, sowing times and density, respecting the phytosanitary protection measures etc.). The many factors involved in controlling this trait greatly reduce the contribution of heredity to phenotypic expression. Moreover, the values of the variance corresponding to the factor year (s2 = 1.97), support the previously stated regarding the involvement of the environment in the phenotypic expression of this trait. The values of the sample F suggest that between the 22 variants analysed there are very significant differences and in interaction with the year they have manifested very differently (Table 1).

The fluctuations of the individual values of the genotypes from the two experimental years together with the parameters of the annual variability (mean, minimum and maximum, the coefficient of variation and variance), stand out the major role of the environment in the phenotype of the grain weight/spike (Table 3). The highest values of this trait belong to the Romanians cultivars Turdeana and Daciana and the western European cultivar Xanadou in 2017, and in 2018 the first three places belong to the three ARDS Turda cultivars: Turdeana, Aura and Daciana. Of the tested genotypes, the cultivar Turdeana is particularly noteworthy, that in both experimental years recorded values beyond control, in 2018 the differences from the average being very significant positive. In a quite similar trend is registered the Aura cultivar, with the mention that it behaved above average only in 2018, the differences

being very significant. Turdeana and Aura cultivars are the first two genotypes created at ARDS Turda being obtained from a biological material from very different areas with a high ecological plasticity. The two varieties have a high plant height and are prone to fall under very favourable conditions but under less favourable conditions they react quite positively. We could recommend that these two crops be destined or used by those farmers who practice organic farming.

Table 3. Behaviour of genotypes in the two experimental years and indicators of variability for grain weight/spike

Genotype	Grain weight/spike (g)		Difference		Variability indicators
	2017	2018	2017	2018	
Control	1.29	1.04	0.00	0.00	Year = 2017 The coefficient of variation = 6.8% Minimum = 1.14 Maximum = 1.42 Sample variance = 0.00
Turdeana	1.41	1.67	0.13	0.63***	
Aura	1.22	1.38	-0.06	0.34***	
Daciana	1.42	1.12	0.14	0.08	
Romanița	1.37	1.11	0.08	0.07	
Capriana	1.32	0.94	0.04	-0.10	
Jubileu	1.41	0.90	0.13	-0.14	
To 2027/10	1.31	1.08	0.02	0.04	
To 2172/01	1.20	0.96	-0.09	-0.08	
To 2170/01	1.33	1.07	0.05	0.03	
Marthe	1.15	1.08	-0.14	-0.25^{00}	
Vienna	1.19	0.86	-0.10	0.04	Year 2018 The coefficient of variation = 17.34 % Minimum = 0.86 Maximum = 1.67 Sample variance = 0.03
Sulilly	1.16	1.09	-0.12	-0.18^{0}	
Tatum	1.28	0.97	-0.01	0.05	
Odyssey	1.14	1.00	-0.15	-0.07	
Chronicle	1.26	1.01	-0.03	-0.04	
Concerto	1.27	0.96	-0.01	-0.03	
Sidney	1.26	1.00	-0.03	-0.08	
Steward	1.29	1.01	0.00	-0.04	
Belgravia	1.33	0.88	0.04	-0.16^{0}	
Xanadou	1.41	1.06	0.12	0.02	
Armada	1.35	1.07	0.06	0.03	
Salome	1.19	0.92	-0.10	-0.12	
LSD (5%)	0.16	LSD (1%)	0.21	LSD (0.1%)	0.27

Source:original, obtained through the statistical program.

Table 4. Behaviour of genotypes in the two experimental years and indicators of variability for grain number/spike

Genotype	Grain number/spike		Difference		Variability indicators
	2017	2018	2017	2018	
Control	25	21	0.00	0.00	Year 2017 The coefficient of variation = 6.64% Minimum = 22 Maximum = 27 Sample variance = 2.80
Turdeana	27	27	2.67	6.15**	
Aura	25	28	0.33	6.82**	
Daciana	27	24	2.67	2.48	
Romanița	27	23	2.33	2.15	
Capriana	25	21	0.33	0.15	
Jubileu	24	19	-0.33	-2.52	
To 2027/10	26	23	1.67	1.48	
To 2172/01	24	22	-0.67	0.82	
To 2170/01	27	21	2.33	-0.18	
Marthe	23	14	-1.67	-7.52 ^{000}	
Vienna	25	21	0.00	-0.52	Year 2018 The coefficient of variation = 15.25 % Minimum = 14 Maximum = 28 Sample variance = 10.91
Sulilly	22	18	-2.33	-3.18	
Tatum	25	21	0.00	0.15	
Odyssey	22	19	-2.33	-2.18	
Chronicle	24	20	-0.33	-0.85	
Concerto	24	22	-0.67	1.15	
Sidney	23	18	-2.00	-2.85	
Steward	24	16	-0.67	-5.52^{00}	
Belgravia	25	20	0.67	-1.18	
Xanadou	27	24	2.00	2.48	
Armada	24	25	-1.00	3.82	
Salome	22	20	-3.00	-1.18	
LSD (5%)	4.08	LSD (1%)	5.40	LSD (0.1%)	6.98

Source:original, obtained through the statistical program.

The number of grains/spike is one of the important trait of the production, being closely related to the number of rows, the length and the density of the spike. The values

of the F sample reflect the important contribution of the genotype factor in the expression of this trait, being followed by the year factor but also by the double interaction between the year and the genotype (Table 1).
The number of grains/spike were higher in 2018 than in 2019. The coefficient of variation of 6.64 indicates a small variability for the analysed genotypes, but there are differences between minimum (22) and maximum (27), which can allows selection for genotypes with a large number of grains (table 4). The data are also underlined by another study conducted by Russu et al. [13], carried out in two experimental years (2016, 2017) on 185 genotypes of spring barley, number of grains/spike presented a coefficient of variation of 8%, with minimum and maximum values between 20 and 31 grains/spike. At the level of 2018, the value of coefficient of variation is 15% indicated moderately variability and the values between the smallest minimum (14) and maximum (28) makes possible identification of genitors for this trait breeding. The Turdeana and Adina cultivars show the highest values for these traits in both experimental years, with significant difference compare to control.
As it is known, in any breeding programme are studied morphological and physiological traits of the plant, easily observable, which influence the yield as well as its quality. Identifying the correlations between these elements is very important in breeding work, to facilitate the selection process of the most valuable genotypes and reduce the time of obtaining the new cultivation. From a theoretical point of view, the study of correlations is noted by the possibility to combine in a modern mathematical methodology, biometric aspects of plants, moving from subjective observations to exact quantitative expression.

Table 5. Phenotypic correlation between yield traits of barley

Trait	grain weight/speak	speak length
grain number/speak	0.86***	0.57**
grain weight/speak	-	0.60**

Source:original, obtained through the statistical program.

CONCLUSIONS

For barley cultivars studied at ARDS Turda, the environment had an important influence on the weight and the number of grains per spike. Significance of the sample F for the genetic factor and interaction between the year and the genotype, for all three studied traits, reflects the fact that between those the 22 distinct genotypes there are very significant differences, which can be used in breeding programmes.
As genitors for breeding programmes we can use cultivars Daciana, Romaniţa and To 2170/01 for spike lenght, cultivars Turdeana, Aura, Daciana and Xanadou for grain weight/spike and cultivars Turdeana and Adina for grain number/spike.
The correlations between the three studied traits, which influence the barley yield, were positive, statistically assured, allowing their simultaneous improvement in the breeding programs.

REFERENCES

[1]Boantă, E.A., Porumb, I., Russu, F., Filip, E., Muntean, L., Ona, A.D., 2019, Variability Of Some Productive Traits Of Two-Row Spring Barley In The Conditions Of ARDS Turda, Agricultura, 109(1-2):8-13.
[2]Capettini, F., Grando, S., Ceccarelli, S., 2010, Barley Breeding History, Progress, Objectives, and Technology, pp.158-218.
[3]Deudon, O., Treut H., Janovici, J.M., Pararnoud, V., Calvet, J.Ch., Rosenzweig, C., Dellecoll, R., 2001, Changements Climatiques, Quelles Consequences pour l'Agriculture, Persp. Agric., 266:44-61.
[4]Faostat, http://www.fao.org/faostat/en/, Accessed in February 10, 2020.
[5]Friedt, W., 2010, Barley: Production, Improvement, and Uses, 158-218.
[6]Friedt, W., Ordon F., 2013, Barley Production and Breeding in Europe: Modern Cultivars Combine Disease Resistance, Malting Quality and High Yield, In book: Advance in Barley Sciences, pp. 389-400.
[7]Lalic, A., Simic ,G., Kovacevic, J., Novoselovic, D., Horvat, D., Abicic, I., Lenart, L., Mijakovic, R., Ugarcic-Hardy, Z., 2010, Analysis of Grain Yield and Cytolytic Degradation of Winter and Spring Barley Cultivars, Not. Bot. Hort. Agrobot, Cluj, 38(1):88-91.
[8]Muntean, L., Ona, A., 2019, Ameliorarea plantelor: Partea specială, Editura AcademicPres (Plant Improvement: Special Part, AcademicPres Publishing House), Cluj-Napoca, pp.46-54.

[9]Porumb, I., Rusu, F., Boantă, A., Filip, E., Tritean N., Stancă-Moise C., Muntean L., 2019, Choosing The Genitors - An Important Measure In Making The Breeding Works Better At The Spring Barley, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(1): 471-476.
[10]Potlog, A.S., Nedelea, G., Cărăuș, V., 1980, Genetica și ameliorarea calității plantelor agricole, Editura ştiinţifică şi enciclopedică, Bucureşti (Genetics and quality improvement of agricultural plants, Scientific and Encyclopedic Publishing House, Bucharest), pp.45-66.
[11]Pržulj, N., Momčilovi, V., 2006, Barley breeding for yield and quality, Glasnik Zaštite Bilja, 29(1):57.
[12]Russu, F., 2015, Studiul unor cultivare de orz de primăvară cu două rânduri în sistem concurențial și neconcurențial, Teză de doctorat (The study of spring barley cultivation with two lines in the competitive and non-competitive system, PhD thesis), University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania.
[13]Russu, F., Porumb, I., Mureșanu, F., Tritean, N., 2019, Estimation of the Variability and Inheritance af Some Quantitative Traits in Two Rows Spring Barley in the Conditions of ARDS Turda, Romanian Agricultural Research, No. 36, Pp 67-77.
[14]Savatti, M., Ardelean, M., Nedelea, G., 2004, Tratat de ameliorarea plantelor, Editura Marineasa, Timișoara (Treatise on plant improvement, Marineasa Publishing House, Timișoara), pp.249-252.
[15]Tiwari, V., 2010, Growth and Production of Barley, In: W.H. Verheye (ed.). Soils, Plant Growth and Crop Production, Encyclopedia of Life Support Systems (EOLSS), 1:1-31.
[16]Zhou, M.X., 2009, Barley Production and Consumption, In: Zhang G., Li C. (eds) Genetics and Improvement of Barley Malt Quality, Advanced Topics in Science and Technology in China, Springer, Berlin, Heidelberg, pp. 1-17.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE CORRELATION BETWEEN MITOTIC ACTIVITY AND YIELD TO *HELIANTHUS ANNUUS* L.

Elena BONCIU[1], Olimpia PANDIA[2], Aurel Liviu OLARU[1], Elena ROSCULETE[1], Ion SARACIN[1], Catalin Aurelian ROSCULETE[1]

[1]University of Craiova, Faculty of Agronomy, 19 Libertatii Street, Craiova, Romania, Phone/Fax: +40251418475, Emails: elena.agro@gmail.com, liviu.olaru.dtas@gmail.com, rosculeta2000@yahoo.com, ion_saracin@yahoo.com, catalin_rosculete@yahoo.com
[2]University of Agronomic Sciences and Veterinary Medicine Bucharest of Bucharest, 59 Marasti Boulevard, Bucharest, Romania, Phone: +40213182266, Fax: +40213180466, Email: olimpia_pandia@yahoo.com

Corresponding author: liviu.olaru.dtas@gmail.com

Abstract

The purpose of this study was to establish the existence of a correlation between mitotic activity in Helianthus annuus (sunflower) and seed production, taking into research five genotypes (G1-G5). The mitotic index had variable values (19.5%-39.4%). It was found a direct correlation between high mitotic activity (39.4%) and high production (2,105 kg/ha); the G3 genotype was the one that stood out from this point of view. Also, the G4 genotype, which recorded the lowest value of the mitotic index (19.5%), was noted with the lowest value of yield (1,758 kg/ha). The results suggest that genotype is one of the most dynamic indicators for sunflower cytogenetic research. This comes in support of genetic research for sustainable management of the agricultural system in general and sunflower crops in special. An intense mitotic activity is directly correlated with plant growth, development and fructification at optimal parameters. However, in addition to intense mitotic activity, environmental factors also play a decisive role.

Key words**:** *mitosis, sunflower, genotype, production, correlations*

INTRODUCTION

Sunflower is one of the most widespread oleic plants in Romania. From its seeds, quality oil is obtained, highly appreciated both in Romania and abroad. The high demand for sunflower oil, but also the multiple importance of this plant is why it is cultivated on very large areas. In our country it occupies significant areas especially in Dobrogea, Romanian Plain and Western Plain.

The importance of sunflower culture is given by its wide use in human nutrition, but also in animal feed, including industrial and energy uses.

Sunflower oil is especially used in people's nutrition because it has a high quality, a superior colour, taste and smell. It is considered one of the best vegetable oils, having a high content of unsaturated fatty acids. It has a low content of saturated fat and cholesterol and a high content of vitamins [22].

Genetics is one of the most current sciences, due to the importance of knowing the mechanisms of transmission of the characters to plants and of the manifestation of these characters as a result of the interaction of the hereditary base with the factors of the natural and anthropic environment [20, 21].

As integral part of genetics, the cytogenetics of crop plants, including sunflower, uses their own means of investigation and interpretation, through which they study the morphology, structure and behavior of chromosomes in mitosis and meiosis, together with the consequences of chromosomal and nuclear anomalies, from numerically and structurally point of view.

The high and constant production potential of the sunflower crop is maintained if the chosen genotype is genetically superior but also if the crop technology and recommended density are respected. The study of mitosis in different sunflower genotypes, cultivated under different environmental conditions and the

correlation of mitotic activity with production could complement the results related to genetic variability and its importance in modern sunflower breeding. Mitosis is the totality of the processes by which a cell grows, duplicates its chromosomes and divides, resulting in two cells identical to the cell from which they were arose [20].
Plant cells reproduction provide the growth, proliferation, differentiation, tissue regeneration and all of which is based on the intense mitotic activity [8, 21]. Also, the decrease in mitosis intensity may be due to the action of some chemicals substances, like herbicides, insecticides and fungicides [3]. The clastogenic effects of a test substance must be researched by in test systems such as chromosomal abnormalities [11, 17, 18]. Heterosis, also called hybrid vigour, is directly involved in obtaining a high sunflower and other crops production [9, 10].

MATERIALS AND METHODS

The genotypes investigated were grown at non irrigated conditions, following the method of multi-stage blocks, in the didactic field of the faculty. After recording the production, a number of 100 seeds from each genotype were brought to the Genetics laboratory of the Faculty of Agronomy for cytogenetic determinations. To this end, the seed samples were placed in Petri dishes, distributing 20 seeds in each recipient. For germination, the filter paper of the Petri dishes was maintained wet with distilled water.
To study the sunflower chromosomes, the meristematic roots were processed according to the staining protocol using the Feulgen method [3, 20]. The microscopic preparations were studied by counting 1,000 cells in each slide, in 3 repetitions.
It was necessary to calculate the mitotic index (Im%) or the frequency of the cells in the division for each genotype, in order to be able to appreciate the correlation between the mitotic activity and the proliferation of the cells.

RESULTS AND DISCUSSIONS

The results of the cytogenetic study to sunflower and their correlation with yield are illustrated in Table 1. The uniqueness of each tested genotype can be observed, expressed by the variable values of the mitotic index, which suggests a different level of adaptability at the cellular level. This cellular adaptability is the result of the interaction between the genetic factor and the environmental conditions [22]. The highest value was 39.4% (G3) and G4 registering the lowest mitotic activity, namely 19.5% (Fig.1).

Table 1. The results of the cytogenetic study to sunflower

G	I_m %	The mitosis index phases				The seed production (kg/ha)
		Mitotic index of prophase %	Mitotic index of metaphase %	Mitotic index of anaphase %	Mitotic index of telophase %	
G1	31.8	46.2	20.7	14.9	18.2	1,962
G2	24.1	44.1	21.3	14.8	19.8	1,845
G3	39.4	47.5	22.3	15.8	14.4	2,105
G4	19.5	45.2	19.8	13.8	21.2	1,758
G5	20.6	41.2	19.2	14.1	25.5	1,810

Source: Own calculation.

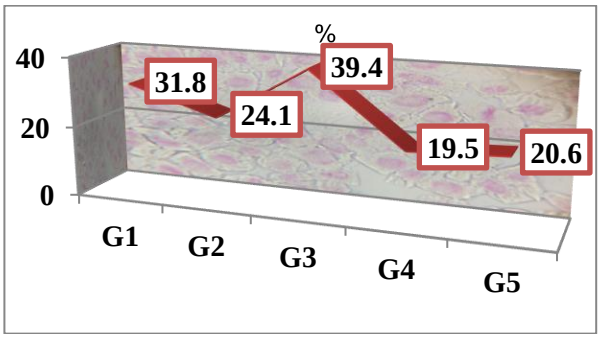

Fig. 1. Graphical representation of the mitotic index (Im%) to sunflower
Source: Own calculation.

The vegetal cell is an open thermodynamic system, in which the intense mitotic activity correlates with the intensity of the other processes that take place in the cells, namely the transformation of assimilated substances and energy into the growth process.
The variability of the mitotic index was noticed in the case of the mitosis stages, where the recorded values had values from minimum to maximum as follows: 41.2%-47.5% for the prophase stage; 19.2%-22.2% for metaphase; 13.8%-15.8% for anaphase and 14.4%-25.5% for telophase.
Plants growth, development and fructification are physiological phenomena characterized by

increasing of the weight and volume of the plant. At the basis of these phenomena is the process of cell proliferation and growth by extension, i.e. mitotic activity. Therefore, an intense mitotic activity is directly correlated with plant growth, development and fructification at optimal parameters. However, in addition to intense mitotic activity, environmental factors also play a decisive role [16, 23]. As shown in Figure 2, there is a direct correlation between intensity of mitotic activity and sunflower seed production.

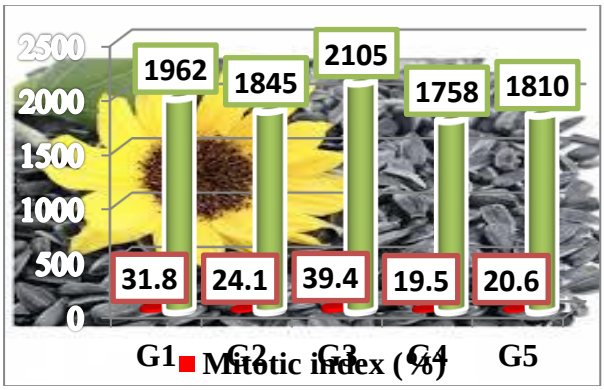

Fig. 2. The correlation between mitotic activity and seed production to some sunflower genotypes
Source: Own calculation.

Thus, G3 genotype was noted by the highest values, both in terms of mitotic index and production (2,105 kg per hectare), thus suggesting the direct correlation between these two characters. Also, the G1 genotype, which recorded a high mitotic index, achieved a good seed production (1,962 kg). The G2 genotype which had a slightly lower mitotic activity, obtained 1,845 kg per hectare seed production. The lowest mitotic activity was found to G4 sunflower genotype and thus he obtained the lowest seed production (1,758 kg per hectare).

We mention that all sunflower genotypes were grown under the same environmental conditions. So, the results suggest that genotype is one of the most dynamic indicators for sunflower cytogenetic research. This comes in support of genetic research for sustainable management of the agricultural system in general and sunflower crops in special.

Application of plant protection measures and an optimal management of agricultural culture establishment create favourable conditions for the photosynthetic process and improving the physiological status of the plants [12-15, 5-7, 19].

The genetic potential of fruiting is variable for each sunflower genotype, but mitotic activity, along with a proper nutrition and other technological elements in optimally ensured can result in high and quality yields, both in seeds and of oil [1, 2, 4, 9].

CONCLUSIONS

The intensity of the mitotic activity to sunflower is directly correlated with plant growth and development. The genetic uniqueness of each tested genotype was expressed by the variable values of the mitotic index and yield, which suggests a positive correlation between the two characters. However, the seed production is a complex hereditary character, determined by genes with various individual effects.

Mitotic activity in sunflower is correlated with seed production, but an intense mitotic activity does not exclude other vegetation factors that must be ensured for optimal growth, development and fructification. The increase of the production indices to sunflower can be achieved through improvement processes that mainly focus on the dominance effects of the genes.

REFERENCES

[1]Bonciu, E., 2013, Aspects of the pollen grains diameter variability and the pollen viability to some sunflower genotypes, Journal of Horticulture, Forestry and Biotechnology, Vol. 17(1):161-165.
[2]Bonciu, E., 2013, Variability of the mitotic activity to some foreign sunflower genotypes, Journal of Horticulture, Forestry and Biotechnology, Vol. 17(3):126-129.
[3]Bonciu, E., 2018, Evaluation of cytotoxicity of the herbicide Galigan 240 EC to plants, Scientific Papers. Series A., Agronomy, Vol. LXI(1):175-178.
[4]Bonciu, E., 2019, The behavior of some sunflower genotypes under aspect of variability of the productivity elements, Current Trends in Natural Sciences, Vol. 8(15):68-72.
[5]Bostan, C., Butnariu. M., Butu, M., Ortan, A., Butu, A., Rodino, S., Parvu, C., 2013, Allelopathic effect of *Festuca rubra* on perennial grasses, Romanian biotechnological letters, Vol. 18(2):8190–8196.

[6]Butnariu, M., 2012, An analysis of *Sorghum halepense's* behavior in presence of tropane alkaloids from *Datura stramonium* extracts, Chemistry Central Journal, Vol. 6:75.
[7]Butnariu, M., Caunii, A., 2013, Design management of functional foods for quality of life improvement, Annals of Agricultural and Environmental Medicine, Vol. 20(4):736–741.
[8]Butnaru, G., Căpâlnăşan, I., Sărac, I., Jurca, M., Baciu, A., Popescu, C., Avramescu, A., 2004, Cromosomes - morpho-functional peculiarities in plants and animals (Cromosomii – particularităţi morfo-funcţionale la plante şi animale), Mirton Press, Timisoara, pp. 94-96.
[9]Capatana, A., 2006, Molecular and genetic aspects of heterosis in sunflower (*Helianthus annuus* L). PhD Thesis, Moldova State University, Chisinau.
[10]Kosev,V., Georgieva, N., 2019, Application of the Ecologo-genetic Model in Broad Bean (*Vicia faba* L.) Breeding, Banat′s Journal of Biotechnology, Vol. X(20):29-36.
[11]Mercimek Takci, H.A., Turkmen, F.U., Sari, M., 2019, In vitro mutagenic effect of cedar (*Cedrus libani* A. Rich) tar in the Salmonella/Microsome Assay System, Banat′s Journal of Biotechnology, Vol. X(20):13-18.
[12]Nikolova, I., Georgieva, N., 2019, Effect of biological products on the population of aphids and chemical components in alfalfa, Banat′s Journal of Biotechnology, Vol. X(19):51-57.
[13]Pandia, O., Sărăcin, I., Sărăcin, A.I., 2018, Management of agricultural culture establishment works, Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 18(2):315-318.
[14]Pandia, O., Sărăcin, I., Olaru, L., 2019, The importance of knowledge of foliage surface index (ISF) influence on production, Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 19(2):317-321.
[15]Pandia, O., Sărăcin, I., Olaru, L., 2019, The importance of knowledge concerning resistance to draught for some types of seeds cultivated on sandy soils, Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 19(2):311-315.
[16]Pereyra-Irujo, G.A., Velázquez, L., Lechner, L., Aguirrezábal, L.A.N., 2008, Genetic variability for leaf growth rate and duration under water deficit in sunflower: analysis of responses at cell, organ, and plant level, Journal of Experimental Botany, Vol. 59(8):2221-2232.
[17]Rosculete, C.A, Rosculete, E., Bonciu, E., 2018, The role of forests in the sustainable development of Romania, Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series, Vol. 48(2):140-149.
[18]Rosculete, C., Bonciu, E., Rosculete, E., Olaru, L., 2019, Determination of the Environmental Pollution Potential of Some Herbicides by the Assessment of Cytotoxic and Genotoxic Effects on *Allium cepa*, International Journal of Environmental research and Public Health, Vol. 16(1):75.
[19]Samfira, I., Butnariu, M., Rodino, S., Butu, M., 2013, Structural investigation of mistletoe plants from various hosts exhibiting diverse lignin phenotypes, Digest journal of nanomaterials and biostructures, Vol. 8(4):1679–1686.
[20]Sărac, I., 2012, Genetics (Genetica), Agroprint Press, Timisoara, pp. 123-127.
[21]Sărac, I., 2017, Genetics (Genetica), Agroprint Press, Timisoara, pp. 148-149.
[22]Vranceanu, A.V., 2000, Hybrid Sunflower (Floarea soarelui hibridă), Ceres Press, Bucharest.
[23]Yegappan, T.M., Paton, D.M., Gates, C.T., Müller, W.J., 1980, Water Stress in Sunflower (*Helianthus annuus* L.): I. Effect on Plant Development, Annals of Botany, Vol. 46:61-70

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

SOME ASPECTS REGARDING THE GENETIC AND BIOTECHNOLOGICAL PROGRESS OF THE *HELIANTHUS ANNUUS* L.

Elena BONCIU[1], Olimpia PANDIA[2], Aurel Liviu OLARU[1], Ion SARACIN[1], Elena ROSCULETE[1]

[1]University of Craiova, Faculty of Agronomy, 19 Libertatii Street, Craiova, Romania, Phone/Fax: +40251418475, Emails: elena.agro@gmail.com, liviu.olaru.dtas@gmail.com, ion_saracin@yahoo.com, rosculeta2000@yahoo.com
[2]University of Agronomic Sciences And Veterinary Medicine Bucharest of Bucharest, 59 Marasti Boulevard, Bucharest, Romania, Phone: +40213182266, Fax: +40213180466, Email: olimpia_pandia@yahoo.com

Corresponding author: liviu.olaru.dtas@gmail.com

Abstract

The genetic and biotechnological progress of the Helianthus annuus L. (sunflower) it can be catalogued through two major directions, namely: tissue culture and meristems in vitro, for the induction and selection of useful characters and genetic engineering or DNA manipulation, for plants transformation. In general, sunflower tissues are very easy to grow, but the problem arises due to the low reproducibility, sunflower being one of the most difficult species from this point of view. The two methods of the vitrocultivated sunflower regeneration are organogenesis and embryogenesis, the difference between them being given by the different number of cells from which the neoplants are formed. To date, a limited number of sunflower genotypes have been found for regeneration. For this reason, several methods are sought for the regeneration of this plant, as it is a necessity to find new, stronger genotypes that adapt to the current conditions. From this point of view, the use for vitroculture of tissues initiated from immature sunflower embryos is an effective strategy for plant regeneration. So far, good results have been obtained in the reproductive genetics of this plant but other future results are being sought, when it is expected that genetic and biotechnological progress will continue. One of the basic research methods of genetics and genetic engineering remains the study of gene expression and the elucidation of new aspects at the genome level of the species H. annuus.

Key words**:** *sunflower, genetics, biotechnologies, vitroculture, DNA*

INTRODUCTION

Biotechnologies generally refers to all techniques and applications that use biological systems, living organisms or derivatives thereof in order to modify or create new products, with improved production, nutritional and quality characteristics.
The sunflower culture, an oleic plant of global interest, has developed progressively and has gone through several stages, determined by the progress made in the genetic improvement of this noble plant. Worldwide, sunflower areas have grown significantly over the years, especially due to their high adaptability [6]. Sunflower is a plant with various uses, in the feeding of humans and animals but also for industrial and energy uses. The sunflower is a crucial source of pollen and nectar in early summer for honeybees. Also, its contribution to the aesthetic value of landscape should be highlighted. In the present and future context of climate change, sunflower cropping offers a wide range of options for adaptation.
According to Vrânceanu (2000), the four major stages of sunflower progress are: the stage of local population selection, with low oil content; the stage of improved varieties, with good stability and adaptability, with medium oil content; the stage with of high oil varieties and the stage of the F1 hybrids, created by crossing the inbred lines [31]. This stage, which began in the 70's, is still ongoing and the hybrid sunflower is experiencing an unprecedented expansion and the production of vegetable oils has spectacular increased.
Within the genus *Helianthus* naturally occur diploid, tetraploid and hexaploid species. In contrast, haploid sunflower plants appear spontaneously at a reduced frequency.

Through polyploidy, biotechnology in general and genetics in special are involved to increase the frequency of formation of diploid tissues and normal sunflower gametes. Wild forms of the genus *Helianthus* are currently used as a very important material for modern sunflower enhancement [16].

The cytogenetics of sunflower is based on the study of heredity on the level of chromosomes and other cellular organisms. The genetic information about this taxon comes from the analysis of interspecific hybrids and molecular studies [11, 29].

The objectives of improving the sunflower are improve the productivity, by increasing the seed production and the oil content; genetic resistance to diseases and pests and increasing the level of ecological plasticity through adaptability to various environmental conditions [2, 3, 4, 31]. A very important objective especially for it is made of very good quality oils that meet the needs of consumers, is to diversify the quality of the oil, by creating new hybrids, with high oleic acid content. It is worth mentioning that some environmental conditions, such as temperature, may change the ratio of oil and linoleic acids to sunflower hybrids [18].

Efficient methods of sunflower regeneration are useful for facilitating breeding programs for improved cultivars by providing rapid multiplication of plants having desirable traits. The availability of a large number of regenerated plants increases the speed of selection and further breeding cycles. It is also of considerable interest to apply the methods of plant genetic engineering to develop improved sunflower cultivars. The application of these methods to sunflower improvements requires the development of methods for the efficient production of plants which have been transformed to contain foreign DNA.

This reason is motivating to encourage more methods of regeneration for the sunflower plant, wanting to be of a physiologically better quality in the plant creator.

For this reason an important role is engineering genetics, where the qualitative reproduction of the sunflower plant is pursued. Foreign DNA obtains rapid application, reducing the number of genetic methods to care for information on obtaining quality soils or hybrids.

MATERIALS AND METHODS

This is a bibliographical study, in which we have tried to render the some recent results communicated by different authors, regarding the sunflower recent development from genetic and biotechnological point of view. Various electronic and printed resources were used for documentation.

RESULTS AND DISCUSSIONS

Sunflower is widely grown in the world [6]. Newly created hybrids of sunflower, which possess genetic resistance to diseases and pests, high production capacity but also resistance to some unfavourable environmental factors, such as drought, for example, have contributed to this expansion.

Since 1948, A.V. Vrânceanu, a Romanian researcher with pioneering in the field of the hybrid sunflower, presented a morphological and physiological ideotype for this plant, that is, a model capable of providing a higher quantity of quality seeds and oil, under certain environment conditions well defined [31]. His scientific activity in the field of sunflower breeding has a major contribution to the genetic progress of this species. In 1975, as recognition of the Romanian priorities in sunflower genetics, it is assigned to A.V. Vrânceanu coordinating the International Research Network F.A.O. in this domain [15].

A sunflower model has been proposed by other authors to determine the changes printed by certain factors (e.g. latitude) on oil yield and quality [22].

Agro-engineering and mechanization are two important factors on which the regeneration of other varieties or hybrids of the sunflower with much improved character depends. For this reason, all the general characteristics of this plant were evaluated and where they had the best performances according to the area of establishment of the culture.

Generally, the evaluation of genetic progress is performed with the results obtained from the cultivar trials performed in different areas.

According to Follmann et al. (2017), just the genotypes with high yield characteristics are suitable for on-going assessment [14].

Historically, moisture and temperature during flowering time had significant impacts on the absolute levels of linoleic fatty acid (polyunsaturated) and oleic fatty acids (monounsaturated), and therefore on their ratios [22].

Sunflower seed grown in cooler climates yielded generally higher linoleic acid contents, while seed produced under warmer conditions saw higher oleic acid contents. In a very general sense, the inverse relationship results in a one percent increase in oleic acid approximating a simultaneous one percent decrease in linoleic acid and vice versa, depending on the climate. The other fatty acids see only limited changes. Some research has been leading to the development of high oleic sunflower varieties with oil that may approach or exceed 90% oleic fatty acid content [29].

In addition to using biological systems for various useful transformations [1, 31], modern biotechnology also involves the use of new technological innovations, some of which are based, for example, on allelopathy [5] or various biochemistry researches [7, 27].

In some cytogenetic studies, the heritability of quantitative and qualitative characters in crop plants is controlled by several genes, both dominant and recessive [9, 28]. In this sense, sunflower oil depends for example on the common action of the embryonic and maternal genomes [19].

The leaves and roots of the plants form the vegetative system that through specific growth processes puts in action the root and foliar sensors. The development of the leaf surface is of major importance on photosynthesis and transpiration. The total leaf surface area per plant is determined as a logistic function of the anthesis and the thermal time from sunrise, while the distribution of the solar radiation at the leaf level is determined by the ISF, the angular distribution of the leaves [21, 21].

Application of plant protection measures and an optimal management of agricultural culture establishment create favourable conditions for the photosynthetic process and improving the physiological status of the plants [1, 8, 25, 26].

Although it is recognized as a drought-resistant plant, sunflower does not produce high yields of seeds and oil under high heat conditions and low humidity conditions. Therefore, genetic progress follows the selection of new plants, capable of tolerating the loss of leaf turgescence.

The modern management of drought in the sunflower includes a series of practices that can have the effect of maintaining its productivity (Figure 1).

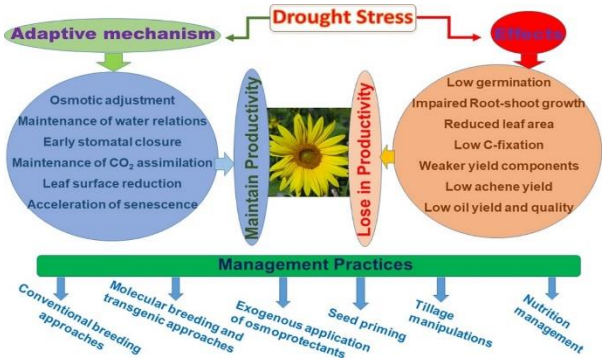

Fig. 1. The drought stress and management practices to sunflower
Source: Mubshar et al., 2018 [17].

Improving of the drought resistance is not straightforward, due to the complex and polygenic nature of this feature. Genetic progress from this point of view implies the improvement of a whole set of characters that will contribute to increasing the tolerance of the sunflower to water stress.

The studies of correlations to sunflower are important for the breeder in order to associate all the possible valuable features in the newly created genotypes. The oil yield is the trait with greater economic interest in sunflower and its increase has being achieved in sunflower with increasing grain yield [14].

One of the secondary products of the oil extraction is seed hulls. They can be ground and used in the feeding of ruminant animals or in the manufacture of fibreboard plaques. Another use of sunflower seed hulls is to obtain the fodder yeast, a valuable protein product for animal and poultry feed.

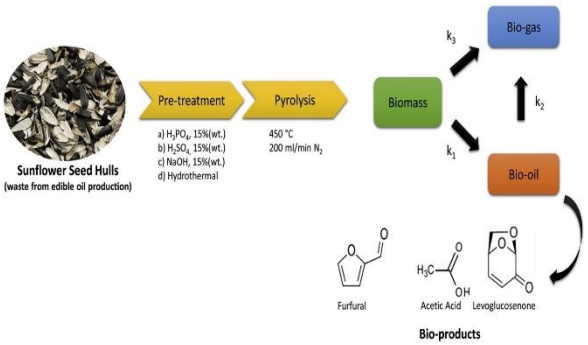

Fig. 2. The involving of biotechnology in transformation of the sunflower waste into bioproducts
Source: Casoni et al., 2019.

However, these secondary products can be transformed, thanks to modern biotechnology, in furfural (Figure 2), widely used in organic synthesis, as well as other types of bio-products, who can be obtained through certain processes such as acid hydrolysis [12].

Another implication of modern biotechnologies in the genetic progress of the sunflower is given by the genetic transformation of the plants and selected of the transformed cells [13]. This transformation is made through the infection with *Agrobacterium tumefaciens*, the technique of bombardment of tissues with microprojectile, respectively the direct absorption of DNA in protoplasts [31].

There are some studies involving transgenic sunflower plants to increase yield, oil content, insect/fungal resistance, stress tolerance and production of biopharmaceutical proteins [10, 23, 24]. As the selection for disease resistance within the genus *Helianthus* remains, for the time being, a sensitive issue, genetic and biotechnological research for sunflower is oriented towards the original source of genes for resistance to diseases, namely, wild species. Using the direct organogenesis method in interspecific hybridization, fertility restorer lines were developed which possess very good combining ability in hybridization and resistance to some economically important diseases and parasites on sunflower.

In the plant biotechnology, the vitroculture and micropropagation can be effective techniques for rapid multiplication a large number of sunflower genotypes. The indirect somatic embryogenesis, with intermediary callus formation, is useful in researches regarding the vitroculture for the resistant forms to biotic and abiotic stress factors. Therefore, extension of time to maintain the callus at culture medium is utile, because can favorized the increase of genetic variation within grown calluses and between regenerated plants. Embryogenesis can be performed directly from the explant source or indirectly from the callus.

The explants used for the sunflower vitrocultivation can have their origin from different tissues of the plant: tips of shoots or apical meristems, stem nodes, hypocotyls, cotyledons of mature and immature embryos, leaves, etc. However, the most used are immature embryos, because the tissues initiated from them allow the reproductive regeneration of sunflower neoplants. Along with immature embryos, sunflower cotyledons also have a high potential for direct regeneration of shoots.

The basic culture medium for sunflower cultivation is made up of different components (mineral salts, amino acids, source of carbon, agar, water, etc.). The most widely used culture medium is MS medium (Murashige-Skoog), supplemented with different concentrations of phytohormones, such as, for example: naphthalene acetic acid, indolyl acetic acid, cytokines (benzyl adenine and benzyl amino purine) and kinetin.

In the present and future context of climate change, sunflower cropping offers a wide range of options for adaptation. That's why we can talk about a high sustainability of the sunflower within an efficient management and genetic control.

CONCLUSIONS

Globally, the expansion of sunflower occurred with the introduction of new genotypes, with improved production qualities and high resistance to stress conditions.

The agricultural biotechnological research with precise targeting toward sunflower brings together results on complex genetic mechanisms that control the manifestation of important traits for improving and understanding the genetic control of seed production and oil quality.

In perspective, genetics and biotechnology must propose new approaches in analysing the genotype-environment interaction at sunflower.

Genetics and biotechnologies represents the future in sustainable sunflower management, by increase the yield, oil content, insect/fungal resistance, stress tolerance and production of biopharmaceutical proteins.

REFERENCES

[1]Bonciu E., 2012, Agricultural biotechnologies, balance factor for the sustainable development of the socio-economic system, Annals of the University of Craiova, Series Biology, Horticulture, Technology of Agricultural Products Processing, Environmental Engineering, Vol. 17(1):69-74.

[2]Bonciu, E., 2013, Aspects of the pollen grains diameter variability and the pollen viability to some sunflower genotypes, Journal of Horticulture, Forestry and Biotechnology, Vol. 17(1):161-165.

[3]Bonciu, E., 2013, Variability of the mitotic activity to some foreign sunflower genotypes, Journal of Horticulture, Forestry and Biotechnology, Vol. 17(3):126-129.

[4]Bonciu, E., 2019, The behavior of some sunflower genotypes under aspect of variability of the productivity elements, Current Trends in Natural Sciences, Vol. 8(15):68-72.

[5]Bostan, C., Butnariu. M., Butu, M., Ortan, A., Butu, A., Rodino, S., Parvu, C., 2013, Allelopathic effect of *Festuca rubra* on perennial grasses, Romanian biotechnological letters, Vol. 18(2):8190–8196.

[6]Bran, A., Ion, V., 2018, Sunflower Varieties and Hybrids Registered for Cultivation in Romania in the Last Century, Sciendo, Vol. 1(1):22-31.

[7]Butnariu, M., 2012, Butnariu M. An analysis of Sorghum halepense behavior in presence of tropane alkaloids from Datura stramonium extracts, Chemistry Central Journal, Volume: 6, Article Number: 75, Published: Jul. 28, 2012 (Accession Number: WOS: 000308021600001, PubMed ID: 22839364.

[8]Butnariu, M., Caunii, A., 2013, Design management of functional foods for quality of life improvement, Annals of Agricultural and Environmental Medicine, Vol. 20(4):736–741.

[9]Butnaru, G., Căpâlnăşan, I., Sărac, I., Jurca, M., Baciu, A., Popescu, C., Avramescu, A., 2004, Chromosomes - morpho-functional features in plants and animals, Mirton Press, Timisoara, pp. 60-71.

[10]Çalışkan, M., Dangol, S., 2016, Genetic engineering studies on sunflower, International Sunflower Conference, Vol. 19:651-655.

[11]Capatana, A., 2006, Molecular and genetic aspects of heterosis at sunflower (*Helianthus annuus* L). PhD Thesis, Moldova State University, Chisinau.

[12]Casoni, A.I., Gutierrez, V.S., A.Volpe, M.A., 2019, Conversion of sunflower seed hulls, waste from edible oil production, into valuable production, Journal of Environmental Chemical Engineering, Vol. 7(1):102893.

[13]Durante, M., Vannozzi, G., Pugliesi, C., Bernardi, R., 2002, The role of biotechnologies in the development of sunflower cultures in the world, Helia, Vol. 25(36):1-28.

[14]Follmann, D.N., Cargnelutti Filho, A., Lorentz, L.H., Boligon, A.A., Caraffa, M., Wartha**,** C.A., 2017, Genetic progress in sunflower crop in Rio Grande do Sul State, Brazil, Genetics and molecular research: GMR, Vol.16(2):1-9.

[15]I.C.C.P-I.N.C.D.A. Fundulea 1957-2017, 60 years of Scientific Research in support of Agriculture, https://www.incda-fundulea.ro/60ani/INCDA60.pdf, Accessed on November 10, 2019.

[16]Liu, Z., Seiler, G.J., Gulya, T.J., Feng, J., Rashid, K.Y., Cai, X., Chao-Chien Ja, C.C., 2017, Triploid Production from Interspecific Crosses of Two Diploid Perennial *Helianthus* with Diploid Cultivated Sunflower (*Helianthus annuus* L.), Gene, Genomics, Genetics, Vol. 7:1097-1108.

[17]Mubshar, H., Shahid, F., Waseem, H., Sami, UA., Mohsin,T., Muhammad, F., Ahmad, N., 2018, Drought stress in sunflower: Physiological effects and its management through breeding and agronomic alternatives, Agricultural Water Management, Vol. 201:152-166.

[18]Neto, A.R., Rauen de Oliveira Miguel, A.M., Mourad, A.L., Henriques, E.A., Vercelino Alves, R.M., 2016, Environmental effect on sunflower oil quality, Crop Breed. Appl. Biotechnol., Vol. 16(3):197-204.

[19]Nikolova, V., Ivanov, P., 1992, Inheritance of the fatty acid composition of oil in some sunflower lines, Helia, 15(16):35-40.

[20]Pandia, O., Sărăcin, I., Olaru, L., 2019, The importance of knowledge of foliage surface index (ISF) influence on production, Scientific Papers Series Management, Economic Engineering in Agriculture and rural development, Vol. 19(2):317-321.

[21]Pandia, O., Sărăcin, I., Olaru, L., 2019, The importance of knowledge concerning resistance to draught for some types of seeds cultivated on sandy soils, Scientific Papers Series Management, Economic Engineering in Agriculture and rural development, Vol. 19(2):311-315.

[22]Pereyra-Irujo, G.A., Aguirrezábal, L.A.N., 2007, Sunflower yield and oil quality interactions and variability: analysis through a simple simulation model, Agricultural and Forest Meteorology, Vol. 143(3-4):252-265.

[23]Peter van Esse, H., Reuber, T.L., Dieuwertje van der Does, 2019, Genetic modification to improve disease resistance in crops, New Phytologist, Vol. 225:70–86.

[24]Qi, L., Long, Y., Talukder, Z.I., Seiler, G.J., C. Block, C.C., Gulya, T.J., 2016, Genotyping-by-Sequencing Uncovers the Introgression Alien Segments Associated with *Sclerotinia* Basal Stalk Rot Resistance from Wild Species-I. *Helianthus argophyllus* and *H. petiolaris*. Frontiers in Genetics, Vol. 7:219.

[25]Rosculete, C.A, Rosculete, E., Bonciu, E., 2018, The role of forests in the sustainable development of Romania, Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series, Vol. 48(2):140-149.
[26]Rosculete, C., Bonciu, E., Rosculete, E., Olaru, L., 2019, Determination of the Environmental Pollution Potential of Some Herbicides by the Assessment of Cytotoxic and Genotoxic Effects on *Allium cepa*, International Journal of Environmental research and Public Health, Vol. 16(1):75.
[27]Samfira, I., Butnariu, M., Rodino, S., Butu, M., 2013, Structural investigation of mistletoe plants from various hosts exhibiting diverse lignin phenotypes, Digest journal of nanomaterials and biostructures, Vol. 8(4):1679–1686.
[28]Sărac, I., 2017, Genetica, Agroprint Publishing House, Timisoara, pp. 173-179.
[29]Skoric, D., Jocić, S., Lecic, N., Sakac, Z., 2007, Development of sunflower hybrids with different oil quality, Helia, Vol. 30(47):205-212.
[30]Vencovsky, R., Morais, A.R., Garcia, J.C., Teixeira, N.M., 1988, Progresso genético em vinte anos de melhoramento do milho no Brasil. In: Congresso Nacional de Milho e Sorgo, 16:300-307.
[31]Vranceanu, A.V., 2000, Hybrid sunflower, Ceres Publishing House, Bucharest, alexandru_viorel-p1002221.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

CIRCULAR ECONOMY APPLIED IN THE ROMANIAN SOCIETY AND INSTITUTIONS-PERSPECTIVES, INNOVATION

Oana Steliana BURLACU, Maria Magdalena TUREK-RAHOVEANU, Constanța Laura ZUGRAVU

University "Dunarea de Jos"Galati, Faculty of Engineering and Agronomy Braila, Romania, Emails: oana.steliana@yahoo.com, mturek2003@yahoo.com, zugravulaura@yahoo.com

Corresponding author: mturek2003@yahoo.com

Abstract

As sustainable development includes environmental protection and that is conditional on sustainable development, an institution's concerns in this regard must be considered as one of the priorities that will set development strategies and programs and will implement them in practice so that environmental protection be permanently taken into account. This paper aimed to highlight the concept of circular economy which refers to the harmonization of sustainable development needs of long-term humanity. It is necessary to optimize resource consumption so as to reduce the consumption of raw materials and energy and reuse them 100% if is possible, and how it is applied in Romania. In conclusion, performing the main principles of sustainable development is a necessity of time, which would result in effective results corresponding to the contemporary ecological provisions, the interests of the human society.

Key words**:** *sustainable development, circular economy, environmental, agriculture, improvement*

INTRODUCTION

The sustainable development represents a process of continuous and permanent improvement, learning and perfecting, and the introduction of sustainable development policies into a society or company guarantees the creation of sustainable (not only immediate) value and consequently long-term benefits.

Circular economy is a concept what refers to the harmonization of sustainable development needs of long-term humanity, it is necessary to perform and optimize resource consumption so as to reduce the consumption of raw materials and energy and reuse as much as possible.

The main goal is to improve as much as possible the use of resources and this fact must reach such a limit that the amount of natural resources consumed net (those extracted for the first time from the natural environment) will not jeopardize their natural recovery rate in sufficient quantities for future generations.

In another words, the circular economy represents an economy that aims to produce only zero waste. This is, in other words, a redefinition of "sustainable development" of the famous Bruntland Commission, focused on resources.

The capitalization of products and secondary resources are vital for the circular economy to be carried out in optimal terms. In this matter, the development of this new market has an important role in the practical implementation of resource efficiency. From this perspective, digital trading platforms for secondary products can actively contribute to the process of optimizing resource consumption at the level of economic activities.

The number of companies in Romania that started to report on sustainable development, in addition to financial data, is rising.

Companies that act according to the principles of sustainable development often have high performance (even in the short and medium term) over other companies due to better control of the different risk categories they are exposed to.

Consumer society appeared at the end of the 20th century, together with the tendency of population growth worldwide, intensification of the urbanization process, development and dissemination of information and communications technology, continuous

increase of the standard of living, reduction of the product life cycle. They contributed to the increase in volume and diversification of waste flows.

Given the sharp decrease in natural resources, the rapid deterioration of air quality, water, soil and the impact of natural ecosystems, international concerns regarding waste management have acquired a dynamic character in the direction of identifying the best solutions and technologies. In this context, waste management has become a fundamental problem of the future social-economic evolution, a direct result of a present economic development of linear type.

Given the sharp decrease in natural resources, the rapid deterioration of air quality, water, soil and the impact of natural ecosystems, international concerns regarding waste management have acquired a dynamic character in the direction of identifying the best solutions and technologies. In this context, waste management has become a fundamental problem of the future social-economic evolution, a direct result of a present economic development of linear type [8].

The implementation of a performing economy aims at the production area in which innovation plays a central role, the resources are recirculated through a circular system and special attention is paid to the intelligent solutions coming from the area of life sciences specific processes.

The debates on the opportunities of the circular economy define it as the protection of the environment, as well as with increasing competitiveness, innovation and technological research.

In this respect, innovation plays an important role in terms of extended producer responsibility by developing new methods for optimizing life cycle costs, new technologies for optimizing (re) use of components, extending product life, providing options for repair, quality monitoring tools, etc.

According to Stahel (2010) [4], the determinants of the performing economy are: competitiveness, innovations in science and technology, trade (e.g. extended product life, refurbished product market), cultural consumption patterns (e.g. the number of new or old cars relative to family members from one country to another).

In other words, the circular economy implies the efficiency of the resources in order to produce more economic value with the same or less resources.

Achieving a circular economy that combines harmoniously with green growth brings to the forefront the need to implement a sustainable approach to economic activity.

Circular economy does not belong to a single area of activity or to single resource; it can be extended to all sectors of different types of synergies that can generate cumulative positive or negative effects. Circular economy requires resource efficiency to produce more economic value with the same or fewer resources.

In the last decades, the accelerated industrialization has increased the consumption, a behaviour that we have seen more and more especially in the context of technology development.

In order to implement a circular economy, the European Commission adopted at the end of 2015 a set of actions aimed at following the whole life cycle of a product, measures which have been taken over by all Member States.

The idea of circularity, respectively of closing the economic loop, appears defined in 1976 in the report "The potential to substitute the human labor force for energy" (Stahel and Reday Mulvey, 1977), being presented the vision of an economic loop in relation to the creation of new jobs, increasing economic competitiveness, saving resources and preventing waste [5].

The interest shown in approach the circularity is intensely debated in the study "Performance Economy" (Stahel, 2010), where all the concerns associated with the sustainability area are considered, a change in the economic thinking from "doing things properly" to "is proposed" he does the right thing " [4].

Specifically, Stahel (2010) proposes a sufficient type approach that can focus on intelligent system solutions and not necessarily on individual products [4].

The ultimate goal is the implementation of a performing economy, which would target the

research area, the creation of new jobs (even at home) and the exploitation of the opportunities of a performing system of extended producer responsibility.
In other words, achieving the three objectives in a coordinated manner will bring substantial synergies and benefits to economic actors.
Circular economy is based on few defining principles:
-"Waste becomes a resource: is the main feature. All the biodegradable material returns to the nature and the not biodegradable is reused.
-Second use: are reintroduced in the economic circuit those products that no longer correspond to the initial consumer's needs.
-Reuse: reuse certain products or parts of those products that still work to elaborate new artefacts.
-Reparation: find damage products a second life.
-Recycle: make use of materials founded in waste.
-Valorisation: harness energy from waste that can't be recycled.
-Functionality economy: circular economy aims to eliminate the sale of products in many cases to establish a system of rental property. When the product completes its main function returns to the company, where it is dismantled for reusing the valid parts.
-Energy from renewable sources: elimination of fossil fuels to produce the product, reuse and recycle.
-Eco-design: considers and integrates in its conception the environmental impacts throughout the life cycle of a product.
-Industrial and territorial ecology: establishment of an industrial organizational method in a territory characterized by an optimized management of stocks and flows of materials, energy and services.
-Collaborate to Create Joint Value - Work together throughout the supply chain, internally within organizations and with the public sector to increase transparency and create joint value.
-Rethink the Business Model - Consider opportunities to create greater value and align incentives through business models that build on the interaction between products and services"[1].
The purpose of this paper was to present a comprehensive image about what does circular economy mean and which is its role and impact on sustainable development.

MATERIALS AND METHODS

For setting up this paper, it was used a large documentation based on main information sources on circular economy, presenting in a logical and critical manner the approaches of various authors regarding: the definition, role and importance, principles, determinants, and achievements in various areas and including agriculture as well.
As a case study in this project, I chose a village from Braila County in Romania, where we can say that circular economy exists first of all, due to simple fact people from villages are more thrifty, because most of them keeping animals and the vegetable rests, junk food become a food source, in this way the close the loop of circular economy.
Regarding the waste wood obtained from different activities (in constructions, furniture, packaging etc.) this is also reusable part on villages area, in households or giving that in majority of Romanian villages heating is done still by burning wood in stoves and not by gas or electric.
The only problem remains the plastics – even is daily collected is important to change the mode of production and used. And for this is necessary to invest in new technologies able to protect the people, the environment and, in the same time the competitiveness and performances of our industries.
In other words, circular economy means a good management or administration no matter if we are talking about our house, our household, or village or our society and our environment, important is to understand what is bad, unsafely and unhealthy for us, for our environment now and next generations.
So, based on villages example, we can extend this idea on national level, of course, adding improvements we can discuss a good circular economy in Romania in the context of sustainable development.

Important is, also, the education and onward transmission of good habits in order to avoid the pollution.
In other words, all above listed principles need be take into consideration in this way to promote sustainable production and consumption models, which can be implemented in a society in continuous search for new sources for self-sustaining economic growth.

RESULTS AND DISCUSSIONS

The realization of a circular economy, which combines harmoniously with a green growth, brings to the fore the necessity of implementing a sustainable approach at the level of economic activities.
The process of transforming the classical - linear model into a circular one involves reconsidering unsustainable aspects in order to identify future development opportunities. The objective of decoupling economic growth from the consumption of natural resources represents an important step in continuing the efforts to promote eco-efficient economies, with an increased focus on the efficient use of natural resources.
In this regard, the approach proposed by the circular economy aims to reduce the consumption of primary sources in the production process by reusing the products, respectively by expanding the share of reused and recycled materials.
An important role is played by the process of efficiency the use of resources so that more economic value can be produced with the same or less resources. At the same time, the sustainable use of natural resources is closely linked to the identification of niches, which can bring added value to the value chain.
The circular economy is a part of sustainable development, bringing to the fore the need to optimize resource consumption in order to prevent, reduce waste and promote reuse.
The three components of sustainable development (economic growth, social inclusion and environmental protection) aim at creating conditions for the well-being of countries and their citizens by eradicating poverty, raising living standards, reducing social inequalities, or implementing global resource management measures natural (Fig.1).
Circular economy is a component part of sustainable development, bringing to the forefront the need to optimize resource consumption to prevent, reduce waste and promote the re-use.
Waste management is an important part of the circular economy but it calls into question the need for a deeper analysis of the product value chain, starting with the extraction of materials, continuing with the eco-design phase and ending with the finished product, which later becomes a new resource for another industry.

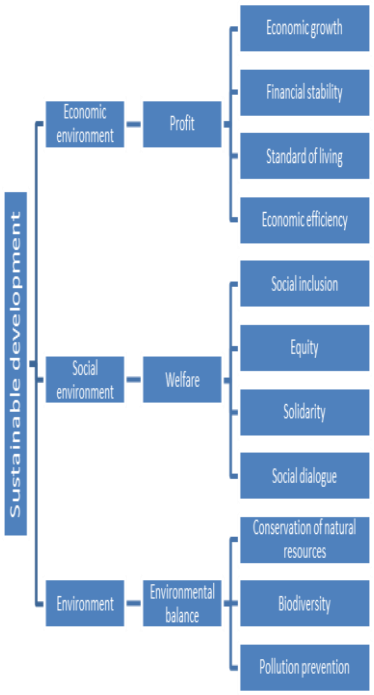

Fig. 1. Sustainable development
Source: Sustainable development (Dezvoltare durabila), Wikipedia,https://ro.wikipedia.org/wiki/Dezvolare_durabil%C4%83, Accessed on 05.02.2020 [9].

As we said above, when we're talking about circular economy we are thinking also at sustainable development and in Figure 1 are mentioned 7 keys elements are taken into consideration as follows:
(1)Prioritizing renewable resources - Ensures that renewable, reusable and non-toxic resources are used as materials and energy efficiently.
(2)Keeping and extending what has already been done - While the resources are in use,

they are being repaired and updated to maximize their lifespan and offer them a second life through takeover strategies when is necessary.
(3)Use of waste as a resource - Use of waste streams as a source of secondary resources and waste recovery for reuse and recycling.
(4)Rethinking the business model - Consider opportunities to create greater value and align incentives with business models that are based on the interaction between products and services.
(5)Design for the future - The account for the perspective of the systems during the design process, the use of appropriate materials, the design for an adequate life and the design for an extended future use.
(6)Inclusion of digital technology - track and optimize the use of resources and strengthen links between actors in the supply chain through digital platforms, online and technologies that offer prospects
(7)Collaborate to Create Joint Value - Work together throughout the supply chain, internally within organizations and with the public sector to increase transparency and create joint value [6, 7] (Fig.2).

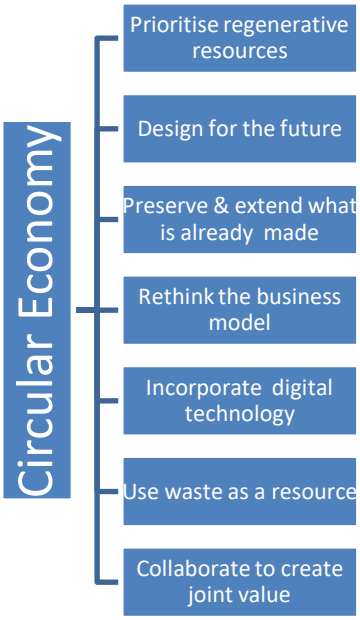

Fig. 2. The 7 Key Elements
Source: Circle economy, The 7 key elements of the circular economy, https://www.circle-economy.com/the-7-key-elements-of-the-circular-economy, Accessed on 05.02.2020 [7].

When we are referring at the village from Braila county, the actual waste collection from each inhabitant is organized on certain flows, such as: cardboard, plastic, glass, metal, wood, batteries and accumulators, electrical and electronic equipment's.
The village hall and the municipality manage carefully the generated waste and gave it to specialized collectors, thus reducing the risks to human health and the environment.
Discussing on a larger scale (county, region, country), and starting from the major differences between the member countries of the European Union regarding the elaboration and implementation of strategies for sustainable development and transition from the linear economy to the circular economy is necessary a thorough analysis of the recycling modalities, but also of community waste, packaging waste and bio-waste requires investment in research and innovation to find solutions to extend the life cycle of raw materials, waste re-use and thus so that we can talk about resource productivity and the real rate of economic growth.
After a lengthy consultation process between member countries, representatives of European producer associations and non-governmental organizations interested in promoting the circulation economy, the European Commission has come to show and endorse some measures such as:
-Introduce mandatory recycling rates for different categories of waste. For example, plastic waste, glass, metals, paper and cardboard waste as well as biodegradable waste will no longer be accepted for final storage.
-Introduction of the obligation to redesign the products with two objectives:
(a)Increasing the proportion of raw materials from recycling in the total raw materials used by companies;
(b)Increasing the recyclability of products at the end of their life cycle, together with rewriting the European Waste Code to re-consider waste as secondary raw materials.
-Adoption of economic instruments to promote re-use and stimulation of industrial symbiosis and greener products.

-Increase the recycling rate of municipal waste to at least 65% by the year 2030.
-Increase the recycling rate of packaging waste to at least 75% by 2030.
Capping the final disposal rate for all categories of waste to a maximum of 10% by 2030, including fiscal and coercive instruments such as interdict the storage of separately collected waste and surplus waste disposal 50% reduction of food waste by 2030.
-Introduce minimum standards and obligations to water users on mandatory recycling rates by sector.
In a study on the efficiency of material resources, published earlier this year by the European Environment Agency, "More from less - material resource efficiency in Europe", 32 countries in Europe were evaluated.

Fig.3.More from less-material resource efficiency in Europe
Sources: https://www.eea.europa.eu/publications/more-from-less, Accessed on 05.20.2020 [3].
http://www.eea.europa.eu/highlights/resource-efficiency-in-europe-benefits, pg.7, Accessed on 05.20.2020 [2].

In order to build the Romanian model of the circular economy, an important role is represented by the good international and European practices, also the structural and cohesion funds, must be actively and continuously supported. This support is essential for recovering development gaps, implementing new technologies, educating consumers on the role of resource efficiency, preventing and combating food waste.
As a future action, consideration may be given to awarding an additional score for funding proposals that promote options for prevention, recycling, disassembly, recycling of products in a sustainable manner by making the activities as small as possible, or introducing a voucher type for companies that promote the circular economy through implemented projects.
Other potential criteria would be: quantity of packaging waste, purchase of renewable energy products, bio-economy, etc.
As a future action step, consideration may be given to providing additional points for financing proposals that promote the options for preventing, recycling, disassembling, recycling the products in a sustainable way by achieving the least impact of the activities or introducing a system of activities. voucher type for companies promoting circular economy through implemented projects. Other potential criteria would be: quantity of packaging waste, purchase of products using renewable energy, bio economy, etc.

CONCLUSIONS

In period of economic growth, several raw materials, energy, water, construction materials and metals are consumed, so it is

important to know how much we use, recover and lose from these resources. This equation includes the circular economy, which proposes to achieve an optimal consumption of resources.

The circular economy area includes all sectors because the efficiency of the use of resources is a topic related to the ability to generate cost savings and to implement new technologies, which will make economic processes more efficient. In this way, we can say that it goes beyond its scope in the area of environmental protection becoming a holistic theme, which can be in synergy with many other policies - for example. industrial policy/clusters/ competitiveness/economic/research/innovation/education, etc.

The circular economy is closely linked to the aspects of increasing competitiveness and at the same time this concept brings with it a number of benefits, but also challenges to which all stakeholders, whether private or public, or simple citizens, must respond.

In conclusion, the key to a circular economy in Romania is represented by the development of new sustainable business models who aims to promote the efficient use of resources and to protect the environment.

REFERENCES

[1]Circular jobs, Understanding employment in the circular economy in the Netherlands, https://circulareconomy.europa.eu/platform/sites/default/files/circular_jobs.pdf, pg. 5, Accessed on 05.02.2020.

[2]More from less-material resource efficiency in Europe,http://www.eea.europa.eu/highlights/resource-efficiency-in-europe-benefits, pg.7, Accessed on 05.02.2020

[3]Sieg, D.D., 2016, Economie circulara (Circular economy), http://sieg-dd.ro/economie-circulara/, Accessed on 05.02.2020.

[4]Stahel,W.R., 2006, 2010, Performance economy, 2nd Ed., Palgrave Mc Millan, https://www.globe-eu.org/wp-content/uploads/THE_PERFORMANCE_ECONOMY 1.pdf, Accessed on 05.02.2020.

[5]Stahel, W.R., Reday-Mulvey, G., 1976/1981, Jobs for Tomorrow, the potential for substituting manpower for energy, Report to the Commission of the European Communities, Brussels/NY, Vantage Press, http://www.gbv.de/dms/zbw/24304965X.pdf, Accessed on 05.02.2020.

[6]Sustainable development. What is circular economy?, https://www.activesustainability.com/sustainable-development/what-is-circular-economy/, Accessed on 05.02.2020.

[7]The 7 key elements of the Circular Economy, Circle economy, https://www.circle-economy.com/the-7-key-elements-of-the-circular-economy, Accessed on 05. 02.2020.

[8]Tirtiu, V.E., Stefanescu, M., Petrache, A.-M., Gurau, C.R., 2018, Tranzitia catre o economie circulara. De la managementul deseurilor la o economie verde in Romania, Institutul European din Romania (Transition to a circular economy. From waste management to a green economy in Romania, the European Institute of Romania), SPOS 2018 No.3, http://ier.gov.ro/wp-content/uploads/ 2019/03/ Final_Studiul-3_Spos-2018_Economie-circular%C4%83-1.pdf, Accessed on 05.02.2020.

[9]Wikipedia, Economie circulara, (Circular economy), https://ro.wikipedia.org/wiki/Economie_circular%C4%83#cite_note-2, Accessed on 05.02.2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ROLE OF THE INTELLECTUAL CAPITAL IN INSTITUTIONAL "HEALTH"

Oana Steliana BURLACU, Maria Magdalena TUREK RAHOVEANU

University "Dunarea de Jos"Galati, Faculty of Engineering and Agronomy Braila, Romania, Emails: oana.steliana@yahoo.com, mturek2003@yahoo.com

Corresponding author: mturek2003@yahoo.com

Abstract

The sustainable development is a process of continuous and permanent improvement, learning and perfecting, and the introduction of sustainable development policies into a society or company guarantees the creation of sustainable (not only immediate) value and consequently long-term benefits. In the age of knowledge, each organization is constantly changing. The success of the organization depends on how the crises that occur during this period are managed. An important factor in managing these crises is the intellectual capital. During the process of assimilating the intellectual capital, a transformation of the individual's identity is also realized. Identity transformation is an important social process that employs dissonance, attributions and divides the role of expectations. In this paper we want to highlight the concept of intellectual capital, which is it role into organizations and societies and which are the benefits for institutional health.

Key words**:** *intellectual capital, sustainable development, institutional health*

INTRODUCTION

At present, the concept of sustainable development is widely used in all areas and it is useful and correct to be applied for satisfying the basic material necessities, in order to provide the resources for optimizing the quality of life in terms of health and education.

Sustainable development is a complex process whose metrics involve a system of common indicators, but which also differs from country to country.

The human resource is considered to be the most important, the only one able to attract, combine and use the other resources necessary for a company, to achieve the proposed objectives.

Human capital has developed as a concept in the economy, where it is regarded in particular as "estimating a person's ability to generate income through work" (Di Bartolo, 1999) [4].

The notion of intellectual capital appeared in the business world in the 1990s, and at the focus is the information that gives rise to intellectual capital.

In the present paper, it was described the meaning of sustainable development for a village, medium in size and population, from Braila county where the main occupation of people is the agriculture. There are two possibilities:

(1)they practice only agriculture all the time in combination with animal husbandry

(2)they can have a daily job into local firm/company/institution and, in parallel with this to practice agriculture in order to obtain them own bio food products.

MATERIALS AND METHODS

To show how is defined the intellectual capital for a Romanian county, we selected some formulas and models.

One of the examples, the AK model developed by Paul Romer and Sergio Rebelo [7] studies the effects of accumulation of knowledge. The phenomenon considered endogenous is that, using new technologies, the economy accumulates experiences and knowledge which, in turn, favours the introduction of new technologies, generating growth.

It recognizes the validity of the growth model developed by Solow (1956) [9], it has tried to exceed its limits (in the absence of technical progress or, of its continuity, the growth is not maintained, in the long term, reaching a

steady state in which the growth is null). In Solow's elaborated version (which includes the technical progress factor) the growth rate is exogenous.
Starting from the Cobb-Douglas formula, with neutral technical progress, the production function is written:

$$Y(t)= K^{\alpha}(t)\,[A(t),L(t)]^{1-\alpha}$$

where:
K= capital;
L = work;
A = technical progress.
The model assumes that technical progress is the result of learning through practice, being a function of capital growth.

$$A(t)= BK^{Ø}(t),\ B>0,\ Ø>0$$

where:
B= coefficient of growth of K factor
The growth rate of the population is constant, the rate of economies is exogenous.
δ – depreciation of capital
And we have:
s(t) = I(t) and s(t) = sY(t) – saving rate;
K(t) = I(t) – δK(t) = capital rate;
For Ø = 1 şi n = 0 – growth is self-sustaining
By substitutions, we obtain:

$$Y(t)= K^{\alpha}(t)\,[BK^{Ø}(t),L(t)]^{1-\alpha}$$ [3].

The mathematical formula which can show the connection between consumed quantities from different factors and maximum quantities of goods obtained only by natural ways, organisational or technical is Cobb-Douglas formula.
Charles Cobb and Paul Douglas, two economists believe that the production is the result of labor and the capital used.
The below mentioned formula proposed by them and called production function Cobb-Douglas represents:

$$Y = a\,L^{\alpha}K^{\beta}$$
$$a > 0;\ \alpha > 0;\ \beta > 0,$$

where:
a = proportionality factor which shows the proportion of the increase of the production over the increase determined by the increase of the mass of the factors L and K;
α, β = coefficients of elasticity of production in relation to the labour factor, respectively capital [2].
Applying this formula into our case, our village from Braila, with a population of 3k inhabitants, results:
$\alpha + \beta > 1$ and that means the yield of factors L and K is increasing, the production increasing faster than the mass of the factors increases.
In another words, the engine of endogenous growth is the stock of technological knowledge [1].Technological knowledge and physical capital are the accumulating factor;
The accumulation of knowledge is realized inside the company through the process of learning through practice: the more it is produced, the more the technological knowledge develops, which will allow to increase the efficiency of the production in the following periods for quantities of invariable factors of production.
The assessment of intellectual capital can be considered a good starting point for a more efficient management, in order to increase the competitiveness, but it can also provide a reporting tool.

RESULTS AND DISCUSSIONS

Referring to our village from Braila county, we can say that agriculture is the number one occupation, the most advantageous for farmers and all local people, from all financial points of view and the formula Cobb-Douglas highlighted this aspect, in this way we can talk about sustainable development of a village.
We can say that everything is related to the supply, production and sale of a product cannot be achieved without the help of the technology set up and directed by the person / employee.
The person/employee to be able and authorized to use the agricultural machines correctly must first be trained. The more people trained in this regard, the better the production goes; in other words, the role of

the intellectual capital is to ensure the health of the farm/institution of which it is a part and for which it works and, of course, to ensure the sustainable development of the of the society [5].

As a statistic at the village taken into account, we can say that:

- 40% of the people have completed high school and a college, which means they have a computer, technical knowledge and a foreign language.
- 60% being assigned to studies belonging to the vocational schools, but following the different trainings they are authorized to use the agricultural equipment, and not only, at a certain level and in different ways.

As a result, over time it has been observed that many farms have higher incomes because they have employees with higher intellectual capital, that's the reason why more and more companies, both large and small, want to recruit in their own personal team with a high level of qualification and education, which can respond to the future demands and requirements of the economy and society.

Critical success factor for all types of organizations intellectual capital, is based, first of all, the evolution of education and studies [6].

It is the ability of employees to innovate in thousands of ways to improve the efficiency of a job.

The importance of investing in intellectual capital is the first step towards economic stability, even in these times of economic crisis.

The intellectual capital means performance into a society or organization/company and this aspect leads to success, prosperity, evolution and a vast portfolio of competencies.

The evolution of the professional career must be part of a knowledge map within the organization. This map is very valuable for the organization, because it includes the knowledge networks that are created between the employees, as well as the way in which they are organized around the production.

In the current economy, more and more managers are fighting to effects of the financial crisis, trying to find all kinds of solutions to increase the value of the company, and the importance of intellectual capital and its components are very important and even vital for some companies. This new era of technologies, new inventions and innovation has a great impact on the strategies, objectives and goals of many companies, which is why many researchers in the economic field regard intellectual capital as a sure source of growth in business value.

Most of the times, intellectual capital is considered a hidden wealth of companies, which, despite not being presented in its financial statements, offers an added value for the company. In today's economy, intellectual capital seems to be one of the safest things to prevent the effects of the current economic crisis, but also for the sustainable development of the economic entity. That's why more and more companies tend to invest more and more in intellectual capital, because they represent the engine of successful business [8].

Sustainable development has also a profound impact on many businesses, their operations and their supply chains.

The complex and interdependent nature of environmental problems will cause businesses to go beyond simply complying with environmental regulations to develop innovative responses to environmental challenges.

Companies that act according to the principles of sustainable development often obtain high performances (even in the short and medium term) compared to the other companies due to a better control of the different categories of risks to which they are exposed.

In the global civilization, the new economies that are based on innovations have as a priority the technological development that leads to a high level of competitiveness and to human development and the proven fact is that technological progress is essential for human progress.

Digital innovations open up new perspectives and "break the boundaries" of how people can use technologies to expand knowledge, stimulating growth and development.

New technologies are diffused, both between different countries and within them.

A rational starting point in examining the notion of intellectual capital is the analysis of the organization made from the perspective of resources. Viewed from this perspective, any organization or firm presents itself as a system consisting of a set of resources mobilized within a given structure [10].

Technological innovations can improve human potential and abilities, in other words they are a source of ensuring human development.

The financial advantages for companies obtained from investing in people, mainly in their education and training, are already proven and known. This investment has a high rate of recovery, respectively benefits in the form of increased labour productivity, professional skills development, innovation capacity, increased mobility of workers. However, many organizations still see employee education and training programs as a cost and not as an investment.

To clearly define the concept of intellectual capital, the below mentioned aspects are defining:

- intellectual capital is the sum of all the people in an organization know, giving it competitive advantages on the market;
- intellectual capital is recognized as a value in most organizations, but also the key to the success of that organization
- Intellectual capital represents the intellectual material that has been formalized, captured and valued to produce even more valuable assets. He is given by that knowledge that can be transformed into values.

The most important factors for sustainable development within an organization or company are: human capital and, of course, the structural capital.

Structural capital refers to ownership of information systems, distribution networks, supply chains.

Human capital consists of:

-educational capital

-biological capital.

Educational capital means: human resources, suppliers, customers with them intellectual skills achieved in schools, studies, trainings etc.

Biological skills refer to physical abilities, a good state of health.

Types of indicators used to measure intellectual capital:

- Leadership;
- Motivation;
- The ability to execute delegated tasks;
- Networking;
- Number of Employees;
- Age in the company;
- Stability in the position;
- Number of managers;
- Number of women managers;
- Percentage of managers with higher education;
- Average age of employees;
- Average duration of training programs (hours / employee);
- The average cost of training programs (hours / employee);
- IT knowledge.

CONCLUSIONS

In order to realize the potential of some businesses, it is very important to attract and retain the right combination of people who have collective expertise and have access to information networks. All the more so given the rapidity of many of the technological advances and the potential profits for private sector organizations, which exploit the first new market opportunities.

In the age of knowledge, each organization is constantly changing. The success of the organization depends on how the crises that occur during this period are managed. An important factor in managing these crises is the intellectual capital. During the process of assimilating the intellectual capital, a transformation of the individual's identity is also realized. Identity transformation is an important social process that employs dissonance, attributions and divides the role of expectations.

It is very important to know and to understand the real value for what means intellectual capital and over and over again, to invest in it, because it provides companies with a much greater well-being than similar companies, but they do not invest in this type of resource. The

current economy is based on these ways of developing the company, because they are reliable methods not only to keep the company afloat but even to develop it.

REFERENCES

[1]Anonymous, 2017, Intellectual capital and education in the context of the new economy and society based on knowledge, (Capitalul intelectual si educatia in contextul noii economii bazate pe cunoastere), http://muhaz.org/capitalul-intelectual-si-educatia-in-contextul-noii-economii-s.html, Accessed on 04.02.2020

[2]Anonymous, 2020, Production functions-Cobb Dougkas function (Functii de productie-Functia Cobb Douglas), http://www.creeaza.com/afaceri/economie/Functii-de-productie-Functia-d967.php/, Accessed on 09.02.2020

[3]Antonescu, D., Zaman, G., Georgescu, G., Goschin, Z., 2015, Economic endogenous development at the regional level. The case of Romania (Dezvoltarea economica endogena la nivel regional. Cazul Romaniei), Expert Publishing House, Bucharest, https://www.researchgate.net/publication/282124806_DEZVOLTAREA_ECONOMICA_ENDOGENA_LA_NIVEL_REGIONAL_CAZUL_ROMANIEI?enrichId=rgreq-c16efcd18be01cf94f748e56934776c7-XXX&enrichSource=Y292ZXJQYWdlOzI4MjEyNDgwNjtBUzoyNzcxODE5MDIxNDc1ODRAMTQ0MzA5NjcyMzExOQ%3D%3D&el=1_x_3&_esc=publicationCoverPdf, Accessed on 04.02.2020.

[4]Di Bartolo, A.,1999, Modern Human Capital Analysis: Estimation of USA, Canada and Italy Earning Functions, Working Paper, Dipartimento di Statistica, Università di Milano-Bicocca.

[5]Fidel, R., Methods used for the intellectual capital assessment (Metode utilizate pentru evaluarea capitalului intelectual), https://www.slideserve.com/rosa/metode-utilizate-pentru-evaluarea-capitalului-intelectual, Accessed on 04.02.2020.

[6]Moroianu, N., Moroianu, D., 2018, Intellectual capital in actuality (Capitalul intelectual în actualitate), http://www.oeconomica.uab.ro/upload/lucrari/820063/18.pdf , Accessed on 04.02.2020.

[7]Rebelo, S., 1991, Long-Run Policy Analysis and Long-Run Growt, The Journal of Political Economy, Vol. 99, No. 3 (Jun., 1991), pp. 500-521.

[8]Schiopoiu Burlea, A., 2013, The impact of the intellectual capital on the organization performance (Impactul capitalului intelectualasupra performantei organizatiei), Informatica Economica Journal, No. 1(25):119-122, http://revistaie.ase.ro/content/25/Schiopoiu.pdf http://online-cig.ase.ro/cignew/pics/ss2013/SESIUNE%20COMUNICARI%20CIG%202013/SECT%201%20CONTAB%20ment%202%20Importanta%20cap%20int.pdf, Accessed on 04.02.2020.

[9]Solow, R.M., 1956, A Contribution to the Theory of Economic Growth, The Quarterly Journal of Economics, Vol. 70, No. 1 (Feb., 1956), pp. 65-94.

[10]Stibli, F., 2012, Intellectual capital-a key resource for extening the prganizational intelligence, (Capitalul intelectual resursa cheie pentru extinderea inteligentei organizationale), https://intelligence.sri.ro/capitalul-intelectual-resursa-cheie-pentru-extinderea-inteligentei-organizationale/, Accessed on 04.02.2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

RESEARCH REGARDING CONSUMERS ATTITUDE, IN RELATION WITH POULTRY MEAT PURCHASE AND CONSUMPTION. CASE STUDY SIBIU, ROMANIA

Mirela CĂRĂTUȘ STANCIU

"Lucian Blaga" University of Sibiu, Faculty of Agricultural Sciences, Food Industry and Environmental Protection, 5-7 Ion Ratiu Street, 550003, Sibiu, Romania, Phone: +40269211338, Fax:+40213182888, Mobile:+40744472790, Email: mirela_stanciu2008@yahoo.com

Corresponding author: mirela_stanciu2008@yahoo.com

Abstract

The paper is based on the study of various reports and different type of articles regarding the EU poultry meat production and poultry meat's quality. In order to determine the Romanian consumers' perception regarding the quality of poultry meat, a questionnaire was prepared which was completed during February-April 2019 by 240 people from Sibiu County. Chicken meat is in the top of the preferences of Sibiu consumers. Consumers associate chicken meat with healthy meat from poultry fed with cereals, with a low-fat content. The respondents consider that the chicken meat contributes to maintaining the health status.

Key words**:** *poultry meat, quality, consumers, behaviour, consumption, local market*

INTRODUCTION

Poultry meat is in the top of the consumers preferences due to the costs of sale and due to its nutritional qualities. The biological peculiarities of the birds, the conquests of science and the genetic advances of the last 50 years regarding the production of high-quality meat chickens' hybrids and the achievement of better and better technical indicators, have led to the supply of increasing quantities of meat.

In 2018 the total production of EU poultry meat was 15,145 thousand tonnes, of which 71% was made in six Member States: Poland, UK, France, Spain, Germany, and Italy [12]. In the same year the domestic consumption of the EU member states was 14,457 thousand tonnes, ensuring a self-sufficiency of 106%.

EU poultry producers mainly exported to the Philippines, Ghana, Ukraine, South Africa, Hong Kong, Vietnam and Benin.

World poultry meat production reached in 2018 the amount of 123,205 thousand tons.

Worldwide the main exporters of poultry meat are Brazil, USA, EU, Thailand, China and Hong Kong [17].

The world production of broiler meat in value of 123,205 thousand tonnes carcass from 2018, registered an increase of 111% compared to 2013 when it had the value of 110,415 thousand tonnes.

At the EU level, the main poultry meat is broiler meat with a total production of 12.58 thousand tonnes in 2017 and 12.87 thousand tonnes in 2018 [1].

In 2018 Romania ranks 10th in the EU regarding broiler meat production (405 thousand tonnes carcass) [11].

In countries such as Romania, Poland, Greece and Portugal, the number of poultry farms are very high, with the largest number of farms with less than 99 birds. In these farms with less than 99 heads of birds, it is considered that the growth in the household system takes place [11].

A study by Horne P.L.M. shows that in 2013 Romania had the largest number of holdings under 99 broilers (1.5907.80), which represented 75.9% of the total holdings of this size in the EU. (2.095.460).

Poultry meat is the second most consumed meat in the EU after pork, representing approx. 30% of total meat consumption. Poultry meat consumption continues to grow in almost all EU Member States [15, 16, 18, 19].

The EU consumption of poultry meat per capita increased by 25% from 21.4 kg in 2013 to 26.8 kg in 2018. Countries such as Portugal (37 kg), Ireland (35 kg), Hungary (32.5 kg) registered the highest consumption of poultry meat per capita in 2018 [1, 9].

Per capita poultry meat consumption in Romania was increased from 17.37 kg/inhabitant in 1990 to 21 kg/capita in 2009, 22.9 kg in 2015 and to 24.1 kg in 2018 [1, 7, 13, 19, 25]

A study published in 2017 shows that the most important factor that influenced the consumption of poultry meat/ capita in Romania is the price, which makes this category of meat accessible to all social categories [6].

The level of consumption of poultry meat/ inhabitant is in direct correlation with the meat production and the purchasing power of the consumer.

The main factors that influence the decision to buy meat and meat products are quality and price as shown in 2015 a study by Soucek et al. [22].

There are few studies on the behaviour of the consumers of poultry meat and their perception on the organoleptic characteristics of this type of meat.

In a paper published in 2005 Hernandez J.M. synthesized data resulting from studies conducted among consumers of chicken meat from different countries. Thus, it is shown that 60% of consumers investigated in Spain in 1999, preferred to buy chickens with yellow skin. The main motivations underlying this purchase decision are the belief of better meat quality, freshness and association with the free-range growing system [10].

Another study conducted in South Africa in 2003 shows, that in the perception of buyers there are a strong correlation between the colour of the skin of the chicken and the quality of the products (61% of them prefer yellow chicken).

These studies have shown that the colour of the skin of the chicken is an important parameter of food quality. Consumers consider colour is a quality attribute of poultry products.

The statistical data available on the website of the Ministry of Agriculture and Rural Development showed that in Romania at the middle of year 2018, there were 76,820,437 bird heads. Of these, 33,918,072 heads were exploited in intensive system (about 44%), while in the household system there were 42,902,365 heads (about 56%) of the total. The distribution of the birds according to the type of production was in 2018 by approx. 41% laying hens and 59% poultry meat. In the intensive system 22.1% of the laying hens were exploited in the same year, while in the household system 77,83% were exploited. The meat chickens grew in the intensive system in proportion of 59.36%, while in the household system they grow 40.64%. These data show us the importance given to the raising of birds in the households, in extensive system [20].

In Sibiu County in 2018, the County Council authorized just 14 persons to market farmed chickens from household, out all of the total 180 that sell local products in the Transylvania market. The price, at which the meat chicken is currently marketed, varies between 22 lei and 25 lei/kg carcass.

The main purpose of the paper is to know, how the consumers of Sibiu perceive the market of poultry meat and their habits regarding the purchase and consumption of this kind of meat.

MATERIALS AND METHODS

The paper is based on the study of various reports and different type of articles regarding the EU poultry meat production and poultry meat quality.

To know the habits of consumers in Sibiu regarding the purchase and consumption of poultry meat, a sociological survey was carried out, using as a working instrument a questionnaire with 23 items, structured in: the motivation that influences the decision to buy poultry meat, data on preferences and consumption habits, degree of information of chicken products, data on the place of purchase, and data on the needs for improvement of the poultry meat market in Sibiu.

The questionnaire also included demographic data on respondents (sex, age, domicile, last graduated school, labour market status, field of activity, number of family members and income / family). After the elaboration of the questionnaire it was distributed online, and it was completed by 240 respondents during the period May-June 2019. The data were systematized, statistically processed and interpreted.

RESULTS AND DISCUSSIONS

The perception of Romanian consumers about the quality of poultry meat. Case study Sibiu

Few studies have been conducted at both international level and in Romania regarding the consumption of poultry meat and poultry production [8].

A study carried out online among 520 consumers in the urban area, by one of the largest chicken producers in Romania, showed that the main motivations underlying the decision to buy chicken are: it is easy cooking (71%), tastes good (62%), is a little fat meat, with few calories (56%). This study brings a current perspective on the culinary and consumption habits of Romanians, but also, about the poultry meat market. The frequency with which this type of meat is consumed, shows that 87.2% of the respondents consume chicken meat at least once a week, which is correlated with the frequency, with which the chicken meat is purchased [23].

Another study published in 2013 on Romanians' preferences for different meat assortments shows that, chicken meat is consumed in large quantities / person, followed by pork and fish. At the opposite end, it is observed that lamb meat is less consumed. Turkey meat is also rarely consumed [14].

The demographic profile of the respondents

Of the 240 individuals used in this study, 57.4% were females and 42.6% were males.

About 80% were between 21-40 years old and 12.7% over 41 years.

Regarding the avergae income level per month and family, 42.6% had over Lei 6,000 and 25,5% had between Lei 4,001-6,000.

About 84% of the questioned individuals were from the urban area.

Regarding education level, 54.3% were high school leavers, 39.4% had attended a faculty (Table 1).

Table 1. Demographic profile of respondents

Variable	Operational variable	Respondents distribution, number (%)
Sex	Male	102 (42,6)
	Female	138 (57,4)
Age	<20	18 (7,4)
	21-40	192 (79,9)
	41-60	30 (12,7)
Net income/month/ family	2,001-4,000 lei	77 (31,9)
	4,001-6,000 lei	61 (25,5)
	>6,000 lei	103 (42,6)
Number of persons in the family	<3	41 (17)
	3-4	163 (68,1)
	>4	36 (14,9)
Domicile	Urban	202 (84)
	Rural	38 (16)
Education level	High school	130 (54,3)
	University degree	95 (39,4)
	Post graduated	15 (6,3)
The status on the labour market	Students	105 (43,7)
	Employees	110 (45,8)
	Contractors	13 (5,3)
	Other	12 (5,2)

Source: Survey Data (2019).

Frequency of buying chicken meat and habits related to its purchase

Chicken meat is purchased at least once a week by 62.48% of the respondents. There are people who buy chicken meat daily (4.6%). 32.92% of those surveyed buy chicken meat minimum once a month. Those surveyed tend to buy chicken meat in the form of carcasses (67.92%), preferring to buy the meat they are going to prepare after.

The respondents prefer to buy mainly fresh meat, in refrigerated condition (63.75%). Only 5.42% of them buy processed chicken meat, in the form of semi-prepared foods.

The decision to buy is influenced by a number of sensory characteristics of the meat: the taste, smell and appearance of meat, quality of meat (65%), freshness / color (63.75%) and

shelf life (58.33%). The price of the product is important for 41.66% of those surveyed.

Respondents tend to buy mostly chicken breast (78.75%) and chicken thighs (65%). The internal organs and spines are purchased by 4.16% of the respondents.

Approx. 60.41% of the respondents used to buy boneless meat. Boneless meat is preferred for grilling or schnitzels. However, for more than one third of them (26.66%), this aspect is not important. A proportion of 12.92% of the respondents prefer to buy meat with bone due to the multiple uses for cooking.

The quantity of meat chicken purchased is for 76.66% of the respondents less than 1 kg, fresh meat, fried.

When buying semi-prepared poultry meat, respondents prefer crispy (41.66%), sausages (32.08%) and cordon-bleo (22.5%).

The respondents who buy chicken meat from local producers (from Transylvania market), think, that the chickens are healthy, and as a result they will consume a healthy food (65%). At the same time, they believe that the chicks from the small breeders are tastier (19.16%), were raised slowly (10.42%) and were fed with cereals.

A recent study shows that there is a need to increase the availability of less processed and healthy food, provided by Romanian farmers [24].

Data on consumption preferences

Chicken meat is consumed by 91.66% of the respondents at lunch. Also, a part of 43.75% of them used to eat this type of meat, for dinner too.

The colour of the chicken meat is considered a quality attribute. For 49.16% of the respondents the colour of the skin, of the chicken is very important. Only a proportion of approx. 16% of them say, that this does not matter.

A study published in 2009 shows that Romanians prefer chicken, and of the carcass parts, the pulp and breast are the most sought after [2].

The degree of information about chicken production.

By advertising, as a product promotion technique, consumer buying behaviour can be greatly influenced [5].

The main sources of information is the internet (67.92%) and is the nutritionist (25.42%), which shows that the respondents are concerned about their nutrition and health. The print media and the mass-media represent sources of information of nutrition for 28.75% of people.

Only approx. 41% of the respondents know the nutritional value of the chicken meat.

In general, those surveyed (about 80%) are not concerned about how the chickens are raised and do not know about the technology of their exploitation in the industrial system. Only 4.3% of the respondents correctly chose the age of slaughter of the chicks [8].

Data about the place of purchase

The respondents tend to buy poultry meat especially from hypermarket (53.2%), supermarket (50%) and specialty shops (40.4%). There are also a share of 25.5% of respondents who said, they prefer to buy poultry meat from local producers / farms.

Data on the needs for improvement of the poultry meat market in Sibiu

In general, the respondents are quite or very satisfied with the market for poultry meat in Sibiu (72.8%).

The respondents expect that the producers to improving the quality of the products and the way they are presented, as well as the diversification of the assortments.

CONCLUSIONS

The purchasing behaviour of agri-food products is different compared to the behaviour observed for other product categories. A major influence on consumer behaviour and food consumption is determined by their lifestyle.

The intensification of advertising could influence a great measure consumer buying behaviour.

At the European Union level consumer surveys show that origin is an important factor in making the decision to buy meat and meat products. The other important factors in making this decision are the price, the taste and the term of validity.

Over time, the consumer profile of poultry products has changed. It mainly looks at the quality of the products and reads the labels.

Different by meat from other species, poultry meat is expected to have an annual growth rate of 1.8% by 2050. Forecasts shows that the price of poultry meat will fall due to lower feed prices [18].

If in 1961 the average weight of the chicken carcasses was 1.3 kg, in 2018 it reached 1.78 kg. On the local market the main hybrids for chicken products are: ROSS 308, COBB 500, Kabir. These hybrids are suitable for use in all 3 production systems (intensive, semi-intensive and extensive).

Currently, there is a trend towards a healthier diet based on local, traditional or organic products [3, 4, 21].

The study proved that Romanians prefer in general chicken carcass parts, especially pulp and breast, many times without bones.

The obtained results. allow us to sign, that 91% of the respondents buy and consume chicken meat, and 67.1% of them buy chicken meat at least once a week. The meat is purchased mainly in refrigerated state (63.8%), in the form of carcass parts (78.7% breast and 64.9% chicken thighs). The quality of the product, the appearance of the product / freshness / colour is the basis of the purchase decision.

Consumers associate chicken meat with healthy meat from birds fed with cereals, with a low-fat content. The respondents consider that, the chicken meat contributes to maintaining the health status.

The respondents mainly buy boneless chicken (60.6%), the quantities purchased weekly are in the case of 76.6% of the respondents to less than 1 kg.

Chicken meat is mainly eaten at lunch (91.50) and dinner (43.6%). Chicken skin colour is an very important organoleptic attribute for 48.9% of the respondents.

Respondents are generally less informed about the nutritional value of the poultry meat and the technology of their production in intensive system. The main source of information remains the Internet (68.1%). Buyers know a lot of the brands under which this type of meat is marketed.

Chicken meat is usually bought from the specialty districts of the big stores (53.2%), although 40.4% of the respondents prefer to buy from the specialized stores of the producers or even from the Transylvania market/ farm (25.5%). Respondents know the local producers in the area, they trust the quality of the chicken raised in the countryside, which they consider to be healthier (53.2%), tastier (19.1%) and raised with cereals (10.6%).

Studies aiming to know the consumers' perception of the chicken market can provide data on the preferences regarding the buying and consumption habits of the poultry meat. Their results can be useful to producers, to improve their product quality and presentation form.

With an average consumption of 26.8 kg per head / inhabitant in 2018, the chicken meat is the second meat from the top of the preferences of the meat consumers in the EU. There must be concerns about improving its quality and increasing the weight of the chest in the carcass. There is also a preoccupation for better promotion of this type of meat, in terms of caloric, protein and vitamin intake.

For the future, consumers need to be better inform about the beneficial effects of the poultry meat. It is also necessary, to improve the confidence of consumers in the labelling system.

REFERENCES

[1]AVEC – Annual Report, 2019, https://www.avec-poultry.eu/wp-content/uploads/2019/10/05494-AVEC-annual-report-2019.pdf, Accessed on Jan.10, 2020.

[2]Buzamat, G., Pet, E., Grigoroiu, E., 2009, Marketing Researches Regarding Meat Consumer's Behaviour in the Western Part of Country, Bulletin UASVM Horticulture, 66(2), p. 80-83.

[3]Cărătuș Stanciu, M., 2019, Study regarding the egg's consumption and the perception regarding the egg's quality. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 19(2): 35-40.

[4]Cărătuș Stanciu, M., 2018, Analysis of the behavior and motivation of consumers towards short food supply chains, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 18(4): 73-78.

[5]Cătoiu, I., Teodorescu, N., 2004. Consumer behaviour, 2nd Ed., Uranus Publishing House,

Bucharest (Comportamentul consumatorului, Ediţia a II-a, Ed. Uranus, Bucureşti), pp.15-16.
[6]Chihaia, A., Costaiche, G.M., Arghiroiu, G.A., Beciu, S., 2017, comparative study of inland production and consumption of poultry meat in Romania. Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 17(3):95-100.
[7]Dobrescu, M., 2016, Romania - Poultry and Products Annual Report 2016, USDA Foreign Agricultural Service, 2015, http://agriexchange.apeda.gov.in/marketreport, Accessed on 17 Nov.2019.
[8]Estes, S., Edgar, L.D., Johnson, D. M., 2015, Consumer Perceptions of Poultry Production: A Focus on Arkansas, Journal of Applied Communications: Vol. 99: Is. 4, https://doi.org/10.4148/1051-0834.1057, Accessed on 17 Nov.2019.
[9] Faostat Data, http://www.fao.org/faostat/en/#data/QA, Accessed on Jan.10, 2020.
[10]Hernandez, J. M., 2005, Sensory perception on quality products across Europe: a case study on poultry quality, https://www.esn-network.com/fileadmin/inhalte/documents/Conference-ESN-Hernandez.pdf, , Accessed on 5 February 2019,
[11]Horne, P.L.M. van, 2018. Competitiveness of the EU poultry meat sector, base year 2017, International comparison of production costs. Wageningen, Wageningen Economic Research, Report 2018-116. 40 pp.
[12]Kranjac, D., Zmaić, K., Crnčan, A., Zrakić, M., 2019, Outlook on EU and Croatian poultrymeat market - Partial equilibrium modelapproach, World's Poultry Science Journal, Vol. 75, p.93-103.
[13]Mulder, M., Zomer, S., 2017, Dutch Consumers' Willingness to Pay for Broiler Welfare, Journal of Applied Animal Welfare Science, 20:2, 137-154.
[14]Pirvuțoiu, I., Popescu, A., 2013, Research on consumer behaviour in Bucharest poultry meat market, Scientific Papers Animal Science and Biotechnologies, Vol. 46(1):389-396.
[15]Popescu, A., 2013, Research on consumer behaviour on Bucharest meat market, Scientific papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 13(1) 301-308.
[16]Popescu, A., 2016, Trends in Romania's poultry meat market in the period 2007-2015, Annals of the Academy of Romanian Scientists Series on Agriculture, Silviculture and Veterinary Medicine Sciences, 54-62.
[17]Poultry Meat Dashborad, Europe EU Info sites, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/poultry-meat-dashboard_en.pdf, Accessed on Jan.10, 2020.
[18] Poultry trends- 2017, www.poultrytrends.com/201711/index.php, Accessed on Feb.10, 2019.
[19]Report from the Commission to the European Parliament and the Council on the impact of genetic selection on the welfare of chickens for meat production, Brussels (Raport al Comisiei către Parlamentul European și Consiliu privind impactul selecției genetice asupra bunăstării puilor destinați producției de carne, Bruxelles), 7.4.2016 COM(2016) 182 final, Accessed on Feb.10, 2019.
[20]Stafie, L., 2017, Multimillionaire chicken! Poultry farming, between statistics and type projects, Farm Magazine (Găina multimilionară! Avicultura, între statistici și proiecte tip, Revista Ferma), Accessed on June 3, 2019.
[21]Stanciu, M., 2013, The attitude and motivation of buyers of traditional/ local/bio products in the context of agrotourism, in Sibiu county, Romania, Scientific papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 13(4):273-277.
[22]Sourcek, M., Turcinkova, J., 2015, Factors for Choosing a Point of Purchase of Meat Products. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 63(2): 639–646.
[23]Transavia, 2020,Trends in poultry meat consumption in Romania (Tendintele consumului de carne de pasare in Romania), http://www.transavia.ro/noutati/tendintele-consumului-de-carne-de-pasare-romania-0, Accessed on Jan.10, 2020.
[24]Voinea, L., Vrânceanu, D. M., Filip, A., Popescu D.V., Negrea, T.M., Dina, R., 2019, Research on Food Behavior in Romania from the Perspective of Supporting Healthy Eating Habits, Sustainability, 11, 5255; doi:10.3390/su11195255.
[25]Windhorst, H.-W., 2018, Patterns of EU poultry meat production and consumption – a 2016 status report, Zootechnica International, https://zootecnicainternational.com/featured/patterns-eu-poultry-meat-production-consumption-2016-status-report, Accessed on 17 Nov.2019.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

STUDIES REGARDING THE ECONOMICAL APPROACH OF PEAR FRUITS COMMERCIALIZATION ACCORDING TO THE QUALITATIVE ASPECTS

Lenuta CHIRA, Adrian CHIRA, Elena DELIAN, Ligia ION, Constantin NICOLAE

University of Agricultural Sciences and Veterinary Medicine, Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania, Phone: +400212243617, Email: lenutachira@yahoo.com, achira63@yahoo.com, elenadelian@yahoo.com

Corresponding author: achira63@yahoo.com

Abstract

There are many situations where farmers exploit their fruit production just as it was harvested, without sorting the fruit by their quality or diameter. The present study that was carried out followed an economic approach of the pear fruit exploitation in terms of some quality aspects, namely it has highlighted the advantage of sorting the fruit into quality classes, as opposed to selling the fruit engross after being harvested from the orchard. The pear fruit belonging to the Conference, Beurre Bosc, Orizont and Cristal cultivars originated from a ten year old orchard located in the Bucharest area. The Orizont and Cristal cultivars in comparison with the Conference and Beurre Bosc cultivars display a genetic resistance to pear scab and fire blight diseases, which determined lower production costs, mainly due to less pre harvest intervention applied in the orchard. Both because of the above mentioned fact and the commercialization of the fruit after sorting, the obtained profit was between 1,150 RON/ha for the Conference cultivar and 13,900 RON/ha for the Cristal cultivar. This determined a higher value of profit, respectively between 5.5% and 25.1% in the case of the fruit sorted by quality criteria than for those exploited directly from the orchard, as soon as they have been harvested without any other postharvest intervention.

Key words**:** *cultivar, commercialization, pear scab, fire blight, sorting, quality criteria, quality indicators*

INTRODUCTION

Nowadays, the global changes of rapid population growth, urbanization and market liberalization generally have an impact on agricultural exploitations, making them more market – oriented and thus more competitive [4]. This trend is also valid in Romania.

Pear is the most mild climate fruit species after apple in the world. Pear fruit can be consumed both fresh and dry [6].

The fruit production obtained in an orchard may be exploited directly after harvesting, without being sorted into quality classes, when there is no storage capacity available or may be stored and exploited after being sorted on quality criteria, mostly taking into consideration the fruit diameter. In any of the above mentioned situations, the economic efficiency has to be analysed, because in order to obtain profit a number of factors are involved, of which the preharvest and postharvest ones are the biggest impact.

As long as the pears are asked for by the consumers, the culture of this species must enter into the attention of the fruit producers. The regress of the pear production must be halted, acting on the causes determining it, among which the most important are: the sensibility to the Psylla sp., bacterial fire (Erwinia amylovora) and not last - the lack of keeping spaces, equipped with refrigerating installations [1, 8].

Therefore growing pear cultivars that are genetically resistant to pear scab and fire blight allows the reduction of the production costs as a consequence of the drop in the number of phytosanitary treatments.

As far as the postharvest practices are concerned, sorting the fruit according to their diameter allows the classification on qualitative categories and their commercialization leads to a higher profit, despite the costs associated with the fruits sorting [2]. At times, due to the lack of work force or of reduced storage capacity, the farmer has to exploit the fruit production

directly after harvesting, through engross selling, which leads to a reduction in the obtained profit, especially if the fruits belong to the sensitive resistance to the main diseases category [3].

This study aimed to identify the economic aspects that resulted after the comparative exploitation of some pear cultivars that are genetically resistant to the main diseases and of others sensitive to these diseases, as well as the influence of the process of fruit sorting on the obtained profit.

MATERIALS AND METHODS

In order to carry out this study fruits from four pear cultivars were taken into consideration, grown in an orchard located in the Bucharest area and harvested in the autumn of the year 2019.

The four analyzed cultivars were: Conference, Beurre Bosc, Orizont and Cristal (Fig.1, 2, 3 and 4). The Conference variety, from the worldwide traditional range is of medium vigor, and the fruits are harvested in September and they reach maturity during the winter months. The medium weight of the fruits ranges between 150 and 300 grams. It is a variety that is sensitive to fire blight and moderately tolerant of scab.

The Beurre Bosc variety, from the worldwide traditional range is of medium vigor, and the fruits are harvested in September and they reach maturity during the winter months. The medium weight of the fruits ranges between 150 and 300 grams. It is a variety that is sensitive to fire blight and moderately tolerant of scab.

The Orizont variety, approved in the year 2003, is of Romanian origin and medium vigor. They are harvested in September and reach maturity in November and December. The fruits have the medium weight of 150-200 grams. It is a variety that is resistant to fire blight and scab.

The Cristal variety was approved in the year 2009, it is of Romanian origin and has a low to medium growth vigor. The fruits are harvested in September and reach consumption maturity in October. Their medium weight is 175-250 grams. It is a variety with a good tolerance to fire blight and scab [9, 10].

The economic analysis took into consideration the production costs, the sorting costs involved in selling according to qualitative categories, the revenue and the profit, both for cultivars genetically resistant to main diseases as well as for the sensitive ones. Moreover, some quality indicators were also determined, such as: Iq – the quality indicator and Kri – the medium quality indicator [5, 7].

Fig.1. Orizont cultivar
Source: Original.

Fig.2. Conference cultivar
Source: Original.

The formulas used for determining these indicators are:

$$I_q = \frac{Q_1}{Q_0}$$

where :
Q_1 = genetically resistant varieties medium production, influenced by quality categories;
Q_0 = standard varieties medium production, influenced by quality categories.
For determining the Kri indicator the following formula was used:

$$K_{ri} = \frac{\Sigma_{qi} \text{x} \text{R}_i}{\Sigma_{qi}} \text{ or } K_{ri} = \frac{\sum gi x \text{Ri}}{100}$$

where :
qi = product quantity by quality categories;
gi = production balance by quality categories;
Ri = the quality category coefficient [5, 7].

Fig.3. Cristal cultivar
Source: Original.

Fig.4. Beurre Bosc cultivar
Source: Original.

The Kri coefficient is representative for the situation in which the quality of a product or of a category of products is analyzed, when the fruit quantity is commercialized by quality categories.
In order to sort the fruits in quality categories, their equatorial diameter was taken into consideration, according to the specific quality standard, respectively: 60 mm – extra class category, 55 mm – first class category and 50 mm – second class category. The fruits that did not come under any of these categories or displayed qualitative flaws were classified as destined for industrial use.
The commercialization of the fruits on quality categories in 2019 in the Bucharest orchard area was carried out with the following prices: 5.5 lei/kg for extra class category; 4.5 lei/kg for first class category; 3.5 lei/kg for second class category and 0.8 lei/kg for the industrial destination. As the engross commercialization is concerned, the average price was around 3.5 lei/kg.

RESULTS AND DISCUSSIONS

As a consequence of the study carried out on the two harvesting categories and the economic analysis according to the type of commercialization (engross selling or quality categories selling) a series of data resulted that highlight the advantages of the genetically resistant cultivars growing as well as that of the commercialization after the pear fruits sorting, irrespective of the additional costs that come with this postharvest practice.
Thus, the data in Table 1 shows the medium quantity of fruits per hectare according to the different cultivars as well as the economic results according to the commercialization type.
The medium quantities of pear fruits obtained per hectare and their classification depending of the quality categories were significantly different for each cultivar, being influenced by the cultivar potential and the climatic characteristics of the year 2019. Therefore, the fruits quantities commercialization depending on the quality categories (fruits sorting included) determined an increased value influenced by the cultivars, varying from 4,760 lei/ha (Beurre Bosc) to 18,940 lei/ha (Cristal), which is equivalent to a higher

percentage rate, starting from 4.7% (Beurre Bosc) up to 17.7% (Cristal), in comparison with the engross selling.

After analysing the structure of the quality categories of the pear fruits for each cultivar it has been shown that the best were the first and second quality categories compared with the extra and industrial quality categories.

Regarding the production costs, the obtained data shows that in the case of Beurre Bosc and Conference cultivars, these were more important than in the case of Orizont and Cristal cultivars because of the increased number of phytosanitary treatments, the first two cultivars being more sensitive to the main pear fruits diseases (Table 2). It is also worth mentioning that in the situation of the fruit quality categories selling process, the production values costs were higher by 0.2 lei/kg because of the sorting practice.

The data shown in the Table 2 demonstrates the values of the profit obtained according to the type of commercialization, depending also on each cultivar category. Regarding the obtained profit values, the study carried out according to the two different selling approaches, highlighted some specific aspects, as follows:

-In the pear orchard it is more important to grow the cultivars which are genetically resistant to the main diseases, because of lower production costs;

-For the pear fruits it is more advantageous for farmers to sell the obtained production after the sorting process, according to the qualitative categories;

-The supplementary profits obtained per surface unit varied between 1,150 lei (Conference) to 13,900 lei (Cristal), when selling by quality categories, that means the increasing of the profit from 5.5% (Conference) until 25.1% (Cristal) in comparison with the en gross commercialisation;

-The supplementary profits obtained per surface unit were 3 – 5 times approximatively more important in the orchard with genetically resistant cultivars, in comparison with pear fruits orchard growing with sensitive cultivars to the main diseases.

Regarding the index of quality (Iq), the obtained values were: Iq extra quality = 1.21; Iq first quality = 1.21; Iq second quality = 0.68 and Iq industrial quality = 0.55.

The same index of quality, determined for the cultivar groups, has the result - Iq = 0.93.

The obtained results of the quality variation index demonstrate that for the both cultivar groups, the pear fruits from extra and first quality category were higher compared to the second and industrial quality categories.

Regarding the medium quality coefficient (Kri), by using the first formula, the obtained values were as follows: Kri Conference = 2.49; Kri Beurre Bosc =2.50; Kri Orizont = 2.30 and Kri Cristal = 2.13. These results were obtained according the following operations:

$$Kri = \frac{4.4\ x\ 1 + 10.2\ x\ 2 + 9.4\ x\ 3 + 4.5\ x\ 4}{28.5} = 2.49$$

(Conference)

$$Kri = \frac{5.2\ x\ 1 + 8.4\ x\ 2 + 8.6\ x\ 3 + 5.2\ x\ 4}{27.4} = 2.50$$

(Beurre Bosc)

$$Kri = \frac{5.6\ x\ 1 + 10.8\ x\ 2 + 6.7\ x\ 3 + 3.5\ x\ 4}{26.6} = 2.30$$

(Orizont)

$$Kri = \frac{6\ x\ 1 + 11.8\ x\ 2 + 5.6\ x\ 3 + 1.8\ x\ 4}{25.2} = 2.13$$

(Cristal)

The obtained results of the medium quality coefficient are in inverse proportion with the cultivars quality, so that ordered by quality the varieties would be: Cristal, Orizont, Conference and Beurre Bosc (the correspondence with the total and supplementary profits for the quality categories sales should be also consulted).

After calculating the Kri at the level of the variety group, the 2.21 value was obtained for the varieties with genetic resistance and 2.49 for the standard ones. This results highlights once again the fact that the cultivars having genetically resistance to the main diseases result in products whose medium quality is more important compared with the sensitive ones and the 2.49 – 2.21 = 0.28 deviation expresses the measure of this difference.

Table 1. The average production and economic results according to the commercialization type

Cultivar	Medium quantity t/ha	Fruits quantity for each quality category		Medium price	Commercialization value for the quality category selling		Commercializa-tion value for the engross selling lei/ha	Commercializa-tion value difference for the quality category selling	
		tons	%	lei/t	lei	%		lei	%
Conference	28.5	E 4.4	15.4	5,500	24,200	22.7	99,750	+6,850	+ 6.4
		I 10.2	35.8	4,500	45,900	43.1			
		II 9.4	33.0	3500	32,900	30.8			
		Ind 4.5	15.8	800	3,600	3.4			
	Total	**28.5**	**100.0**	**(3,740)**	**106,600**	**100.0**			
Beurre Bosc	27.4	E 5.2	19.0	5,500	28,600	28.4	95,900	+4,760	+4.7
		I 8.4	30.6	4,500	37,800	37.5			
		II 8.6	31.4	3500	30,100	29.9			
		Ind 5.2	19.0	800	4,160	4.2			
	Total	**27.4**	**100.0**	**(3,674)**	**100,660**	**100.0**			
Orizont	26.6	E 5.6	21.0	5,500	30,800	29.2	93,100	+12,550	+ 11.9
		I 10.8	40.6	4,500	48,600	46.0			
		II 6.7	25.2	3,500	23,450	22.2			
		Ind 3.5	13.2	800	2,800	2.6			
	Total	**26.6**	**100.0**	**(3,972)**	**105,650**	**100.0**			
Cristal	25.2	E 6.0	23.8	5,500	33,000	30.8	88,200	+18,940	+ 17.7
		I 11.8	46.8	4,500	53,100	49.6			
		II 5.6	22.2	3,500	19,600	18.3			
		Ind 1.8	7.2	800	1,440	1.3			
	Total	**25.2**	**100.0**	**(4,252)**	**107,140**	**100.0**			

Source: Own calculation.

Table 2. The profit value obtained according to the commercialization type

Cultivar	Engross commercialization			Quality categories commercialization			Profit value difference according the commercialization type	
	Value obtained lei/ha	Production cost lei/ha	Profit value lei/ha	Value obtained lei/ha	Production cost lei/ha	Profit value lei/ha	lei/ha	%
Conference	99,750	79,065	20,685	E 24,200	19,242	4,958	+1,150	+5.5
				I 45,900	36,534	9,366		
				II 32,900	26,107	6,793		
				Ind 3,600	2,882	718		
Total	**99,750**	**79,065**	**20,685**	**106,600**	**84,765**	**21,835**		
Beurre Bosc	95,900	80,090	15,810	E 28,600	24,302	4,298	+1,280	+8.1
				I 37,800	32,089	5,711		
				II 30,100	25,585	4,515		
				Ind 4,160	3,594	566		
Total	**95,900**	**80,090**	**15,810**	**100,660**	**85,570**	**17,090**		
Orizont	93,100	61,162	31,938	E 30,800	19,413	11,387	+7,230	+22.6
				I 48,600	30,582	18,018		
				II 23,450	14,759	8,691		
				Ind 2,800	1,728	1,072		
Total	**93,100**	**61,162**	**31,938**	**105,650**	**66,482**	**39,168**		
Cristal	88,200	62,139	26,070	E 33,000	20,688	12,312	+13,900	+25.1
				I 53,100	33,316	19,784		
				II 19,600	12,293	7,307		
				Ind 1,440	873	567		
Total	**88,200**	**62,130**	**26,070**	**107,140**	**67,170**	**39,970**		

Source: Own calculation.

CONCLUSIONS

It is better for the farmers to have in the pear orchard genetically resistant cultivars to the main diseases, because of the reduced number of phytosanitary treatments which determine lower production costs and less polluted fruits.

As far as the type of fruits commercialization is concerned, it is recommended to sell the

sorted production by qualitative categories, rather than engross selling, thus achieving a supplementary profit.

The supplementary profits obtained per hectare were significant, ranging between 1,150 lei (Conference cultivar) and 13,900 lei (Cristal cultivar), when the commercialization was performed by quality categories. That means obtaining a higher profit starting from 5.5% (Conference cultivar) to 25.1 % (Cristal cultivar), compared to the gross type of commercialization.

The supplementary profits obtained per hectare were 3 - 5 times bigger for the pear orchard cultivated with genetically resistant cultivars, compared with the standard pear orchard cultivated with the sensitive cultivars.

The values obtained for the index of quality (Iq) were as follows: Iq extra quality = 1.21; Iq first quality = 1.21; Iq second quality = 0.68 and Iq industrial quality = 0.55.

The results obtained regarding the medium quality coefficient (Kri) were: Conference = 2.49, Beurre Bosc = 2.50, Orizont = 2.30 and Cristal = 2.13. These values are inverse correlated with the cultivars quality, the most valuable being the Cristal cultivar.

REFERENCES

[1]Andrieş, N., Petre, V., Erculescu, M., 2008, New breeds and elites with perspective, with genetic resistance against the principal diseases and pests of the pear tree. Scientific Papers. Series B. Horticulture, Vol. LII, 9-12..

[2]Chira, A., Chira, L., Stoian, E, 2012, Researches regarding the influence of apple fruit sorting upon the economic efficiency in the commercialisation process. Scientific Papers. Series B. Horticulture, Vol. LVII, 399-402.

[3]Chira, L., Pașca, I., 2004, Părul și gutuiul. (The pear tree and quince tree), M.A.S.T. Publishing House, 157-158.

[4]Kahan, D., 2013, Market-oriented farming: an overview. FAO, Rome, 3.

[5]Moraru, G., 1998, Fascinația calității produselor agricole (Fascination of the agricultural products quality). Dacia Publishing House, 169-174.

[6]Okatan, V., Pola, M., Ercisli, S., Askin, M.A., 2017, Some pomological and chemical properties of local pear varieties in Usak, Turkey. Scientific Papers. Series B. Horticulture, Vol. LXI, 11-14.

[7]Pană, I., Percă, V., Mănoiu, I., 1983, Methods of economic assessment of agricultural products quality. Ceres Publishing House, Bucharest, 79-80.

[8]Pandaru, R.C, Butcaru, A.C, Stănica, Fl., 2019, Behaviour of some new Romanian pear disease resistant genotypes cultivated in Bucharest area. Scientific Papers. Series B. Horticulture, Vol. LXIII, No. 2, 87-90..

[9]Stănica, F., Braniște, N., 2011, Ghid pentru pomicultori (Guide for fruit tree growers), Ceres Publishing House, 56-58.

[10]Sumedrea, D. I., Olteanu, A., Isac, I.I., Coman, M., Iancu, M., Duțu, I., 2014, Pomi, arbuști fructiferi, căpșun-Ghid tehnic și economic (Fruit tree and bushes, strawberry- Technical and Economical Guide, Invel Multimedia Publishing House, 71-74.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ANALYSIS OF CONSUMER PREFERENCES REGARDING TOURISM AND ROURAL TOURISM ACTIVITY IN HUNEDOARA COUNTY

Horia Nicolae CIOCAN, Ioan Niculae ALECU, Reta CONDEI, Ion DONA

University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Mărăști Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax:+40213182888, Mobile:+40744 6474 10, Emails: horia_cn@yahoo.com, alecuioanniculae@yahoo.com, r_condei@yahoo.com, ion_dona@yahoo.com

Corresponding author: horia_cn@yahoo.com

Abstract

In the last years the share of tourism in the Romanian GDP has grown steadily and started to represent an important part of the Romanian economy. An important aspect of the tourism industry is represented by the rural tourism which have a high growth potential in our country. At present, rural tourism and agritourism represent only a small part of total tourism, but this niche has increased significantly in the last years. The rural areas of Romania attract many tourists from the country and from abroad who appreciate them due to the picturesque landscapes and the cultural habits kept by generations. In order to be able to find out exactly how this activity can be improved, a quantitative research based on the questionnaire method was performed. This research aims to find out what are the main characteristics that tourists look for when choosing how to spend their holidays and how important are certain aspects in the decision of choosing the tourist destination. The paper aimed to analyze consumers' perceptions and expectations regarding rural tourism and agritourism in Hunedoara county, Romania. The results revealed that the majority of consumers who answered the questionnaire had a positive opinion about rural tourism, which was found in the top of the preferences of consumers who choose to spend their holidays in Romania.

Key words**:** *rural tourism, agritourism, consumer behavior, decision making, consumption, rural development*

INTRODUCTION

The aim of this paper is to find out what are the main tourists' expectations when choosing how to spend their free days and how important are certain points in their decision of choosing the tourist destination. The paper aimed to analyze consumers' perceptions and assumptions regarding rural tourism and agritourism in Hunedoara county Romania.

Hunedoara county has a great tourism and agritourism potential because on its territory there are numerous archaeological remains, natural reserves with very beautiful mountain trails and exceptional landscapes [13].

In addition to the main archaeological sites, Sarmizegetusa Regia and Sarmizegetusa Ulpia Traiana that are dating back to antiquity and used to be capital of Dacia and the capital of Roman Dacia, in the Hunedoara County there are numerous emblematic medieval buildings, the most important being the Corvin Castle. Also, in Hunedoara County there are numerous religious edifices and monuments that attract an impressive number of tourists every year [1].

Considering this high tourism potential, the investors from Hunedoara county have all the premises to develop successful agritourism businesses [8].

Another very important aspect is the possibility of investors to access European funds for new tourism projects in rural areas of Hunedoara County [9],[7].

Due to the closure of mining activities, many people were left without jobs in Hunedoara. These persons can provide the labor force needed for the agritourism activities [2],[3].

Moreover, in addition to a job, rural tourism can become a profitable business for those with entrepreneurial skills [5].

The assessment of touristic resources and opportunities was made using the analysis of

available touristic objectives in order to see if the potential tourists are aware of their existence and importance.
Paper aimed to achieve a hierarchy of these objectives according to consumers preferences.

MATERIALS AND METHODS

This research uses quantitative method. The first step is to collect the data based on either hypothesis or a theory through a descriptive or inferential statistic. The data was gathered using a survey. It is the most appropriate instrument because is used either on small or large population. There is need it a sample from the wanted population in order to discover certain patterns or relations between variables. The aim is to find out about some populations by questioning a sample of it. In order to get the information a series of questions will be asked from the people. Their answers will be summarized in percentages or frequency distribution [10].
There are two types of surveys: longitudinal surveys, which are done during a period, to see the changes that might appear and cross-sectional survey, which helps gather the data at one point of time. It is called cross-sectional because the population sample might be male or female, above 18 years old with different socio-economic backgrounds [12].
Once the data are collected, they must be analyzed by employing different statistical components in quantitative data analysis: mean or average shows the central tendency and the standard deviation helps the researcher to see how far away or close are the scores around the mean [11].

RESULTS AND DISCUSSIONS

The survey was conducted on a number of 758 respondents living in different areas of Romania and with different social background. The genre split of the sample was 53% women and 47% men.
The respondents' distribution by age was made tacking in account seven categories of age. The most numerous age category was 25-35 years old with 30.2% of respondents, followed by category 36-45 years old with 23.8%. The next category by respondents' number is 46-55 years old with 15%, followed by category 18-24 years old with 13.5%. Category 55-65 years old was 12.4% and category under 18 years old was only 0.8% (Table 1).
The distribution of respondents touristic preferences by age revealed that in the situation of the holiday in Romania, 36.9% of the respondents prefer the agritourism to the detriment of other forms of tourism. Of these the most numerous age category is the category 36-45 years, in this age category 43.5% of the respondents prefer the agritourism. In the case of the following three age categories, 46-55, 55-65 and over 65 years old, over 50% of the respondents, respectively 52.1%, 52.4% and 53.5% prefer the agritourism.

Table 1. Distribution of respondents touristic preferences by age.

	I prefer agritourism-ism (from total)	I prefer agritourism-ism (from age category)	I prefer other types of tourism	Total
under 18 years old	0.0%	0.0%	0.8%	0.8%
18-24 years old	1.5%	11.0%	12.1%	13.6%
25-35 years old	8.5%	28.2%	21.7%	30.2%
36-45 years old	10.4%	43.5%	13.5%	23.9%
46-55 years old	7.8%	52.1%	7.2%	15.0%
55-65 years old	6.5%	52.4%	5.9%	12.4%
over 65 years old	2.2%	53.5%	1.9%	4.1%
Total	36.9%	-	63.1%	100%

Source: Own calculation.

The respondents education level was split into four categories, middle school studies with 1.6% of respondents, high school studies that represents 62.5% of respondents, university and master studies with 33.8% of respondents and postgraduate studies with 2.1% of respondents.
The respondents occupational status was divided into five categories. The first category that is also the most numerous is represented by employees with 61.0%. The second category is represented by students with 17.9% from respondents. Third category is

retirees with 9.7%, followed by fourth category of entrepreneurs with 3.4% and fifth category of freelancers with 7.7%.

The respondent's monthly income data represents the monthly income per person and was divided into six categories. Cumulated, the first two most numerous income categories represent almost 59% of the total respondents. The most numerous answers were for category 2,000-3,000 lei.

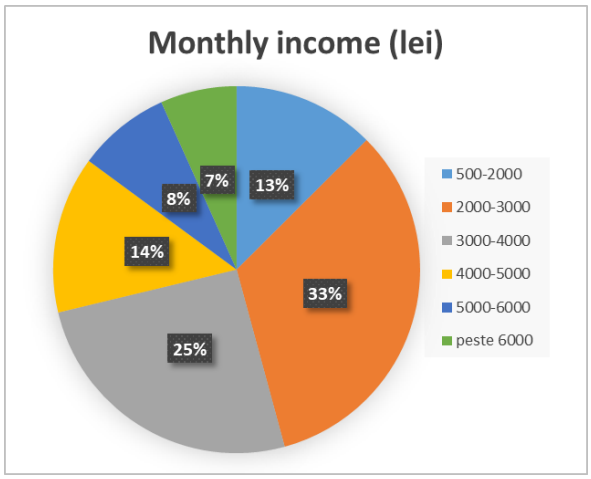

Fig. 1. Distribution of respondents by monthly income
Source: Own calculation.

According to the National Institute of Statistics, in November 2019, the nominal average net salary in Romania was 3,179 lei [14]. Taking this official report the average value as a reference point for a comparison with the weighted average for the monthly income of the respondents can show if the sample used in this study is representative for the Romanian population. If the first five categories of average incomes are calculated and weighted according to the number of respondents in each category, and the last category is considered to be approximately 6,500 lei, the weighted average arithmetic of the monthly incomes of the respondents is 3,389 lei [8]. This value is only 6.6% higher than the average value calculated by the NIS. This small difference can be explained by the fact that 68% of the respondents of this survey live in urban and peri-urban areas, compared to the national average, which is only 53.6%, according to the National Institute of Statistics. With more respondents in the urban area, the weighted average arithmetic of respondents' monthly incomes has increased, as this category of respondents has easier access to better paid jobs compared to people living in rural areas.

The category of 4,000-5,000 lei monthly income represents 13.8% of the total respondents, followed by the category 500-2,000 lei monthly income which represents 12,5% from total respondents.

The last two categories, 5,000-6,000 lei and over 6,000 lei monthly income represents only 8.1% respectively 6.7% from total respondents.

Regarding respondents travel mobility, when asked: What transport methods do you use when traveling on holiday in Romania? by far the most frequent transport method used by the respondents is the passenger car, only 7% of the respondents usually use the train or bus. The vast majority, respectively 97% use the car as the first option for travel. Of these, 57% use their own car, 34% travel with the car of friends / companions and only 1% use modern car sharing applications.

This fact has both advantages and disadvantages in relation to the agritourism activity. As an advantage, tourists traveling by passenger cars have very good mobility and independence [6]. They can cover a larger visible area in a shorter time and have easier access to remote rural areas as compared to tourists traveling by train or bus. but, as a disadvantage, given the existing road infrastructure problems, the tourists who use the car during their holidays leave cause more pollution with CO2 and other greenhouse gases compared to tourists that use public transport [4] [15].

Regarding the average duration of respondent's leave, 25.7% answered 4-6 days, 39.7% answered 7-9 days, 21.64% answered 10-14 days. Only 2.1% replied that usually stay on leave for more than 14 days. The results did not show an important gender differences in terms of the average length of leave (Table 2).

Regarding the holiday's financial aspects, survey respondents answers had a significant variation and were on split into eight categories.

Table 2. Distribution of respondents by gender depending on vacation length

Gender	4-6 days	7-9 days	10-14 days	over 14 days	Total
Women	12.70%	20.70%	10.40%	3.80%	53.10%
Men	13.03%	19.01%	11.24%	3.19%	46.90%
Total	29.68%	39.71%	23.61%	6.99%	100.00%

Source: Own calculation.

These expenses include all costs: transportation, accommodation, food, access to tourist attractions and leisure activities. The most numerous answers fall into 1,500-2,000 lei category which represents 26% of total answers. Other two important categories are 1,000-1,500 lei with 24.4% and 2,000-2,500 lei with 22.2%. (Fig 2)

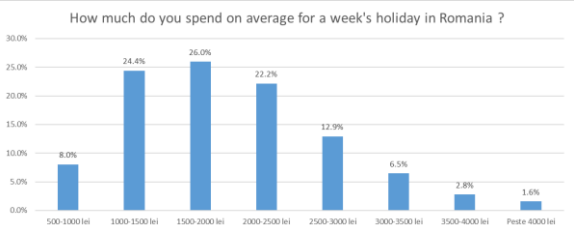

Fig. 2. Distribution of respondents average spending for a week's holiday in Romania
Source: Own calculation.

Another survey question was related with the number of persons who spend holidays together and the relationships between them. The answers are split between five categories. Family and other family friends with 25.2%, together with life partner represents la largest category with 29.9%; together with partner and child/children 19.7%; 17.9% of respondents travel with a group of friends and 7.3% are going in vacation alone (Fig. 3).

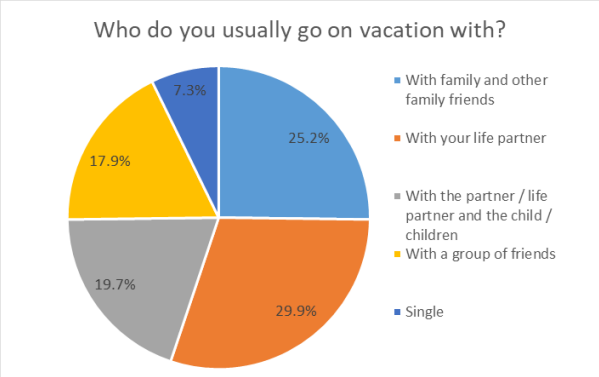

Fig. 3. Distribution of answers according to the number of persons who spend holidays together and the relationships between them
Source: Own calculation.

In connection with the process of choosing the holiday destination, the main sources of information used by the survey respondents were: Sites with accommodation offers and travel blogs with 38.1%, recommendations of friends or acquaintances with 35%, online advertising with 23, 9%, radio and TV commercials with 19%, travel agency offers with 17.2% and flayers and street ads represented 11.3% (Fig. 4).

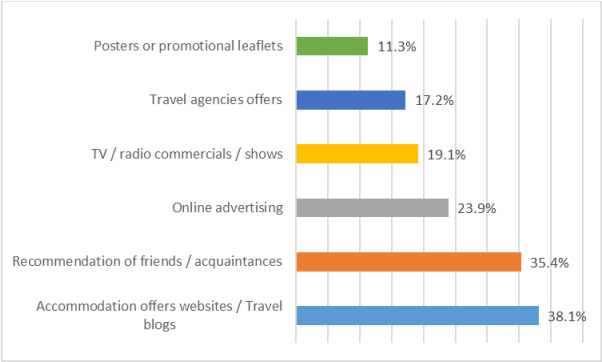

Fig. 4. The share of information sources used in the process of choosing the holiday destination
Source: Source: Own calculation.

Another matter tackled in this study was the importance of certain factors in the process of choosing the holiday destination. As expected, Services quality was rated first, 81% of the respondents rated service quality as very important, followed by the rest of 19% that rated it as important. There were no respondents to consider this aspect unimportant. Also, the cleanliness and hygiene where were considered to be important by 31% of respondents and very important by 66%. The prices charged are in third place according to the hierarchy of importance with 48% of the respondents considering that this aspect is very important and 37% considering this important aspect. Only 3% of the respondents considered this aspect unimportant (Fig 5).

Other aspects to which a significant percentage of about 20-30% of the respondents replied that they have average importance are: the multitude of tourist attractions, peace and quiet, the distance and the proportion of traditional products in the menu (Fig 5).

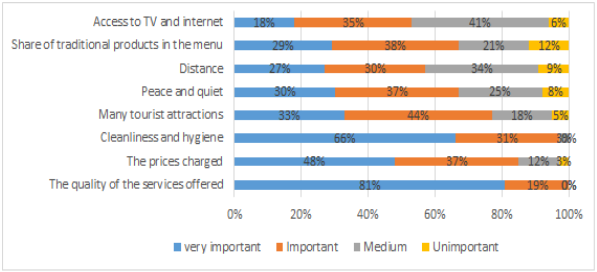

Fig.5.Importance of various factors in tourist destination choosing
Source: Own calculation.

Of all the aspects analyzed, the least important aspect was the access to television and internet, 41% of the respondents considered that this aspect is of average importance, and 6% considered it not important (Fig 5).
The answers given by respondent's question regarding the importance of certain sports activities revealed that quite a few tourists are interested in playing practicing certain sports.
The most important sports activity from respondent's perspective is hiking in nature. In total, 65% of the respondents considered this activity to be important or very important to them. The second place is the swim which is important or very important for 22% of the respondents, followed by fishing with 24% and cycling with 18%. As expected, climbing, a riskier niche sport, received the most responses in the "I'm not interested" category, 72% of the respondents were not interested in this activity (Table 3).

Table 3. Respondents interest in sports activities

Activity	*Very important*	*Important*	*Medium*	*Unimportant*	*Not interested*
Climbing	1%	2%	1%	24%	72%
Cycling	7%	11%	21%	37%	24%
Hiking	29%	36%	31%	3%	1%
Horse riding	4%	2%	7%	32%	55%
Swimming	12%	20%	27%	18%	23%
Fishing	5%	19%	10%	14%	52%

Source: Own calculation.

Regarding the preferences for future accommodation, it can be observed that the number of respondents who would like to stay in agritourism pensions in the future is very high, if in the past about 13.6% of the respondents stayed in agritourism pensions, in the future 24.1% of respondents expressed the desire to stay in agritourism pensions. If these wishes will materialize, the change of preferences will negatively influence the number of tourists who will stay in tourist villas with 5.4% and 3.3% the number of tourists who will choose to stay at the hotel (Fig .6).

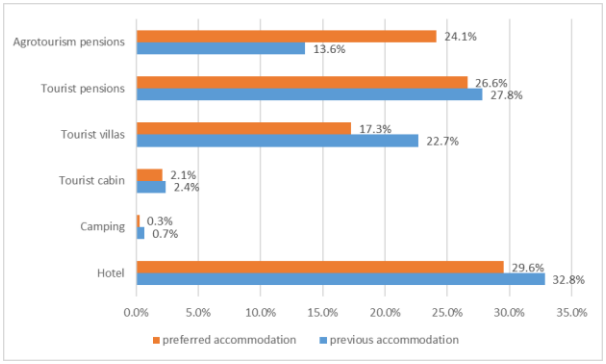

Fig. 6. Comparison between the previous choice of accommodation and the future preferred type of accommodation
Source: Own calculation.

Furthermore, the comparison of these answers shows that at present, the offer of accommodation services in agritourism pensions is below the demand level.
Another important series of questions referred to the main tourist objectives in Hunedoara region. The list of tourist objectives included all the types of objectives that can be found on the territory of Hunedoara county, respectively cultural, religious, historical or natural objectives.
Respondents were asked if they visited the tourist attraction, if they would like to visit it in the near future, if they are interested in the tourist attraction or if they would visit it only if they were nearby [16].
The most visited tourist objective was the Prislop Monastery and the grave of Father Arsenie Boca, 52% of the respondents visited this tourist objective. The second most visited tourist attraction after the Prislop Monastery was the Corvin Castle in Hunedoara city. This medieval castle was visited by 51% of the respondents (Table 4).
The third most visited tourist objective was the Roman Sarmizegetusa. 30% of the

respondents visited this tourist objective. It can be observed that the percentage difference between this objective and the first two is large, of just over 20%, although the objective is only 30 km away from the Prislop Monastery.

Table 4. Distribution of respondents touristic preferences by age.

Tourist attractions	I would like to visit	I'm not interested	Only if I were in the	Visited	I would Like to revisit	Interest in revisiting
The Roman baths in Geoagiu-Băi	56%	4%	32%	8%	6%	75%
The church of Densus	49%	15%	16%	20%	16%	80%
Corvin Castle (Hunians)	48%	0%	1%	51%	39%	76%
The Fortress of Deva	77%	0%	2%	21%	20%	91%
Țebea Memorial Complex	56%	12%	24%	8%	4%	50%
Dinosaur Geopark Țara Hațegului	44%	13%	35%	8%	5%	63%
Prislop Monastery (Arsenie Boca)	24%	11%	13%	52%	41%	79%
The Parang mountain	40%	4%	28%	28%	20%	71%
The Gold Museum in Brad	59%	4%	32%	5%	2%	40%
Retezat National Park	50%	4%	20%	26%	24%	88%
Hațeg Bison Reserve	32%	12%	36%	20%	11%	55%
Sarmizegetusa Regia	78%	0%	6%	16%	12%	75%
Roman Sarmizegetusa	63%	0%	7%	30%	22%	73%
Parâng tourist resort	65%	4%	15%	16%	13%	81%
Straja tourist resort	57%	3%	16%	24%	21%	88%

Source: Own calculation.

Analyzing the answers received, it can be observed that the respondents who have not so far visited certain objectives in Hunedoara County are interested in visiting most of the objectives. The percentage of those interested is directly influenced by the percentage of those who have already visited and the notoriety of the tourist objective. The greatest interest to visit is for Sarmizegetusa Regia, the former capital of the Dacian state. an important tourist objective that so far, was missed by only 16% of the respondents but, apart from those who visited it, 78% want to visit it.

The Deva Fortress is another tourist objective that is similar to Sarmizegetusa Regia, was visited by only 21% of the respondents, but the rest of 79% are interested to visit it.

Regarding the percentage of tourists who want to review certain tourist objectives, the highest percentage is found in Deva fortress, 91% of those who have visited this tourist objective want to review it. On the second place, the Retezat National Park and the Straja tourist resort are on an equal footing with 88%, and on the third place are the Parâng tourist resort. On the fourth place are the Prislop Monastery with 79% desire to revisit.

CONCLUSIONS

In conclusion, the analysis based on the survey reveals the following aspects.

If the respondents spend their holidays in Romania, 36.9% of them prefer the agritourism instead of other types of tourism. Among those who are over 46 years old prefer rural tourism in proportion of over 50%.

Most of the respondents earn between 2,000 lei and 4,000 lei per month and they agree to pay between 1,000 lei and 2,500 lei for a week's holiday in Romania.

By far, the main mode of travel used in the holidays are passenger vehicles, and the longer travel distance is not a major impediment to them.

The most frequent stay is one week, about 40% of the respondents fall into this category.

Only 7.3% of respondents go on vacation alone. 92.7% of the respondents go on vacation accompanied 29.9% travel with their partner, 25.2% are accompanied by family and other family friends. 19.7% go on leave with their life partner and children, and 17.9% go with a group of friends.

The main type of information and procurement of all the information needed to choose the holiday destination is the Internet. 38.1% of the respondents make the decision with the help of information obtained from accommodation websites or from travel blogs and forums. 35.4% is based on the recommendations of friends and

acquaintances. 23.9% are influenced by online advertising.

As a result, online advertising seems to be one of my most effective advertising methods today [6].

The services quality, the cleanliness and hygiene and the prices charged are the most important aspects

The main type of information and procurement of all the information needed to choose the holiday destination is the Internet. 38.1% of the respondents make the decision with the help of information obtained from accommodation websites or from travel blogs and forums. 35.4% is based on the recommendations of friends and acquaintances. 23.9% are influenced by online advertising.

As a result, online advertising seems to be one of my most effective advertising methods today because respondents are using it when they choose holiday destination and type of accommodation.

Regarding the categories of accommodation facilities it is observed that although up to the time of completing the questionnaire only 13.6% of the respondents stayed in agritourism pensions, in the future this category will increase significantly. 24.1% of the respondents sad that want to do rural tourism in the next years.

Respondents are interested to visit many touristic objectives from Hunedoara county, and the majority those who already visited these places are willing to return and revisit.

REFERENCES

[1]Bara, S., Toma, D., Lazăr, I., 2012, Hunedoara County-Monography, Vol.1, Timpul Publishing House (Județul Hunedoara, Monografie, Vol.1, Editura Timpul), Deva, pp. 72.

[2]Condei, R., Alecu, I.N., Popescu, A., Ciocan, H.N., 2016, The analysis of the human resources involved in the rural tourism in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and rural development, Vol. 16(2):85-94.

[3]Condei, R., Popescu, A., Bălan, A., Tudor, V. 2015, Aspects of employment in agriculture in the main development regions of Romania, Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 15(2):67-74.

[4]Costache, R.-D., Popescu, C., 2013, The touristic accessibility in the Hunedoara county in terms of road network, Geographia Technica, 18(2):1-12.

[5]Cretu, R.C., Ștefan, P., Gheorghe, S., Bibicioiu, S., 2015, New challenges for rural tourism specialization of agritourism guest houses. Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 15(1):123-126.

[6]Csoka, G., Kecse, G., 2019, Strategy Development and Promotion of Tourism in Romania. International Journal of New Technology and Research. Vol.5(7):98-101.

[7]Franzutti, R., Vintu, C.R., Smedescu, D., Ungureanu, D., Tudor, V.C., G.F. 2019, The National Rural Development Program-A chnace for agrotourism development in Suceava County, Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 19(2):129-134.

[8]Hincu, D., Ioan, I., Bran, F., 2010, Potential of rural tourism in Romania, Revista de turism/ Journal of tourism. 10. 28-31.

[9]Iova, A.R., Nastase, M., Lascar, E., 2016, Development of rural tourism and agrotourism in Romania by implementing European Programs. Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 16(1):233-238.

[10]Kuhn, T.S.., 2012, The structure of scientific revolution 4th edition. Chicago: University of Chicago Press, 10-23.

[11]Kumar, R., 2005, Research methodology. SAGE Publications, 39-50.

[12]Leedy, P. D., 1993, Practical research: planning and design. New Jersey: Prentice-Hall, 60-62.

[13]Muntean, I. O, Cuglesan, N., 2008, Objectives of sustainable development in the Hunedoara county, Journal of Environmental Protection and Ecology, 2008, 9(4): 852-867.

[14]National Institute of Statistics (Institutul Național de Statistică), 2020. Average gross salary, Press Release No. 10/13 January 2020 (Câștigul salarial mediu brut. Comunicat de presă Nr. 10 / 13 Ianuarie 2020.
<http://www.insse.ro/cms/sites/default/files/com_presa/com_pdf/cs11r19.pdf, Accessed on Jan.15, 2020.

[15]Xia, T., Zhang, Y., Crabb, S., Shah, P., 2013, Cobenefits of Replacing Car Trips with Alternative Transportation: A Review of Evidence and Methodological Issues. Journal of Environmental and Public Health. 2013. 10.1155/2013/797312.

[16]Zugravu, A., Soare, I., Costache, S., 2010, Rural tourism in Romania-Evolutions and discontinuities, Revista de turism/Journal of tourism. 12. 66-71.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

USE OF THE EXPERT SYSTEM-CROM IN APPLE ORCHARDS

Daniela DANA[1], Irina-Adriana CHIURCIU[2], Valentina VOICU[3,4], Elena SOARE[2], Daniela RĂDUCU[3]

[1]Ion Maiorescu National College, Giurgiu, Romania, Mihai Eminescu School, Giurgiu, Romania, Email: danam9569@gmail.com
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Management and Rural Development, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania, Emails: irina.chiurciu@yahoo.ro, economiegen2009@yahoo.com
[3]National Research and Development Institute for Soil Science, Agrochemistry and Environment - ICPA, 61 Mărăşti Blvd., District 1, Bucharest, Romania, Emails: valy_c76@yahoo.com, daniela.raducu@icpa.ro
[4]"Dunărea de Jos" University of Galați, Faculty of Engineering and Agronomy of Brăila, 29 Călăraşilor St., 810 017, Brăila, Romania

Corresponding author: irina.chiurciu@yahoo.ro

Abstract

Although Romania was the third apple grower in the European Union in 2018, after Poland and Italy, the country's apple production accounted for only 4.6% of total European production. The paper presents the evolution of the production of apples and the number of apples grown in the Macroregions of Romania, during the period 2010-2018, emphasizing the values registered in the Macroregion Four. Establishing the restrictions and recommendations for the improvement of the land and of the apple orchards was the main purpose of this paper. The experiments were made at Domaşnea farm, Caraş Severin County (Macroregion Four) on apple trees orchards, Golden Delicious and Starkrimson varieties.

Key words**:** *apple, criteria, expert system, indicators, orchard*

INTRODUCTION

Apple cultivation is a tradition in Romania. The total production of apples obtained in 2016, was ranked 2nd, after the plum production [9]. However, Romania continued to import large quantities of apples, especially from Poland [2].
The two varieties that were chosen for use in experiments are among the most cultivated in the country - Golden Delicious and Starkrimson [8].
In the Macroregion Four was done the research presented in this paper, where the smallest production of apples in the country was obtained for the period 2010-2018.
Domașnea Farm is located in the West Development Region (Macroregion Four), in Caraș-Severin County (Fig. 1).
Following the experiments, a set of restrictions and recommendations for apple orchards was established, through the CROM expert system.

Fig. 1. The position of the Domașnea farm in Romania
Source: [6].

The main objectives of the expert system CROM are:
- conservation of natural and artificial resources of fruit trees through the efficient and sustainable management of apple tree lands and orchards in an expert system [3], [11], [12];
- designing and testing at national level a unique and operational set of measurable

criteria and indicators, as a basis for a comprehensive (unitary) computer system, used to produce a quantified and integrated ecological model of climate resources, soil and land resources, specific infrastructure of apple tree lands and orchards [4], [5];
- establishing the value of the apple orchards and the apple tree plantations;
- efficient forecasting of the use of orchards and apples needed for evaluation in financing programs with European funds [1];
- facilitates the efforts of the Ministry of Agriculture and Rural Development for the formation of fruit farms with productions realized at low costs [7], [10].

MATERIALS AND METHODS

The expert system CROM was used to characterize the artificial and natural resources found at Domaşnea farm, in Caraş Severin. The study was conducted on apple tree orchards, where the expert system CROM was applied. This system was developed following the original methodology by "I.C.P.A.", which quantifies the land, soil, infrastructure resources and climate, the quality and the production of fruits [3], [11] and [12].
For this study were taken and processed statistics from the National Institute of Statistics [10], MARD [9] and Eurostat [7].

RESULTS AND DISCUSSIONS

From the analysis of the data made available on the Eurostat website [7] it can be concluded that Romania was the third apple grower (53,940 ha) at the European Union level, in 2018, after Poland (166,150 ha) and Italy (57,440 ha). The surface cultivated with apples in Romania represented in 2018 - 10.34% of the total area cultivated with apples of the European Union.
The apple production obtained in the same year (643,856 t) ranked Romania in the 6th place among the top apple producers, after Poland (3,999,520 t) and Italy (2,466,990 t) and represented 4.6% of the total apple production of the European Union.

Figure 2 shows the apple production obtained in the four Macroregions of the Country, in the period 2010-2018.

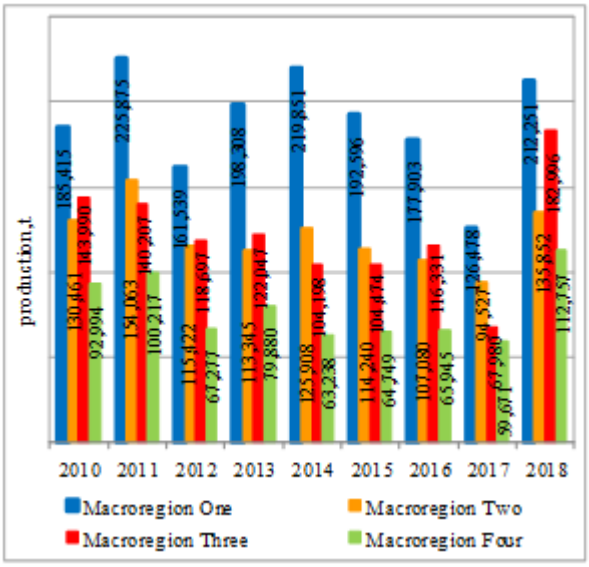

Fig. 2. Apple production in the four Macroregions of development (t)
Source: [10], own interpretation.

Analyzing the data presented in Fig. 2, we can see the increase of apple production, during the analyzed period, in all four Macroregions. Macroregion One was in the first place in terms of apple production, registering in 2018 - 212,251 t. On the last place was Macroregion Four, with 112,757 t of apples.

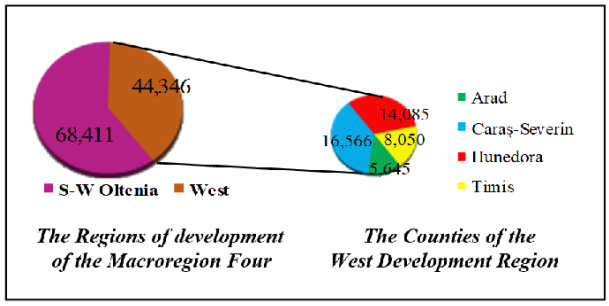

Fig. 3. Production of apples in Macroregion Four (t), in 2018, by Regions and Counties
Source: [10], own interpretation.

Within Macroregion Four, the highest apple production of 68,411 t was obtained in the S-W Oltenia Development Region (Fig. 3). In Caraş-Severin County, part of the West Development Region, the largest apple production was harvested, of 16,566 t.
Regarding the number of cultivated apples, with the exception of Macroregion Two,

during 2010-2018 the number of these fruit trees has decreased (Fig. 4).

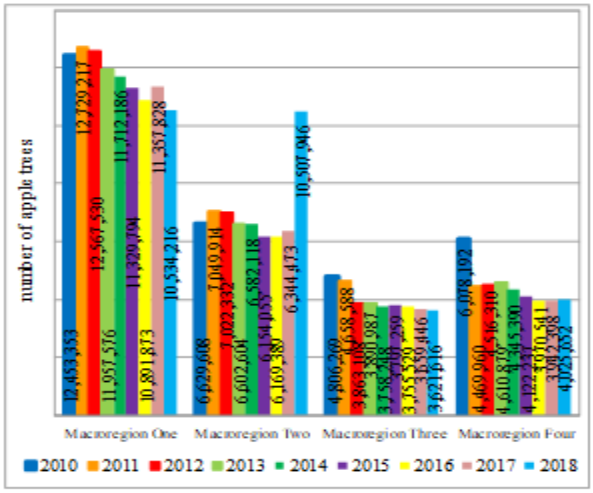

Fig. 4. The number of apple trees in the four Macroregions of development
Source: [10], own interpretation.

In 2018, Macroregion One held the first place, with 10,534,216 apple trees, and Macroregion Three last, with 3,621,616 apple trees. During the same period, in the Four Macroregion 4,025,652 apple trees were cultivated.

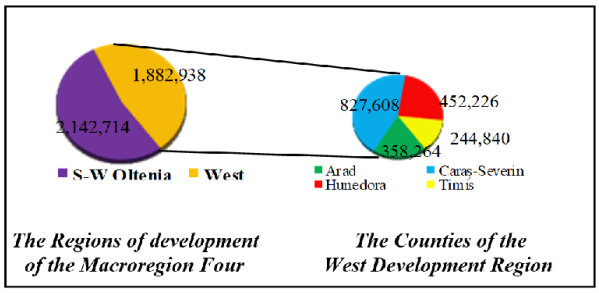

Fig. 5. Number of apple trees cultivated in Macroregion Four (t), in 2018, by Regions and Counties
Source: [10], own interpretation.

The Western Development Region held in 2018 - 46.77% of the total number of apples registered in Macroregion Four (Figure 5). In Caraș-Severin County, the most apples in the region were cultivated, 827,608 copies.
The results of the experiments performed at Domașnea Farm will be presented in the following:

Climate resources expertise
For the apple culture, the optimal average air temperature is between 7°C - 10°C and in the period of study it was 10.3°C. The frequency of repetitiveness of the optimum intervals was about 90% (Fig. 6).

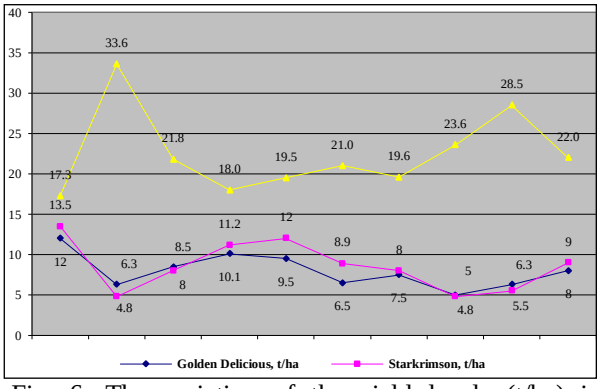

Fig. 6. The variation of the yield levels (t/ha) in relation to the thermal amplitude (°C, XI-II months) for apple trees, Golden Delicious and Starkrimson varieties, at the Domașnea farm, Caraș Severin
Source: Own determination.

For the period November-February, the thermal amplitude greater than 20°C had a frequency of repetitiveness about 40% (Fig. 7).

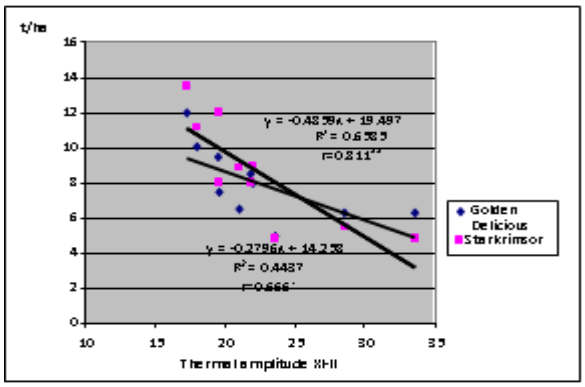

Fig. 7 The relation between the yield levels and the thermal amplitude (°C, XI-II months) for apple trees, Golden Delicious and Starkrimson varieties, at the Domașnea farm, Caraș Severin
Source: Own calculation.

After the quantification of the climatic resources for the apple trees, using the expert system-CROM, 50 addition points were obtained (Table 1).

Table 1. The quantification of the climatic resources for apple trees, Golden Delicious and Starkrimson varieties, at the Domașnea farm, Caraș Severin

Species/variety/ rootstock/age	Class of expertise	Addition points
Golden Delicious, Starkrimson/ apple/M106/25	With climate restrictions	50

Source: Own determination.

Soil resources expertise

The soil resources from the Domaşnea farm, Caraş Severin, receive 25 addition points and the apple orchards were included in the class without soil restrictions (Table 2).

Table 2. The quantification of the soil resources for apple trees, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/variety/ rootstock/age	Class of expertise	Addition points
Golden Delicious, Starkrimson/ apple/M106/25	Without soil restrictions	25

Source: Own determination.

Land resources expertise

For the relief conditions and for the drainage conditions 13 addition points were granted (Table 3). Also, the apple orchards from Domaşnea farm, Caraş Severin were included in the category with land restrictions.

Table 3. The quantification of the land resources for apple trees, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/variety/ rootstock/age	Class of expertise	Addition points
Golden Delicious, Starkrimson/ apple/M106/25	With land restrictions	13

Source: Own determination.

Expertise for apple orchards characterization criteria, production and the quality of the fruit

In Table 4 the indicators for the characterization of the apple orchards are quantified, being granted 67 addition points in the expert system-CROM.

The apple orchards infrastructure received 5 depreciation points (Table 5). The profitability of investment and the economic indicators are not affected so the production potential is in a proper balance with a proper management.

Table 4. The expertise of the apple orchards, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/variety/ rootstock/age	Class of expertise	Addition points	Indicators of characterization
Golden Delicious, Starkrimson/ apple/M106/25	> 20 years	10	Age of apple trees
	High	40	Assortment of species
	Good	17	Stage of vegetation for the orchards
	Total addition points	67	-

Source: Own determination.

Expertise for apple orchards infrastructure

Table 5. The expertise of the apple orchards infrastructure, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/variety /rootstock/age	Class of expertise	Depreciation points	Indicators of characterization
Golden Delicious, Starkrimson/ apple/M106/25	High	0	The equipping degree of the lands and orchards
	High	0	Possibilities for valorizing fruit production
	High	0	Proximity of the market
	Low	5	Possibilities of access to the market
	Total depreciation points	5	-

Source: Own determination.

The evaluation of apple land and orchard

Table 6 shows how the expert system-CROM at the Domaşnea farm was applied. The apple orchards received 150 points, being included in the category with natural and artificial restrictions.

Table 6. The evaluation of the apple trees lands and orchards, obtained by applying the expert system CROM, Golden Delicious and Starkrimson varieties, at the Domaşnea farm, Caraş Severin

Species/ variety/ rootstock/ age	**Class of expertise**	**Natural resources**			**Artificial resources**		**Total points**
		Climate	Soil	Land	Indicators of orchard characteri-zation	Orchard Infra-structure	
Golden Delicious, Starkrimson /apple/ M106/25	**With natural and artificial restrictions**	**50**	**25**	**13**	**67**	**5**	**150**

Source: Own determination.

CONCLUSIONS

Succeeding the application of the expert system-CROM, the apple orchards at the Domaşnea farm, Caraş Severin, were included in the category with natural and artificial restrictions.

The natural conditions favor the culture of this species and the frequency of optimum temperatures is 90%, not affecting the fruit trees.

The climate factor with negative effect on the apple yields is the thermal amplitude (November-February) greater than 20°C. The recommendations are to use a larger assortment of varieties in order to compensate

the decrease of apple yields caused by the climate resources.

Domaşnea area is a specific area of fruit tree culture, Golden Delicious and Starkrimson varieties producing at their genetic capacity only in years without climate restrictions.

The range of the area for the apple species has been improved by the autumn variety cultivation, which requires a lower level of the thermal factor for the development of physiological processes.

In order to have a positive economic balance, it is necessary to respect all phytosanitary treatments.

The market is provided by the local area and the neighboring one from the counties of Oltenia.

ACKNOWLEDGEMENTS

The research was carried out with the support of the Ministry of Education, AMCSIT-Politehnica Bucharest, project 3707 CEEX.

REFERENCES

[1]AFIR (Agency for Rural Investment Financing), www.afir.info, Accessed on 19.12.2019.

[2]Cimpoi, T., Contradictory statistics. Why we import so many apples from Poland (Statistici contradictorii. De ce importam atatea mere din Polonia), https://romanialibera.ro/economie/ statistici-contradictorii-de-ce-importam-atatea-mere-din-polonia-712783, Accessed on 19.12.2019.

[3]Dana, D., Lazăr, C., Răducu, D., Ştefănescu, S.L., Voiculescu, N., 2008, Operational handbook for evaluation of the fruit trees lands and orchards using expert system, Estfalia Publishing House, Bucharest, Romania, 3-89.

[4]Dana, D., Chiurciu, I.A., Voicu, V., Soare, E. 2018, The Management of the plots and of the plum orchards using an Expert System-Crom. Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 18(1):137-142.

[5]Dana, D., Chiurciu, I.A., Voicu, V., Soare, E. 2018, Management of Sweet Cherry Tree Lands and Orchards in Expert Systems-Crom. "GLOREP 2018 Conference, Timisoara 15-17 November 2018", Conference Proceeding, 48-50.

[6]Domașnea, https://domasnea.com/asezare, Accessed on 29.12.2019.

[7]Eurostat, https://ec.europa.eu/eurostat, Accessed on 19.12.2019.

[8]Fermierul Argeșean, The best varieties of apple trees cultivated in Romania (Cele mai bune soiuri de mere cultivate in Romania), http://fermierulargesean.ro/ cele-mai-bune-soiuri-de-mere-cultivate-in-romania, Accessed on 29.12.2019.

[9]MARD, Ministry of Agriculture and Rural Development, https://www.madr.ro, Accessed on 21.12.2019.

[10]NIS (National Institute of Statistics), www.insse.ro, Accessed on 20.12.2019.

[11]Voiculescu, N., Cepoiu, N., Leca, M., 2001, The eco-pedological bases of the nutrition of the fruit species, Muntenia Leda Publishing House, Constanța, Romania, 7-296.

[12]Voiculescu, N., Hoza, D., Spiță, V., 2006, Land references values in the absorption and migration of nutrients in fruits, Elisavaros Publishing House, Bucharest, Romania, 19-291.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

STOMATA-A KEY FACTOR WITH MULTIPLE FUNCTIONS IN THE CONDITIONS OF GLOBAL CLIMATE CHANGE: A BRIEF OVERVIEW

Elena DELIAN

University of Agricultural Sciences and Veterinary Medicine Bucharest, 59 Mărăşti, District 1, 11464, Bucharest, Romania, Phone/Fax: 00 40 744 6474 10; E-mail: elenadelian@yahoo.com

Corresponding author: elenadelian@yahoo.com

Abstract

The main components of climate change are carbon dioxide from the atmosphere, air temperature and drought. Considering the major changes of these parameters over time, nowadays especially, but also in the future, in order to cope properly with the new conditions, it is necessary to adjust the photosynthesis process in the sense of increasing its intensity and improving of water use efficiency. Because the stomata are formations of the epidermis involved in the process of carbon dioxide absorption (raw material in photosynthesis) and in its release (in the case of the respiration process), as well as in the release of water vapor during the transpiration, their behavior become defining for what it means not only the plants existence and their good functioning, but stomata influence is also extended and is not limited to just that. Besides the special importance for the physiological processes of plants, for plants own existence and good functioning, stomata also have significant effects for what the concentration of gases in the lower troposphere means and more than that, they can represent risks for vegetation or for human health. In view of the above, the purpose of this mini-synthesis is to present some new information on the central role played by stomata and especially their conductance property, under the conditions of climate change, in relation to the impact on plant productivity, on the carbon cycle in nature, as well as on water flow, but also on human health, with special reference to the conditions specific to the urban environment.

Key words**:** *climate change, stomata, plant productivity, water use efficiency, carbon cycle, human health*

INTRODUCTION

Global warming is a concept, but also a reality of today, as a result of multiple generating effects (e.g. anthropogenic activities which increase greenhouse gas emissions, as the increase in carbon dioxide) and it is well known that environmental climate change will influence our future [11], [48].

The main components of climate change are carbon dioxide from the atmosphere, air temperature and drought. Their changes will result in plants experiencing multiple co-occurring environmental stress factors and which require further studies [43].

As Xu et al. [56] mentioned, based on a more undisciplined management scenario, according to the Representative Concentration Pathway (RCP8.5) of Intergovernmental Panel on Climate Change (IPCC 2013), there has been a continuous increase in carbon dioxide concentration from 280 μmol mol^{-1}in 1750, to 400 μmol mol^{-1}, today. It is also expected that it will reach a value of around 900 μmol mol^{-1} by the end of the 21st century. At the same time, it is estimated that the temperature will increase with 2.6–4.8°C at the end of this century.

Consequently, along the time, this topic has been the subject of numerous discussions, scientific conferences, and public policy debates in some countries [46], [44], being taken into consideration also the effects and reactions that these changes can have at the level of individual, communities and societies, as a whole [20]. As mentioned by Dryzek et al. [17], the subject begins with science, which initially identified the climatic change problem and continues with how it is received by society and government.

In addition to the global impact, the problem of increasing carbon dioxide is also worrying the scientific community, about the need to study plants morpho-physiological disorders that may have direct effects on photosynthesis. These include the changes that may occur in the cuticular waxes, as well as the response to the development of stomata, as a consequence of the chemical changes in the atmosphere [35].

Stomata complexes (as the "gatekeepers") [31] are specialized formations located on the epidermis of leaves and plant stems, having as a main role the control of the gas exchanges between the plant and the environment [26], [55], namely the release of water vapors and the absorption of carbon dioxide (CO_2).The characteristics of these complexes are different in relation to the species' specificity, but the differences are also due to the specific environmental conditions, to which the stomata exhibit a strong sensitivity [58].This control depends on the degree of opening of the stoma (ostiole), but also on the density of the stomata, and implicitly has consequences on gas exchanges in plants [39]. Both characteristics are under the influence of environmental factors on the one hand and on the other hand under internal control, especially a hormonal one [26]. Moreover, the regulation of the degree of opening of the ostiole is actively carried out by numerous abiotic and biotic factors, which has significant global implications on evapotranspiration and on the carbon cycles [33].

Taking into account the fact that through the stomata a high proportion of gas exchanges between the leaf and the environment is ensured (95%), the preoccupations to reduce water losses and implicitly to improve the water use efficiency (WUE) should be considered. Beside WUE, another major indicator of the ability of plants to adapt to climate change (e.g. precipitation, temperature) is the carbon use efficiency (CUE) [15], cited by Masri et al. [37], as a ratio between the rate of net carbon uptake (net primary production) and gross carbon uptake (gross primary production).

Stomata manipulation represents an effective means to achieve these major objectives of the current period, characterized by the reduction of water availability [31], next to other new technologies, comprised in the concept of "smart" agriculture [22].

Besides the special importance of the physiological processes of plants, for their own existence and good functioning, stomata also have significant effects for what the concentration of gases in the lower troposphere means and more than that, they can represent risks for vegetation or for human health [2].

In view of the above, the purpose of this mini-synthesis is to present some new information on the central role played by stomata and especially their conductance property, under the conditions of climate change, in relation to the impact on plant productivity, on the carbon cycle in nature, on water flow, but not at the end on human health, with special reference to the conditions specific to the urban environment.

MATERIALS AND METHODS

This short bibliographic synthesis has been elaborated mainly on the basis of scientific information present in recent publications, indexed in internationally recognized databases. The data relevant to the topic of interest were systematized and discussed, so that finally some conclusions were drawn regarding the importance of the topic under discussion, as well as the need to approach it with interest in future research.

RESULTS AND DISCUSSIONS

The behavior of the stomata in the case of high temperatures

Progress has been made regarding the assessment of the consequences of drought on terrestrial plants and of the effects of climatic achievements on the functions at the ecosystem level. So, recent discoveries lead to the need to revise current opinions on the functional coordination between stomata and their hydraulic characteristics and respectively to offer a mechanistic framework for modeling plant mortality under drought conditions [36].

At the same time, Sperry et al. [49] succeeded on the basis of several mathematical formulas, in which they included different characteristics, to argue and quantitatively demonstrate the concept of a new and synthetic model regarding the stomata responses at the leaf level scale. As Wolf et al. [54] pointed out, several physiologically based stomata algorithms have the potential to

improve the simulation of carbon, water and energy flows in some models, which leads to increased confidence in the systems for predicting vegetation response to extreme climate change.

Local species are the ones that help maintain the functioning of the ecosystem and studies carried out by Craine et al. [12] suggest that different grasslands around the globe have the potential to withstand drought, if species tolerant to this abiotic stress factor are widespread locally. Moreover, Gago et al. [22] noticed that within the "smart" agriculture, for a more efficient use of water, among the new technologies applied, those designed to regulate the irrigation program (such as innovative technologies "Unmanned Aerial Vehicles – UAVs" equipped with remote sensors, to scale up levels from leaf to whole plant water status) are of interest, too. Their studies opened the challenge for the multidisciplinary and integrative approach of the concept of WUE.

As a result of climatic change, there was registered an increase in the frequency, magnitude and duration of the heat waves [41].Thus, the climatic models, such as those in the Copled Model Intercomparison Project (CMIP5) highlight the significant increase in the frequency and severity of these extremes [28].So, urgent understanding the mechanisms that lead to these undesirable results is required [14].

The stomata control of energy, water and carbon dioxide flows is a key component in terms of vegetation and atmosphere, coupling within the models of terrestrial systems. In this context, Bonan et al. [7] presented a framework for modeling the stomata conductance, which includes the connections between the gas exchanges that take place at the leaf level, the hydraulic constraints at the plant level, and the soil-plant-atmosphere system. The purpose of such a model was that of optimizing the photosynthetic carbon gain, on the unit of water loss, simultaneously avoiding dehydration caused by a low potential of water at the leaf level. With a view to a more robust modeling of carbon and water cycles, the recommendation of Masri et al. [37], for those dealing with this aspect is to re-examine the patterns of stomata conductance and soil-vegetation interactions.

As De Kauwe et al. [13] mentioned, in climatic models such as the CMIP5 model, the land surface is represented by modules in which photosynthesis and transpiration (via stomata conductance) are inherently coupled. Practically: the high temperatures cause the reduction of the rate of photosynthesis due to the direct effects on the enzymatic phase of the photosynthesis; intensification of the respiration process takes place; the stomata conductance decreases due to an increased of vapor pressure deficit value. In addition to the above, De Kauwe et al. [14] specified that finding additional evidence regarding the decoupling of photosynthesis from stomata conductance (reducing photosynthesis to near zero, but increasing transpiration into the boundary layer) in the case of elevated temperatures would involve revising the hypotheses existing in current climate models, with no negligible implications for developments based on the role of the land surface in amplifying temperature extremes.

Genetic engineering is an effective means to improve the tolerance of plants to heat stress. For example, in rice leaf blade, the strong expression of OsMDHAR4 (monodehydroascorbate reductase) protein (a key enzyme in the maintenance of the ascorbate acid pool through the ascorbate acid - glutathione cycle) was identified in chloroplast, due to heat treatment. Unlike the wild type, the osmdhar4mutant expressed an improved tolerance to heat stress, while OsMDHAR4 overexpression line showed enhanced sensitivity to heat stress. Also, in the rice leaves, the authors found that suppression of the gene OsMDHAR4 indicated the closing of the stomata and the accumulation of hydrogen peroxide. An overexpression of this gene caused an increase of the degree of openness of the stomata, while the hydrogen peroxide content decreased [34].Moreover, they found that suppression of OsMDHAR4 promoted stomata closure and hydrogen peroxide accumulation, while overexpression of OsMDHAR4 increased stomata opening and

decreased hydrogen peroxide content in rice leaves.

Under climatic changes, worldwide, at the level of agriculture it is registered an increase in the combined incidence of drought and thermal stress [57]. Temperature changes in the direction of their increase are a factor that affects inclusive stomata conductance. Although high temperatures would be expected to result in decreased of stomata conductance due to a decreased of leaf water potential and increased transpiration, Urban et al. [51] studies have highlighted an increase in stomata conductance for poplar (*Populus deltoides x nigra*) and loblolly pine (*Pinus taeda*) at an increase in temperature by 10 °C, from 30°C to 40°C, at a constant vapor pressure deficit of 1 kPa. In part, the authors' explanation was that at high temperatures the degree of viscosity at the xylem and mesophyll solution was decreased, which increased conductivity. The beneficial effect on the plant of increasing the stomata conductance is to maintain the proper temperature, thanks to the intensification of transpiration.

Plant species respond differently to temperature increase, as demonstrated also in two dominant tree species of the subtropical forest [53]. Thus, although there are changes in the stomata morphology and sensitivity to water deficiency, the species *Schima superba* found a conservative strategy, that is, a reduction in stomata density, but a constant maintenance of the stomata size, as a possible measure to prevent the loss of water and at the same time with the cost of reducing carbon gain. However, in *Syzygium rehderianum*, a balance has been achieved between what is the loss of water by transpiration and the absorption of carbon dioxide, by reducing the stomata size, but without affecting their density. Such behavior allowed the photosynthesis process to unfold even under high temperature conditions.

As Le et al. [32] emphasized, in the conditions of the climatic changes due to the increase of the temperature and of the precipitation reduction during the summer, an increase of the evapotranspiration for all the cultures is registered, with impact of reducing the water storage in the soil, as well as of the surface runoff. This also causes changes in the water cycle, as evidenced when the maize crop expanded to meet the demand for bioenergy has been replaced by miscanthus and switchgrass, that use more water for total evapotranspiration per season, by approximately 58% and 36%, respectively, as compared to maize.

Different behavior was found by Zhu et al. [39] too, respectively an increase in the plant stomata density and its shape index under urban conditions, as the temperature increased, while the stomata area decreased significantly. And in this case, plants resort to an ecological compensation strategy to adapt to the particular growing environmental conditions.

The negative impact of temperature increase on photosynthetic efficiency and on the physiology of stomata has been recently demonstrated in olive [25]. A marked reduction of RuBisCO enzyme activity, a deterioration in photosystem II, as well as a reduction of stomata conductance was determined. Therefore, the authors recommended the selection of olive varieties with a higher tolerance to thermal stress, as well as strategies to avoid the impact of high temperatures, in the context of developing a sustainable agriculture in the Mediteranean area.

The results obtained by Anav et al. [2] can be used to improve the representation of the effects of soil water stress on vegetation, with chemical transport models and for a better description of biogeochemical and biophysical feedbacks, within the soil-plant-atmosphere complex system, in response to the climate changes that lead to the existence of higher temperatures and conditions of increased drought.

As Chaves et al. [10] noticed, because the dilemma of “carbon compromise and leaf temperature” must be considered, in the case of semi-arid areas, genotypes that can simultaneously meet several requirements would be appropriate to successfully cope with the action of high temperatures: 1. to have the capacity to maximize the absorption of water from the soil (either through the

presence of a vigorous root system and / or the use of suitable rootstocks); 2. to have the ability to regulate the stomata conductance, so as to allow the amount of water lost through transpiration to be reduced, to the unit of carbon fixed (to be characterized by an increased of WUE) and at the same time to ensure the optimization of the water use in relation to the growth cycle phase; 3.to adjust the surface of the vegetal carpet according to the available water; 4.to exhibit characteristics that they allow the avoidance of heat (such as paraheliotropic movements) or heat resistance, at the level of the leaf mesophyll level; 5.to maintain cool canopies in case of irrigation application, in order to cope with periods of enhanced temperatures.

The behavior of the stomata in the case of high CO_2 level

At the plant level as an organism, the stomata are a major factor in the control of water loss and carbon dioxide absorption, respectively and at the ecosystem level they represent the main constraint regarding the continuous flow of water within the soil-plant-atmosphere system. Thus, an increase in CO_2 concentration modifies the stomata conductance and water use of plants, which may have a considerable effect on the hydrological cycle [27].Therefore, for the future management of water resources, especially in the water-limited areas, it is necessary to treat with interest the responses of different plants and the hydrological cycle that lead to the increase of CO_2 in the dry and wet areas. The overall estimates of the conductance of the plant carpet and of the evapotranspiration are of particular importance in terms of realigning the water cycle in nature and the energy partition [47].

Stomata conductance has major influences on photosynthesis and handling this feature can improve crop productivity and yield. Therefore, the natural variation of this feature and the identification of genomic regions involved may represent unexploited targets in future plant breeding programs [21].

Although known and accepted for a long time (about 40 years), the theory regarding the opening of the stomata until the carbon obtained balances the water lost during that time, is not in accordance with the competition for water between plants. Wolf et al. [54] developed an alternative theory according to which plants can maximize carbon gain without reducing water loss. Both theories, both the classic and the latter, are added two characteristics: 1. water flow through xylem that can be adversely affected as the water potential in xylem decreases; 2. the costs of feeding with carbon due to the reduced potential of the water, in combination with other mechanisms, which include the restoration of the damage caused at the xylem level. The authors have mentioned that the last alternative for carbon-maximization optimization is consistent with plant competition, because it yields an evolutionary stable strategy (ESS) - species, with the ESS stomata behavior that will outcompete all others.

Generally, an increase in carbon dioxide levels leads to a decrease in stomata conductivity, but also to stomata density [5] which can reduce the use of water by vegetation and can affect the climate [8]. Moreover, this behavior is a well-known response, characteristic of C3-type plants, which manages to reduce water losses, while maintaining the process of carbon dioxide absorption [30]. If from the point of view of the fixation of carbon dioxide during the photosynthesis, an increased of its concentration in the environment becomes limiting due to the decrease of the stomata conductance, at the same time it can increase the WUE. As a result, the growth of plants can be favoured, even in the context of climate change, which is associated with an increase in periods of water shortage [50]. The significantly improvement of the functioning of a tropical forage species grown in the field was also suggested by the results obtained by Habermann et al. [24], under elevated atmospheric carbon dioxide concentration, combined with a warmer environment. In this case, the stomata opening control and stomata anatomy were mainly due by elevated CO_2, and warming influence was noticed especially on photosystem II activity, as well as on antioxidant system, as a mean to defence to abiotic stress, such as drought.

An absolute necessity is to know whether manipulation of the stomata guard cells (in terms of the balance between carbon dioxide absorption and water loss by transpiration) to improve the response to increased carbon dioxide concentration can lead to increased photosynthesis efficiency [55]. In this context, a positive result was obtained by Dunn et al. [19] in wheat, where the expression of genes for manipulation of epidermal patterning factor (EPF) was achieved by reducing the density of stomata, and the increase of WUE was recorded in the case of a moderate reduction (<50% reduction in stomata density on leaves prior to tillering). The authors pointed out that the result is a promising one and can be a means to be followed during the breeding of the wheat plants, in order to cope with the deficiencies regarding the water supply under restricted environments, without registering losses of yield. Also, Caine et al. [9], by genetic engineering dedicated to reducing the number of stomata (through the overexpression of OsEPF1 in the epidermis) have been obtained a very productive rice cultivar (IR64), with a smaller number of stomata and at the same time, with a lower stomata conductance.

In contrast, Purcell et al. [42] demonstrated the fact that in an environment with a high concentration of carbon dioxide (hot and dry climate, with a high vapor pressure deficit), the stomata conductance increases, and it has a global significance for what the future modeling of the soil-vegetation – climate feedbacks. Although in many cases, a decrease in stomata conductance was recorded as the concentration of carbon dioxide increases, but, if the biomes were exposed to drought conditions, the increase in stomata conductance became one of the specific responses.

Stomata behavior in urban environment

The behavior of the stomata is of interest not only from the point of view of their influence on the productivity of plants evaluated, for example as net photosynthesis. If we refer to the urban environment, very exposed in terms of the number of inhabitants, associated with the incidence of the polluting factors derived from the intense traffic, the increase of the concentration of carbon dioxide, as well as of the pollutants in the air are very harmful to the health of the people.

Associated with the conditions mentioned above, the air temperature is higher and it is well know the "urban heat island" (UHI) phenomena, [40] cited by [38].This is mainly due by modification of surface properties that permit a greater solar radiation absorbtion, as well as a reducing of the convective cooling, associated with a lower water evaporation rates [23].

Ballinas and Barradas [3] highlighted the complexity of mitigating the UHI phenomenon and the need for the involvement of multidisciplinary teams (urban developers, ecologists, architects, engineers, climatologists, geographers, sociologists, etc.). They should take into account the characteristics of key native species, so, the obtained results, respectively the recommended procedures or techniques, will be suitable for a particular city. The authors emphasize that the measures taken in urbanism must stop the growth of this phenomenon and lead to a more sustainable city.

An excellent meta-analysis has recently been performed on the key pathways through which green and blue space affect both urban canopy and boundary layer temperatures. All aspects have been examined from the perspectives of city-planning, urban climatology and climate science [23].The authors consider that especially in the countries where rapid urbanization is expected, within the framework of the urban planning policy, the way in which the green and blue space infrastructure is applied should lead to mitigating the adverse effects of the UHI and to increasing the climate resilience. For instance, Alizadeh and Hitchmough [1] highlight the need to design a multi-layered vegetation community and a dynamic public landscape, consisting of a mixture of marine climate species and Mediterranean species from southern Europe, proven to have a high level of sustainability in current and future climate scenarios for United Kingdom.

In addition to other indicators used to monitor and characterize the situation, the features of

the stomata have proven to be useful. From this point of view, the decrease in the number of stomata, of the stomata indices and of the number of epidermal cells at the surface unit, with the increase of the length and the breadth of the stomata and respectively of the size of the epidermal cells have been shown to be possible biomarkers regarding the auto pollution [52].

Studies in Gothenburg, Sweden, by Konarska et al. [29] confirmed that trees can counteract heat stress in urban area, through shading and transpiration. They also have shown a positive correlation between the intensity of transpiration and the rate of air cooling in the presence of trees, compared to an area without vegetation. This beneficial effect was recorded around the period of sunset and no cooling effect due to transpiration has been noticed later in the night, or during daytime.

In is obvious that vegetation (in parks, gardens, etc.) as one of the effective remediation strategies has become useful including by extending the green walls of perennial and annual herbaceous plants. These, in addition to the many beneficial functions in terms of reducing pollution, but also increasing urban biodiversity, have the role of reducing the concentration of carbon dioxide thanks to the sequestration of significant amounts of carbon dioxide, at the plant level, as well as in the soil, through known physiological processes. Such a positive potential has been shown both in the case of grass species and shrubs (the perennial herbaceous species *Rudbeckia fulgida* var. sullivantii 'Goldstrum', *Erigeron karvinskianus*, *Veronica longifolia*, *Filipendula vulgaris*, *Gaura lindheimeri*, *Campanula persicifolia*, the perennial aromatic *Origanum vulgare*, *Salvia nemorosa* and *Achillea millefolium*, also the shrub *Lonicera pileata*), whose increased photosynthetic capacity, marked stomata conductance and intense transpiration have been shown to be more suitable for carbon dioxide absorption, as well as gaseous pollutants [4]. Many of the studied species have proven to be suitable for urban planning programs and due to a low emission of volatile organic compounds (VOCs), respectively characterized by low to moderate ozone forming potential (OFP) values. However, the species of the shrub category did not have the same potential (for the removal of the pollutants and for the storage and sequestration of the carbon, respectively) due to their specific morphological and anatomical characteristics (smaller leaf surface and specific structure).

Besides this, plants having the ability to absorb gas from the atmosphere if the stomata are open, a change in their behavior consequently affects the concentration of compounds remaining in the lower atmosphere. Thus, for example, in case of lower soil moisture, stomata conductance decreases and as a consequence there is a decrease in the amount of O_3 (ozone) removed by dry deposition, a process carried out during the summer, correlated with the marked limitation of stomata conductivity due mainly to soil moisture [2].

Climate is one of the key factors affecting the health of forests, but, even in temperate Romanian forest, the studies conducted by De Marco et al. [16] emphasized the obvious influence of ozone on defoliation and highlighted the need for its control in order to improve the health and vitality of the forest. Ozone reduces stomata conductance and consequently influences both the carbon dioxide assimilation and the WUE. Also, the improvement of knowledge regarding its impact on different signaling stages at the cellular level, as well as on the functioning of the ion channels involved in the movements can lead to the explanation of different types of responses to many and varied environmental conditions [18].

Urban greenery has proven to be a key component of the landscape architecture theory since the mid-19th century, with a positive impact on ventilation, improved sanitation and healthier indoor conditions. Moreover, in the specialized literature, the contribution of urban greenness to the physical and mental well-being was mentioned, more so in dense urban areas. The construction of green buildings represents part of the green economy meant to have less damaging effects on the environment and

bring substantial benefits to the society as a whole, but also to each individual [6].It should not be neglected that the net effects of urban greening on local microclimate, emissions, and air quality result from multiple competing physical and chemical processes that are highly site-specific. So, the use of genetically modified plants that have a tolerance to higher temperatures under global climate change could be one of the very promising prospects [45].

CONCLUSIONS

Global warming is a concept, but also a reality of today, as a result of multiple generating effects and it is well known that environmental climate change will influence our future [1].The main components of climate change are carbon dioxide from the atmosphere, air temperature and drought. Their changes will result in plants experiencing multiple co-occurring environmental stress factors [3]. Because the stomata are formations of the epidermis involved in the process of carbon dioxide absorption (raw material in photosynthesis), but also of its release (in the case of the respiration process), as well as the release of water vapor during the transpiration, their behavior become defining for what it means not only the plants existence and good functioning, but their influence is also extended and is not limited to just that. Besides the special importance of the physiological processes of plants, for their own existence and good functioning, stomata also have significant effects for energy, carbon and water flow cycles, for what the concentration of gases in the lower troposphere means and more than that, they can represent risks for vegetation, or for human health.

Future researches are needed with a view to clearly understand stomata functioning mechanism, their multiple functions for plant own life and for plants productivity, as well as for other additional functions, including those regarding the reduction of environmental pollution and preserving people health. Only thus, further, by biotechnological approaches the stomata behavior can be manipulated, as well the proper plant species can be recommended for a local area, according to the specifically conditions, mainly nowadays, when the climate changes are greatly extended over the world.

REFERENCES

[1]Alizadeh, B., Hitchmough, J.D., 2019, Designing sustainable urban landscape and meeting the challenge of climate change: a study of plant species adaptation and fitness under different climate change scenarios in public landscape of UK, Landscape Research, DOI: 10.1080/01426397.2019.1606185.

[2]Anav, A., Proietti, C., Menut, L., Carnicelli, S., De Marco, A., Paoletti, E., 2018, Sensitivity of stomatal conductance to soil moisture: implications for tropospheric ozone. Atmos. Chem. Phys., 18: 5747–5763.

[3]Ballinas, M., Barradas, V.L., 2015, The urban tree as a tool to mitigate the urban heat island in Mexico city: A simple phenomenological model. Journal of environmental…doi:10.2134/jeq2015.01.0056.

[4]Baraldi, R., Neri, L., Costa, F., Facini, O., Rapparini, F., Carriero, G., 2019, Ecophysiological and micromorphological characterization of green roof vegetation for urban mitigation. Urban Forestry and Urban Greening, 37:24-32.

[5]Bertolino, L.T., Caine, R.S., Gray, J.E., 2019, Impact of stomatal density and morphology on water-use efficiency in a changing world. Front. Plant Sci., 06 March 2019. 10:225. doi: 10.3389/fpls.2019.00225.

[6]Blaj, R. 2013, Green economy - the economy of the future. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 13 (4):63-68.

[7]Bonan, G.B., Williams, M., Fisher, A., Oleson, K.W., 2014, Modeling stomatal conductance in the earth system: linking leaf water-use efficiency and water transport along the soil–plant–atmosphere continuum. Geosci. Model Dev., 7:2193–2222.

[8]Bunce, J.A., 2004, Carbon dioxide effects on stomatal responses to the environment and water use by crops under filed conditions. Oecologia, 140:1-10.

[9]Caine, R.S., Yin, X., Sloan, J., Harrison, E.L., Mohammed, U., Fulton, T., Biswal, A.K., Dionora, J., Chater, C.C., Coe, R.A., Bandyopadhyay, A., Murchie, E.H., Swarup, R., Quick, W.P., Gray, J.E., 2019, Rice with reduced stomatal density conserves water and has improved drought tolerance under future climate conditions. New Phytologist, 221:371–384.

[10]Chaves, M.M., Costa, J.M., Zarrouka, O., Pinheiroa, C., Lopes, C.M., Pereira, J.S., 2016, Controlling stomatal aperture in semi-arid regions-The dilemma of saving water or being cool? Plant Science, 251:54–64.

[11]Collins, M., Knutti, R., Arblaster, J., Dufresne, J-L, Fichefet, T., Friedlingstein, P., et al., 2013, Long-term

climate change: projections, commitments and irreversibility. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V, Midgley PM, editors. Climate change 2013: the physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, 1029–1036.

[12]Craine, J.M., Ocheltree, T.W., Nippert, J.B., Towne, E.G., Skibbe, A.M., Kembel, S.W., Fargione, S.W., 2013, Global diversity of drought tolerance and grassland climate-change resilience. Nature Climate Change, 3:63–67.

[13]De Kauwe, M. G., Medlyn, B. E., Zaehle, S., Walker, A. P., Dietze, M. C., Hickler, T., Jain, A. K., Luo, Y., Parton, W. J., Prentice, I. C., Smith, B., Thornton, P. E., Wang, S., Wang, Y. , Wårlind, D., Weng, E., Crous, K. Y., Ellsworth, D. S., Hanson, P. J., SeokKim, H., Warren, J. M., Oren, R., Norby, R. J., 2013, Forest water use and water use efficiency at elevated CO_2: A model-data intercomparison at two contrasting temperate forest FACE sites. Glob. Change Biol., 19:1759–1779.

[14]De Kauwe, M.G., Medlyn, B.E., Pitman, A.J., Drake, J.E., Ukkola, A., Griebel, A., Pendall, E., Prober, S., Roderick, M., 2019, Examining the evidence for decoupling between photosynthesis and transpiration during heat extremes. Biogeosciences, 16:903–916.

[15]DeLucia, E. H., Drake, J. E., Thomas, R. B. & Gonzalez-Meler, M., 2017, Forest carbon use efficiency: is respiration a constant fraction of gross primary production? Global Change Biology, 13:1157-1167.

[16]De Marco, A., Vitale, M., Popa, I., Anav, A., Badea, O., Silaghi, D., Leca, S., Screpanti, A., Paoletti, E., 2017, Ozone exposure affects tree defoliation in a continental climate. Science of the Total Environment, 596-597:396-404.

[17]Dryzek, J.S., Norgaard, R.B., Schlosberg, D., 2012, Climate change and society: Approaches and Responses. The Oxford Handbook of Climate Change and Society. Edited by Dryzek, J.S., Norgaard, R.B., Schlosberg, D.

[18]Dumont, J., Spicher, F., Montpied, P., Dizengremel, P., Jolivet, Y., Le Thiec, D., 2013, Effects of ozone on stomatal responses to environmental parameters (blue light, red light, CO2and vapour pressure deficit) in three Populus deltoids x Populus nigra genotypes. Environmental Pollution, 173:85-96.

[19]Dunn, J., Hunt, L., Afsharinafar, M., Al Meselmani, M., Mitchell, A., Howells, R., Wallington, E., Fleming, A.J., Gray, J.E., 2019, Reduced stomatal density in bread wheat leads to increased water-use efficiency. Journal of Experimental Botany, 248, https://doi.org/10.1093/jxb/erz248.

[20]Ebi, K.L., Semenza, J.C., 2008, Community-based adaptation to the health impacts of climate change. American Journal of Preventive Medicine, 35 (5):501–507.

[21]Faralli, M., Matthews, J., Lawson, T., 2019, Exploiting natural variation and genetic manipulation of stomatal conductance for crop improvement. Current Opinion in Plant Biology, 49:1-7.

[22]Gago, J., Douthe, C., Florez-Sarasa, I., Escalona, J.M., Galmes, J., Fernie, A.R., Flexas, J., Medrano, H., 2014, Opportunities for improving leaf water use efficiency under climate change conditions. Plant Science, 226:108-119.

[23]Gunawardena, K.R., Wells, M.J., Kershaw, T.**,** 2017, Utilising green and blue space to mitigate urban heat island intensity. Science of the Total Environment, 584–585:1040-1055.

[24]Habermann E., Dias de Oliveira, E.A., Contin, D.R., San Martin, J.A.B., Curtarelli, L., Gonzalez-Meler, M.A., Martinez,C.A., 2019, Stomatal development and conductance of a tropical forage legume are regulated by elevated [CO2] under moderate warming. Front. Plant Sci., https://doi.org/10.3389/fpls.2019.00609.

[25]Haworth, M., Marino, G., Brunetti, C., Killi, D., De Carlo, A., Centritto, M., 2018, The impact of heat stress and water deficit on the photosynthetic and stomatal physiology of olive (Olea europaea L.) -A Case Study of the 2017 Heat Wave. Plants, 7, 76; doi:10.3390/plants7040076.

[26]Hetherington, A.M., Woodward, F.I., 2003,The role of stomata in sensing and driving environmental change. Nature, 424:901-907.

[27]Hong, T., Dong, W., Ji, D., Dai, T., Yang, S., Wei, T., 2019, The response of vegetation to rising CO_2 concentrations plays an important role in future changes in the hydrological cycle. Theoretical and Applied Climatology, 136:135-144.

[28]Kharin, V. V., Zwiers, F.W., Zhang, X., Wehner, M., 2013, Changes in temperature and precipitation extremes in the CMIP5 ensemble. Climatic Change, 119: 345 –357.

[29]Konarska, J., Uddling, J., Holmer, B., Lutz, M., Lindberg, F., Pleijel, H., Thorsson, S., 2015, Transpiration of urban trees and its impact on daytime and nocturnal cooling in Gothenburg, Sweden. ICUC9 -9th International Conference on Urban Climate jointly with12thSymposium on the Urban Environment.

[30]Lammertsmaa,E.I., Jan de Boer, H., Dekker, S.C., Dilcher, D.L., Lotter, A.F.,Wagner-Crème, F., 2011, Global CO_2 rise leads to reduced maximum stomatal conductance in Florida vegetation. PNAS, 108 (10):4035–4040.

[31]Lawson, T., Blatt, M.R., 2014, Stomatal size, speed, and responsiveness impact on photosynthesis and water use efficiency. Plant Physiology, 164:1556–1570.

[32]Le, P.V.V., Kumar, P., Drewry, D.T., 2011, Implications for the hydrologic cycle under climate change due to the expansion of bioenergy crops in the Midwestern United States. PNAS,108 (37):15085-15090.

[33]Lin, Y-S., Medlyn, B.E., […], Wingate, E., 2015, Optimal stomatal behaviour around the world. Nature Climate Change, 5:459–464.

[34]Liu, J., Sun, X., Xu, F., Zhang, Y., Zhang, Q., Miao, R., Zhang, J., Liang, J., Xu, W., 2018, Suppression of OsMDHAR4 enhances heat tolerance by mediating H_2O_2-induced stomatal closure in rice plants. Rice, 11: 38.
[35]Machado, M.R., 2014, Plant cells in the context of climate change. Braz. Arch. Biol. Technol., 57 (1): 126-137.
[36]Martin-StPaul, N., Delzon, S., Cochard, H., 2017, Plant resistance to drought depends on timely stomatal closure. Ecology Letters, doi: 10.1111/ele.12851.
[37]Masri, B.E., Schwalm, C., Huntzinger, D.N., Mao, J., Shi, X., Peng, C., Fisher, J.B., Jain, A.K., Tian, H., Poulter, B., Michalak, A.M., 2019, Carbon and water use efficiencies: A comparative analysis of ten terrestrial ecosystem models under changing climate. Scientific Reports, 9, Article number: 14680.
[38]Mohajerani, A. Bakaric, J. and Jeffrey-Bailey, T., 2017, The urban heat island effect, its causes, and mitigation, with reference to the thermal properties of asphalt concrete. Journal of Environmental Management, Elsevier, United Kingdom, 197:522-538.
[39]Monda, K., Araki, H., Kuhara, S., Ishigaki, G., Akashi, R., Negi, J., Kojima,M., Sakakibara, H., Takahashi, S., Hashimoto-Sugimoto, M., Goto, N., Iba, J., 2016, Enhanced stomatal conductance by a spontaneous Arabidopsis tetraploid, Me-0, Results from increased stomatal size and greater stomatal aperture. Plant Physiology, 170: 1435–1444.
[40]Oke, T.R., 1982, The energetic basis of the urban heat island. Q. J. Roy. Meteor. Society, 108 (455):1-24.
[41]Perkins, S.E., Alexander, L.V., Nairn, J.R., 2012, Increasing frequency, intensity and duration of observed global heat waves and warm spells. Geophysical Research Letters, 39, L20714, doi:10.1029/2012GL053361.
[42]Purcell, C., Batke, S.P., Yiotis, C., Caballero, R., Soh, W.K., Murray, M., McElwain, J.C., 2018, Increasing stomatal conductance in response to rising atmospheric CO_2. Annals of Botany 00:1–13.
[43]Qaderi, M.M., Martel, A.B., Dixon, S.L., 2019, Environmental factors influence plant vascular system and water regulation. Plants, 8, 65.
[44]Resnik, D.B., 2016, Bioethics and climate change: A response to Macpherson and Valles. Bioethics, 30(8): 649–652.
[45]Santamouris, M., Ban-Weiss, G., Osmond, P., Paolini, R., Synnefa, A., Cartalis, C., Muscio, A., Zinzi, M., Morakinyo, T., Ng, E., Tan, Z., Takebayashi, H., Sailor, D., Crank, P., Taha, H., Pisello, A., Rossi, F., Zhang, J., & Kolokotsa, D., 2018, Progress in urban greenery mitigation science - assessment methodologies advanced technologies and impact on cities. Journal of Civil Engineering and Management, 24(8):638-671.
[46]Scheraga, D., Ebi, K.L., Furlow, J., Moreno, A.R., 2003, Chapter 12. From science to policy: developing responses to climate change in: A.J. McMichael, D. Campbell-Lendrum, C.F. Corvalan, K.L. Ebi, A. Githeko, J.D. Scheraga, A. Woodward (Eds.) Climate change and human health: risks and responses.
[47]Shan, N., Ju, W., Migliavacca, M., Martini, D., Guanter, L., Chen, J., Goulas, Y., Zhang, Y., 2019, Modeling canopy conductance and transpiration from solar-induced chlorophyll fluorescence. Agricultural and Forest Meteorology, 268:189-201.
[48]Simeon, P.P., Jijingi, H.E., Apaji, N.J., 2018, Climate change: a challenge to sustainable land resource management in agriculture and the extension of arable crops mechanization in Nigeria. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18 (3):399-406.
[49]Sperry, J.S., Venturas, M.D., Anderegg, W.R.L., Mencuccini, M., Mackay, D.S., Wang, Y., Love, D.M., 2017, Predicting stomatal responses to the environment from the optimization of photosynthetic gain and hydraulic cost. Plant, Cell and Environment, 40:816–830.
[50]Sreeharsha, R. V., Sekhar, K. M., and Reddy, A. R., 2015, Delayed flowering is associated with lack of photosynthetic acclimation in Pigeon pea (Cajanus cajan L.) grown under elevated CO_2. Plant Sci. 231:82–93.
[51]Urban, J., Ingwers, M., McGuire, M., Teskey, R.O., 2017, Stomatal conductance increases with rising temperature. Plant Signaling & Behavior, 12(8):00-00.
[52]Verma, V., Chandra, N., 2014, Biochemical and ultrastructural changes in Sida cordifolia L. and Catharanthus roseus L. to Auto Pollution. Int Sch Res Notices., 263092.
[53]Wu,G., Liu, H., Hua,L., Luo, O., Lin,Y., He, P., Feng, S., Liu, J., Ye, Q., 2018, Differential responses of stomata and photosynthesis to elevated temperature in two co-occurring subtropical forest tree species. Front Plant Sci., 9: 467.
[54]Wolf, A., Anderegg, W.R.L., Pacala, S.W., 2016, Optimal stomatal behavior with competition for water and risk of hydraulic impairment. PNAS Early Edition, 113 (46): E7222-E7230.
[55]Xu, Z., Jiang, Y., Jia, B., Zhou, G. 2016, Elevated-CO_2 response of stomata and its dependence on environmental factors. Front Plant Sci., 7: 657.
[56]Xu, Z., Jiang, Y., Jia, B., Zhou, G., 2017, Elevated-CO_2 response of stomata and its dependence on environmental factors. Front. Plant Sci., 7:1-15.
[57]Zhou, R., Yu, X., Ottosen, C.O., Rosenqvist, E., Zhao, L., Wang, Y., Yu, W., Zhao, T., Wu, Z., 2017, Drought stress had a predominant effect over heat stress on three tomato cultivars subjected to combined stress. BMC Plant Biology, 17:24.
[58]Zhu, J., Yu, Q., Xu, C., Li, J., Qin, G., 2018, Rapid estimation of stomatal density and stomatal area of plant leaves based on object-oriented classification and its ecological trade-off strategy analysis. Forests, Vol.9:616.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE ROLE OF STATE SUPPORT IN ENSURING THE INCUSIVE DEVELOPMENT OF THE AGRI-FOOD SYSTEM

Elena DERUNOVA[1], Natal'ya KIREEVA[2], Olesya PRUSCHAK[2]

[1]Institute of Agrarian Problems of the Russian Academy of Sciences, 94, Moskovskaya St., 410012, Saratov, Russia, Phone: +78452263179, Fax:+78452264768, Mobile:+79873093797, Email: ea.derunova@yandex.ru
[2]Saratov Socio-Economic Institute (branch) of Plekhanov Russian University of Economics, 89, Radisheva, 410003, Saratov, Russia, Phone: +78452211723, Mobile:+79272217354, Mobile:+7 9093412927, Emails: natalkireeva1@yandex.ru, o.pruchak@yandex.ru

Corresponding author: ea.derunova@yandex.ru

Abstract

It is proved that a new impetus to the sustainable growth of regional agri-food systems and rural territories can be given by a paradigm shift in socio-economic development. The advantages of an inclusive development model, aimed not only at ensuring economic growth, but also at solving social and environmental problems, strengthening the potential of both regions and the state, are substantiated. Problems in the field of state support for agriculture were identified (inadequate level of financing, irrational structure of subsidies, asymmetry in the distribution of funds by regions and economic forms, discriminatory approach to sustainable development of rural territories, lack of a clear mechanism for substantiating the limits and extent of state intervention). The possibilities of inclusive development of the agri-food system are shown (uniform and fair state support for all agricultural producers, employment growth and activation of rural population reproduction, conservation of rural territories, solution of environmental problems of natural capital depletion and ecosystem exploitation). Methodological approaches have been developed to assess the effectiveness of state support for the agri-food system at the macro and meso levels. The results of the study indicate that the current system of state support is mainly compensatory in nature and does not provide a solution to a wide range of social and environmental problems, which contradicts the imperatives of sustainable development based on inclusive growth.

Key words**:** *agri-food system, sustainable growth, government support, subsidies, inclusive and extractive development models*

INTRODUCTION

The most important imperatives of modern civilization development (the world food crisis, structural unemployment, a high degree of differentiation of population incomes, political disasters, etc.) actualizes the search for adequate models of the socio-economic development of the world economy. The solution of these problems is especially relevant for the further development of the agri-food system, which objectively requires a transition to a new model of its economic development - an inclusive, consistent with the paradigm of sustainable growth. These challenges lead to a significant modernization of the existing system of state support for the agricultural sector.

Today, the main mechanism of state support for the national food system is the currently implemented "State Program for the Development of Agriculture and Regulation of Agricultural Products, Raw Materials and Food Markets for 2013–2025" (hereinafter referred to as the "State Program"). The project part of the State program includes federal projects "Export of agricultural products" and "Creation of a system of support for farmers and the development of rural cooperation", departmental projects: "Development of agricultural sectors providing accelerated import substitution of the main types of agricultural products, raw materials and food", "Promotion of investment - national activities in the agricultural sector", "Technical modernization of the agricultural sector", "Digital agriculture", as well as the departmental program "Development of the reclamation complex of Russia." At present, the

mechanism of state support for the agro-industrial complex is actively transforming, the total amount of financing at current prices is increasing (up to 303.6 billion rubles in 2019), the structure and priorities of subsidizing are changing. So in 2019 (which is considered transitional in improving the state support system) compared to 2018, export support increased from 1.3 billion rubles. up to 38.8 billion rubles [8].

However, the approaches to an objective assessment of the features of regional agri-food systems, their resource requirements, ensuring inclusive growth of the agri-food system against the background of sustainable development of rural territories, have not yet been developed.

Given the prevailing model of development of extractive institutions in the prevailing model, there is a high risk that government support will continue to be asymmetric, infringing on the interests of individual regions, small businesses, and vulnerable groups of the population. Priorities for state support of the agro-industrial complex should be formed proceeding from the goals of sustainable development on the basis of an inclusive model.

The model of inclusive development of the Russian agri-food system should be based on mechanisms and institutions that have already proved their effectiveness in the system of state support in developed economies. However, due to the specifics of the agricultural sector, the development of which carries the burden of solving not only economic and social problems, but also taking into account regional specifics, there is a risk of losing identity and falling into the trap of unification. The key principles of the model of inclusive growth of the agri-food system are economic growth based on innovations generated within the country, efficient use of all resources (especially human resources), environmental friendliness of production, integration into global food chains with high value-added products.

The role of the state in regulating the economy, the extent, scope and mechanisms of state intervention - one of the most discussed issues among economists for more than a century. This issue was widely discussed in the writings of classical economists in the framework of various scientific areas: marginalist, neoclassical, Keynesian and neo-Keynesian, institutional. Various scientific schools interpreted the role of the state in different ways - from the complete non-interference of the state in socio-economic processes to the complete control of the economy by the state.

Representatives of the marginalist trend (J. Boden, T. Men, A. de Montcretien, H. Ustaris, S. Fortrey and others) recognized the active role of the state in the initial accumulation of capital. Representatives of the neoclassical trend (W. Petty, P. Buagilber, A. Smith, F. Quesnay, D. Ricardo) advocated limiting government intervention in the economy. Keynesian direction is based on the assumption of the instability of a market economy and the need for government intervention in it (J. Maynard Keynes R. Harrod and E. Domar).

Representatives of monetarism (M. Friedman, F. Hayek, J. Hicks, R. Solow, M. Brown) considered the economic system as a stable, self-regulating system, which is inherent in a state of dynamic equilibrium with optimal resource utilization. The imbalance they associated precisely with government intervention in socio-economic processes.

Representatives of the institutional direction (T. Veblen, J. Commons, W. Mitchell, J. Galbraith, Jan Tinbergen) associate the development and regulation of the economy with a change in the legal, social, technical, ethical institutions of society.

The Russian economic school also developed various theoretical concepts about the role of the state in the economy, and one can note the evolution of views - from purely market positions at the beginning of the period of market transformational transformations to the realization of the leading role of state regulation in the subsequent stages of market reforms. The experience of transformational transformations allowed us to rethink the previous theoretical principles and create new domestic concepts in the theory of state regulation of the economy. The greatest contribution to the development of the

problem under consideration was made by L.I. Abalkin, V. Gerashchenko, S.Yu. Glazyev, A.G. Granberg, S.S. Dzarasov, D. Lvov, Yu.Ya. Olsevich, Yu.M. Osipov, V.M. Polterovich, N.P. Shmelev, S.O. Shokhin, E. Yasin, Yu.V. Yakovets. Among modern economists who consider state theory in Russian economic science in historical retrospect, one can single out S.V. Afanasyev, S.G. Kirdin, V.A. Mau, R.M. Nureyev, T.N. Yudin.

In the field of state regulation of the agricultural sector of the economy, the works of such outstanding scientists of the beginning of the 20th century as A.V. Chayanov, N.D. Kondratiev, V.D. Brutkus, N.P. Makarov, A.I. Bukharin, A.A. Rybnikov, V.A. Bazarov et al. Various theoretical, methodological and practical issues of state regulation of the economy, including the agricultural sector, are reflected in the scientific works of such well-known scientists and economists as A.I. Altukhov, A.A. Anfinogentova, I.N. Buzdalov, L.A. Bronstein, V.G. Venzher, S.V. Kiselev, E.N. Krylatykh, M.Ya. Lemeshev, V.V. Leontiev, A.A. Nikonov, N.Ya. Petrakov, A.M. Sukhorukova, V.A. Tikhonov, V.Ya. Uzun, N.I. Shagayda, I.G. Ushachev, D.B. Epstein, N.A. Yakovenko et al.

The formation of methodological approaches to the analysis of the role of the state in ensuring a model of inclusive development was influenced by the work of representatives of institutionalism, who, as a fundamental factor ensuring economic growth in the long term, consider institutions and their quality: Douglas North [11].The generality of these works consists in examining the theory of economic growth depending on the predominance of extractive and inclusive development institutions [1, 2].

A deep study of the effectiveness of state support for the agricultural sector is contained in the writings of such scholars as N. Shagaida, V. Uzun, R. Yanbykh [10, 16, 19].

These studies analyze the aggregate state support of commodity producers, give a comparative characterization with the world level of support, evaluate its effectiveness in Russia as a whole and in the regional context [15,18].

The problems of the effectiveness of state regulation of the agro-industrial complex in resolving food security problems are considered in the monograph [9], as well as in the works of Derunova E.A., Kireeva N. A., Prushchak O. V. [4, 5, 6].

These studies led to the formation of an author's approach to the analysis of the role of the state in ensuring inclusive development, the essence of which is as follows. First, the research methodology is based on the recognition of the complementary nature of the market and state mechanisms for regulating socio-economic processes. Secondly, the scope and extent of government intervention is determined by the specifics of the object of study - the agri-food system, as well as the relevance of its transition to an inclusive development model. Thirdly, the problem was considered at the macro- and mesoscale levels, in the context of regional and institutional features of the agri-food system of Russia.

The purpose of the article is to analyze, from the standpoint of practical use in substantiating agri-food policies, the extent to which the measures and instruments of state support currently being implemented are in line with the requirements of the state's active participation in ensuring inclusive growth for sustainable development.

MATERIALS AND METHODS

Methodological issues of assessing the level of inclusive development have been developed by various international organizations (UN, IMF, OECD, World Bank, the Board of the Eurasian Economic Commission, etc.). A conceptual apparatus has already been formed defining the concepts of "inclusiveness", "inclusive growth", and "inclusive development". Given the available methodological approaches to the definition of an inclusive development model and the specifics of the agri-food system as an object of study, inclusiveness should be understood as the existence of non-discriminatory conditions, including the possibility of

participation of all regions in the processes of production, distribution and consumption, as well as access of all groups of the population to social infrastructure, provided that quality of life of the population as a whole and its individual groups.

An assessment of the role of the state in ensuring inclusive growth of the agri-food system and sustainable development of rural territories can be carried out using the index of orientation of public spending on agriculture (AOI). This indicator is calculated as the ratio of the share of government spending on agriculture in total federal budget spending to the share of agriculture in GDP. This indicator can be used at the macro level as a criterion for assessing the effectiveness of state policy in terms of ensuring food security, improving nutrition and promoting sustainable rural development. The growth of the AOI index is facilitated by an increase in investment in rural infrastructure, the development of biotechnology, and the introduction of innovations. If the value of the AOI index exceeds 1, then this indicates a high orientation of state support to the agricultural sector, the costs of which exceed its contribution to economic value added.

At the medium-scale, government participation in solving the problems of inclusive development of regional agri-food systems can be accessed through the convergence (convergence) of the quality of life of all groups of the population, achieved not only due to the redistribution by the state of the results of economic activity, but also largely due to the formation of non-discriminatory conditions, allowing each group of the population to provide themselves with a decent and comparable quality of life with other groups while improving the quality of life of the population to in the regions and in the country as a whole.

For this purpose, we estimated the indicators of financing regional agri-food systems using the example of the Volga Federal District (VFD). The regions of the Volga Federal District differ in the level of agricultural specialization, the scale and structure of the regional economy, and the conditions for budgetary provision. The use of relative indicators (financing of state support per 1 hectare of agricultural land, per 1 employee employed in agriculture, per 1 ruble of gross agricultural output) makes it possible to conduct a comparative analysis and assess the effectiveness of state support for regional agro-food systems.

RESULTS AND DISCUSSIONS

Inclusive growth means involving in the process of modernization and innovative development of the Russian economy not only high-tech sectors of the economy, but also the agricultural sector, which will diversify income sources, create decent jobs, ensure the availability of social protection and expand the opportunities of the rural population. These issues are important when substantiating agri-food policies, strategies and programs that consider the interests of the poor. We believe that such an approach will contribute to the inclusive growth of the agri-food system and the sustainable development of rural areas.

Table 1. The role of state support for Russian agriculture in solving the problem of its sustainable development

Indicators	2014	2015	2016	2017	2018
Expenditures on agriculture and fishing of the federal budget, billion rubles	180.0	208.2	203.1	214.1	225.7
in% of total expenses	1.2	1.3	1.2	1.3	1.3
in% of GDP	0.2	0.2	0.2	0.2	0.2
Share of gross value added of agriculture in GDP,%	3.4	3.9	3.9	3.6	3.1
Agricultural Expenditure Orientation Index (AOI)	0.12	0.10	0.10	0.11	0.096

Source: Rosstat data.

State support should promote the development of the agri-food system as the most "vulnerable" and strategically important sector of the economy, which requires a significant increase in funding. Despite the absolute growth in funding, the share of consolidated budget expenditures on

agriculture in total expenditures is just over 1% (Table 1).

An analysis of the government spending on agriculture (AOI) index showed that the share of gross agricultural added value in Russia's GDP is more than double the share of agricultural spending in total federal budget spending.

The value of the index of orientation of government spending on agriculture (AOI) is far from even a neutral value of 1. At the same time, the AOI is approaching zero, which characterizes not only a low orientation of government spending on agriculture, but also a shift of government priorities from agricultural spheres to other areas. A more favorable impression is made by the assessment of the index of orientation of government spending on agriculture in other EAEU countries. In 2015-2016 AOI was: in the Republic of Belarus 1.3, in the Republic of Kazakhstan 0.9, which indicates a higher level of state support for the agricultural sector of the economy.

Evaluation of the effectiveness of state support at the mesoscale based on the example of the regions of the Volga Federal District was based on the calculation of relative indicators: the volume of financing of state support per 1 hectare of cultivated land, per 1 employed in agriculture and 1 rub. agricultural products (Table 2).

Table 2. Characteristics of the amount of funding for state support of the agro-industrial complex and the financial results of the regions of the Volga Federal District

Subject of the federation	The amount of financing of state support per 1 hectare of sown area, rubles	The amount of financing of state support per 1 employed in agriculture, rubles	The amount of financing per 1 rub. agricultural products, rubles	The proportion of profitable organizations in the total number of agricultural enterprises, %
Russian Federation	1,452.5	22,907.17	21732.52	79.7
Volga Federal District	1,077.30	22,929.74	21,608.56	83.6
Rep. of Bashkortostan	996.21	18,977.21	19,002.99	84.1
Mari El Republic	2,998.17	33,743.45	20,825.48	61.5
The Rep. of Mordovia	2,467.38	23,646.23	28,897.48	89.6
Republic of Tatarstan	1,838.42	37,165.72	24,877.54	85.6
Udmurt Republic	1,444.11	33,250.55	22,669.01	85.3
Chuvash Republic	2,193.31	19,266.97	31,727.91	89.7
Perm region	1,501.21	22,994.11	25,599.48	76.1
Kirov region	1,271.54	20,390.08	26,312.39	97.6
Nizhny Novgorod Region	1,292.37	21,165.36	21,679.3	85.0
Orenburg Region	509.84	16,052.02	19,951.46	65.9
Penza Region	1,246.12	24,405.54	20,837.58	72.5
Samara Region	808.89	18,586.23	18570.31	87.2
Saratov Region	449.98	19,229.68	13,338.37	93.2
Ulyanovsk Region	796.54	16,593.2	21,602.31	74.1

Source: Own determination.

The volume of state support on average in the Volga Federal District is at the level of average Russian indicators. However, the differentiation of these indicators in a regional context is significant. Noticeable is the difference in regions in the financial situation of agricultural organizations. Thus, the share of profitable agricultural enterprises in the subjects of the Volga Federal District ranges from 61.5% to 97.6%, with an average Russian value of about 80%.

In the future, when implementing the favorable scenario of inclusive development of regional agri-food systems, the indicators characterizing their access to resources should be aligned due to the approximation of the values of indicators of outsider regions to the values of indicators of leading regions. This convergence of indicators (convergence) can be estimated using quadratic coefficients of variation calculated by the formula:

$$V = \frac{\sqrt{\frac{\sum_i^n = (x_i - x_{cp})^2}{n}}}{x_{cp}} * 100\%$$

where V –is the quadratic coefficient of variation; %;

x_i – is the value of the indicator in the i-th region;

n – is the number of regions in the sample;

x_{cp} –the average value of the indicator.

Table 3 gives an assessment of the convergence of government support across the regions of the Volga Federal District.

Table 3. Evaluation of the convergence of volumes of financing of state support for agribusiness in the regions of the Volga Federal District

Indicators	The amount of financing of state support per 1 hectare of sown area, rubles	The amount of financing of state support per 1 employed in agriculture, rubles	The amount of financing per 1 rub. agricultural products, rubles	The proportion of profitable organizations in the total number of agricultural enterprises, %
Worst value	449.98	16,052.02	13,338.37	61.5
Best value	2,998.17	37,165.72	31,727.91	97.6
Median value	1,281.955	22,036.27	21,643.93	84.55
Average	1,396.47	23,206.45	22,452.04	81.92
Mean square deviation	695.56	6,251.41	4,338.97	9.75
The coefficient of variation, %	49.81	26.94	19.33	11.90

Source: Own determination.

Table 4. Assessment of the effectiveness of state support for the agro-industrial complex (by the example of the Volga Federal District)

Subject of the federation	The share of financing of the subject of the federation in the financing of state support of the Russian Federation,%	The share of the subject of the federation in the production of agricultural products of the Russian Federation,%	Government support effectiveness ratio
Russian Federation	100.00	100.00	1.00
Volga Federal District	22.16	22.28	1.01
Rep. of Bashkortostan	2.57	2.94	1.14
Mari El Republic	0.78	0.81	1.04
The Rep. of Mordovia	1.58	1.19	0.75
Republic of Tatarstan	4.84	4.23	0.87
Udmurt Republic	1.26	1.21	0.96
Chuvash Republic	1.02	0.70	0.68
Perm region	0.97	0.83	0.85
Kirov region	0.93	0.77	0.83
Nizhny Novgorod Regior	1.26	1.26	1.00
Orenburg region	1.85	2.02	1.09
Penza region	1.48	1.54	1.04
Samara region	1.42	1.66	1.17
Saratov region	1.48	2.42	1.63
Ulyanovsk region	0.70	0.71	1.01

Source: Own determination.

The study showed that the allocated volumes of subsidies practically do not affect the strengthening of the financial situation of agricultural enterprises in the regions of the Volga Federal District. So in the Republic of Mari El, with the minimum percentage of profitable agricultural enterprises in the Volga Federal District (61.5%), the amount of financing significantly exceeds the average values. And, on the contrary, in the Saratov Region, with relatively modest support, the share of profitable agricultural organizations reaches 93.2%. The asymmetry of state support is also manifested in a significant gap

in the profitability levels of agricultural organizations, considering and excluding subsidies from budgets of all levels. The profitability of agricultural enterprises without subsidies on average in the regions of the Volga Federal District amounted to 3.6%, in the Republic of Mari El - minus 10.5%, in the Saratov Region 14%. Due to subsidies, these indicators are leveled up to 11.2%, -3.9% and 18.6%, respectively.

To assess the effectiveness of state support for the agricultural sector in the regional context, we used the ratio of the share of the subject of the federation in the production of agricultural products of the Russian Federation to the share of state support of this subject in financing (Table 4).

If the efficiency coefficient of state support exceeds 1, this indicates that the region's share in the country's agricultural production is higher than the region's share in state subsidies. A striking example is the Saratov region, where this indicator reached its maximum value in the Volga Federal District and amounted to 1.63 (Fig. 1).

However, this situation illustrates not so much the high return on budgetary support for the region, but the limited size of this support. Therefore, regions with low budgetary security are discriminated in the allocation of resources, often do not participate in co-financing the directions of the state program, which contradicts the currently relevant concept of inclusive development.

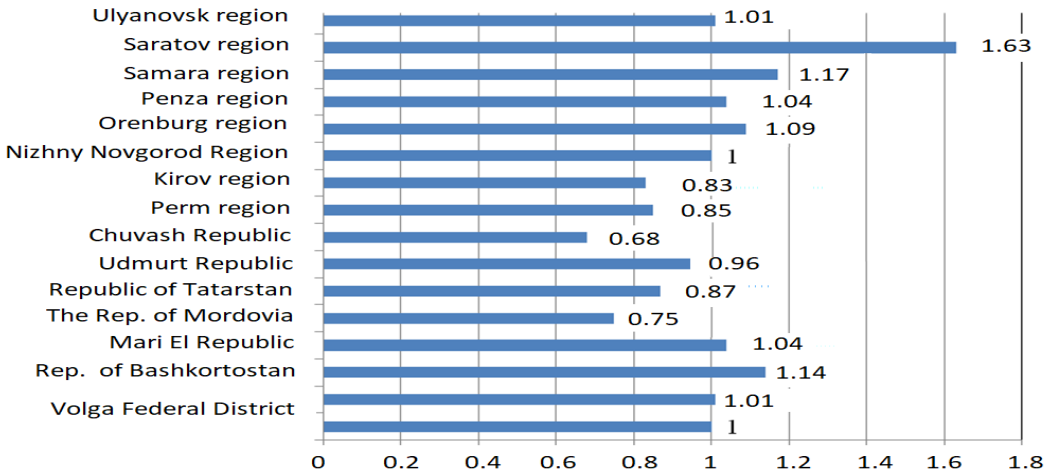

Fig. 1. The coefficient of effectiveness of state support (the ratio of the share of the subject of the federation in the volume of agricultural products to its share in the financing of state support for agriculture)
Source: Own determination.

Table 5. The degree of agricultural development in the regions of the Volga Federal District

Subject of the federation	Level of specialization	Localization level
Volga Federal District	1.514	0.660
Rep. of Bashkortostan	1.580	0.633
Mari El Republic	3.576	0.280
The Rep. of Mordovia	4.181	0.239
Republic of Tatarstan	1.498	0.668
Udmurt Republic	1.625	0.615
Chuvash Republic	1.939	0.516
Perm region	0.520	1.924
Kirov region	1.879	0.532
Nizhny Novgorod Region	0.751	1.332
Orenburg region	1.838	0.544
Penza region	3.163	0.316
Samara region	0.923	1.083
Saratov region	2.704	0.370
Ulyanovsk region	1.557	0.642

Source: Own determination.

As part of the Volga Federal District, regions of various specializations are distinguished. The regions of agricultural specialization include the republics of Mari El, Mordovia, Chuvashia, as well as the Penza and Saratov regions. The lowest level of agricultural development is characterized by the Samara and Nizhny Novgorod regions (Table 5). Correlation-regression analysis showed an almost complete absence of a relationship between the level of subsidization of the regional agribusiness and the coefficient of specialization of the regional economy in agricultural production (the correlation coefficient does not exceed 0.04).

This conclusion is confirmed by the clustering of the regions of the Volga Federal District, depending on the level of specialization and the volume of agricultural products per 1 ruble. state support. Among those shown in Fig. 2 regions of the Volga Federal District, the following groups can be distinguished:

1) regions of agricultural specialization with a relatively high level of support: the Republic of Bashkortostan, Mari El, as well as the Orenburg, Penza, Saratov regions;

2) regions of agricultural specialization with a relatively low level of support: the Republic of Mordovia, Tatarstan, Udmurtia Chuvashia and the Kirov region;

3)non-agricultural regions with a relatively high level of support: Nizhny Novgorod and Samara regions;

4)non-agricultural regions with a relatively low level of support: Perm Territory.

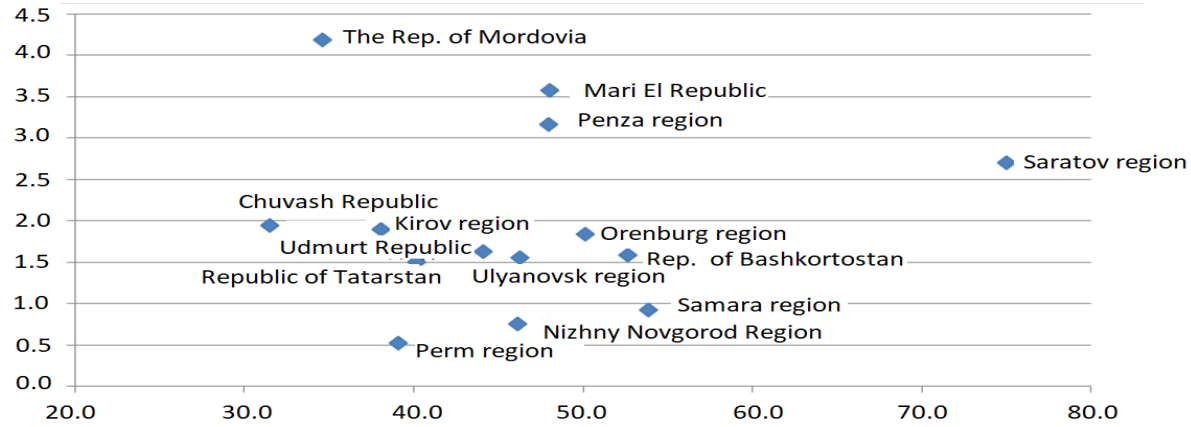

Fig. 2. The relationship between the level of specialization and the volume of agricultural products per 1 rub. financing
Source: Own determination.

Such heterogeneity, even within the framework of one federal district, indicates the need for a deep justification of the priorities, tools, mechanisms of regional agri-food policy.

According to the authors, the goals of inclusive development of regional agri-food systems are more consistent with the state support model, which stimulates the growth of agricultural production in the region, taking into account its absolute and comparative competitive advantages. We consider it expedient to implement not only the stimulating, but also the compensating functions of state support. If the first function is associated with the further point-by-point development of agricultural production, motivating the formation of new directions, then the second is aimed at stabilizing the achieved level of production. In this case, the most difficult methodological issue remains the justification of the optimal proportions between the stimulating and compensating parts of the subsidy.

In accordance with the model of inclusive development, government support should be aimed not only at ensuring economic growth, but also at solving social and economic problems. An analysis of the structure of agricultural subsidies in 2018 revealed that only 10% of Russian subsidies were allocated as part of the “Sustainable Development of Rural Areas” direction (Fig. 3). Moreover, in the regions of the Volga Federal District this indicator is significantly differentiated: from 2% in the Saratov Region to 30% in the Ulyanovsk Region.

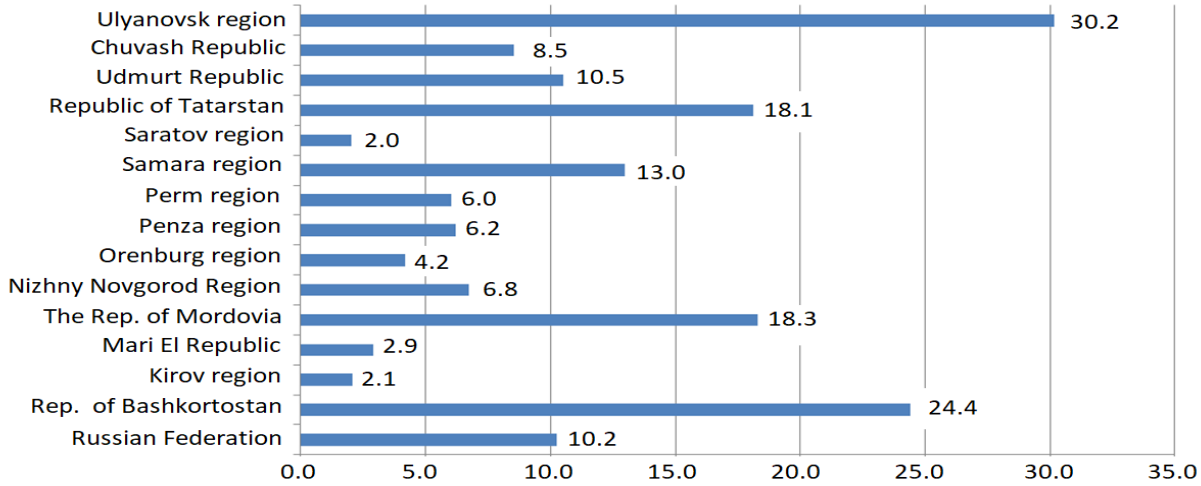

Fig. 3. The share of the direction "Sustainable development of rural territories" in the total volume of state subsidies in 2018, %
Source: Own determination.

Thus, the existing system of state support for the agricultural sector requires fundamental modernization in order to ensure its relevance to the modern model of inclusive development. At the same time, without denying the full significance of operational management, more attention should be paid to the strategic component. Formation of a strategy for the development of national and regional agri-food systems within the framework of a public contract of authority, business and the population will ensure uniform and fair state support for all agricultual commodity producers, employment growth and activation of rural population reproduction, preservation of rural territories, environmental decision the issue of depletion of natural capital and the exploitation of ecosystems. [3].

We can distinguish the following areas of increasing the effectiveness of state support for regional agri-food systems:

- Improving the adaptation of forms of state support to the diversity of agrarian structures in the regions of Russia, including by expanding their powers to distribute funds;
- stimulation of attraction of external financial resources [12,13];
- linking state support with measures aimed at improving the management of regional agri-food systems [17].

At the same time, one should consider the current change of priorities in the state agri-food policy: from focusing on import substitution to stimulating the building up of export potential [20].

CONCLUSIONS

It is substantiated that state support for the development of the agri-food system is inextricably linked with the problems of its sustainability, and mechanisms and tools should be aimed not only at quantitative indicators of agricultural production growth, but also indicators of social inclusion and environmental safety to ensure sustainable competitiveness of the national agri-food system. Inclusive growth strategies, combining the concepts of sustainable and innovative development, transformed considering modern problems, will help to confront the global challenges facing humanity in the 21st century. The study revealed a significant differentiation of regional agri-food systems in terms of state support, the lack of a clear methodological base in substantiating its volumes and structure, violation of the principle of justice in supporting different categories of farms. The vast majority of subsidies goes to large agricultural holdings, a small portion to support farms, and households are practically cut off from all types of support [14]. The situation is exacerbated by the almost complete lack of protection of agricultural spending in the consolidated budget of the Russian Federation. At the same time, the

state agrarian policy at both the federal and regional levels is extremely unstable: the volumes of financing, the directions of state programs are changing, the mechanisms for subsidizing are not worked out [7].

To this day, urgent social problems have not been resolved: rural employment, depopulation of the village, high poverty, ensuring equal access to public goods.

An agri-food policy that is consistent with the principles of inclusive growth should change the development model by improving the technological and institutional structure of the industry, involving all available resources, and improving the living conditions of the rural population. This will not only solve the problem of food independence, but also create sustainable competitive advantages of Russia in world food chains. As the study showed, the mechanisms and tools within the existing system of state support to some extent contribute to the positive dynamics of the economic development of the agri-food system of Russia, but at the same time they do not provide a connection between the growth rate of the agrarian economy and the solution of a wide range of social problems, including a more equitable distribution of created in an income society, with particular attention to the poorest segments of the population, that is, they do not meet the imperatives of sustainable development based on inclusive wow growth.

ACKNOWLEDGEMENTS

The reported study was funded by the Russian Foundation for Basic Research according to the research Project № 18-010-01129 «Development of methodology and assessment and forecasting tools for monitoring the innovative development of the agro-industrial complex».

REFERENCES

[1]Acemoglu, D., Johnson, S., Robinson, J., 2005, Institutions as a fundamental cause of long-run growth. Handbook of economic growth. Vol. 1. P. 386-472.

[2]Acemoglu, D., Robinson, J.A., 2013, Economics versus Politics: Pitfalls of Policy Advice, Journal of Economic Perspectives. Vol. 27(2):173–192.

[3]Akpoti, K., Kabobah, A.T., Zwart, S.J., 2019, Agricultural land suitability analysis: State-of-the-art and outlooks for integration of climate change analysis. Agricultural Systems.№ 173, pp. 172-208.

[4]Derunova, E., Kireeva, N., Pruschak, O., 2019, Assessment and relationships between physical and economic accessibility of food: status and forecast. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 19 (1):147-160.

[5]Derunova, E., Kireeva, N., Pruschak, O., 2019, Tipology of regions according to the level of food security: methodological approaches and solutions. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 19 (1):135-146.

[6]Derunova, E., Kireeva, N. A., Prushchak, O. V., 2019, Inclusive development of the agri-food system as a driver for sustainable growth in the region's economy. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.19 (3):165-174.

[7]Golubev, A.V., 2017, New trends in the development of the agrarian economy of Russia, Economics of agricultural and processing enterprises. 2017, No. 3, pp. 8–12.

[8]Government support is changing direction. The system of subsidizing the agricultural sector is being adjusted again. https://www.agroinvestor.ru/analytics/article/31483-gospodderzhka-menyaet-apravlenie/, Accessed on December 28, 2019.

[9]Kireeva, N. A., Prushchak, O. V., Sukhorukova, A. M., 2018, Agro-food system of the region: evolution, problems, prospects of development. Saratov: Saratov socio-economic Institute (branch) of Plekhanov Russian University of Economics.

[10]Lerman Z., Uzun V. Ya., Shagayda N.I., 2019, Russian agriculture: Growth and institutional challenges. Land use policy: Elsevier. pp. 475-487.

[11]North, D., 1997, Institutions, institutional changes and the functioning of the economy. Moscow: Fund of the economic book "Beginnings". 98 p.

[12]Popescu, A., 2018, Main aspects regarding the contribution of domestic trade to the development of Romania's economy in the period 2008-2017, Scientific Papers Series Management, Economic Engineering in culture and Rural Development Vol. 18(4): 250-259.

[13]Popescu, A., Dinu T., Stoian E., 2019, Changes, trends and relationships between average income and consumption expenditures per household in Romania in the period 2007-2017, Scientific Papers Series Management, Economic Engineering in culture and Rural Development Vol. 19(2): 364-375.

[14]Sandu, I.S., Veselovsky, M.Ya., Fedotov, A.V., Semenova, E.I., Doshchanova, A.I., 2015, Methodological aspects of social and economic efficiency of the regional activities. Journal of

Advanced Research in Law and Economics,T. 6, № 3,650-659.

[15]Shagayda N.I., 2019, Drivers of growth and structural changes in Russian agriculture, Moscow: Publishing House "Case", 2019.

[16]Shagayda N.I., Uzun V.Ya., Gataulina E.A., Yanbykh R.G., 2015, Assessing the level of support for agriculture and developing mechanisms for synchronizing federal and regional agrarian policies in the context of Russia's membership in the World Trade Organization, Moscow: Russian Academy of National Economy and State services under the President of the Russian Federation, 98 p.

[17]Svetlov, N.M., Yanbykh, R.G., Loginova, D.A., 2019, On the heterogeneity of the effects of state support for agriculture. Economic Issues.No.4, 59-73.

[18]Uzun, V.Ya., Shagayda, N.I., Yanbykh, R.G., 2017, Land Policy in Russia: new challenges. The eurasian wheat belt and food security: global and regional aspects, Berlin: Springer Science+Business Media B.V., Formerly Kluwer Academic Publishers B.V. pp. 33-50.

[19]Uzun, V.Ya., Shagayda, N.I., 2019, Assessment of the impact of institutional and structural changes on the development of the agricultural sector in Russia. Economic Issues No.4, 39-58.

[20]Yakovenko, N.A., Kireeva, N.A., Ivanenko, I.S., Sukhorukova, A.M., 2018, Export potential as the competitiveness indicator of the agri-food complex. International journal of engineering and technology, Vol. 7, no 4.38.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

METHODOLOGY OF SPATIAL PLANNING OF AGRICULTURAL LAND USE

Olha DOROSH, Iosyp DOROSH, Yevhen BUTENKO, Liliia SVYRYDOVA, Andriy DOROSH

National University of Life and Environmental Sciences of Ukraine, Land Management faculty, 17 Vasylkivska Str., Kyiv, 03040, Phone: +38 044 258 05 25; E-mails: dorosholgas@ukr.net, doroshjosyp@gmail.com, evg_cat@ukr.net, kydrjasha@gmail.com, doroshandriy1@ukr.net.

Corresponding author: dorosholgas@ukr.net

Abstract

The article describes the methodology of spatial planning and organization of agricultural land use in land management projects that provide ecological and economic justification of crop rotation, based on ecological-landscape and ecological-economic basis. It's advantage in comparison with the methodology of the Soviet planning system is that it harmonizes the issues of economic development, organization and production technology, the structure of the territory in accordance with local natural conditions with productive and spatial properties of soils, their natural potential. The methodology was tested on the example of agricultural land use of the NSP "Nyva" in the Stavyshchenskyi rayon of Kyivska oblast. This methodology is based on social, economic and environmental aspects. It is substantiated that the economic efficiency of arable land use depends on the creation of appropriate organizational-territorial conditions. Field and forage crop rotation were introduced in the studied territory, considering the physical, geographical and economic conditions within the agro-landscape type of land use. It has been proved that social efficiency is ensured through the additional jobs creation and improvement of the life quality of local people. The determining factor for calculating the ecological efficiency of arable land use is the maintenance of a non-deficit humus balance. In particular, the humus balance in field and forage crop rotations was calculated for 2018 and 2019. A humus deficiency balance between 0.22 and 0.48 t/ha was obtained in three of the nine crop rotation fields, which prompted us to adjust the fertilizer system.

Key words**:** *spatial planning, ecological-landscape approach, ecological-economic approach, land management project, humus balance*

INTRODUCTION

In recent decades, an imbalanced deficient farming system has been dominating in Ukraine, which is associated with the disregard of environmental laws and regulations of land and nature management, and imperfect legal support in the field of land protection. As a consequence, we have a high economically and ecologically unjustified level of agriculturally used lands (80%) [9], which has led to the intensification of the agrarian sector, the dispersion of material resources, the attraction of unsuitable land as arable land. Neglect on environmental requirements for land use has a negative impact on economic performance.

There are also environmental losses associated with soil destruction, erosion and other degradation processes. Currently, annual humus losses are between 600 and 700 kg per 1 ha of agricultural land [4, p.180].

Obviously, the implementation of rational use and protection of land measures should be based on scientifically substantiated methodological foundations of their spatial development in such a sequence: "territory – landscape – land plot – soil" [5, p.20]. Therefore, the territorial planning of the organization of agricultural land use should be based on the principles of ecological-landscape and ecological-economic approaches to the arrangement of the territory in the course of land management process.

Due to the rapid change of the economic system in Ukraine there is a systematic redistribution of land resources, new land ownings and land use organizations are being formed. Currently, various organizational and legal forms of management (joint-stock companies, private and private-lease

enterprises, agricultural cooperatives, farms, etc.) are functioning in the structure of agricultural land use. Huge agrarian enterprises, one of these agro-formations, contribute to improving the overall efficiency of agricultural production through the use of modern high-tech equipment and the latest technologies. At the same time, they displace part of small agricultural enterprises, including farmers, from the land lease market, which negatively affects the socio-economic situation in the countryside.

Usually, newly created entities do not adhere to the classical principles of organization of agricultural land use of territory (ignoring crop rotation factor, measures for protection of land (soils), projects of internal land management, etc.), which led to a sharp deterioration of the quality of land [8, p.4].

Scientific studies of the National Academy of Sciences of Ukraine show that crop rotation, if is scientifically substantiated, can be the basis of agriculture, because it regulates biological, nutrient and water balances of soil and the rate of detoxification of harmful substances entering the soil in the process of agricultural production. The same introduction of crop rotation helps to protect the environment, preserve and enhance the natural fertility of soils. And the placement of basic crops on suitable land for them increases yields and reduces the cost of production.

The purpose of the case study is to develop a crop rotation on the basis of ecological-landscape and ecological-economic principles on the territory of study site and to achieve a non-deficit humus balance in this crop rotation.

Literature review. The substantiation of theoretical and methodological foundations of the directions of use of arable lands of Ukraine on the basis of their classification according to the suitability for cultivation of agricultural crops, taking into account specific features of natural and environmental conditions of the environment, is studied in the works of D.I. Babmindra, D.S. Dobriak, O.P. Kanash, I.A. Rozumnyi [2]. Formation of ecological and economic approaches to rationalization of agricultural land use and protection, formation of sustainable land use – A.V. Barvinskyi, H.D. Hutsuliak, O.S. Dorosh [7]. The basic principles of introduction of contour-melioration organization of territory are revealed in the works of O.H. Tararico and M.H. Lobas [11]. V.M. Tertiak grounded the basics of landscape typing of land use, improved the method of ecological and landscape land use of agricultural enterprises, which is based on the data assessment of land and resource potential of the territory [6]. Scientific bases of formation of soil protection systems of agriculture on agro-landscape basis for different agro-ecological groups of lands of agricultural land uses of the forest-steppe zone are grounded in the works of V.F. Kaminskyi [8], V.M. Kryvov [10] and others. But issues related to ecological-economic and ecological-landscape approaches in the development of land management projects for ecological and economic justification of crop rotations and land management are not sufficiently researched.

MATERIALS AND METHODS

Given the current conditions of the development of a market-oriented system of land use, priority must undoubtedly be given to the environmental-landscape and ecological-economic component in the development of land management projects. The underestimation of the heterogeneity and variability of landscape conditions over time and space during crop rotation planning on the territory of agricultural land use leads to the emergence of negative processes that affect the productivity and quality of land. In this regard, the ecological-landscape organization of the territory should become the basis for designing fields in land management projects.

There is an opinion in the scientific community that a methodological approach to the organization of ecological and economic justification of crop rotation and land management of agricultural enterprises on an ecological-landscape basis should combine the ecological-landscape approach (as a general construction of agro-landscape) with agro-ecological landscape approach [6, p. 29].

The methodology of territorial and spatial planning of the organization of agricultural

land use based on ecological-landscape and ecological-economic approaches in land management projects was implemented in the preparation of the land management project that provides ecological and economic justification of crop rotation and land use management of the NSP "Nyva" in the Stavyshchenskyi rayon of Kyivska oblast. The project identifies measures aimed at protecting land (soils) and increasing their productivity, improving agricultural landscapes, optimizing land structure with the most favorable ratio, preserving degraded land, and outlining approaches to their use. The importance of developing such projects is seen in the scientific substantiation of proposals related to:

(1)creation of appropriate territorial and spatial conditions for agricultural production, considering the suitability of soils for growing basic crops;

(2)determination of the crop rotations types, considering the specialization of agricultural production with the subsequent design of fields in these crop rotations and drawing up a scheme of crop rotation;

(3)identification of protection, sanitary protection zones for regime-forming objects with a corresponding restricted land use regime.

In the process of crop rotation planning on the territory of the research object, based on the existing agricultural production groups of soils and their condition, as well as the relief, we have identified the types of agricultural landscapes. In determining the types of landscapes, the steepness of the slope plays a significant role. Depending on the type of landscape, we choose what proportion of the area is appropriate to cultivate at the same time, as well as the choice of crops and technologies for their cultivation in order to protect the soil from erosion processes, humus loss and depletion.

Then it is necessary to identify the types of crop rotations needed and design them based on the types of agro-landscapes located in the design area, the production specialization of the enterprise or farm, employment in animal husbandry (the need for production of feed) and the demand for certain types of crop production on the market.

There are the following types of crop rotations:

(I)Field (the most widespread, designed mainly in large areas for the production of basic crops);

(II)Cereal;

(III)Forage (designed mainly on the territories of farms that include livestock production);

(IV)Non-rotation areas (are not assigned to any crop rotation without intensive agricultural production).

Further, a set of measures for reproduction of land fertility on the territory of the study object is developed, if necessary. The next step is to evaluate the effectiveness of rotation. The environmental component of rotation efficiency can be achieved by a non-deficit humus balance.

Humus balance can be calculated as the difference in humus loss and revenue for each crop rotation. In our study, the technique of H.Y. Chesniak has been applied. The level of humus inflow into the soil is accounted for by the humification of nutrient-root residues (R_1) and the formation of humus from organic fertilizers (R_2), which in sum represent the total humus revenue (Rg): [3]

$$R_g = R_1 + R_2$$

Humus level growth from the humification of nutrient-root residues depends on what crop was grown this year on a particular field, since different amount of residues remain after different plants. This is determined by the coefficient of accumulation (Ka). The degree of humification, which is determined by the coefficient of humification (Kg) depends on crop grown at that particular year as well. Accordingly, to determine the revenue from the humification of nutrient-root residues, the yield (Y) of the respective crop must be multiplied by both of the above coefficients: [1]

$$R_1 = Y \times K_a \times K_g$$

The formation of humus from organic fertilizers depends entirely on the amount of organic fertilizers introduced and is added to the amount of humus formed from the nutrient-root residues.

Instead, determining the humus expense component (Lg) in the fertile soil layer is a more complicated process. Humus is lost primarily due to the following processes: humus mineralization (Mg) and humus loss due to water erosion (Le): [3].

$$L_g = M_g + L_e$$

The mineralization of humus is determined by the following formula:

$$M_g = G \times h \times \rho \times K_m \times K_b,$$

where G is the humus share in the soil's arable layer (%), this is one of the soil's main genetic indicators, influenced by climate, particle size distribution and erosion.

h – depth of the arable layer (cm), depending on the culture.

ρ – the soil folding density (g/cm^3), depends on the particle size distribution and humus content and ranges from 1.00 to 1.60 g/cm^3.

K_m – humus mineralization rate, the annual proportion of humus that is mineralized (determined over an average of several years). Mineralization depends on the frequency of cultivation and soil-climatic zone.

K_b – relative index of biological productivity, which characterizes the ratio of local climatic conditions of humus mineralization to the average in Ukraine taken as 1 [1].

The loss of humus under the influence of water erosion can be calculated using the next formula:

$$L_e = L_s \times G,$$

where Ls is the soil losses under water erosion influence, which depend on the soil-climate zone and slope and are shown in table 1.

G – the humus share in the soil (%) [12].

Table 1. Annual soil losses under the influence of water erosion on the slope lands of Ukraine

Soil and climate zone	Slope, %	Earth particles washed away, t/ha
Polissia (Woodlands)	0.5-2	7-8
	2-5	17-20
	5-10	50-65
Forest-steppe	0.5-2	6-10
	2-5	17-37
	5-10	60-95
Steppe	0.5-2	1.5-4.5
	2-5	6-45
	5-10	23-45

Source: Humus loss due to erosion, Studopediia (stand 02.02.2020)

RESULTS AND DISCUSSIONS

In the study site, the most common are dark gray soils with varying degrees of erosion, and black soils with varying degrees of erosion. For the planning of land conservation measures related to the increase of fertility of lands close in genesis, production indices and conditions of occurrence, by relief and soil cover and their implementation within the land use area, eight high-yielding soils were selected.

In the course of the researches within the land use area 5 types of agro-landscapes were identified, the characteristics of which are given in Table 2.

Table 2. Types of agricultural landscapes, their characteristics within the territory of the study object

Type of agro-landscape	Slope, degrees	Acceptable area of arable land, %
plain field	plateaus with a slope of less than 1°	75-80
slope-hollow	slopes of 1–3° with hollows without ravines	not more than 70
slope-ravine	catchment areas on slopes of 3–5° steepness	55-60
beam-ravine	beams and ravines with slopes of 5–7°	not more than 30
steep slope	steep slopes of over 7° with dense network of ravines	not more than 30

Source: developed by authors.

In the studied territory, considering the physical, geographical and economic conditions within the landscaping type of land use, field and forage crop rotations were introduced, the characteristics of which are given in the Table 3.

Table 3. Characteristics of crop rotations and non-rotation areas within the territory of the study object

Name of crop rotation	Number of fields	Total area, ha	Field code	Average field area, ha
Field	9	1,618.2	I	179.8
Forage	4	197.9	IV	49.5
Non-rotation areas	2	40.7	1	-
Sum		1,856.8	X	X

Source: developed by authors.

Field crop rotation is foreseen on flat lands with predominance of black soils. This crop rotation is planned on 9 fields with a total area of 1,618.2 ha (average field size is 179.8 ha), within which the following rotation of crops is envisaged: 1. perennial grasses; 2. winter wheat; 3. soybeans; 4. barley; 5. sunflower; 6. corn on silage; 7. winter wheat; 8. sugar beet; 9. corn for grain; 10. barley with sowing of perennial grasses.

Forage grassland crop rotation is projected on flat lands and partly on slopes up to 3-5º with predominance of typical black soils. This crop rotation is planned on 4 fields with a total area of 197.9 hectares (average field size – 49.5 hectares), within which the following rotation of crops is envisaged: 1. perennial grasses; 2. perennial herbs; 3. winter wheat for green fodder (corn for green fodder); 4. annual grasses with sowing of perennial grasses.

The importance of developing a land management project lies in defining a set of measures related to the cultivation of soils and the reproduction of their fertility within the agricultural production groups of soils (Table 4).

Table 4. Complex of measures for reproduction of soil fertility on the territory of the study object

№	Measures	The content of the measure and its quantitative characteristics	Note
Black earth poorly degraded, medium loam (code of agricultural production group 41d, 49d, 51d) *Black earths typica with low humus and highly degraded, medium-loam and washed away* (agricultural group 53d, 55d, 56d) The total area is 1826.2 ha			
1	Cultures used in rotation	Soils are suitable for all grain, fodder, industrial and vegetable crops.	
2	Methods of tillage	The combined tillage should be used: a combination of flat-cut and surface plowing. For improvement of agrophysical properties – timely cultivation of soil, saturation of rotation of legumes on sloping lands (agricultural production group of soils 49d, 55d), application of only shelf-free cultivation. All technological operations of cultivation, sowing, care of crops should be carried out only across the slopes.	It is better to avoid deep plowing.
3	Supporting liming	Due to the decalcification of soils, it is advisable to deacidify them with liming (especially for agricultural groups of soils 4Id, 49d, 51d).	Dose 3 t/ha once every 10 years.
4	Application of organic and mineral fertilizers	Fertilizer application in the rate of 12-14 t/ha to ensure a non-deficit humus balance. Application of phosphate and nitrogen fertilizers for industrial and vegetable crops. Potash fertilizers application only if needed	Application by tape method during sowing.

Source: developed by authors.

The project activities have been evaluated in economic, social and environmental aspects. In fact, the systematic principle of land use, which tries to find a way to combine three mechanism's components, which contribute to realization of the land use system goals. This principle as well provides the optimal correlation between soil quality improvement, economic growth and improvement of life quality of local residents. Economic efficiency can be achieved in the way of creation of territorial and organizational conditions suitable for agricultural production processes efficiency improvement. Territorial properties

of the land are reflected in the cost of production, which is affected by yield, technological properties of soils, contours of land, etc. Social efficiency is determined by the level of life quality (creation of new jobs, improvement of working conditions and life of the local people, etc.).

A decisive indicator of the ecological efficiency of arable land is the maintenance of a non-deficit humus balance in the fertile soil layer. We have calculated the humus balance in field and forage crop rotations on the territory of the studied object as of 2018 and 2019. The calculation of the humus balance for 2019, performed on the planned yield, using the principle of obtaining the desired positive humus balance in rotation.

Table 5. Calculation of humus balance in field rotation soils on the territory of the study object for 2019

№ of field	The volume of humus in the fertile soil layer, t/ha, (%)	Culture grown on the field	Yield (Y), t/ha	Humus revenue (R_g)							Humus loss (L_g)			Humus balance, t/ha
				humification of nutrient-root residues (R_1)			formation of humus from organic fertilizers (R_2)			total revenue t/ha	humus mineralization (Mg), t/ha	humus loss due to water erosion (Le), t/ha	total humus loss	
				coefficient of accumulation (Ka)	coefficient of humification (Kg)	total humification, t/ha	manure	other organic fertilizers	sum, t/ha					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	101.08 (3.11)	Sugar beet	35.0	0.11	0.10	0.39	2.70	-	2.70	3.09	1.35	0.25	1.60	1.49
		Corn for the grain	8.0	1.30	0.23	2.39	–	"	*	2.39	0.65	0.25	0.90	1.49
2	95.88 (2.95)	Barley	4.0	1.60	0.22	1.41				1.41	0.61	0.24	0.85	1.09
3	126.38 (3.57)	Winter wheat	5.5	1.30	0.25	1.79			’	1.79	0.70	0.29	0.99	0.80
		Barley	4.0	1.60	0.22	1.41	-	-	-	1.41	0.70	0.29	0.99	0.42
4	124.96 (3.53)	Winter wheat	5.5	1.30	0.25	1.79		-		1.79	0.69	0.28	0.97	0.82
		Perennial herbs	18.0	1.70	0.25	7.65				7.65	0.43	0.28	0.71	6.94
5	130.63 (3.69)	Sunflower	2.5	1.70	0.15	0.64	1.08		1.08	1.72	0.72	0.30	1.02	0.70
6	127.40 (3.92)	Perennial herbs	18.0	1.70	0.25	7.65				7.65	0.50	0.31	0.81	6.84
7	117.33 (3.61)	Winter wheat	5.5	1.30	0.25	1.79				1.79	0.75	0.29	1.04	0.75
8	121.23 (3.73)	Corn for silage	45.0	0.16	0.15	1.08	2.70		2.70	3.78	0.77	0.30	1.07	2.71
9	129.35 (3.98)	Soy	2.1	1.3	0.23	0.63	1.08		1.08	1.71	0.83	0.32	1.15	0.56

Source: calculated by authors.

The calculation of the humus balance in the soil in terms of crop rotation fields is given in Table 5.

According to the actual 2018 yield, a positive humus balance was obtained on 1, 2, 4, 5, 7 and 9 fields. In other fields (3, 6 and 8), where soybean, barley with perennial grass and sunflower were grown respectively, deficient humus balance (from 0.22 to 0.48 t/ha) was recorded.

This indicates that in order to stabilize the humus state of the soil within these fields of crop rotation it is necessary to adjust the fertilizer system of both its precursor and the pole-catching crop.

In addition, there is a need to attract alternative sources of organic fertilizer replenishment by maximizing the use of livestock waste and by-products, including straw as an organic fertilizer and expanding the use of bacterial fertilizers.

In this respect, it is necessary to follow the developed zonal standards of the structure of acreage of major groups of crops, which allows to master biological principles in the development, introduction of field, forage and other crop rotations with a high degree of use of bioclimatic potential and to realize the idea of ecological rationalization of agriculture.

Humus balance in accordance with our proposals is calculated in Table 5.

CONCLUSIONS

On the basis of the conducted researches the advantages of the combination of ecological-landscape and ecological-economic approaches in the development of land management projects on ecological-economic justification of crop rotations and the ordering of lands providing the combination of economic, ecological and social components of the mechanism of realization of the goals of the land-use system are substantiated. The proposed approach ensures the systematicity, dynamic and integrity of the process of spatial planning of the organization of agricultural land use.

An indispensable condition for conducting highly productive, competitive agricultural production is the resource conservation and increase of soil fertility, the prevention of degradation processes, which is largely determined by the nature of land use. The developed project managed to achieve a non-deficit humus balance.

REFERENCES

[1]Ahrohenetychna kharakterystyka ta okulturennia hruntiv hospodarstva., 2016, [Agrogenetic characteristics and cultivation of soils], https://otherreferats.allbest.ru/agriculture/00778024_0.html, Accessed on 03.02.2020.

[2]Babmindra, D.I., Dobriak, D.S., Kanash, O.P., Rozumnyi, I.A., 2009, Klasyfikatsiia silskohospodarskykh zemel yak naukova peredumova yikh ekolohobezpechnoho vykorystannia [Classification of agricultural land as a scientific background of its ecological use]. 2nd ed. Ukraine, Kyiv: Urozhai, 464.

[3]Balans humusu v hrunti, 2010, [Humus balance in the soil], Navchalni materialy, https://pidruchniki.com/76246/agropromislovist/balans_gumusu_grunti, Accessed on 03.02.2020.

[4]Budziak, O., 2016, Formuvannia ekolohobezpechnoho zemlekorystuvannia na silskohospodarskykh uhiddiakh Ukrainu [Formation of ecologically safe land use of agricultural lands of Ukraine]. Balanced nature using, 3, 180-187.

[5]Dorosh, O., 2012, Metodolohichni zasady okhorony zemel v Ukraini [Methodological principles of land protection in Ukraine]. Zemlevporiadnyi visnyk, 8, 19-23.

[6]Druhak, V., 2013, Ekoloho-landshaftne vporiadkuvannia zemlekorystuvannia silskohospodarskykh pidpryiemstv v umovakh novykh zemelnykh vidnosyn: monohrafiia [Ecological-landscape management of land use of agricultural enterprises under new land relations: monograph]. Ukraine, Kyiv: "Komprynt", 185.

[7]Hutsuliak, H.D., 2010, Stalyi rozvytok zemlekorystuvannia: metodolohichni aspekty upravlinnia: monohrafiia [Sustainable development of land use: methodological aspects of management: monograph]. Ukraine, Chernivtsi: Prut, 365.

[8]Kaminskyi, V., 2018, Metodyka proektuvannia adaptyvno-landshaftnykh system zemlerobstva dlia silskohospodarskykh zemlekorystuvan zony Lisostepu Ukrainy [Methods of designing adaptive-landscape systems of agriculture for agricultural land uses of the Forest-Steppe zone of Ukraine]. Ukraine, Kyiv: ahrarna nauka, 56.

[9]Kaminskyi, V., 2018, Ukraina ne vykorystovuie svoho potentsialu zemelnykh resursiv [Ukraine doesn't use its land resources potential]. News of NAAS. http://naas.gov.ua/newsall/newsnaan/4411/, Accessed on 02.02.2020.

[10]Kryvov, V.M., 2006, Ekolohichno bezpechne zemlekorystuvannia Lisostepu Ukrainy. Problema okhorony hruntiv [Ecologically safe land use of the Forest Steppe of Ukraine. The problem of soil protection]. Ukraine, Kyiv: "Urozhai", 301.
[11]Tarariko, O.H., Lobas, M.H., 1998, Normatyvy hruntozakhysnykh konturno-melioratyvnykh system zemlerobstva [Standards of soil-protective contour-melioration systems of agriculture]. Ukraine, Kyiv: NAAS, Derzkomzem, Institute of Agroecology and Biotechnology, Agrarian Institute "Ahroinkom", 158.
[12]Vtraty humusu vid erosii, 2016, [Humus loss due to erosion] Studopediia.
https://studopedia.com.ua/1_166173_vtrati-gumusu-vid-erozii.html, Accessed on 03.02.2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ANALYSIS OF THE DETERMINANTS OF THE PROFITABILITY OF CASHEW NUTS IN BENIN: CASE OF THE COMMUNES OF PARAKOU AND N'DALI

Nonvignon Theodore DOSSOU, Şinasi AKDEMIR

Çukurova University, Faculty of Agriculture, Department of Agricultural Economics, PO Box 01330 Bacali, Adana, Turkey, Emails: theodoredossou1@gmail.com, sinasi.akdemir@gmail.com

Corresponding author: sinasi.akdemir@gmail.com

Abstract

This study is part of the analysis of the determinants of cashew nut production in Benin. For this purpose, in the provinces of Borgou and Alibori, 80 producers and 20 traders were surveyed in 2018. The data collected were related to the size of the production holdings, the yield of the cashew nuts, the expenses and production costs; as well as profit margins. The analysis of the results from the multiple regression model based on a one-to-one elimination of the variables from the SPSS v 20 software made it possible to identify the factors that influence the profitability of the farms. These include the amount of credit used, variable costs, labor costs and capital. A regression model based on the Cobb-Douglas production function concluded that the producer's investment in the labor force remains the important parameter in order to increase income from production. In order to improve the profitability of cashew production in Benin, it is imperative to develop policies that take into account all of these identified parameters.

Key words**:** *Benin, cashew nuts, marketing system*

INTRODUCTION

Benin is one of the poorest countries in the world with an annual per capita income of 800 USD. In the United Nations Human Development Index study, Benin ranks 167 out of 188 countries with a value of 0.48 [12]. Despite an annual growth rate of 5% since 2012, poverty is a major problem in the country and improvements in the humanitarian index have not been sufficiently observed in recent years [12]. The poverty index in rural areas is quite high compared to the urban area. The proportion of those who spend less than a dollar a day is 63.5%. Poverty in the country is identified in rural areas [9]. In Benin, the agricultural sector is the primary source of wealth. Indeed, it contributes on average to 36% of the GDP and employs more than 70% of the active population in Benin and feeds a good part of the activities of the tertiary sector (RNDH, 2015) [9].

On the other hand, the 1999-2000 cotton market crisis has shown how much the dependence of the country's exports on a single product affects economic fragility (PPAB, 2001) [8]. As a result, diversification of agricultural production has become a priority issue for the country and rural development. In this context, the Ministry of Food, Agriculture and Livestock has identified 13 products of particular importance, including cashews.

The cashew nut sector is an economically attractive alternative for Benin, which is the country's second most important agricultural export product (after cotton) (Sossou, 2004) [10].

The cashew nut is important for the national economy and generates income for planters as well as other actors in the value chain (traders, processors, exporters, etc.) (Arouna, et al., 2005) [2]. In addition to benefiting from forest products, peanuts, apples are very valuable products, both in the country and on the international market. By improving the organization of marketing and thus increasing the income of producers, this income is considered an important element in terms of providing capital to respond to agricultural activities and other needs of producers.

The analysis of the structure of the cashew marketing system should make a major contribution to the national economy through an increase in the incomes of domestic producers, is analyzed. It is therefore with this in mind that this study was carried out in the municipalities of Parakou and N'dali, which are seen as the production zones par excellence for cashew nuts.

MATERIALS AND METHODS

This study was carried out in the communes of Parakou and N'Dali, precisely in the departments of Borgou and Alibori. These areas were selected because of their significant contribution to the total production of cashews in Benin. The surveys were conducted in the period from December 2018 to January 2019. A total of 80 producers and 20 traders were surveyed.

The data collected were related to the size of the production holdings, the yield of the cashew nuts, the expenses and production costs; as well as profit margins. Based on the work of Dossa et al. (2018), Tovignan et al. (2014) and Allagbé et al. (2014) [1, 5, 11], a multiple linear regression model based on a one-to-one elimination of the variables was run using SPSS v 20 software and then made it possible to identify the factors that influence the profitability of farms. Multiple linear regression can be written as follows:

$$y = \alpha_0 + \alpha_1 x_i + \varepsilon_i \qquad (1)$$

where:
y is the variable explained,
xi the explanatory variables,
α is a constant called "intercept",
Ɛ is the error term of the model.

A regression model based on the Cobb-Douglas production function was also developed to evaluate the effect of factors of production in agriculture on the income of cashew producers and traders. According to Germain (1969) [6], then Cette and Szpiro (1990) [4], it is a relation between the production (P) and the contributions in work (L) and in capital (C). The most general mathematical expression of this function is:

$$P = b \cdot L^k \cdot C^j \qquad (2)$$

where b, k and j are constants.

RESULTS AND DISCUSSIONS

Socioeconomic and demographic characteristics of the traders surveyed

The socio-demographic characteristics of the producers were presented according to the areas sown by them. Thus, three (3) groups were formed. The first corresponds to producers whose total area sown is between 0 and 10 ha; the second group between 11 and 30 ha then the third group represents the class of producers with more than 30 ha.

The socio-demographic characteristics discussed relate mainly to the sex of the producers, their level of education and then their use of agricultural credit. Analysis of the descriptive statistics obtained shows that the cashew producers in the communes of Parakou and N'Dali are mainly men. This conclusion was drawn considering that men represent 93.7% of the total sample, against 6.3% for women. Note that in particular a rate of 100% of man was recorded in the third group. The highest rate among women is among the first group (11.8%). This important involvement of men in the production of cashew nuts is due to the fact that cashew plantations are bequeathed from father to son as an inheritance.

From the statistics obtained, from a general point of view, 48.7% of producers can neither read nor write. This rate is due to the low level of literacy found in the rural areas of Parakou and N'Dali. In addition, 50% of the producers in the first group can read and write. Producers with large areas (groups 3) are the most educated, with a rate of 80%. Most of them have the secondary education level. In general, compared to other socio-economic studies conducted in northern Benin, cashew farmers in the Parakou and N'Dali communes have at least a higher level of education. Particularly, producers in the third group are those with the most advanced

level of education. In fact, it concerns particular inhabitants of urban areas and exercising a given function.

As for the statistics on the use of agricultural credits, it was noted that 41.2% of producers do not use agricultural credits. Note that 61.7% of producers in the first group do not take credit. This can be explained by the fact that these producers are insignificant small areas. Unlike the latter, producers in the third group all borrow from state structures. Only 29.2% of producers in the second group do not use financial lending services.

Determinants of the profitability of production

The determinants of the profitability of cashew production were identified from a multiple linear regression with SPSS v 20 software. In this model, the income of the nut producer was identified as the dependent variable in the 'analysis. Variables such as gender, marital status, educational attainment, organizational and non-organizational status, amount of credit used, fixed costs, variable input costs, labor costs and capital have been taken into account.

By eliminating the variables one by one in order to identify the best model, variables such as: the amount of credit used, capital, variable costs and labor costs were identified as the variables having an influence on the income of producers. At the same time, variables such as sex, marital status, educational attainment, organizational and non-organizational status were removed from the model.

The model obtained is globally significant at the 1% threshold ($p = 0$) with R^2 equal to 0.871. The variables identified therefore account for 87% of the income of producers and traders of cashew nuts. In addition, the index of the test F is equal to 122.854.

The model variables all have a positive and significant effect at the 1% income threshold of cashew producers and traders. Thus, the increase in the amount of the loan, the capital, the variable costs and then the labor force will lead to an increase in the income of the farm manager. Agricultural credit and the producer's investment are therefore of some importance for producers, in that they enable them to improve their income (Miassi et al., 2019) [7]. Note that Balogoun et al. (2014) [3] identify producers' access to credit as a determinant of annual income from the sale of cashew nuts in Benin. The increase in production-related expenses and the labor force also remain important parameters in order to increase the income from production. By increasing these costs, the farm manager gets better product from his farm.

Starting from the results of the model, unlike the amount of the loan, capital, variable costs, the labor force mobilized by the farm manager has a much larger effect (114,662). In other words, it will be easier to boost the income from production by investing more in the workforce.

The following table presents the results of the regression.

Table 1. Regression Analysis Results

Variables	Coefficient	Standard Error	t	Probability	Multiple statistical relations	
					Tolerance	VIF
Amount of the loan	0.914	0.102	8,937	0.000	0.717	**1395**
Capital	0.627	0,184	3,410	0.001	0.386	**2590**
Variable costs	0.138	0.057	2,446	0.017	0.318	**3142**
Labor costs	**114,662**	**19,010**	**6,032**	**0.000**	**0.592**	**1.690**

Source: Model estimate results (2019).

Effect of factors of production on income

The Cobb-Douglas function was used to assess the effect of the factors of production on the income of cashew producers and traders. In this function, income was considered to be the dependent variable, followed by capital, labor and the space occupied for production as the independent variable.

The results of the analyzes are presented in Table 2.

The results obtained make it possible to rewrite the production function as follows:

Income = 0.081 x 0.721 (Capital) x 0.987 (labor) x 0.492 (cultivated area)

Table 2. Elasticity of production

	Capital	Labor	Cultivated area	Total
Income elasticity	0.721	0.987	0.492	2.2

Source: Model estimate results (2019)

Research results indicate that the number of factors combined for nut production is low. So we will say that there is increasing production on a scale. In particular, the increase in the labor force will have a positive effect on the income from production. This confirms the conclusions previously drawn. The total elasticity recorded is 2.2. We therefore deduce that a 10% increase in the factors of production will lead to a 22% increase in producer income.

Theoretically, in terms of production factors, a 10% increase in training capital an increase of 7.21% in income. At the same time, a 10% increase in the work force will increase revenues by 9.87%. The 10% increase in the area reserved for nut production will encourage a 4.92% increase in income. Note that the R-square (R^2) obtained is 0.903.

CONCLUSIONS

This study was part of the analysis of factors determining the profitability of cashew production in Benin. Analysis of the results shows that the amount of credit used, capital, variable costs and labor costs were identified as the variables having a positive influence on producers' income. The producer's investment in labor has been identified as the most important parameter for increasing production income. The development of policies aimed at improving income from nut production in Benin would therefore require taking these different parameters into account. This will not only facilitate the development of the national economy but will contribute to the fight against food insecurity that threatens the people of Benin.

ACKNOWLEDGEMENTS

This article is an extract from the research thesis of the main author funded by the BAP. The authors thanks BAP for funding this research.

REFERENCES

[1]Allagbe, C.M., Adegbola, P. Y., Ahoyo Adjovi, N. R., Komlan-Ahihou, C. M., Crinot, G. F. D. J. C. E., Hessavi, P. M., Djenontin, A. J. P., Mensah,G. A., 2014, Etude financée par le Projet Multinational d'Appui à la Filière Coton-Textile dans les quatre pays de l'Initiative Sectorielle sur le Coton (PAFICOT)-Bénin, Rapport technique d'exécution de l'INRAB, p 45.

[2]Arouna, A., Adégbola, P. Y., Adékambi, S. A., 2005, Analyse de l'efficacité technique, allocative et économique des unités de production de noix cajou au Bénin. Communication présentée à l'Atelier National, Parakou.

[3]Balogoun, I., Saïdou, A., Ahoton, E. L., Amadji, L.G., Ahohuendo, C.B., Adebo, I. B., Babatounde, S., Chougourou, D., Adoukonou-Sagbadja, H., Ahanchede, A., 2014, Caractérisation des systèmes de production à base d'anacardier dans les principales zones de culture au Bénin, Agronomie Africaine, Vol.26(1), p.14, https://www.ajol.info/index.php/aga/article/view/104427, 15 July 2019.

[4]Cette, G., Szpiro, D, 1990, Les rendements d'échelle dans les IAA: Une analyse du dimensionnement des entreprises sur données de panel, Cahiers d'économie et sociologie rurales, No.17, p 20.

[5]Dossa, F., Miassi, Y., Banzou, K., 2018, Onion (Allium Cepa) Production in Urban and Peri-Urban Areas: Financial Performance and Importance of This Activity for Market Gardeners in Southern Benin, Current Investigations in Agriculture and Current Research, 3(2): 13.

[6]Germain, C., 1969, Les fonctions de production dans la littérature économique, L'Actualité économique, Vol. 45, No. 1, p.23, https://doi.org/10.7202/1003595ar, 12 May 2019.

[7]Miassi, Y.E.S., Dossa, Labiyi, I.A., Dossouhoui, S., Yabi, J. A., 2019, Production d'anacarde sous contrat au Nord-Bénin: Importance socio-économique et déterminants de la profitabilité, Journal of Agricultural Research Advances, 2019.
[8]PPAB, 2015, Etude de capitalization sur l'intervention du PPAB, p.26.
[9]RNDH, 2015, Rapport national sur le développement humain 2015: Agriculture, sécurité alimentaire, p.141.
[10]Sossou, H., 2004, La filière anacarde au Bénin: Potentialités de production et opportunités de marché.
[11]Tovignan, S., Hinvi, J., Glin, L.C., Sodjinou, E., Bonou-Zin, R., Koussahoué, S., Nicolay, G., 2014, Déterminants de la rentabilité de la production du coton biologique au Bénin'', 3 ième conférence Ouest Africaine sur l'Agriculture Biologique du 27 au 29 Août, Cotonou, Bénin, p.1.
[12]UNDP, 2015, Rapport sur le développement durable, p. 48.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

TECHNOLOGY OF MECHANIZATION IN SUNFLOWER UNDER THE CONDITIONS OF IP, SĂLAJ COUNTY, ROMANIA

Anișoara DUMA COPCEA, Nicoleta MATEOC – SÎRB, Casiana MIHUȚ, Radu ILEA, Ramona ȘTEF, Dana SCEDEI, Lucian Dumitru NIȚĂ

University of Agricultural Sciences and Veterinary Medicine "King Mihai I of Romania" from Timisoara, 300645, 119 Calea Aradului, Romania, Phone: +40256277001, Fax:+40256200296, Emails: duma_anisoara@yahoo.com, mateocnicol@yahoo.com, casianamihut@yahoo.com, ileaupc@yahoo.com, chirita_ramona@yahoo.com, dana_olaru78@yahoo.com, lucian_nt@yahoo.com

Corresponding author: mateocnicol@yahoo.com

Abstract

The purpose of this work relates to the study of sunflower on an area of 8 ha, carried out in the territory of Ip in Sălaj County, Romania, on the land of a family farm. The choice of aggregates is also based on direct operating expenditures. When carrying out works with different agricultural aggregates, one should always choose the optimal variant that is apreciated by the minimum amount of the number of aggregates taking part in the performance of the work or the minimum amount of time, i.e., after the consumption of fuel. Two types of tractors were used for the execution of mechanized works in sunflower: Tractor U 650 M and tractor FENDT FARMER 311 LSA. In order to obtain large and high-quality production in sunflower, fertilization is of particular importance. The soil fertiliser reserve must provide plants with nitrogen, phosphorus and potassium supply from the first days of vegetation. The doses of fertilisers to be administered vary depending on soil reserve, soil type and on other factors related to climate and soil. The factors that influenced sunflower production in 2019 were: climatic conditions, crop rotation, soil fertility, mechanical work quality, sowing time, and cultivated hybrid.

Key words**:** *production, Sălaj, sunflower, mecahnization technology*

INTRODUCTION

This work presents an analysis of the consumption and costs of mechanized works and materials used to optimize crop technology in sunflower [13, 5].

The studies in this paper were carried out under the conditions specific to the Șimleu Depression, belonging to the great geographical units of the West Hills. The territory taken in the study belongs to the Ip village in Sălaj County, and is representative for the Șimleu Depression [4]. The work aims to render the information existing in the literature on sunflower as concretely as possible, followed by information about the natural framework and our own results.

It should be noted that Romania is the largest producer of sunflower in the European Union, being ranked 5th globally (1.6 million t) after Ukraine, Russia, Argentina, and China. Also, with good management within the farms, sunflower can bring a much higher profit to agricultural holdings [9, 10].

At the moment, manufacturers capitalize on production, largely in the form of grains, in the domestic market and on export [7, 17].

For Romania, that has great agricultural potential through the area of land per capita and favourable pedoclimatic conditions, it is important to increase labour productivity by increasing the degree of mechanization in agricultural holdings [8]. Sunflower is the most important oleaginous plant cultivated in our country [13]. Romania is part of the great sunflower cultivators, being the first country in which sunflower hybrids have been introduced and cultivated. Sunflower has uses in human nutrition and animal feed, in industry and energy, plus a number of specific uses [13]. Sunflower is grown compulsory in long-lasting rotations in which the straw cereals (wheat) and maize predominate [3]. Given the peculiarities of sunflower (high water consumption and nutrients, attack by

diseases, by sunflower broomrape attack), in most of them research recommends the cultivation of sunflower in rotations of 4 to 10 years [7].

In rotation, sunflower follows straw cereals, maize, peas, potatoes, oil linen, various fodder plants, silage maize, or green fodder. It should not be grown after sugar beet, alfalfa or monoculture (sunflower returns on the same soles after 5-6 years) [18]. When cultivating sunflower cultivars with high resistance to downy mildew and other diseases, the return interval on the same soles may be reduced to 4 years. In sunflower, no large productions can be obtained without proper fertilization [15,16]. The determination of the system of fertilization in sunflower is made according to the estimated production, to specific consumption, to natural soil fertility, to pre-emergent plant, to water reserve in spring at the beginning of vegetation, to the peculiarities of nutrition in sunflower [2, 11].

Sunflower is a plant with high requirements towards soil work. For sowing, the soil must be aerated in depth, without hardpan and without lumps on the surface, with a good porosity, without weeds, and well stocked with water in the shallow layer [1, 6, 14]. Only certified seed shall be used for the establishment of sunflower crops. The seed must have a purity of at least 98%, germination at least 85%, and uniformity in size and weight (calibrated) [10]. In sunflower, maintenance work begins before the plants sprout: harrowing the culture after sowing for the levelling of the land and crushing the crust and sprouting weeds, before sunrise with an adjustable coulter harrow or a rotative hoe. It is a work of great importance in sunflower [12, 20]. The time of the harvest in sunflower is linked to the maturity of inflorescence and the humidity of the seed. In uniform maturing hybrids, the humidity of the seeds can be appreciated by the colour of the capitulum [19].

MATERIALS AND METHODS

The studies in this paper were carried out on the territory of Ip in Sălaj County, Romania, from 2018 to 2019, on the land of a 35-ha family farm. Part the land of the farm is personal property (12 ha) and the rest is a lease from landlords (23 ha). The study refers to the culture of the sunflower.

The farm is equipped with the following machines: a FENDT FARMER-311 LSA tractor, a U-650M tractor, a 3-plough body reversible HUARD plough, a PP-4.30 plough, a GD-3.2M disc harrow, an EBRA 4.5 combiner, a CPPM-4 cultivator, a straw cereal STEGSTED STA 3M25RK seeder, a SPC 4 maize seeder with fertilization equipment, a NORDAGRI 500 solid chemical fertiliser machine, a WIRAX 400 portable herbicide machine, a tractor trailer, a John Deere 1052 grain harvester, and a SIP SEMPETER EKO 3500 maize harvester.

In the agricultural year 2018-2019, 8 ha were cultivated with sunflower, 10 ha with wheat, 10 ha with maize, 3 ha with triticale, and 4 ha with oat.

The main mechanized works in sunflower and the aggregates used were:

-Fertilisation: U-650M tractor + NORDAGRI 500 fertiliser machine;

-Ploughing: FENDT FARMER 311 LSA tractor + reversible HUARD plough;

-Soil preparation: FENDT FARMER 311 LSA tractor + EBRA 4.5 combiner;

-Sunflower sowing: U-650M tractor + SPC 4F seeder;

-Herbicide treatment: U-650M tractor + WIRAX 400 herbicide spreader;

-Weeding: U-650M tractor + CPPM-4 cultivator;

-Sunflower harvesting: JOHN DEERE 1052 combine + RFS equipment.

The types of tractors are chosen according to the technological process of the works and the biological properties of crops, following such indicators as ground clearance, gauge, outline dimensions, plot dimensions, energy consumption of machines, soil humidity, and the manoeuvrability of the aggregate.

The choice of aggregates is also based on direct operating expenditures. If two aggregates, after the cost of the works, require the same production costs, choose the one that satisfies the requirements of the machine system. The technical, technological and

economic performance of agricultural aggregates is appreciated by the following techniques, also called indices of use or exploitation: working depth, working width, working speed, tensile strength, actuation power, working capacity, power source load, and fuel consumption. The mobile aggregate moves into work at a certain speed, which is determined by the agri-technical requirements imposed by the quality of the work and the possibilities of traction and actuation of the working machines in the aggregated. Actual working speed influences the quality of the work performed. In order to achieve quality work, it is necessary to observe a working speed, specific to each work, called technological speed. Any agricultural machine operated from the power outlet has established, by design and construction, the actual power necessary for the realization of the technological process at qualitative indices and appropriate productivity. Therefore, upon formation of aggregates, the power available at the tractor power outlet should be greater than 5 ÷ 15% than the actual power necessary for the operation of the working bodies of the agricultural machine.

Working capacity of agricultural aggregates

The theoretical working capacity of aggregates may be determined by working time (W_h^t) or on the exchange of work (W_{sch}^t) and shall be calculated, taking into account the theoretical breadth B, the theoretical working speed v_t, and the time of an exchange T_s, with the help of relations:

The actual working capacity is the amount of work that an aggregate that has the actual width B_l (m) and moves with the working speed v_l (km/h) during the actual time of an hour T_l or exchange T_{ls} (h), respectively:

RESULTS AND DISCUSSIONS

Two fertilization works were carried out on the land cultivated with sunflower:

-Basic fertilization with complex NPK fertilisers (4:12:12) – 200 kg/ha;

-Sowing fertiliser with complex NPK fertilizers (16:16:16) – 200 kg/ha.

In basic fertilization, the aggregate of the tractor U-650 M and the portable fertilizing machine Nordagri 500 were used. The Nordagri 500 fertilizing machine is a portable machine operated from the tractor's power socket shaft. The capacity of the bunker is 500 l, the maximum payload is 1000 kg and the working width of 12-18 m. Fertilisation was achieved with a constant working speed of 8 km/h, a working width of 12 m, and a fuel consumption of 4 l/ha. The economic indices of the fertilized work are synthesised in (Table 1).

Table 1. Technological chart for the mechanization of fertilization works (expenditures per fertilised ha)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	42
of which: - wages	C_S	12
- fuel	C_C	20
depreciation	C_A	5
- service	C_{dt}	5
Auxiliary expenditures	C_{ax}	8
TOTAL	C_T	50

Source: Own calculation.

When performing the mechanized ploughing work, the aggregate formed from the Fendt Farmer 311 LSA tractor and the Huard T 130 reversible plough were used. The Huard T 130 reversible plough is equipped with 3 plough bodies. The working width of a plough body is 40 cm. The working width of a plough body is 1.2 m. The display was performed after the bobbin moving method at a depth of 30 cm. The working speed was 8 km/h. Average fuel consumption was 29 l/ha.

The technological chart of ploughing (expenditure per ploughed ha) is shown in (Table 2).

Table 2. Technological chart for ploughing (expenditures per ploughed ha)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	190
of which: - wages	C_S	19
- fuel	C_C	145
- depreciation	C_A	14
- service	C_{dt}	12
Auxiliary expenditures	C_{ax}	38
TOTAL	C_T	228

Source: Own calculation.

The preparation of the land for sowing was carried out with the agricultural aggregate

consisting of the Fendt Farmer 311 LSA tractor and the Ebra 4.5 combinator. For proper preparation of the germination bed, two works with the combiner have been carried out. The technological chart for the mechanization of the germination bed preparation works (two works) is shown in (Table 3).

Table 3. Technological chart for the mechanization of germination bed preparation works (two works)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	110
of which: - wages	C_S	16
- fuel	C_C	70
- depreciation	C_A	10
- service	C_{dt}	14
Auxiliary expenditures	C_{ax}	22
TOTAL	C_T	132

Source: Own calculation.

The sowing was carried out with the aggregate U-650M tractor + SPC-4F seeder at the distance of 70 cm between rows and 24 cm between grains at a time. Fertilization with complex NPK fertilisers (16:16:16) – 200 kg/ha was performed concomitantly with sowing. The working speed was 6 km/h, the productivity of 0.6 ha/h with average fuel consumption of 6 l/ha. The technological chart of mechanization of sunflower sowing (expenditure per sowing + fertilisation) is shown in (Table 4).

Table 4. Technological chart of mechanization of sunflower sowing (expenditures per sowing + fertilisation)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	70
of which: - wages	C_S	14
- fuel	C_C	30
- depreciation	C_A	11
- service	C_{dt}	15
Auxiliary expenditures	C_{ax}	14
TOTAL	C_T	84

Source: Own calculation.

The herbicide treatment work was performed with the aggregate of the U-650M tractor + Wirax 400 spreader. Three works were performed: pre-emergent herbicide, post-emergent herbicide, and foliar treatment in vegetation.
The technical characteristics of the Wirax 400 herbicide spreader are:
- Solution tank capacity: 400 l;
- Working width: 12 m;
- No. of hydraulic dispersers with nozzle: 24 pcs;
- Nozzle Type: three-head drip 100-30;
- Solution rule: 40-600 l/ha.
- Working pressure: 2-5 Bar;
- Hydraulic pump type: piston.

The herbicide work was carried out at a speed of 8 km/h at the working pressure of 3 bar, with a 300 l/ha solution. Fuel consumption was 2 l/ha. The technological chart for the mechanization of the herbicide treatment (expenditure per ha – three works) is shown in (Table 5).

Table 5. Technological chart for the mechanization of herbicide treatment (expenditure per ha – three works)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	60
of which: - wages	C_S	12
- fuel	C_C	30
- depreciation	C_A	9
- service	C_{dt}	9
Auxiliary expenditures	C_{ax}	12
TOTAL	C_T	72

Source: Own calculation.

The work was done with the aggregate of U-650M tractor and CPPM-4 portable cultivator. The cultivator is equipped with 5 sections to be weeded, at a distance between the sections of 70 cm. The sections at the extremities of the frame weed half an interval between the rows. It went into the same traces as the sowing and a number of 4 intervals between the rows at a pass (3 complete intervals + two half-ranges with extreme sections) were weeded.
The working speed was 6 km/h, the productivity of the aggregate of 2 ha/h at a medium fuel consumption of 5 l/ha. The technological chart for mechanization of weeding (expenditure per ha) is shown in (Table 6).

Table 6. Technological chart for mechanization of weeding (expenditure per ha)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	50
of which: - wages	C_S	13
- fuel	C_C	25
- depreciation	C_A	6
- service	C_{dt}	6
Auxiliary expenditures	C_{ax}	10
TOTAL	C_T	60

Source: Own calculation.

Upon harvesting sunflower, the technical working indices were: speed 4 km/h, productivity 0.7 ha/h, average fuel consumption 10 l/ha. The average production was 2,500 kg grains/ha, fuel consumption was 4 l/t of grains, i.e., a productivity of 1.75 t/h. The technological chart of mechanization of sunflower harvesting works (expenditure per ha and per t of grains) is shown in (Table 7).

Table 7. Technological chart of mechanization of sunflower harvesting works (expenditure per ha and per t of grains)

Economic indices	Symbol	RON/ha	RON/t
Direct expenditures	C_D	110	44
of which: - wages	C_S	30,0	12
- fuel	C_C	50,0	20
- depreciation	C_A	16,0	6,4
- service	C_{dt}	14,0	5,6
Auxiliary expenditures	C_{ax}	20	8
TOTAL	C_T	130	52

Source: Own calculation.

The costs of mechanized works in sunflower in RON/ha are centralised in Table 8.

Table 8. Technological chart of mechanization of works in sunflower (Expenditure – RON/ha)

Work	Wages C_S	Fuel (Diesel) C_C	Depreciation C_A	Service C_{DT}	Direct expenditures C_D	Auxiliary expenditures C_{AC}	Total expenditures C_T
Fertilisation	12.0	20.0	5.0	5.0	42	8	50
Ploughing	19.0	145.0	14.0	12.0	190	38	228
Soil preparation x 2	16.0	70.0	10.0	14.0	110	22	132
Sowing	14.0	30.0	11.0	15.0	70	14	84
Herbicide treatment x 2	12.0	30.0	9.0	9.0	60	12	72
Weeding x 2	13.0	25.0	6.0	6.0	50	10	60
Harvesting + chopping	30.0	50.0	16.0	14.0	110	20	130
Transport	8.0	25.0	6.0	6.0	45	9	54
TOTAL	124	395	77	81	677	133	810

Source: Own calculation.

Table 9. Materials needed in cultivating sunflower (RON/ha)

Name	Amount (ha)	Value (RON/ha)
Sunflower seeds Syngenta NEOMA CL	60,000 grains/ha	471
Complex fertilisers (4:12:12)	200 kg/ha	260
Complex fertilisers (16:16:16)	200 kg/ha	324
Pesticides		659
Supplies expenditures	-	124
TOTAL	-	1,838

Source: Own calculation.

CONCLUSIONS

The following conclusions and recommendations are drawn from the studies carried out:

The total expenditure for mechanized works in sunflower was 810 RON/ha, of which 677 RON/ha (80%) direct expenditures and 133 RON/ha (20%) indirect expenditures.

From the value of direct expenditures of 677 RON/ha, 19% (124 RON/ha) represents wages, 58% (395 RON/ha) represents diesel, 11% (77 RON/ha) is the 12% depreciation, and (81 RON/ha) is technical service.

Fuel expenditure (395 RON/ha) accounts for 49% of the total expenditures of mechanized works.

If the total expenditure of the mechanized works of 810 RON/ha is added to the value of the materials required for the sunflower culture of 1,838 RON/ha, it follows that the total expenditure amount was 2,648 RON/ha and 1,059 RON/t, respectively.

Taking into account that the average sunflower production was 2,500 kg/ha and that the price of sunflower was 1.35 RON/kg, it follows that the value of production was 3,375 RON/ha. Therefore, the profit per ha was 727 RON, respectively 22% of the average production value per ha of sunflower.

Factors that influenced sunflower production in 2019 were climatic conditions, crop rotation, soil fertility, mechanical work quality, sowing time, and cultivated hybrid.

In order to gain profit in sunflower, in climatic conditions specific to the Şimleu Depression, the choice of hybrids adapted to climate and soil conditions in the area is recommended.

Under the conditions of 2019, with a summer drought period, it has been proven that sunflower can provide good production and profit for growers in the Ip, Sălaj County area, Romania.

REFERENCES

[1]Canarache, Al., 1990, Fizica solurilor agricole, Ed.Ceres, Bucureşti (Physics of agricultural soils. Ceres Publishing House, Bucharest), pp.114.

[2]Costache, N., Luca, E., 1982, Mecanizarea lucrărilor de chimizare în agricultură, Ceres, Bucureşti (Mechanization of chemical works in agriculture. Ceres Publishing House, Bucharest) pp.52.
[3]Cârciu, Gh., 2006, Managementul lucrărilor solului, Ed. Eurobit, Timișoara (Management of soil works. Eurobit Publishing House, Timișoara), pp.98.
[4]Duma-Copcea, A., Mihuț, C., Ilea, R., Sîrbu, C., Scedei, D. N., Pop, V., Cuțui, M. C., 2019, Barley Sowing Technology, Filodiritto Editore, Proceedings, International Conference on Life Sciences Trends in the European Agriculture development, Timișoara, pp.413-419.
[5]Duma-Copcea, A., Mateoc-Sîrb, N., Mateoc, T., Mihut, C., 2013, Economic evaluation of agricultural land in the town Covaci, Timis county, Scientific papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 13(3):85-88.
[6]David, G., 2003, Tehnologia plantelor de câmp, Ed. Eurobit, Timișoara (Field plant technology. Eurobit Publishing House,) pp. 39.
[7]Dănilă, I., Niculăiasa, V., 1995, Procese de lucru și mașini de recoltat, Ed. A92, Iași (Work processes and harvesters, Ed. A92, Iași) pp.132
[8]Ilea, R., 2013, Mașini agricole, Curs IFR, Ed. Agroprint, Timișoara (Agricultural machinery. Agroprint Publishing House), pp.76.
[9]Mateoc-Sîrb, N., Gavrilescu, C., Mateoc, T., Nan, A.I., Mănescu, C., 2018, Assessment of biofuel production efficiency on the agricultural farms in Romania, Proceedings of the Conference on Energy and Clean Technologies, Vol.18**,** Issue: 4.1, pp. 149-156, Albena, Bulgaria.
[10]Mihuț, C., 2018, Fizica solurilor agricole, Ed. Agroprint, Timișoara (Physics of agricultural soils. Agroprint Publishing House,Timisoara), pp.63.
[11]Naghiu, A., 2008, Baza energetică pentru agricultură și silvicultură, Ed. Risoprint, Cluj-Napoca, (Energy base for agriculture and forestry. Risoprint Publishing House), pp.123.
[12]Pîrșan, P., 2003, Tehnologia plantelor de câmp, Ed. Agroprint, Timișoara (Field plant technology. Agroprint Publishing House)Timișoara, pp.187.
[13]Pop, G., 2007, Tehnologii agricole, Ed. Agroprint, Timișoara, (Agricultural technologies. Agroprint Publishing House), pp.48.
[14]Scripnic, V., Babiciu, P., 1979, Mașini agricole, Ed. Ceres, București(Agricultural machinery.Ceres Publishing House), pp.145.
[15]Stahli, W., 2003, Maşini pentru aplicarea tratamentelor fitosanitare şi fertilizarea foliară a culturilor legumicole, Ed. Agroprint, (Machines for the application of the phytosanitary treatments and the foliar fertilization of the vegetable crops. Agroprint Publishing House, Timisoara), pp. 50.
[16]Șandru, A., Cristea I., 1983, Exploatarea utilajelor agricole, E.D.P. București, (Operation of agricultural machinery. Didactic and Pedagogical Publishing House), pp.133.
[17]Suster, G., A., Mateoc Sîrb, N., Mateoc, T., Mănescu, C., 2013, Assessing of benefits considerend in cost-benefit analysis for energy and environmental biotechnology investment projects financed by structural funds, Current Opinion in Biotechnology, Vol. 24(S1), pp.74.
[18]Tabără, V., 2005, Fitotehnie vol. I – Plante tehnice oleaginoase și textile, Ed. Brumar, Timișoara, (Oil and textile technical plants. Brumar Publishing House, Timisoara), pp.181.
[19]Tonea, C., 1996, Tractoare, Editura Marineasa, Timişoara, (Tractors. Marineasa Publishing House,Timisoara), pp.122.
[20]Tudorache, D., Sârbu, L. L., 2013, World promotion of organic farming. Scientific Papers Series Management, Economic Engineering in Agriculture and rural development, Vol. 13(4): 291-294.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ANALYSIS OF AGRICULTURAL HOLDINGS IN ROMANIA IN TERMS OF SIZE

Eduard Alexandru DUMITRU, Daniela Nicoleta BĂDAN, Ionuț-Laurențiu PETRE, Alexandra-Marina BRĂTULESCU (MANOLACHE)

Research Institute for the Economy of Agriculture and Rural Development, 61 Marasti Boulevard, District 1, 011464, Bucharest, Romania, Phone: +4021.313.60.87, Fax: +021.313.60.96, Emails: dumitru.eduard@iceadr.ro, badan.daniela@iceadr.ro, petre.ionut@iceadr.ro, bratulescu.alexandra@iceadr.ro.

Corresponding author: bratulescu.alexandra@iceadr.ro

Abstract

According to statistics, Romania is in the last place when it comes to the average of the agricultural surfaces used by agricultural holdings. The article aims at comparative analysis and identification of territorial discrepancies at the level of the 41 counties, regarding the dimension of agricultural holdings. Taking into consideration the average area of the farms, using the national statistical data (GAR, SSA), as well as the data on the beneficiaries who have received subsidies through the Paying and Intervention Agency for Agriculture (APIA), we notice a significant difference, thus showing the polarization of the types of farms.

***Key words*:** *agricultural holdings, farm size, physical size, agricultural development*

INTRODUCTION

The agricultural land and the agricultural production resources are found in different types and forms at the at the farm level. They are differentiated by the amount of resources held, with particular reference to surface and / or the number of animals.

The production results depend, also on the volume of resources, as well as on how they are valued. The size of a farm is mainly represented by the area of land or the number of animals held [4], [11].

High-performance agriculture can only be realized within modern agricultural holdings, holdings with legal personality, which, on private property lands or on leased, concessioned or rented lands, have organized holdings that respond to the agrotechnical requirements specific to the type of holding.

The persistence of the major importance of agriculture in the Romanian rural economy is generated by the fact that the agricultural area used by the commercial, efficient and competitive agricultural farms, is approximately equal to that on which a subsistence agriculture is practiced [2].

After 1989, by applying the land laws and promoting the new structures of agricultural holdings based entirely on the private ownership of agricultural land, it was reached in 2010 that agricultural holdings without legal personality hold 52.9% of the total area of agricultural holdings in Romania, agricultural area used by them represents 56%, and the total area difference 47.1% of agricultural holdings or the agricultural area used 44% to be composed of agricultural holdings with legal personality [6], [5], [10].

After 1989, by reassessing the land ownership structures and remodeling the physiognomy of the agricultural holding in Romania, it was considered necessary to study, analyze and evaluate the quantitative and qualitative evolution of the field.

At the moment, at national level, the legal framework is extremely complex, directly influencing by the way of setting up and functioning of agricultural holdings, at the regional level, with evident particularities [3].

The structural changes aimed mainly at the economy generate complementary changes in various sectors and aspects, which in turn affect the growth and development process of that field.

Structural changes, in agriculture, are analyzed through a wide range of indicators, among which are most often found in the specialized literature the number of farms (farms), farm size, level of investments, etc.[9].

In the work "Structural Analysis of Agricultural Farms In Romania" by Unguru M. (2017), a structural analysis of the agricultural sector at national level is made, from the point of view of the typology of agricultural holdings, realizing possible correlations with the added value achieved [14].

Anghel, Anghelache and Panait (2017) studied the data recorded by all the EU member countries regarding the agricultural sector, highlighting the performances recorded by Romania, taking into consideration the evolution of agricultural production, livestock, the GVA from agriculture, the areas used by agricultural holdings and the labor force [1].

In the specialized literature there are numerous studies regarding both the territorial physical dimension of the farm and their economic dimension. The physical dimension of a farm (the surface of the farm) may indicate vague the degree of resource concentration, being poorly correlated with efficiency as well as economic results.

Increasing the physical size of the farm leads directly to the rapid growth and its economic dimension, so that the intensification of production per unit of agricultural area is considered more important than the increase of the surface, according to A. Tofan, 2006. [13].

MATERIALS AND METHODS

Structural analysis of agriculture is a priority issue and of current importance. Farms express the degree of concentration of agricultural areas. Romania at the level of the U.E. is placed in the last places in terms of the average area used on a farm.

In the study it was performed a qualitative and comparative analysis of the statistical data found in the General Agricultural Register (GAR 2010), the Structural Survey of Agriculture (SSA 2013, 2016) and the Agency for Payment and Intervention for Agriculture (APIA).

The final objective of the paper is to highlight the significant differences regarding the physical sizing of agricultural holdings.

RESULTS AND DISCUSSIONS

At the beginning of this research, aspects regarding the two main elements will be addressed, which will help determine the average size of the farm, respectively: the total areas and the number of farms. At the same time, as mentioned in the section on material and method, an analysis will be made regarding the indicators mentioned above, between the statistical data presented by the National Institute of Statistics (through the General Agricultural Register and the Structural Survey in Agriculture), and data provided by the Agriculture Payments and Intervention Agency, which provides data on the areas and farms that have received subsidies.

Taking into consideration, the utilized agricultural area of agricultural holdings, according to Table 1, it was found that it decreased during the analyzed period, in 2016, being 5% lower than the 2013 structural survey (13.03 million hectares) and 6% respectively compared to the RGA of 2010.

Using the statistical data registered within APIA, it is found that the agricultural areas receiving subsidies represent an average of over 70% of the agricultural areas used.

Table 1. The weight of the areas declared at APIA compared to the statistical data

Specification	2010	2013	2016
GAR + SSA areas (ha)	13,298,190.9	13,055,849.8	12,502,535
APIA areas (hectares)	9,503,452.07	9,863,922.71	9,223,341.4
Weight	71.46%	75.55%	73.77%

Source: acc. to Data GAR 2010 [7], SSA 2013, 2016, [12], APIA.

At the level of 2016, the number of agricultural holdings found in the Structural Survey on Agriculture was 3.42 million, which is 6% less than the number of registered farms at the level of 2013, and

compared to 2010 (according to the General Agricultural Census 2010) their number is 12% lower. By delimiting the holdings according to the type of holding, it was observed that the number of holdings with legal personality was 3,399 million in 2016, this number being 5.7% lower than in 2013, this category accounting the majority of the total number of farms. In the case of the number of subsidies applicants, according to data provided by APIA, the number of applicants decreased from 10.93 million in 2010, by 5% in 2013 and by 18% in 2016 (9.01 million). Associating the number of applicants to the number of holdings that have benefited from subsidies, we can say that the share of farms receiving subsidies of total holdings at country level for the year 2016 was 26.34%.

Table 2. Share of agricultural holdings declared to APIA compared to statistical data

Specification	2010	2013	2016
RGA + ASA farms	3,856,245	3,629,656	3,422,026
Number of applicants (APIA)	1,093,167	1,048,728	901,502
Weight	28.35%	28.89%	26.34%

Source: acc. to Data GAR 2010 [7], SSA 2013, 2016, [12], APIA.

Analyzing the number of applications for subsidies according to the type of applicant, the highest share is held by the applications submitted by individuals, over 90%.

Table 3. Structure of the beneficiaries of subsidies granted through APIA (%)

Number of the application according to the type of applicant	2010	2013	2016
Foreign citizen	0.01	0.02	0.02
Simple association forms without legal personality	0.00	0.01	0.00
Family businesses	0.01	0.05	0.10
Individual businesses	0.03	0.39	1.20
Individual	98.15	95.24	92.53
Legal entity	1.75	2.77	2.83
Authorized natural persons	0.05	1.53	3.31

Source: data processed according to APIA.

Following the evolution during the 3 years studied, it is found that the applications submitted by the legal entities increased from a share of the total number of subsidies applications from 1.75% in 2010 to 2.83% in 2016; this is also the case for the applications submitted by the PFA, from 0.05% in 2010, to 3.31% in 2016 of the total applications submitted.

Studying the data from the Agricultural Structural Surveys, it turned out that the agricultural area that returned per farm at national level did not undergo major changes (Table 3).

Thus, in 2016, the agricultural area per farm was 3.65 hectares, 1% higher than in 2013 (3.6 hectares per farm) and 6% higher than in 2010 (3.45 ha per holdings). Analyzing according to the categories of agricultural holdings, it can be observed that in 2013 the agricultural surface used on average on an agricultural holding with legal personality is lower by 3% compared to the average of 2016 (213 hectares per farm), while the area used of a farm with legal personality was only 2.04 hectares.

When reporting the number of applicants to the registered agricultural areas for the granting of subsidies (according to the APIA data), it is noted that the agricultural area that returns per farm at national level has been increasing during the 3 years studied, recording the value of 10, 23 ha / farm in 2016, 2% more than in 2013 (9.41 ha / farm).

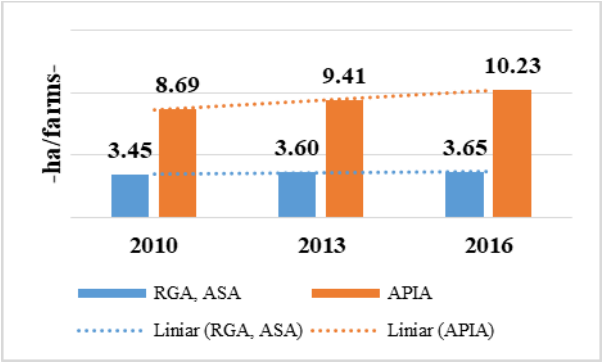

Fig. 1. The average size of the holding at national level of the APIA beneficiaries compared to the statistical situation

Source: own processing based on GAR, SSA and APIA data.

Both the agricultural area used and the number of farms varies from one region to another, depending on the specific area.

For a more detailed view of the situation, the 41 counties from Romania were taken for analysis, highlighting the regional discrepancies regarding the agricultural dimension at county level.

According to the data recorded in the structural agricultural surveys, the counties with the highest values of the agricultural surface used per farm, in 2010 were Constanta (11.21 ha), Timisoara (8.37 ha), Braila (7.63 ha) and Tulcea (7.58 ha), these counties remaining in positions in 2013 and 2016, with an increase in the value of agricultural areas used per farm up to 13.57 ha. On the last positions stands counties like Bucharest (0.63 ha), Prahova (1.50 ha), Dambovita (1.60 ha) and Bacau (1.83 ha).

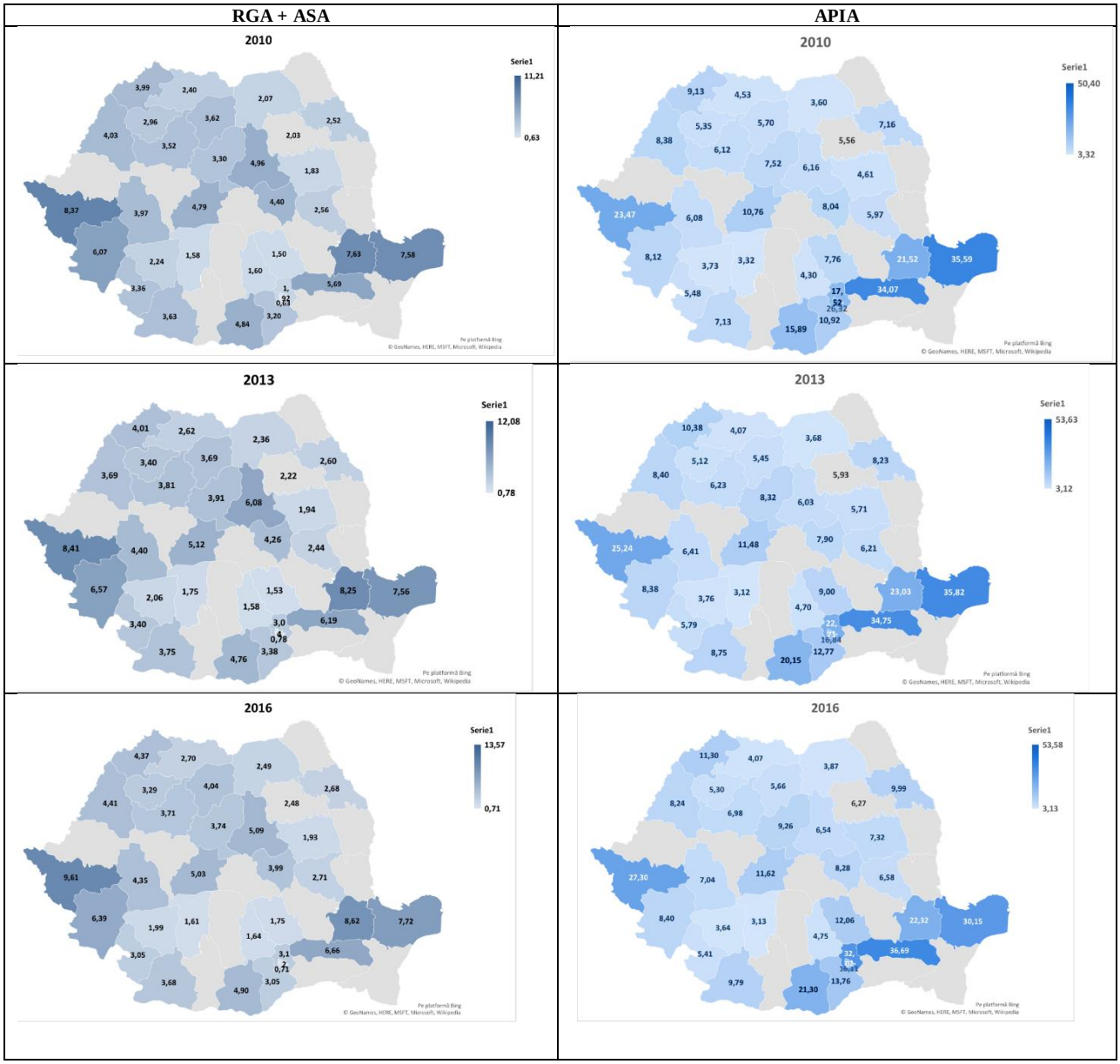

Fig. 2. Graphical representation of the average size of the exploitation at county level of the APIA beneficiaries compared to the statistical situation
Source: own processing based on GAR, SSA and APIA data.

In the case of APIA data processed at county level, the maximum values of the agricultural areas used per farm of 50.40 ha in 2010, 53.63 ha in 2013 and 53.58 ha are found during the 3 years analyzed. in 2016, in Constanta and Calarasi, a fact due to the large agricultural area per request for application (per farm) of the subsidies.

The counties with the lowest values of the agricultural surface used on the farm, in 2010 were Valcea (3.3 ha), Suceava (3.6 ha), Gorj (3.7 ha) and Dambovita (3.7 ha), positions that are also found in 2013 and 2016.

CONCLUSIONS

By Romania's accession to the European Union and agricultural programs, they contributed to the land consolidation of agricultural holdings, thus increasing average areas, reaching in 2016, an area of 3.65 hectares. However, if we were to look at the beneficiaries of agricultural subsidies, the average area worked was 10.23 hectares, this is a considerable difference.

Also, the subsidies granted by APIA contributed to the land consolidation, which increased farmers' interest in cultivating land and raising animals, subsidies that contributed to the profitability of the farms.

It should be noted that in the data provided by the Structural Survey at the level of 2016, in Calarasi county the average area of a farm was 6.28 hectares, while the average area of the farms that received APIA subsidies from the same place was 53.6 hectares. And in the case of Constanta county from INSE data, an average area of 13.57 hectares, but at the level of the agricultural holdings that received subsidies, their average size was 44 hectares.

In the case of counties such as Galati, recognized as a vegetable area, the average area used in 2016 of those who have received subsidies APIA was 13 hectares, while the average area of the farms analyzed by the Structural Survey was only 3, 67 hectares.

According to the legislation, by law no. 37/2015 [8], on the classification of farms and agricultural holdings, the farm is a form of organization made up of all the units used for agricultural activities and managed by a farmer, located in the territory of the same Member State of the European Union. Also the notion of farmer is defined as a natural or legal person or a group of natural or legal persons who own or use an agricultural farm in which he performs, alone or together with members of his family or other associated members, to obtain agricultural production. Given that in 2016, the number of farms with an economic dimension of 0 euros and below 2,000 euros (subsistence and semi-subsistence) were around 2 million, the definition of the concept of farmer is incomplete, and a clear definition of the farmer concept is necessary, in order to elaborate concrete measures and as close to reality as possible.

Thus, taking into consideration the data identified regarding the number of agricultural holdings (INSSE) and the number of beneficiaries of subsidies (APIA), it is found that there is a significant difference between this two indicators, although in the case of the number of beneficiaries from APIA they are not included and households (these holding a high share in the total number of agricultural holdings).

If an analysis is made regarding the weight of the areas registered at APIA, but also of the number of applicants, from the total of farms and areas declared by the statistics, there will be a quite significant difference. For example, if of the total number of farms at national level, only 28% are those applying for subsidies to APIA, they make up 74% of the total area at national level. On the other hand, if an analysis of the statistical data regarding the weight of farms without legal personality would be performed, this is 99.2%, working an area of 56%. In conjunction with these facts, two hypotheses can be launched, either the Pareto optimum is respected, respectively 20% of the farms own 80% of the areas, this may mean that the holdings registered with APIA have leased more land.

REFERENCES

[1]Anghel, M.G., Anghelache, C. and Panait, M., 2017, Evolution of agricultural activity in the European Union. Romanian Statistical Review, Supplement, 6, 63-74.

[2]Bohataret, V.M., Bruma, I.S., 2015, Regional chnages in the agricultural holdings structure in Romania during the 2002-2010 period (Mutatii regionale in structura exploatatiilor agricole din Romania in perioada 2002-2010), https://www.researchgate.net/publication/291756455_MUTATII_REGIONALE_IN_STRUCTURA_EXPLOATATIILOR_AGRICOLE_DIN_ROMANIA_IN_PERIOADA_2002_-_2010_REGIONAL_CHANGES_IN_THE_AGRICULTURAL_HOLDINGS_STRUCTURE_IN_ROMANIA_DURING_THE_2002-2010_PERIOD, Accessed on 5.01.2020.

[3]Bruma, I.S., Bohataret, V.M., 2015, The implications of the agricultural holdings with legal

entity when using the agricultural lands in Romania, Agrarian Economy and Rural Development - Realities and Perspectives for Romania. 6th Edition of the International Symposium, The Research Institute for Agricultural Economy and Rural Development (ICEADR), Bucharest, pp. 105-112, https://www.econstor.eu/bitstream/10419/163285/1/ICEADR-2015_p105.pdf, Accessed on 05.01.2020.

[4]Burcea, M., Micu, M.M., 2011, Size and characterization of agricultural holdings in Romania reported in EU - 27, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.11(1):22-25.

[5]Dumitru, E., Micu, A., Alecu, I., Tudor, V., Micu M., 2017, Analysis Regarding The Romanian Village - Case Study, Grindu, Ialomita County, Proceedings of the 29th International Business Information Management Association Conference, 3-4 May 2017 Vienna Austria, Education Excellence and Innovation Management through Vision 2020: From Regional Development Sustainability to Global Economic Growth, pp. 740-747.

[6]Dumitru, E., Micu, M.M., Tudor, V.C., 2019, Conceptual Approaches Regarding The Romanian Rural Area, Scientific Papers-Series Management Economic Engineering in Agriculture And Rural Development, Vol. 19(2):121-127.

[7]General Agricultural Register, GAR, (Registrul General Agricol), 2010, http://www.rga2010.djsct.ro, Accessed on 07.01.2020.

[8]Law no. 37/2015 on the classification of farms and agricultural holdings (Leagea No.37/2015 privind clasificarea fermelor si exploatatiilor agricole, https://lege5.ro/Gratuit/gu4tcnrygy/legea-nr-37-2015-privind-clasificarea-fermelor-si-exploatatiilor-agricole, Accessed on 07.01.2020.

[9]MADR, 2013, Social and Economic analysis of rural development in the prospect of 2014-2020 (Analiza socio-economica a dezvoltarii rurale in perspectiva 2014-2020), http://www.madr.ro/docs/dezvoltare-rurala/programare-2014-2020/analiza-dezvoltarii-rurale-agricultura-iulie-2013.pdf, Accessed on 5.01.2020.

[10]Micu, A., Dumitru, E., Tudor, V., Alecu, I., Micu, M., 2017, The Factors That Influence The Development Of Rural Villages - Case Study Semlac Commune, Arad County, Proceedings of the 29th International Business Information Management Association Conference, 3-4 May 2017 Vienna Austria, Education Excellence and Innovation Management through Vision 2020: From Regional Development Sustainability to Global Economic Growth, pp. 748-756.

[11]Otiman, P.I., 2012, The current agricultural structure of Romania - a big (and unresolved) social and economic problem of the country, Romanian Journal of Sociology, Current Problems of the Romanian Rural Area, New Series, Year XXIII, No. 5-6, pp.339-360, Bucharest.

[12]Structural survey in agriculture, SSA, (Ancheta Structurala din Agricultura), 2013, 2016, http://www.insse.ro/cms/ro/tags/ancheta-structurală-în-agricultură, Accessed on 07.01.2020.

[13]Tofan, A., 2006, The economic dimension of agricultural holdings. Scientific Annals of "Alexandru Ioan Cuza" University of Iasi, Vol. II/LIII.

[14]Unguru, M., 2017, Structural analysis of agricultural farms in Romania – identified problems and likely development opportunities, http://www.nos.iem.ro/handle/123456789/1261, Accessed on 07.01.2020

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ESTIMATING PEASANT FARMS INCOME AND THE STANDARD OF LIVING OF A RURAL POPULATION BASED ON MULTI-FACTORIAL ECONOMETRIC MODELING: A CASE STUDY OF UKRAINE

Mykola DZIAMULYCH[1*], Tetiana SHMATKOVSKA[2], Antonina GORDIICHUK[1*], Myroslava KUPYRA[1], Tetiana KOROBCHUK[1**]**

[1]Lutsk National Technical University, [*]Department of Economics, 75 Lvivska Str., 43018, Lutsk, Volyn Region, Ukraine, Phone: +380332785 666; E-mails: m.dziamulych@lntu.edu.ua, allure77@ukr.net, **Department of Finance, Banking and Insurance, 75, Lvivska Str., 43018, Lutsk, Volyn Region, Ukraine, Phone: +38 0332 785 566; E-mails: m.kupyra@lutsk-ntu.com.ua, tatianakor1970@gmail.com
[2]Lesya Ukrainka Eastern European National University, Department of Accounting and Audit, 28, Vinnichenko Street, Building 7 (G), 43021, Lutsk, Volyn Region, Ukraine, Phone: +38 0332 242 145; E-mail: shmatkovska2016@gmail.com

***Corresponding author**:* shmatkovska2016@gmail.com

Abstract

The paper deals with the influence of incomes from personal peasant farms on quality of life of the rural population in Ukraine. The estimation of impact of different factors on incomes from personal peasant farms in regional aspect of Ukraine, which is needed for understanding the main trends and directions of development of the given problem in perspective, is reflected in this article. In work was investigated dependence of average per capita average monthly income on the functioning of personal farms in households in the administrative regions of Ukraine from the effect of separate factors. In work was calculated matrix of pair coefficients of correlation between factorial and productive to signs for the studied model. According to the results of the study it is established, that all the selected factors showed a direct or inverse relationship with the change in the productive feature. In order to determine the density of the detected relationship, using a Microsoft Excel processor, we developed a multifactor correlation-regression model and calculated its main statistical characteristics. As a result, it was discovered that, there are now clear prerequisites for forming on the basis of mutually beneficial symbiosis, close, aimed at strengthening the private sector in the countryside, integration of personal farms with other agricultural producers, because of the fact that the population is depopulated, because and many other factors confirm the rapid exhaustiveness of extensive production methods that not only hinder further development. to the personal peasant farms, but also contribute to their degradation.

Key words: *peasant farms, rural population, income, standard of living, econometric modeling*

INTRODUCTION

The standard of living is one of the most important socio-economic categories, characterizing the position of a person in society, the possibility of meeting a person's needs and human development [3].

As a result of an acceptance of a course further, the economic countries of development on integration into the international European community occurred high-quality changes in approaches to determination of the category of the standard of living [5]. We consider it expedient to emphasize the significant increase in the importance and role of the standard of living of the rural population in the assessment of the social conditions of functioning of personal farms. It is well known that the concept of quality (standard) of life is being developed and used in the research of international organizations and many foreign scientists [1, 6, 7, 9, 15]. Quality of life indicators is quite widely used in the theory and practice of interstate analysis [2]. In particular, among the main results of the annual monitoring of the socio-economic development of countries [9] conducted by the Institute for Management Development International, Lausanne, Switzerland, within

the «World Competitiveness Project», one of the leading positions are measured in a ten-point scale, Quality of Life.

5It should be noted that the concept of «standard of living» is often interpreted as the degree of satisfaction of material, spiritual and social needs of the population. This definition characterizes the static of the studied category. However, living standards are a dynamic process that is influenced by many factors. On the one hand, the standard of living is determined by the composition and volume of the needs for various constantly changing benefits. On the other hand, it is limited to meeting the needs based on the market situation, income of the population, salaries of workers [3].

Central places in the system of scientific intelligence on living standards is occupied by household income and expenditure indicators. As income is the main source of satisfaction of the personal needs of the population in goods and services [13], their assessment is one of the priorities in the study of living standards. It should be noted that nowadays there is a significant increase in interest among scientists in the identified problems, which is confirmed by a considerable amount of intelligence in this area.

In our opinion, among the scientists involved in the development of these topics, it is advisable to note D. Bohynia [4], M. Vdovychenko [23], G. Kupalova [11], E. Libanova [12], P. Sabluk, M. Oraltyi [18], V. Yakubiv [24] and others whose scientific achievements have provided a solid basis for modern research, including our exploration. At the same time, a considerable amount of issues concerning the formation of regional peculiarities of the outlined issues in connection with their particular discussion and relevance continue to remain open for new scientific explorations.

MATERIALS AND METHODS

Construction of regression multi-factorial econometric model.

Step 1. Application of the regression of econometric modeling in the research

To determine the density of the identified relationship using the software Microsoft Excel, the multifactor regression model was elaborated and the basic statistical characteristics were calculated.

The equation of the regression contains one effective variable y and an unlimited number of factors – x_i . While researching of economic indicators from three to eight most significant factors carry almost all the information. Input of the additional variables makes it necessary to increase the number of totality of units (n~10x).

The process of building a multifactorial regression model begins with the selection of all possible factors which influences the effective rate.

Then checking of factorial signs on multicollinearity is conducted and special statistical ratios to evaluate the adequacy of the correlation of the econometric model are counted. The coefficient of multifactor equation of regression reflects the conditional impact of certain factor on effective feature, namely the coefficient of multifactor equation of regression shows the impact of certain fixed factorial variable on the effective indicator in term of certain values of the other factors that may change with the shift of the effective indicator.

The coefficient of multifactorial regression equation reflects the net impact of the factorial variable if regression of the econometric model covers all factors which affect the efficient variable. Herewith, the total impact of factors allocated between them. But actually the number of factors is quite larger and it is impossible to take them into account in the model. It is proved that there are several important factorial variables among all the other and the influence of others is insignificant.

It is important that in the multiple regression equation its parameters describe a conditional net impact of a single factorial variable on the effective in term of fixed average values of other factors which are included in the model, but the rest factors, which are not included, are variable.

While constructing the multifactorial (multiple) regression equation the background information should be submitted in the form of numbers of one order that will enable to interpret the economic content of individual regression coefficients better.

However, it is impossible to determine the factors that influence the value of the effective rate the most, if it is based on partial regression coefficients. Therefore, it is advisable to calculate the β_i – coefficient, where *i* - serial number of the factor sign in this regression econometric models.

Partial β_i – coefficients are calculated as a product of the regression coefficient of this factor and the ratio of standard deviation factorial and efficient features. The coefficients that were received in such way show how much the value of resulting sign will change as for the standard deviation with the change of the corresponding factor to one standard deviation granted the fixed (average) value of the other investigated factors.

Step 2. The concept and definition of multicollinearity in econometric regression models

One of the classical assumptions of the regression statistical analysis is the absence of multicollinearity.

Multicollinearity is a phenomenon in which there is the relationship between the factorial signs that is close to the functional

$$(r_{x_i x_j} \longrightarrow 1, i \neq j).$$

To examine the model on the multicollinearity the symmetric matrix of coefficients of pair correlations is built.

	Y	x_1	x_2	x_3	…	x_n
Y	r_y^2	r_{yx_1}	r_{yx_2}	r_{yx_3}	…	r_{yx_n}
x_1		$r_{x_1^2}$	$r_{x_1x_2}$	$r_{x_1x_3}$	…	$r_{x_1x_n}$

where: r_y^2, r_{yx_1},... $r_{x_1x_n}$ – linear correlation coefficients (pair correlation) between the relevant factors and the effective indicators.

So, in order to detect possible multicollinearity, the phenomenon of existing of a close linear dependence or a strong correlation between two or more variables that negatively affects the quantitative characteristics of econometric model or even makes its construction impossible, the matrix of coefficients of pair correlation of factorial and effective features is built.

If the inequality for the constructed model is carried out: $r_{x_i x_j}$ >0.8 ($i \neq j$), then there is the multicollinearity in the model.

Step 3. Interpretation of indicators of the econometric regression model

The indicator for evaluating of the density of the correlation due to the multifactorial model is cumulative coefficient of determination.

The formula for its calculation is as follows:

$$R^2_{yx_1x_2x_3\ldots x_n} = \frac{Var(\tilde{y})}{Var(y)}$$

The total variance is determined by the formula:

$$Var(y) = \overline{y^2} - \overline{y}^2.$$

Theoretical variance is determined by the formula:

$$Var(\tilde{y}) = \frac{1}{n} \cdot (a_0 \cdot \sum y + a_1 \cdot \sum x_1 \cdot y + \ldots = a_n \cdot \sum x_n \cdot y) - \bar{y}^2 \cdot$$

Another indicator that is used to evaluate the density of the correlation in multifactorial regression models is cumulative (multiple) correlation coefficient, which is calculated using the formula:

$$R_{yx_1x_2\ldots x_n} = \sqrt{\frac{Var(\tilde{y})}{Var(y)}}$$

It is important that if multiple correlation coefficient is 0.8 or more, the relationship between the factorial and effective features can be considered as tight.

$$R^2_{yx_1x_2\ldots x_n} = \frac{a_1 \cdot Cov(yx_1) + a_2 \cdot Cov(yx_2) + \ldots + a_n \cdot Cov(yx_n)}{Var(y)},$$

or by calculating the coefficients using the formula:

$$R^2_{yx_1x_2\ldots x_n} = \sum_{i=1}^{n} \beta_i \times r_{yx_i}$$

Step 4. F-test for econometric regression models

To examine the materiality of the relationship according the coefficient of determination $R^2_{yx_1x_2x_3\ldots x_n}$ F-test is used (F – criterion).

The formula for calculating the F-test:

$$F = \frac{R^2_{yx_1x_2x_3\ldots x_n}}{1-R^2_{yx_1x_2x_3\ldots x_n}} \times \frac{n-m}{m-1},$$

$$k_1 = m-1; k_2 = n-m.$$

where:

m – number of factors in the regression econometric model;

n – the number of observations in the regression econometric model.

The actual value of F-criterion $F_{(1-\alpha)}$ (k_1;k_2) should be compared with critical, which is included in the relevant calculation tables. If the inequality $F_{(1-\alpha)}$ (k_1;k_2) > F_{tabl}, is carried out, the relationship between effective and factorial features in the constructed regression econometric models is essential.

Thus, according to the results of the comparison of calculated value of F-test $F_{(1-\alpha)}$ (k_1;k_2) in term of the degrees of freedom k_1 and k_2 and the adopted level of probability (1–α)=0.95 with tabular (F_{tabl}) it is set that: $F_{(1-\alpha)}$ (k_1;k_2) > F_{tabl}, which is a confirmation of materiality of connection between the dependent and independent variables of the constructed multifactorial regression econometric model.

As a result, if all the parameters are typical for the econometric model, the indicators of connection are essential, then the constructed econometric regression model is adequate and can be used for further analysis.

RESULTS AND DISCUSSIONS

The globality and scale of transformations of the agrarian sector cause the need for the continuous analysis of their results for the purpose of timely and adequate corrections of the developed actions and optimization of innovations. Besides, the research of the existing patterns and relations of socio-economic processes that determine the formation of the standard of living of the population, in particular income from the functioning of personal farms, which under the current conditions of management provide the lion's share of agricultural resources, is an indispensable source of objective analytical information to forecast trends in the standard of living of the rural population in the future. Therefore, in our opinion, it does not lose its relevance to study the magnitude of the impact of factors on the volume of population income resulting from the functioning of personal farms, as well as outlining trends in the development of such income and determine their role in shaping the standard of living of the rural population, as is the publication purpose.

It is revealed that the volume of the population's income from the functioning of personal farms (PFs) is influenced by a whole range of factors. For the purpose of definition of extent of their influence on formation productive signs – the average monthly average per capita income from the functioning of personal farms (y) - it is carried out productive groupings of regions of Ukraine (Table 1) [calculations it is executed on the basis of materials: 8, 14-17, 19].

Moreover, the resultant indicator is calculated by summing the average monthly per capita monetary income from sales of products made in PF; cost of consumed products obtained from PF; as well as monetary evaluation of assistance from relatives and other persons with food products derived from PFs.

The study was based on statistical materials by administrative regions of Ukraine, since for the purposes of such calculations by administrative districts of a single oblast (region of Ukraine), no primary data are needed, and no survey of household income and expenditure at the district level is conducted by statistical authorities. In addition, the patterns that have been established as a result of grouping are, in our opinion, sufficiently scientifically substantiated and are not inconsistent with the requirements for the processing of empirical data by statistical methods.

Table 1. Dependence of average per capita average monthly income on the functioning of personal farms in households in the administrative regions of Ukraine from the effect of separate factors, 2018

Groups of areas behind income from functioning of OG, on average in a month counting on one person, UAH.	The number of areas in group, piece.	The average per capita income from functioning of OG, on average in a month, UAH.	production of gross agricultural products farms in all categories of	The average monthly salary in agriculture, UAH.	Share of persons employed in agriculture, hunting, forestry and fisheries in the total number of employees,%	Unemployment rate according to ILO methodology,%	Average per capita cash expenditures of households on food, on average in a month, UAH.	Share of remuneration as a part of total household resources, on average per month, per person,%	Retail turnover of enterprises for 1 person, UAH.	Gross regional product at the rate of 1 person, in the actual prices, UAH.
26.0–48.2	4	35.08	52.7	525.0	6.9	6.3	234.86	52.8	1,746.3	9,747.5
48.3-70.5	7	63.17	61.9	418.1	11.3	7.6	205.94	44.7	1,912.6	7,815.0
70.6-92.8	8	85.81	66.8	363.4	16.2	8.7	192.70	36.0	1,451.4	6,051.1
92.9-115.1	5	102.60	71.9	351.8	15.1	8.3	179.45	35.9	1,445.6	7,402.0
Together or on average	24	63.55	61.0	415.0	10.3	7.2	218.59	46.0	2,003.0	9,372.0

Source: Author's results based on [8, 14-17, 19].
Note: Data on the Autonomous Republic of Crimea is not available due to the occupation of this territory.

It should be noted that the following factors are selected among the factors: X_1 – the share of personal households in the production of gross agricultural production, in all categories of farms, %; X_2 – the average monthly wage in agriculture, UAH; X_3 – share of persons employed in agriculture, hunting, forestry and fisheries in the total number of employees, %; X_4 – ILO unemployment rate, %; X_5 – household cash expenditures on foodstuffs, on average per month per person, UAH; X_6 – share of wages in the total household resources, on average per month, per person, %; X_7 – retail turnover of enterprises for 1 person, UAH; X_8 – Is a gross regional product per person, at actual prices, UAH. The adequacy of the selection of factor traits was based on the need to form the most complete and rich picture of the factors that can affect the size of the population's income from the functioning of the personal economy.

The grouping results (Table 1) indicated the ambiguity of the relationship between outcome and factorial characteristics. In particular, in the section of selected groups it was found that from the 1st to the 4th group the average monthly per capita income from the functioning of PF increased by 2.9 times, the share of rural population in the total number of permanent population – 2.6 times, the share of employed in agriculture among the total number of employees – 2.2 times (from the aggregate tendency the indicator of group IV dropped slightly), the share of personal farms in the production of gross agricultural production in all categories of farms – by 36.4 %, the level was ILO methodology output – by 31.7 % (only the fourth trend fell slightly from the general trend). At the same time, from the 1st to the 4th group the average monthly wage in agriculture decreased by 49.2 %, the share of wages in the total resources of households - by 47.1 %, the average per capita money expenditures of households on foodstuffs - by 30.9 %, gross regional product per capita - by 31.7 % (slightly different from the general trend indicator of group IV), retail turnover per person – by 20.8 % (except indicator group II) out of trend).

Thus, it can be argued that all the selected factors showed a direct or inverse relationship with the change in the productive feature. In order to determine the density of the detected relationship, using a Microsoft Excel processor, we developed a multifactor correlation-regression model and calculated its main statistical characteristics. In order to identify possible multicollinearity – the phenomenon of the existence of a close linear dependence, or strong correlation, between two or more variables, which negatively affects the quantitative characteristics of the econometric model or in general makes it

impossible to construct it [10], a matrix of coefficients of pairwise correlation of factor and result traits was formed (Table 2).

Table 2. Matrix of pair coefficients of correlation between factorial and productive to signs for the studied model

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Y
X_1	1.000	-0.663	-0.186	0.470	-0.570	-0.368	-0.108	-0.543	0.387
X_2	-0.663	1.000	-0.488	-0.593	0.625	0.644	0.353	0.717	-0.635
X_3	-0.186	-0.488	1.000	0.388	-0.292	-0.677	-0.546	-0.448	0.636
X_4	0.470	-0.593	0.388	1.000	-0.489	-0.619	-0.590	-0.613	0.540
X_5	-0.570	0.625	-0.292	-0.489	1.000	0.609	0.260	0.640	-0.544
X_6	-0.368	0.644	-0.677	-0.619	0.609	1.000	0.537	0.689	-0.853
X_7	-0.108	0.353	-0.546	-0.590	0.260	0.537	1.000	0.461	-0.411
X_8	-0.543	0.717	-0.448	-0.613	0.640	0.689	0.461	1.000	-0.488
Y	0.387	-0.635	0.636	0.540	-0.544	-0.853	-0.411	-0.488	1.000

Source: Own calculations.

In addition, pairwise correlation coefficients provide an estimate of the relationship between dependent and independent variables. Thus, it is found that between the VIII and the II factors the even correlation coefficient is more than 0.7, which indicates a certain probability of the presence of multicollinearity between them (Table 2). Therefore, in order to identify the possible presence and elimination of the phenomenon of multicollinearity, we calculated the value of the variance inflation factor VIF (variance inflationary factor) for each variable:

$$VIF_t = \frac{1}{1 - R_t^2}$$

R^2 – determination coefficient for each i-th factor [13, p. 239].

As a result of the calculations, it is established that the magnitude of the variance-inflation factor in the studied model does not exceed the critical value ($VIF_I \geq 10$) which gives grounds for claiming that multicollinearity is absent among the studied features. Thus, all selected factors can be fully represented in the developed correlation-regression model.

So, the multiple-factor equation of linear regression we have is as follows:

$$y=0.893x_1+0.041x_2+2.744x_3+0.602x_4-0.016x_5-1.824x_6+0.007x_7+0.004x_8-4.033.$$

The scientific novelty of the obtained results is that, based on the analysis of the developed model, it is established that the increase in the share of employed in agriculture in the total number of employees by 1 % will cause an increase in average per capita income from the operation of personal farms by 2.74 UAH. per month; a 1 % increase in the share of remuneration in the composition of total per capita average monthly household resources will lead to a decrease in income from the functioning of personal farms by 1.82 UAH. per month. An increase in the share of personal farms in the production of gross agricultural production in all categories of farms by 1 % will cause an increase in the average per capita income from maintaining a private farm by 0.89 UAH. per month.

However, based on partial regression coefficients, it is not possible to determine the factors that most influence the average monthly per capita income from the functioning of personal farms. Therefore, it is considered appropriate to calculate the partial coefficients of elasticity (E_i) and β_i - coefficients (i –number of factorial signs).

The partial coefficients of elasticity are determined by the product of the regression coefficients of the respective factors for the ratio of the arithmetic mean factor and the resultant sign and show how many percent the average sign will change by changing the studied factor by one percent of its mean value at the mean factors [22]. The estimation of the obtained partial elasticity coefficients indicates a significant impact on the performance trait of all traits included in the model, only slightly lower for the IV and V factors (Table 3). According to the degree of influence, the first position is taken by the share of wages in the average per capita average monthly total resources of households: its increase by 1 % causes a decrease in the effective indicator by 1.004 %, the second – the share of personal farms in the production of gross agricultural products in all categories an increase of 1 % leads to an

increase of the effective indicator by 0.767 %.

Table 3. Statistical characteristics of the degree of influence of the studied factors on the average per capita average monthly income from the functioning of personal farms in the regional section of Ukraine

Factors	Average arithmetic	Average square deviation	Partial regression coefficients (a_i)	Partial coefficients of elasticity. (E_i)	Partial β_i - coefficients
X_1	64.20	15.05	0.893	0.767	0.591
X_2	402.28	93.80	0.041	0.221	0.169
X_3	13.10	5.22	2.744	0.481	0.630
X_4	7.90	1.42	0.602	0.064	0.037
X_5	200.50	32.99	-0.016	-0.043	-0.023
X_6	41.10	7.75	-1.824	-1.004	-0.621
X_7	1,626.56	378.87	0.007	0.144	0.110
X_8	7,406.60	2,179.30	0.004	0.423	0.409
Y	74.71	22.76	X	X	X

Source: Own calculations.

It should be noted that, under the realities of today, the main cause of social insecurity for workers is the low levels of labor income, which are not able to counteract poverty from the point of view of minimum wage guarantees and targeted assistance [21]. This, explains the existence of a significant interdependence between wages and income from the operation of personal farms.

Among other indicators that have the most significant positive impact on the growth of average monthly per capita incomes from the functioning of personal farms, it is advisable to allocate the III, VIII and II, their increase by 1 % leads to an increase in the effective indicator by 0.48 %, 0.42 % and 0.22 %.

Partial β_i – coefficients are calculated as the product of the regression coefficient of a given factor and the ratio of the standard deviation of the factor and the resultant traits. The coefficients thus obtained show which part of the root mean square deviation will change the value of the resultant sign with the change of the corresponding factor by one standard deviation with a fixed (mean) value of other investigated factors [22].

Based on the analysis of β_i – coefficients, as well as the results of estimation of partial coefficients of elasticity, it is established that the indicators of the share of remuneration in the composition of average per capita total resources for the average per capita aggregate total resources, forestry, and fisheries in the total number of employees (Table 3). Factors 1 and 8 also play a significant role in the formation of a performance indicator.

It is worth noting that since the multiple correlation coefficient is 0.92, it is advisable to recognize the correlation between factor and result traits as dense. The analysis of the coefficients of determination shows that the average per capita average monthly income from the functioning of PFs in the region by 83.9 % is determined by the variation of selected factors and 16.1 % by the action of factors not taken into account in the model.

By comparing the calculated value of the Fisher test ($F_{(1-\alpha)}(k_1;k_2)$ =10.44) in term of the degrees of freedom k_1=9–1=8 and k_2=25–9 =16 and the adopted level of probability (1–α) =0.95 with tabular (F_{tabl}=2.59) it is set that: is carried out, the relationship between effective and factorial features in the constructed regression econometric models is essential. By comparing the calculation ($t_{(1-\alpha)}(16)$ = 9.14) and tabular t–Student's Criterion (t_{tabl}=2.58) at the accepted probability level (1–α) = 0.99 the significance (materiality) of the multiple correlation coefficient is confirmed, as $t_{0.99}(16) > t_{tabl}$.

CONCLUSIONS

Summarizing the results of the study, it should be noted that personal farms, which by their socio-economic essence combine the owner and the employee in one person, having lost the subsidiary character and demonstrating the dynamism, adaptability to difficult economic conditions, lead to the formation of a new type of owner in the countryside, and therefore in our opinion, policies need the most support. We believe that a significant increase in the economic value of personal farms traces the role of the system of determining factors:

- under current economic conditions, private farms are the dominant model of overcoming the risk of poverty, unemployment and insecurity and one of the main sources of income for the rural population;
- personal farms have become the center of labor activity of the rural population, and as long as each new share of the extra labor

spent will be paid back by an additional amount of income, the household members will prefer to increase the exploitation itself [20] in their own farms. In addition, the level of value of work of each household member and the availability of alternative employment opportunities determine the feasibility of employment in personal farms;

- since private farms, operating on the principles of self-financing, show lower dependence on the rise in price of energy and other material resources, due to the low capital intensity and availability of labor resources, there are opportunities for further increase in their agricultural production;
- however, the low level of technical equipment of personal farms does not provide for the possibility of intensification of agricultural activities with the use of scientific and technological progress, so in the case of increasing the size of land resources, increasing production in personal farms is possible only due to extensive factors.

Based on these points, we believe that there are now clear prerequisites for forming on the basis of mutually beneficial symbiosis, close, aimed at strengthening the private sector in the countryside, integration of personal farms with other agricultural producers, because of the fact that the population is depopulated, because and many other factors confirm the rapid exhaustiveness of extensive production methods that not only hinder further development. to the personal peasant farms, but also contribute to their degradation.

REFERENCES

[1]Ayvazian, S.A., 2003, On the methodology of measuring the synthetic categories of quality of life of the population. Economics and mathematical methods, 39 (2): 33-53.
[2]Artemenko, V.B., 2002, Methods of integral assessment of the quality of life of the population in management of regional development. Regional Economics, 1: 166-177.
[3]Bida, L.S., 2019, Economic activity of Volyn population in 2018: Statistical Collection. Lutsk: Main Department of Statistics in Volyn Region. 307 p.
[4]Bohynia, D.P., 2003, Labor Market Competitiveness in the System of Social and Labor Relations. Kyiv; NAS of Ukraine, Institute of Economics. 214 p.
[5]Boiar, A.O., Shmatkovska, T.O., Stashchuk, O.V., 2018, Towards the theory of supranational finance. Cogent Business & Management. 5(1):1-12. http://doi.org/10.1080/23311975.2018.1482594, Accessed on Nov. 24, 2019.
[6]Community and Quality of Life: Data Needs for Informed Decision Making. 2002. National Academy Press. Washington, D.C. 191 p.
[7]Dziuba, I.V., 2004, Category of living standards of the population: a modern approach. Statistics of Ukraine, 1: 68-73.
[8]Grygorovych, N.V., 2019, Labor of Ukraine 2018: Statistical Collection. Kyiv: State Statistics Committee of Ukraine. 352 p.
[9]Human Development Report 2004: official website of the United Nations Development Program (UNDP): http://hdr.undp.org/reports/global/2004. Accessed on Dec. 14, 2019.
[10]Kostirko, I.G., Bitter, O.A., Petryshyn, L.P., 2007, The solvency of the population and the efficiency of agriculture. Lviv: Ukrainian Technologies. 160 p.
[11]Kupalova, G.I., Chetveryk, V.M., 2013, Statistical-economic analysis, estimation and prospects of development of personnel of agricultural enterprises. Kyiv. 211 p.
[12]Libanova, E.M., 2006, Human development in Ukraine: opportunities and directions of social investment. Kyiv: Institute of Demography and Social Research of NAS of Ukraine. 355 p.
[13]Luginin, A.E., Belousova, S.V., Belousov, O.M., 2005, Econometrics. Kyiv: Center for Educ. Lit. 252 p.
[14]Malikova, I.Y., 2019, Development of personal farms in transition economy. Economy and State, 10: 53-55.
[15]Osaulenko, O.G., 2019, Ukraine in Figures 2018: Statistical Reference Book. Kyiv: State Committee for Statistics of Ukraine. 239 p.
[16]Osipov, I.I., 2019, Costs and resources of Ukrainian households in 2018 (according to a sample survey of living conditions of Ukrainian households). Kyiv: State Statistics Committee of Ukraine. 380 p.
[17]Prokopenko, O., 2019, Gross agricultural output of Ukraine (at comparable prices in 2017) for 2018. Final data: Statistical bulletin. Kyiv. 24 p.
[18]Sabluk, P.T., Orlatyi, M.K., Bulavka, O.G., 2002, Material well-being of rural residents. Kyiv. 369 p.
[19]Streliuk, S.V., 2019, Distribution of Volyn Region Resident Population by Sex and Age: Statistical Collection. Lutsk: Statistics Department in Volyn Region. 101 p.
[20]Sodoma, R., Skhidnytska, H., Shvorak, A., Shmatkovska, T., Zhurakovska, I., 2018, Peculiarities of agrarian receipts as a modern financial tool. Economic annals-XXI. 169 (1-2): 46-49. https://doi.org/ 10.21003/ea.V169-09. Accessed on Nov. 16, 2019.
[21]Statistical Yearbook of Ukraine for 2018, 2019. Kyiv: State Statistics Committee of Ukraine. 578 p.
[22]Vavilina, N.D., 2013, Quality of life: essence, evaluation, formation strategy. World of Science, 3: official website: http://mir-nauki.com/PDF/ 03MN313.pdf. Accessed on Nov. 28, 2019.
[23]Vdovychenko, M., Nesterets, M., 1996, Income of rural population and its social protection. Ukraine: aspects of work. 1; 34-37.
[24]Yakubiv, V., Poliuk, M. 2019, Innovative methodologies for estimating the personnel of agricultural enterprises in Ukraine. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development. 19 (1): 617-624.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

AGRICULTURE AND SUSTAINABLE SOIL USE IN TIMIŞ COUNTY, ROMANIA

Saida FEIER DAVID, Nicoleta MATEOC –SÎRB, Teodor MATEOC, Cristina BACĂU, Anișoara DUMA COPCEA, Casiana MIHUȚ

University of Agricultural Sciences and Veterinary Medicine "King Mihiai I of Romania" from Timisoara, 300645, Calea Aradului nr. 119, Romania, Phone: +40256277001, Fax:+40256200296, Emails: roxanadavid24@yahoo.com, mateocnicol@yahoo.com teomateoc@yahoo.com, ccurec@gmail.com, duma_anisoara@yahoo.com, casianamihut@yahoo.com,

Corresponding author: mateocnicol@yahoo.com

Abstract

The main purpose of this study was to analyse the main development resources of Timiş County, Romania, and to find opportunities for sustainable development of agriculture on the basis of available resources. Thus, the main objective of this study was to assess the resources regarding the development of sustainable agriculture that do not affect the environment in Timiş County. From the analyses carried out, it was found that, from the point of view of natural resources, Timiş County can be considered a rich county, both in terms of natural resources (fertile soils favourable to cereals, vegetables, fruit trees or vines, natural deposits of lignite, basalt, crude oil, natural gas, mineral waters or geothermal water), as well as economically, socially or culturally.

Key words**:** *natural resource, soils, sustainable agriculture*

INTRODUCTION

Timiş County is located in Western Romania, in one of the most prosperous areas of our country, namely the Western Plain. It is also the largest county of our country, ranking first, with a total area of 8,697 km², i.e. 3.6% of our country's total area [11].

From the point of view of the administrative organization, Timiş County has two municipalities – Timişoara and Lugoj; eight cities – Sânnicolau-Mare, Jimbolia, Buziaş, Făget, Deta, Ciacova, Recaş and Gătaia; and 87 communes. The relief is particularly varied, so in the central and western part of Timiş County there are plains, and in the eastern area, there is a hilly and mountainous relief. The plain is the predominant form of relief in the county: Timişului Plain, which has altitudes of 80-90 m, Arancăi Plain (Mureş-Aranca), which includes the Mureş meadow and the Arancăi Meadow, Vinga Plain and Gătaia Plain [12].

Since the past centuries, the special fertility of the soils of Banat Region has been acknowledged, which has been supported by famous historiographers of the time, such as Francesco Griselini (1777), author of a well-known history of Banat in which he pointed out that the lands of this region are so good that even in the absence of natural fertilisers they have high productivity that goes far beyond the productivity of the land in any other country in Europe

Agriculture is a priority of our country's economy; its main purpose is to meet human needs and the overall progress of the national economy. The main functions of our agriculture are: food function, socio-economic function, environmental protection and sustainable development of agriculture function. [9, 10].

At present, Romania's Food Agenda is characterized by the inconsistency of the supply of agricultural products, by a deficient structure in terms of quality of food consumption, by the high share of expenditure sourcing in the budget of a middle-income family, and by increased dependence on the import of basic foods needed for daily consumption [5, 6]. This food imbalance in our country is given by the relatively low

consumption of animal protein and the relative low fruit consumption, but also by an increased degree of biological and chemical pollution of food [3, 7].

Agriculture makes an important contribution to the overall economic growth process, being an important source of income and jobs, both in this economic sector and in related sectors such as industry, infrastructure, or tourism [1].

At national level, agriculture is an export source, with an important role in the balance of payments. This sector of the economy is also a defining element of rural space progress, ensuring the development of many small- and medium-size businesses in various fields, thus fostering a wide distribution of revenues [4].

Agriculture also performs the function of preserving, protecting and beautifying the environment, ensuring the maintenance of ecological balance on Earth. However, it has dual effects on the environment: on the one hand, it performs the function of environmental protection through agricultural landscaping systems that ensure the value of premises and landscapes to protect them and, on the other hand, it can destroy the ecological balance by misuse of chemicals, irrational irrigation, water and air pollution, soil compaction, etc. [4, 10].

Ensuring the purity of food products and promoting the quality and compatibility of environmental requirements are increasingly important features of competitiveness in agriculture nowadays. Areas that will produce food with higher ecological characteristics will receive financial support through various programmes promoted by the European Union, thus organic farming can become a growth factor for Romania rural areas [2, 8].

In addition to these three vast agricultural functions, the following can also be listed: agriculture is an active participant in foreign trade; it constitutes a market for other sectors; it is a permanent generator of raw materials needed for the food and light industry

MATERIALS AND METHODS

The material used here is mostly the result of studies and research carried out by the authors of the article, carried out over several years at the Centre of Excellence "Sustainable Rural Development of Romania" at the Banat University of Agricultural Science and Veterinary Medicine “King Michael I of Romania” from Timisoara, Romania. Many references come from the literature in the field. The methods used are specific to economic research: collection and selection of material, processing, comparing, observing and drawing conclusions.

RESULTS AND DISCUSSIONS

Agriculture is a particularly important economic branch in Western Romania, which owns 13.2% of the country's agricultural area and has a very high production potential due to the high fertility of soils in the Western Plain Romania.

In Timiş County, the agricultural sector is of particular importance, due to the fruitfulness of the land and the high productions over the years in the field. At the level of Timiş County, the structure of the land and the categories of use is presented according to Table 1.

Table 1. Land distribution by use categories in Timiş County, 2017

Use category	Area (ha)	%
Agricultural lands, of which:	693,094	
• Arable land	530,808	76.59
• Meadows	121,741	17.56
• Haymaking fields and natural meadows	28,106	4.06
• Vineyards and viticultural nurseries	8,334	1.20
• Orchards ad fruit nurseries	4,105	0.59
Agro-zootechnical buildings	2,058	
Degraded and non-productive land	4,190	
Forest fund administered by the Timiş Forestry Directorate	84,370	
Forest fund administered by the R.P.L. Ocolul Silvic Stejarul R.A.	8,812	

Source: Statistical yearbook of Timiș County, 2017.

According to Table 1, the largest share of Timiş County's area (530,808 ha, i.e. 76.59%)

is represented by arable land which has a high but not properly exploited fertility.
Following the study, in Timiş County there is a gradual increase in the total area cultivated in recent years in most crops (Table 2, Figure 1).

Table 2. Area cultivated with main crops (ha)

Crop	2014	2015	2016	2017
Total cultivated area	453,569	445,738	434,850	501,424
Grain cereals	363,054	345,406	342,970	327,388
Wheat and rye	146,673	138,961	142,909	127,280
Barley and two-row barley	24,978	20,072	16,552	18,048
Maize	179,064	175,000	174,787	167,519
Legumes	766	728	392	646
Sunflower	37,387	46,000	46,785	73,451
Soybean	4,665	7,591	3,451	25,047
Potato	5,591	5,469	3,309	3,010
Vegetables	12,579	12,670	11,228	11,282
Others	29,527	29,527	26,715	60,600

Source: Statistical yearbook of Timiș County per year 2017.

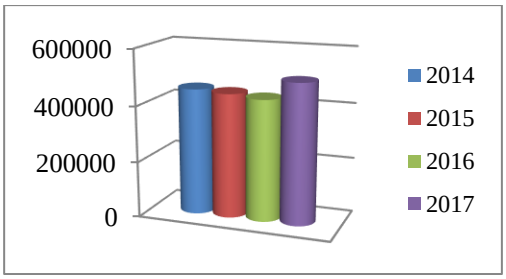

Fig. 1. Evolution of total cultivated area (ha) in Timiş County
Source: Our own construction based using the data of the Statistical Yearbook of Timiş County for the year 2017.

The most significant increase in terms of areas were in sunflower and soybean, as illustrated in Table 2, as well as in fodder crops. It is noted that, in the cultivated area, the largest share is held by grains (wheat and rye, barley, two-row barley, maize and other cereals). Timiş County has the largest share in grain production in the Western region, with an average of around 50% of all production at region level. This activity contributes more than 50% to the formation of total turnover in the primary sector of the economy. At present, the land is not capitalized at its true value, because the productions recorded are below the fertilising potential of the soils of Banat.

With regard to crop production obtained, the largest productions were in cereals, but significant increases were also recorded in 2017 in sunflower and soybean.
The highest average productions (kg/ha) were recorded in sugar beet, which increased in 2017 compared to 2014, and substantially in 2015.
With regard to the valorisation of productions, it should be noted that, from the data obtained, it was found that, on small- and medium-size farms in Timiş County, much of the production made is intended for family consumption.
Sustainable agriculture, agriculture of the future.
Sustainable agriculture is a complex system through which very high productivity is achieved, the food needs of the population are ensured, and large and secure profits are achieved, all in the context of environmental protection and conservation.
Sustainable agriculture involves the scientific and balanced use of modern technologies regarding soil works, crop rotations, fertilization, sowing, care work (weed, disease and pest control, including through biological methods), irrigation, animal husbandry, storage, processing and use of residues from agricultural activities, for the production of high and stable productions, without adverse effects on the environment.
Sustainable soil use involves maintaining its three ecological functions: providing habitat for organisms; biomass production; and filtration, buffering, processing of matter and soil water in order to ensure their circuit in nature. The situation of the environment and the efficient and rational use of natural resources visibly impact the conditions of economic growth, as well as the level and quality of life of the population.
In Romania, the interest in sustainable development in agriculture was based on long-term research on crop productivity factors, on biodiversity, environmental protection, and bioresources, and have been important objectives over the past decades, correlated at European and global level.

Soil is a vital component of the biosphere, resulting from the action of climatic and biotic factors on the rocks on the surface of the earth. It also contributes, together with vegetation and climate, to regulating the hydrological regime and the quality of the environment. At the sane time, this is a complex and dynamic environment, comprising characteristic fauna and flora, a set of mineral and organic elements, and its own air and water circulation.

Soil quality depends on the suitability and favourability of land for use for various purposes and for different crops. The area covered by the soil is limited. The total area of land globally is estimated at 13.395 billion ha, of which 11% represent arable land, 22% meadows and 30% forests, i.e., on average an area of 0.35 ha arable per inhabitant around the globe. In Romania, this value is estimated to be 0.495 ha arable land/inhabitant. Demographic growth and increased food needs have revealed the need to expand agricultural land. Worldwide, around 460 million people are believed to suffer from malnutrition.

In recent decades, agricultural ecosystems have been overburdened as a result of increased food demand, and this has significantly decreased soil stability and increased soil degradation.

Soil degradation is achieved by erosion of the humus layer, which produces serious negative effects on soil fertility. Soil pollution and degradation are strongly correlated phenomena. The following are considered the main causes of soil degradation and pollution: excessive tree cutting and uncontrolled deforestation; expansion of housing districts and of communication systems; expansion of industrial platforms, of waste materials (excavation materials) and dump sites (sterile deposits derived from mining works); expansion of agricultural crops; irrational application of irrigation; salting of swamps and soils; introduction into soil of heavy metals, residues, pesticides, industrial emissions, etc. Agricultural crops, apart from their role in providing food for humans and animals, play an increasingly important role in ensuring environmental balance.

Excessive chemisation induces involution processes: microorganisms in the soil disappear and structural destabilisation of the soil occurs. In order to maintain soil fertility, they continue the application of chemical fertilizers, thus leading to soil intoxication, in which case degradation can no longer be avoided. Deforesting and drying swamps and puddles cause irreversible imbalances within ecosystems. The use of excess chemicals (pesticides, herbicides, fertilizers) is an important source of pollution and soil degradation because they introduce chemicals affecting its qualities and fertility. Soil damage can also occur because of the exploitation of surface and underground deposits, by continuing this process at a high pace. At the same time, massive deforestation leads to soil erosion, climate aridity and increased wind speed, and intensive grazing contributes to soil erosion, to natural habitat modification, to vegetation removal, and induce other negative effects on the soil and ecosystem in general.

The irrational application of irrigation can also contribute to soil erosion and is the main cause of sediment water pollution, the clogging of the soils in flooding meadows, and contributes to the stopping of reservoirs and water tank functioning. Household waste and waste from industrial activities, from agriculture or other activities also contribute to the poor state of soils and, if discharged into the environment, thus altering the geochemical abundance of soil elements. Agricultural practice taking place under various conditions, under the influence of a complex of environmental factors and conditions, modified in time and space by human intervention, requires the deepest knowledge of all ecological and soil determinants. The qualitative evaluation of the soil and the choice of the most suitable way of using the land based on science in relation to the degree of suitability contribute to the increase and conservation of productivity and, thus, increase the resilience

capacity of the most sensitive and fragile soils.

The crediting of agricultural land is the complex operation of in-depth knowledge of the conditions for the growth and development of crops and to determine the degree of favourability of these conditions for different uses and crops through a system of technical indicators and creditworthiness notes (MADR Order no. 278/2011). Credit worthiness in the research area studied revealed a number of limiting factors acting on the production capacity of agricultural land within Timiş County, including excess stagnant and phreatic moisture, compactness and moisture deficiency, salting and acidification. Their analysis results in a number of requirements and measures of improved and/or mandatory use, as well as requirements and measures to prevent soil degradation and preserve soil fertility. In the analysed western area, i.e. in the Aranca-Galaţca Inter-River Plain, it was found that 36.21% of the territory, i.e. 65,494 ha, is affected by excess surface moisture and 35.38% is affected by excess ground moisture, according to the data in Table 3. When determining excess moisture, the essential factors that determine humidity conditions are groundwater depth, hydric balance, microrelief, soil permeability and soil texture.

Table 3. Land with excess surface and ground water from the inter-river Aranca-Galaţca Plain

Locality	**Agricultural land (ha)**	**Of which land with:**					
		Surface water excess			**Ground water excess**		
		low	**medium**	**strong**	**low**	**medium**	**strong**
Gotlob	4,114	650	0	0	350	116	43
Lovrin	**3,807**	**780**	**0**	**0**	**816**	**180**	**170**
Periam	5,886	0	0	0	840	416	138
Pesac	3,147	0	0	0	550	400	186
Saravale	9,620	3,510	495	158	1,680	298	418
Sânpetru Mare	9,176	3,508	488	176	2,094	339	401
Sânnicolau Mare	12,689	9,068	142	0	1,960	1,820	650
Teremia Mare	7,748	450	31	852	452	1,083	283
Tomnatic	3,547	620	0	0	580	128	30
Valcani	5,760	230	750	1,810	2,660	2,560	1,560
Total (ha)	65,494	18,816	1,906	2,996	11,982	7,340	3,879
Total (%)	100	28.73	2.91	4.57	18.29	11.21	5.88

Source: OSPA Timisoara archive.

Depending on the phreatic level, lands without limitations are lands where groundwater is deeper than 2 m, with moderate limitations, those with groundwater between 1-2 m, and unfavorable (strong and excessive limitations) land, where the depth of groundwater is 1 m (i.e. in the first 50 cm). In view of these restrictive factors, soil and hydroameliorative measures (depleting, drainage, deep-watering, etc.) and the development of a balanced aero-hydraic regime and measures to promote the processes of concentration of nutrients and organic matter in soil are mandatory. It is also noted from the analysis that a significant area of the land of the localities analysed is affected by compactness, i.e. 70.12%, while another area of 44.28% is affected by moisture deficit. The situation is presented in Table 4. Compaction is a particularly important restrictive factor of increasing the root system, reducing water infiltration into the soil and increasing the risk of excess moisture on the surface, but also on the soil profile. It reduces soil fertility and accessibility of nutrients to plants in particular. The use of agricultural machinery or any machines on too wet land leads to severe compaction of the soil and significant reduction of the root system. When using

agricultural machinery, for any kind of work, it is always absolutely necessary to know the degree of humidity. Moreover, agricultural machinery systems, as well as the moment of "entry" into the land must be in line with the specifics of the soil.

Measures should be taken to improve the physical state of soils on land affected by physical processes of surface degradation (crustification, dusting, clogging of porous space, etc.) by reducing the number of soil works, by introducing long-term crop rotations with protective and improving plants, alternation of deep soil work for annual weeding crops with superficial works.

Table 4. Land affected by compactness and moisture deficiency in the Aranca-Galaţca Plain

Locality	Agricultural land (ha)	Of which land with:					
		compactness			moisture deficit		
		low	medium	strong	low	medium	strong
Gotlob	4,114	2,134	560	258	2,560	730	350
Lovrin	**3,807**	**1,081**	**685**	**242**	**1,384**	**813**	**315**
Periam	5,886	2,264	959	680	787	3,798	0
Pesac	3,147	1,268	860	188	680	2,560	0
Saravale	9,620	3,680	1,970	350	1,260	2,950	1,360
Sânpetru Mare	9,176	3,023	1,797	420	986	1,865	1,290
Sânnicolau Mare	12,689	6,516	1,291	1,410	2,560	3,980	1,460
Teremia Mare	7,748	2,071	1,470	526	31	2,856	3,106
Tomnatic	3,547	1,850	695	280	2,360	790	378
Valcani	5,760	1,260	1,350	960	1,120	3,369	230
Total (ha)	65,494	25,147	11,637	5,314	13,728	23,711	8,489
Total (%)	100	38.40	17.77	8.11	20.96	36.20	12.96

Source: OSPA Timisoara archive.

Table 5 shows the land in the ten analysed localities affected by salting and acidification. It was found that 51.58% of the area are affected by salting, but a share of 38.84% is affected by medium salting, 6.78% suffer moderate salting, and only 5.96% experience strong, excessive salting. Of the 65,494 ha in the Aranca-Galaţca Plain, 19.47% are affected by low and medium acidification.

Table 5. Land affected by salting and acidification in the Aranca-Galaţca Plain

Locality	Agricultural land (ha)	Of which land with:				
		salting			acidification	
		low	medium	strong	low	medium
Gotlob	4,114	960	46	0	560	150
Lovrin	**3,807**	**1,446**	**70**	**56**	**890**	**194**
Periam	5,886	2,556	110	43	1,960	350
Pesac	3,147	2,180	85	25	510	130
Saravale	9,620	4,160	695	1,160	1,110	230
Sânpetru Mare	9,176	3,960	615	960	1,280	193
Sânnicolau Mare	12,689	3,476	1,623	738	1,571	218
Teremia Mare	7,748	3,339	213	201	1,927	0
Tomnatic	3,547	1,202	57	3	620	180
Valcani	5,760	2,158	928	719	680	0
Total (ha)	65,494	25,437	4,443	3,905	11,108	1,645
Total (%)	100	38.84	6.78	5.96	16.96	2.51

Source: OSPA Timisoara archive.

In this context, actions are required to correct pH (soil acidity) and proper fertilisation of the soil, on the basis of authorised agrochemical mappings, as well as the application of agricultural and soil improving measures aimed at achieving a balanced air and water regime with optimal operating parameters. The quantity of mineral and organic fertilisers applied on the surface unit shall not exceed 170-210 kg N/ha/year.

CONCLUSIONS

On the basis of the research and analysis carried out, it is possible to say that the agricultural potential of Timiş county is considerable due to large agricultural areas and favorable soil and climate conditions in many localities that have soils with high fertility and need to be properly exploited.

The main objectives pursued in order to practice sustainable agriculture are: maintaining soil quality and ensuring proper correlation between food quantity and quality, human health and maintaining the quality of the environment.

Under the current economic conditions, it is necessary to find an optimal ratio between agricultural technologies, productions and ecology, ensuring a balanced economic-social development of the rural area by satisfying food and social requirements, improving the quality of the environment and the sustainable exploitation of natural resources, optimal and sustainable use of limited and non-renewable resources, and improving the quality of rural life.

It is important to note that degraded soil is regenerated due to the beneficial influence of sun energy and of atmosphere. The process of ecological reconstruction of the soil is very long-lasting, with specialists considering that even ten centuries are needed, to restore only a few cm of soil thickness. Since the conditions and history of soil formation cannot be replicated, it is absolutely necessary to use this vital natural resource, which has the ability to increase its fertility provided it is used properly.

For economic reasons and for environmental protection, at the level of each agricultural holding of more than 10 ha, it is necessary to properly manage fertilizers at farm level. In order to achieve this objective, good management based on a nitrogen and other nutrients fertilization plan is required for each soil or plot cultivated with a particular crop.

REFERENCES

[1]Borcean, I., Țărău, D., Borcean, A., David, Gh., Borcean, E., 2005, Fitotehnia și protecția culturilor de câmp în Vestul României, Editura de Vest, Timișoara. (Phytotechnics and field crop protection in Western Romania, Wes-ern. Publishing House, Timisoara), pp. 197.

[2]Dona, I., 2015, Economie rurală, Editura Economică, București. (Rural economy. Economic Publishing House, Bucharest), pp. 205.

[3]Gavrilescu, C., Florea A., David S., Popescu, A., Mateoc-Sirb, N., 2016, Agri-food organic products – A fast increasing market, European Biotechnology Congress 2016 - Riga, Latvia 05th – 07th of May 2016, Abstracts /Journal of Biotechnology 231S (2016) S4–S109 http://dx.doi.org/10.1016/j.jbiotec.2016.05.333, Accessed on Jan. 20, 2020.

[4]Man, T. E., Mateoc-Sîrb, N., 2007, Dezvoltarea rurală și regională durabilă a satului românesc, Editura Politehnica, Timișoara. (Sustainable rural and regional development of the Romanian village. Politehnica Publishing House, Timisoara), pp. 291.

[5]Mateoc-Sîrb, N., Mateoc, T., Nan, A. I., David, S., Mănescu, C., 2018, Evolution of rural population and rural development, Scientific Papers, Agricultural Management, Series I, Vol. XX (2):71-76, Agroprint Press, Timişoara.

[6]Otiman, P. I., Mateoc-Sîrb, N., Mănescu, C., 2013, Economie rurală, Editura Mirton, Timișoara. (Rural Economy. Mirton Publishing House, Timisoara), pp.61.

[7]Popescu, A., Stoian, E., Șerban V., 2019, Oil seeds crops cultivated area and production in the EU-28 - trends and correlations, 2008-2018, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 19(4):265- 272.

[8]Toth, A., Mateoc-Sîrb, N., David, S., Mateoc, T., Mănescu, C., Venig, A., Sârb Gh., 2016, Organic agriculture: An opportunity for sustainable development of Romanian villages, European Biotechnology Congress 2016 - Riga, Latvia 05th – 07th of May 2016, Abstracts / Journal of Biotechnology 231S (2016) S4–S109, S83, http://dx.doi.org/10.1016/j.jbiotec.2016.05.299, Jan. 20, 2020.

[9]Teaci, D., 1996, Probleme ale cunoașterii resurselor edafice și ecologice ale României în context european, Știința Solului Seria a III-a, vol. XXX, București. (Problems of knowing the edaphic and ecological

resources of Romania in a European context. Soil Science III, Vol. XXX, Bucharest), pp 142.
[10]Ţărău, D., Rogobete, Gh., Dicu, D., 2016, Solurile din vestul României - caracterizare, evaluare, ameliorare, Editura Eurobit, Timişoara. (Soils in western Romania - characterization, evaluation, improvement. Eurobit Publishing House, Timisoara) pp.209.
[11]Timis County, Statistical Yearbook 2017 (Anuarul Statistic al Județului Timiș 2017).
[12]Timis County Agricultural Division (Direcţia pentru Agricultură a Judeţului Timiş), www.dajtm.ro, Accessed on Jan. 20, 2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

WEARING BEHAVIOURS FOR ABRASIVE PEELING MACHINE UNDER USING FRESH AND STORED POTATOES

Tarek FOUDA, Mohamed DARWESH, Mahmoud ELKHODAREY

Tanta university, Faculty of Agriculture, Agriculture Engineering Department, Egypt,
Emails: tfouda628@gmail.com, rmdarwish@yahoo.com, mahmoudkotb_675@yahoo.com

Corresponding author: tfouda @yahoo.com

Abstract

The aim of this research to study the effect of using fresh and stored potatoes on the wearing behaviours for abrasive peeling drum, The wearing accrue in inner peeling drum were covered with emery paper to remove peel from potatoes by scratch. The potato using two different cases fresh and stored for three months under the optimum store conditions. The measurement such as wearing rate, wearing resistance, and emery change were tested to study the wearing behaviour. The changes in physical properties of potato tubers accrued because dry matter decreased after storing. The results showed that effect on peeling which varied between 25 to 50 second at constant load of 25 kg, also peeling productivity varied between 1,800 to 3,600 kg/h. the peel amount varied between 45 to 90 kg/h. addition to the minimum time to change emery sheet after 250 h., and 980kg with wearing resistance about 0.011 h/kg while the maximum time to change emery sheet after 1,950 h., and 4,380kg with wearing resistance about 0.022 h/kg.

Key words**:** *potatoes, physical properties, peeling productivity, wearing resistance*

INTRODUCTION

Wear happened by hard particles sliding on a softer solid surface and displaying or detaching material. Different types of interactions are distinguished between the sliding particles and the wearing surface of the solid [2]. In mechanical peeling quantity of peeling is high but quality of peeling is high. Only rotary cutters are flexible one which are most popular among all even on different uneven surfaces. There are different types of mechanical peelers. Based on the mechanism used for peeling, system uses knife or blade, abrasive, rollers, milling cutters and rotary cutters .Developed a diamond cut mesh drum abrasive peeler [1]. The optimum parameters for maximum peeling with minimum loss was obtained at a drum load of 7 kg per batch, operated at a drum speed of 30 rpm for a peeling duration of 15 min, to produce sufficiently peeled. The peeling efficiency and material loss at the optimum conditions were determined as 59.43%, 4.76% respectively. The composition of dried ginger is found to be 0.82%, 2%, 4.6% and 2.5% respectively for moisture content, essential oil, oleoresin, crude fibre content respectively [5].

The peel was removed from the drum through the peripheral clearance of the drum along with the flow of water, spraying unit washed the potatoes. The peeling drum, with protrusion on the inside surface, rotated and detached the peel from the potatoes by abrasion. The machine worked at 45 rpm with a 65 kg/hr capacity [8]. The positive manufacture of a potato peeling is one of the major challenges in potato processing. The peeling machine was designed for peeling and washing of potatoes. The capacity of machine is 400 kg/h with a peeling efficiency and peel losses of 97% and 0.5% respectively which is an improvement over previously fabricated design [10]. The peeling efficiency decreased by 16.1 % with using stored potato tubers, the peel losses of potatoes during peeling process decreased by average 16.95 % with using stored potato tubers from a lot of results showed the performance of the abrasive peeling machine of potatoes varied by using freshly harvested potato tubers and stored in refrigerators [3].

The aims of this work to observing the wearing behaviour for peeling drum.

MATERIALS AND METHODS

The research was permitted to realize the influence of fresh and storing potato were harvested from sandy and clay soil.
A refrigerator work for three months at a 5 C^o temperature and 90% as a relative to stored potato. The treatments of potato were coded as T_1, T_2, T_3, and T_4 using different potato varieties, soil types and potato conditions as shown in Table 1.

Table 1. The potato samples treatments

Measuremei		Varieties		Soil type		Conditions	
		Herms	Lady	Clay	sandy	Fresh	Stored
T_1	HCF	*		*		*	
	HCS	*		*			*
T_2	HSF	*			*	*	
	HSS	*			*		*
T_3	LCF		*	*		*	
	LCS		*	*			*
T_4	LSF		*		*	*	
	LSS		*		*		*

Source: Own results in the laboratory.

The Peeling machine

Using Model BP batch Peelers the peeling machine removed potato skin from tubers by friction with amount of water. Emery paper covered the peeling drum to remove the peel from potatoes by washing. The water spraying unit claning potatoes and the peel was removed. Abrasive sheet kit and disc for potato peeler as shwoing in Fig.1. The first stage in peeler potato pass through coarse abrasive in the peeler rapidly removes peel. The component of emery abrasive from naturally occurring aluminum oxide mixed with other minerals such as silica were used. The sheat hardness ranges between 6-8 on the Mohs scale And 950 VHN Hardness Vickers. The second stage fine abrasive to polishes product surfaces with fewer fines are discharged and product absorbs less oil when fried. The softer abrasive is used in emery boards, emery cloth, and polishing abrasives reducing polishing line depth. Potatoes enter drum, the rotary disc slows motion to prevent damage. During peeling process potato skin remove as shown in Fig.2. For maximum throughput, the hopper is pre-filled before each peeling cycle ends as shwon in Fig.3.

Fig.1. Abrasive sheet kit and disc for potato peeler
Source: own processing based on from Catalogue.

Fig.2. Drum and disc for potato peeler
Source: own processing based on from Catalogue.

Fig. 3. Potato before and after peeling
Source: own processing based on from Catalogue.

Measuring

The changes in physical characteristics of potato tubers [7] such as surface area, shape index, volume, geometric mean diameter and sphericity

Peeling process measurements

Peeling time: duration time to remove potato peel for potato patch (25 kg)

The peeling efficiency using the following formula [9]:

The peeling efficiency =(fraction of peel in raw potatoes - fraction of peel in peeled potatoes)/ fraction of peel in raw potatoes

Peel losses: using the following formula

$$Peellosses = \frac{Wr - Wp.}{Wr} * 100,\%$$

where: Wr : weight of washed potato

Wp: weight of peeled potatoes in kg.

Hardness

The hardness is defined by Vickers hardness number (VHN) were determined from the following equation [4]:

$$VHN = \frac{2p \sin\left(\theta/2\right)}{L^2}$$

P: applied load, kg.
L: average length, mm
θ: diamond angle

Mass losses percent

Mass losses were calculated as follows**:**

Mass losses percent = (mass before using - mass after using)/ mass before using

Wearing rate

Wearing rate were calculated as follows

$$\text{Wearing rate} = \frac{\text{Materials removal from surfaces, g.}}{\text{time h.}}$$

Wearing resistance

Wearing resistance was calculated as inverted wearing rate [6]:

$$\text{Wearing resistance, h/g.} = \frac{1}{\text{Wearing rate , g/h}}$$

RESULTS AND DISCUSSIONS

The results of this study evaluated the effect of changes in physical characteristics of potato tubers resulting from using fresh and stored Haerms and Lady potatoes harvested from clay and sandy soil types on wearing behaviour for abrasive sheet for potatoes peeling.

Effect of potato conditions on changes in physical characteristics of potato tubers

The data in Fig (4) shows the change happened before and after potato stored which harvested from sandy and clay. At T1 the length, width, thickness, diameter, shape index sphericity and volume changed by 7.80, 3.78, 3.74, 5.34, 3.03, 0.5, 8.77 and 10.96 %, respectively. While At T4 the length, width, thickness, diameter, shape index, sphericity and volume changed by 8.67, 3.50, 3.89., 7.18, 3.17, 4.09, 14.14 and 20.66 %., respectively. The amount of changes in physical characteristics of potato tubers accrued because dry matter decreased after storing.

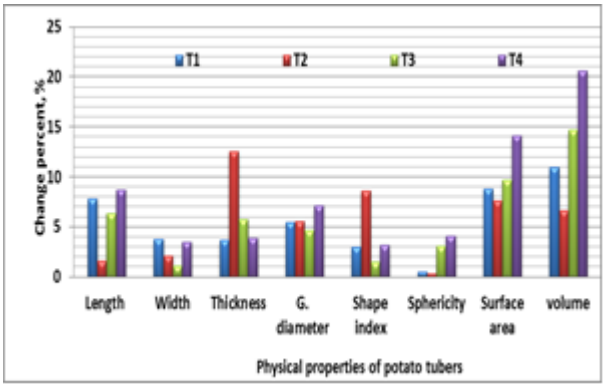

Fig. 4. Effect of potato conditions on physical characteristics of potato tubers changes
Source: Own results in the laboratory.

Peeling time

Fig. 5 shows the peeling duration at constant load of 25 kg, affected by potato samples conditions varied between 25 to 50 second the maximum peeling time at HSC and HSS with 50, S. while the minimum peeling time were LCS at 25 second that refer to varieties of potato and stored conditions.

Productivity and amount of peel

The effect of potato conditions on peeling productivity and peel amount shows, in Fig 6 and 7 the results showed when peeling productivity varied between 1,800 to 3,600 kg/h. the peel amount varied between 45 to 90 kg/h.

Emery change and wearing resistance

Fig. 8, 9 and 10 shows effect of potato conditions on emery change time and per ton, the results showed more factor affecting on emery changes such as potato varieties, freshly harvested and stored in refrigerator addition to potato harvested from soil type. The minimum time to change emery sheet after 250 h., and 980kg at LCS with wearing resistance about 0.011 h/kg while the maximum time to change emery sheet after 1,950 h., and 4,380kg at HSF with wearing resistance about 0.022 h/kg.

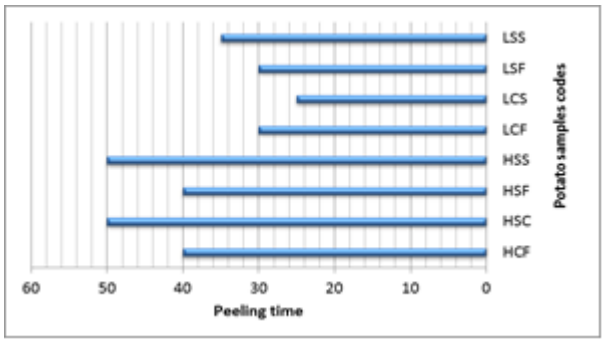

Fig. 5. Effect of potato conditions on peeling time per, second for (25 kg) potato patch
Source: Own results in the laboratory.

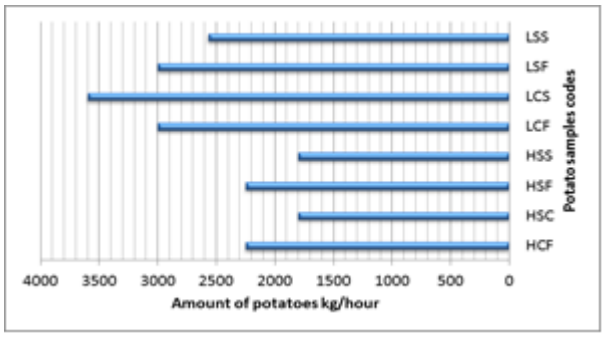

Fig. 6. Effect of potato conditions on peeling productivity
Source: Own results in the laboratory.

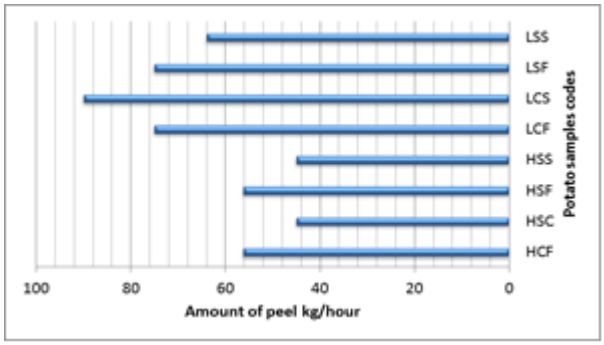

Fig. 7. Effect of potato conditions on amount of peel
Source: Own results in the laboratory.

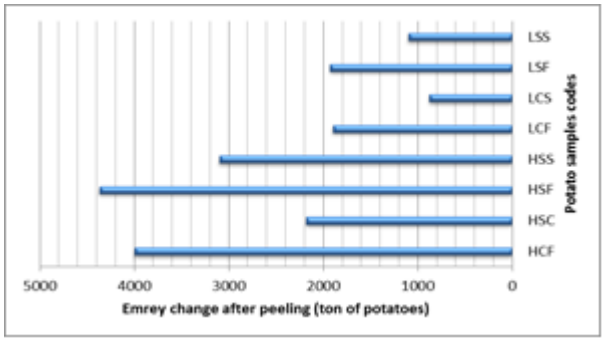

Fig. 8. Effect of potato conditions on emery change per ton
Source: Own calculation.

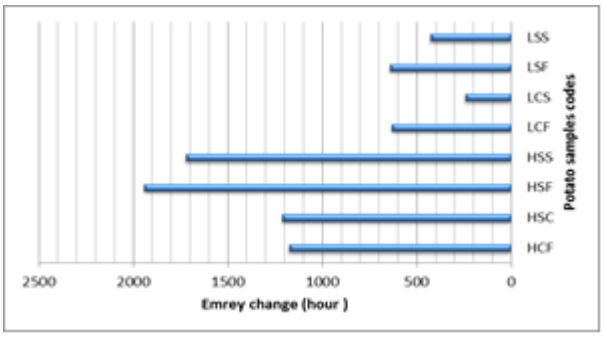

Fig. 9. Effect of potato conditions on emery change time
Source: Own calculation.

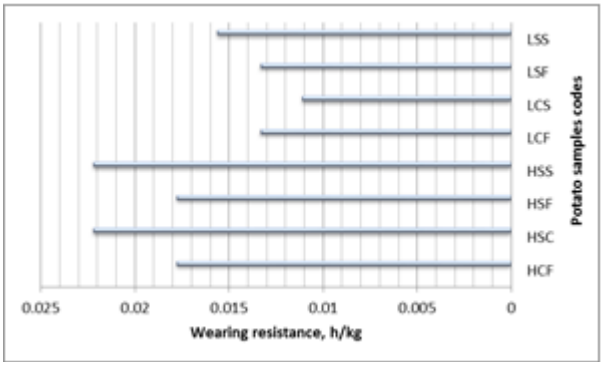

Fig. 10. Effect of potato conditions on wearing resistance
Source: Own results in the laboratory.

CONCLUSIONS

Freshly and stored potato tuber harvested from sandy and clay soil were using in peeling process effect on wearing behaviours for abrasive peeling machine. The amount of changes in physical characteristics of potato tubers accrued after storing. This change effect on peeling time, peeling productivity varied and peel amount which varied between 45 to 90 kg/h. also lead to minimize the time of change emery sheet and decreased wearing resistance

REFERENCES

[1]Chan, K., Pandey, R. K., Shahi, N. C., Lohani, U. C., 2013, Pedal Operated Integrated Potato Peeler and Slicer, Agricultural Mechanization in Asia, Africa & Latin America, Vol.44(1):63-68.
[2]Fouda, T., Derbala, A., Darwesh, M., Elkhodarey, M., 2017, Improving the performance of potato chips production line. MISRJ. Ag. Eng., 34 (2): 911 - 924.
[3]Fouda, T., Darwesh, M., Elkhodarey, M., 2019, A study on some different parameters affecting the abrasive peeling machine performance Scientific Papers Series Management, Economic Engineering in

Agriculture and Rural Development Vol. 19(1):193-197.
[4]George, E. D., 1984, Mechanical metallurgy. McCraw-Hill international book company Japan: 395-400.
[5]Jayashree, E., Visvanathan, R., 2013, Development of a hand operated diamond cut mesh drum abrasive ginger peeler. Indian Institute of Spices 53 ll. 12. 13. 15. 16. 17. 18. Research. Kozhikode-673 012, Kerala, India. Journal of Spices and Aromatic Crops. Vol. 22 (2): 174—180.
[6]Kantarc, 1982, Abrasive wear in tillage equipment. Ph.D. degree thesis I. T. U. Izmir Univ. Turkey.
[7]Mohsenin, N.N., 1986, Physical Properties of Plant and Animal Materials. Gordon and Breach Science Publishers, 20–89.
[8]Singh, K.K., Shukla, B.D., 1995, Abrasive peeling of potatoes. J. of Food Eng., 26:431–442.
[9]Tyagi, S.K., Chandan, S., Sandeep, M., 2018, Design and fabrication of a potato peeling cum washing machine, International Journal of Chemical Studies, Vol. 6(2): 1447-1451.
[10]Willard, M. J., 1971, A grading system of peeled potatoes. Proc. 21st Nat. Potato Util. Conf., July 28.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ORGANIZATIONAL AND ECONOMIC MECHANISM OF MIGRATION REGULATION OF WORKING-AGED RURAL POPULATION (ON THE EXAMPLE OF THE SARATOV REGION), RUSSIA

Sergey Germanovich GLUKHOV, Marina Sergeevna YURKOVA,
Gennadiy Gennadievich KRYUCHKOV, Nataliya Vladimirovna PROVIDONOVA

Volga Research Institute of Economics and Organization of Agro-Industrial Complex (VRIEOAIC), Saratov, Russia, Mobile 8 (987) 805-22-62, Emails: glukhov.sergey87@gmail.com, marina-mss@mail.ru, djoker2333@yandex.ru, providonova@yandex.ru

Corresponding author: glukhov.sergey87@gmail.com

Abstract

Problems of migration of working-aged countryside population of rural territories are revealed. The organizational and economic mechanism of migration regulation of working-aged country people consisting of 2 modules – organizational and economic is developed and offered. The organizational module includes the directions of reduction of migration due to accounting of the major attracting and repellent factors. A basis of the economic module – fixing of professionals and working-aged population by means of creation of new and additional jobs in the village with using a wide package of measures. Use of the offered mechanism will allow to provide conditions for fixing of working-aged population in rural territories and to reduce migration.

Key words**:** *labor migration, working-aged rural population, rural territories, attracting and repellent factors, organizational and economic mechanism*

INTRODUCTION

In economic science many researchers dealt with problems of labor migration. The base of development of the migration theory many scientists recognize E.G. Ravenshtayn's works in which he formulated regularities of migration processes – in 1885 [2, 8] (the first edition), and further – in the second edition in 1889 [9]. He came to conclusion that: key motives of migration are economic; migration has step-by-step character; each migration flow generates a stream of an opposite direction; flows of migrants are sent from agricultural areas to the centers of the industry and trade. Ravenshtayn for the first time gave interpretation of the attracting factors as key motives of an attraction of migrants in the territory with safe conditions.

The different view on migration processes was developed by the American sociologist S. Stoffer. In 1940 it published article "The interfering circumstances: the theory of interaction of mobility and distance" in which the conclusion was drawn that not remoteness of areas of resettlement influence intensity of migration flows, and quantity of the interfering circumstances (or obstacles – transport costs, a lack of information, a negative spirit from aboriginals, etc.) [13].

A bit later, in 1949 D.K. Zipf formulated gravitational model of migration which was widely adopted subsequently and began to be used by many researchers. The intensity of a migration flow between two objects in gravitational model depends on two sizes – distances (constant) and measures of the importance (as a rule, population). The feature of this model is that it does not consider extensive list of the interfering circumstances [18]. After the publication of this work mathematical modeling became universal for using in the research process of problems of labor migration.

It should be noted a significant scientific contribution of the theory of migration of Everett Li (1966). He rethought Ravenshtayn's theory, having allocated the pushing-out and attracting factors of migration flows [1]. Some factors of

economic character (unemployment, low income level, high taxes) can belong to pushing out; social and political (poverty, discrimination, restrictions for freedom of worship and religions, wars); adverse natural and climatic conditions, etc. Can be the attracting factors: high level of economic development, higher income, safety, an opportunity to get access to labor market (including in the informal sector that is especially important for illegal immigrants) and others.

It is necessary to mention works of William Arthur Lewis, the Nobel laureate, the author of two-sector model of economy which assumes allocation of the rural and city sector. The author pays special attention in this model to migration from rural areas to the city against the background of increase in production and employment in Third World countries [5].

The noticeable contribution to development of the migration theory was brought by the American geographer V. Zelinski. He analyzed migration processes according to social and economic development of regions on the basis of the Concept of the "mobile transition" disclosing the regularities in increase in territorial mobility occurring step by step which represent an essential element of process of modernization. It allocated 5 phases of migration transition: primitive traditional society, early mobile society, late mobile society, the developed society, the overdeveloped society [17]. What pushes on a conclusion about continuous historical evolution in migration processes.

In the 1990s there was a synthetic theory of the international migration which author is the American sociologist D. Massey and his co-authors. Migration in it is considered as result of processes of integration in political, economic and public life and also as a result of economic growth. The attracting factors are more relevant, than pushing out. At the same time, the difference in the income of the population will not be the main factor of sharp increase or reduction of intensity of migration flows. D. Massey pays considerable attention to the level of development of the infrastructure created by migrants providing communication with the homeland, expat communities and also money transfers [6].

In Russia many scientists were engaged in problems of external and internal labor migration. It should be noted first of all works of the academician of Russian Academy of Sciences (RAS) G.V. Osipov and professor L.L. Rybakovsky which developed the author's theory of migration process (Institute of socio-political researches of RAS) [7].

It is also worth allocating the long-term works of V.A. Iontsev and his colleagues from the Center of the population of Moscow State University (MSU) devoted to problems of the international population shift and migration policy [4].

Big contribution to a research of problems of migration policy, the international migration, "brain drain", labor migration, employment of the population in the small Russian cities, illegal migration in border territories, migration mobility Zh.A. Zayonchkovskaya and her colleagues (Institute of Economic forecasting of RAS) brought [16].

At the present stage to teoretiko-methodological bases of this problem S.V. Ryazantsev, [11] Yu.M. Filatova [2] works are devoted. Influence of external labor migration on social and economic development of Russia is investigated in E.Yu. Hrustalyov's works [3], R. S. Tabasaranskiy [14], P. A. Smelov, [12] and many others.

The objective of the paper was to analyze the organizational and economic mechanism of migration regulation of working-aged rural population on the example of the Saratov Region, Russia.

MATERIALS AND METHODS

When carrying out a research on a problem of labor migration of agricultural workers information of the Ministry of Agriculture of the Russian Federation, municipal databases of Federal State Statistics Service was used. Works of the Russian and foreign scientists concerning interregional and intraregional migration of country people were used.

Studying of dynamics and current state of migration flows of working-aged rural population in agro-industrial complex of Russia and the Saratov region, in particular, leaned on economical and statistical and economic-mathematical methods of the analysis.

Definition of the directions of development and creation of the organizational and economic mechanism of regulation of migration of able-bodied country people was based on abstract and logical and calculation and constructive methods and also on use of a method of the sociological survey which is guided by recommendations about statistics of the international migration, developed by the UN in 1998 (Department on economic and social problems. Statistical department) [15].

Also, in a research of problems of labor migration of country people V.V. Patsiorkovsky's methodology (ISEPN RAHN) assuming a research of two groups of factors was used:

1) the first group – the territorial organization of rural population and migration flows.

2) the second group – socio-economic factors the defining standards of living of people and motives to labor migration.

RESULTS AND DISCUSSIONS

In the Commonwealth countries, as well as in the states of other regions of the world, population shift exerts a certain impact on change of number and structure of the population. At the same time for many years migration processes in the region of the CIS in general are characterized, first, by prevalence of the interstate migration making from 85 % in Azerbaijan up to 90 % of the total migration turnover in other countries. From 10 Commonwealth countries for 2010-2018 only at 4 countries the positive migration balance (Azerbaijan, Belarus, Ukraine, Russia) is observed. In Moldova in 2018 the quantity of left was made even to quantity driving to the country (Table 1). Despite high appeal of Russia to migrants from the neighboring countries of the CIS, in 2010 - 2018 inflow was reduced, the positive balance of migration decreased by 33.2 thousand people.

Table 1. Dynamics of balance of the international migration in CIS countries

Countries	Balance of interstate migration (thousands people)				
	2010	2015	2016	2017	2018
1. Azerbaijan	1.4	1.1	1.5	1.2	1.6
2. Armenia	- 37.3	- 25.9	- 24.8	- 24.0	- 18.3
3. Belarus	10.3	18.5	7.9	3.9	9.4
4. Kazakhstan	15.5	- 13.4	- 21.1	- 22.1	- 29.1
5. Kyrgyzstan	- 50.6	- 4.2	- 3.9	- 3.9	- 5.2
6. Moldova	- 0.5	- 0.6	- 1.1	- 0.4	0.0
7. Russia	158.1	245.4	262.0	211.9	124.9
8. Tajikistan	- 6.5	- 4.8	- 4.3	- 3.7	- 3.0
9. Uzbekistan	- 44.1	- 29.3	- 26.2	- 18.6	- 14.7
10. Ukraine	16.1	9.3	7.8	12.0	18.6

Source: calculated on the basis of data of Statcommittee of the CIS.

In the Russian Federation the greatest migration outflow is pointed in the Volga Federal District – from 37.7 to 62.1 thousand people from 2010 for 2018 the Saratov region entering this federal district stands up on the 2nd place among the neighboring areas on intensity of migration outflow of the population – from 3.3 to 7.8 thousand people for an above-specified period (Table 2).

The research of migration flows of working-aged rural population of the Saratov region was under construction in a section of 4 groups of administrative regions which were defined by the Concept of migration policy in the Saratov region until 2025 (of August 2, 2013 No. 375-P) [10]:

1 group – depressive (9 areas);

2 group – partially depressive (11 areas);

3 group – border (that is, on a number of socio-economic indexes, not entered into group of safe areas, but also left group partially depressive) (6 areas);
4 group – safe (12 areas).
On researches of migration flows in the Saratov region for 2010-2018 considerable migration outflow of the population in all municipal districts (Table 3) is traced. In the majority of areas (with the 1st on the 3rd group) the tendency of excess of rate of migration outflow of the population in comparison with natural losses is traced.
Therefore, migration of able-bodied country people acts as primary factor of outflow of shots from branch of agriculture.

Table 2. Dynamics of migration flows in the Russian Federation

Federal Districts (FD)	Migration gain (decline in population) in absolute expression, persons.				
	2010	2015	2016	2017	2018
Central Federal District	103,502	119,382	126,734	85,226	124,902
North Western Federal District	7,653	35,771	38,351	38,537	45,072
Southern Federal District	…	18,234	20,117	36,989	17,373
North Caucasian Federal District	…	- 28,027	- 31,549	- 25,411	- 29,058
Volga Federal District	- 37,669	- 50,458	- 60,813	- 46,774	- 62,095
including Saratov region	- 3,301	- 4,368	- 7,169	- 5,609	- 7,810
Ural Federal District	- 8,410	- 13,432	- 20,450	- 15,879	- 20,013
Siberian Federal District	- 26,057	- 45,795	- 48,480	- 47,420	- 51,815
Far Eastern Federal District	- 30,439	- 35,675	- 32,816	- 25,268	- 24,366

Source: calculated on the basis of data of Federal State Statistics Service.

Table 3. A mechanical and natural population growth of the Saratov region (on groups)

Years	Mechanical gain (decrease) of the population (on average in group), persons.			
	1 group	2 group	3 group	4 group
2010	- 61	- 99	- 133	224
2015	- 148	- 108	- 264	246
2016	- 110	- 187	- 281	87
2017	- 115	- 246	- 290	- 211
2018	- 151	- 246	- 286	- 376
	Natural increase (decrease) of the population (on average in group), persons.			
2010	- 160	- 164	16	- 440
2015	- 162	- 115	- 2	- 250
2016	- 152	- 149	- 7	- 302
2017	- 155	- 167	- 36	- 353
2018	- 131	- 183	- 73	- 417

Source: calculated on the basis of the Database of municipal statistics.

As a result of the conducted exit researches in 6 areas of the Saratov region relating to different groups and located in various climatic microzones of area it was revealed that loss of constant earnings and an opportunity to provide family as a result of bankruptcy of a number of the large agricultural and industrial enterprises (Table 4) is the main reason for migration outflow of country people of working-age.
For monographic studying of the main reasons for migration outflows by authors questioning of the population of the above-designated areas as a result of which survey of 105 women and 90 men aged from 23 till 61 year was conducted was carried out.
All respondents had the higher and secondary professional education. More than 70% of respondents are employees of the agricultural enterprises. Most of them (90%) noted that the gained income is enough only for acquisition of food, clothes and fees of housing and communal services. On a question "What objects of social and household infrastructure you would like to improve?" the vast majority answered that it is necessary to organize infirmaries (including,

mobile) and also to make capital repairs of the building of the available school.

It was revealed that among young workers from among interviewed (from 23 to 35 years) more than 85 % plan to make moving to the regional center in the short term. Act as the main motives (as ranging): higher level of the salary (more than 90% of answers), improvement of social conditions (more than 65 % of answers), availability of medical and other social services (more than 35 % of answers).As a result of the conducted research, based on empirical data, polls and the existing standard legal status of regulation of labor migration in rural territories of the region, the organizational and economic mechanism which use will allow to reduce outflow of the population was developed, to increase effective employment and the income of residents of the village.

Table 4. Main reasons for migration outflow rural population of municipal districts of the Saratov region

Name of the municipal districts	Migration outflow, persons and % of country people	Outflow reasons
1. Krasnoarmeyskiy (4th group)	333 (1.6%)	The insufficient level of development of social and engineering infrastructure in the village, a low wage. 2 agricultural enterprises went bankrupt (since 2013): LLC Spring Agricultural Firm and LLC Ilovlya. Strong outflow of workers was traced at the enterprises: collective farm "Victory", JSC MTS Grain-grower, APC Gvardeyskoye
2.Petrovsky (3rd group)	415 (3.3%)	Falling of prestigiousness of complex work, outflow of the most effective workers to new sectors of economy. By 2018 7 agroenterprises, including 2 large were closed: JSC Ptitsesovkhoz Petrovsky and LLC Studenovskoye that led to reduction of 380 jobs. Strong outflow of workers was traced in LLC Artel, APO Abodimovsky, APO Niva, APO of V.I. Chapayev
3.Novouzensky (3rd group)	431 (3.0%)	Bankruptcy of brick-works, poultry farm and creamery; deterioration in a financial position of a number of the large agricultural enterprises. By 2018 7 agroenterprises, including 2 large were closed: CJSC Petropavlovskoye and CJSC GPP Algaysky. It led to reduction of 209 jobs. Strong outflow of workers is revealed in CJSC Dyurskoye, CJSC Novaya zhizn, CJSC Krasny partizan.
4.Turkovsky (1st group)	136 (8.4%)	Falling of prestigiousness of complex work, outflow of the most effective workers to new sectors of economy, absence of qualified personnel.
5.Baltaysky (1st group)	83 (1.4%)	Lack of jobs
6.Voskresensky (2nd group)	42 (0.3%)	Rather low income of the population caused by the developed branch structure of economy

Source: calculated by authors according to regional 'The strategy of social and economic development till 2030', and Database of municipal statistics.

The developed organizational and economic mechanism of regulation of migration of working-aged rural population consists of 2 modules – organizational and economic and also includes standard legal support of administrative and managerial influence for implementation of solutions of objectives (Table 5).

The organizational module includes the following directions of reduction of migration due to accounting of the major attracting and repellent factors:

1) improvement of social infrastructure in the village which enters: the organization of free aid in capital repairs and the maintenance of objects of social infrastructure (schools, kindergartens, hospitals); providing experts with own housing on the terms of long-term employment contracts (not less than 10 years);

2) preservation and increase in stable earnings of country able-bodied population, namely: providing social guarantees for workers and "transparency" of system of compensation, expansion of a social package.

Table 5. Organizational and economic mechanism of regulation of migration of working-aged rural population of the Saratov region

<table>
<tr><td colspan="3">Purpose: reduction of outflow of working-aged population of rural territories of the area</td></tr>
<tr><td colspan="3">Tasks:</td></tr>
<tr><td>1. Increase in employment rate and growth in incomes of the population</td><td>2. Development and improvement of social infrastructure</td><td>3. Reduction of rates of migration outflow of the population</td></tr>
<tr><td colspan="3">Subjects of influence: (the authorities having influence on social and economic development and position of rural territories in the region) – executive authorities of the Saratov region: Ministry of social development; Ministry of Economic Development; Ministry of employment, work and migration; Ministry of Agriculture; administrations of municipal districts</td></tr>
<tr><td colspan="3">It is offered to create the interdepartmental commission on development of rural territories</td></tr>
<tr><td colspan="3">DECISION-MAKING MECHANISM</td></tr>
<tr><td>ORGANIZATIONAL MODULE:
1)improvement of social infrastructure in the village:
- the organization of free aid for capital repairs and the maintenance of infrastructure facilities (schools, kindergartens, hospitals)
- providing experts with own housing on the terms of long-term employment contracts (not less than 10 years)
2)preservation and increase in stable earnings of employees of economic entities: - providing social guarantees; - respect for "transparency" in the system of compensation;
- expansion of a social package for the worker.</td><td>STANDARD LEGAL SUPPORT:
1) strategy, programs, plans of social and economic development of rural territories (federal, regional, municipal levels)
2)the laws, orders, provisions governing the economic and social and labor relations in the region
3) collective agreements, individual employment contracts.</td><td>ECONOMIC MODULE
Implementation of investment projects in the main directions (the volume of investment provided in the Strategy of social and economic development of municipal districts of the Saratov region till 2030 in the studied areas – 6297.7 million rubles):
1) agriculture:
- crop production (development of vegetable growing of the closed soil);
- livestock production (expansion of a livestock of cattle and sheep, increase in production of fish and bird)
2)processing of production of agrarian and industrial complex:
- modernization of grain flows and elevators;
- construction of slaughter units, shops on deep processing of meat</td></tr>
<tr><td colspan="3">ADMINISTRATIVE AND MANAGERIAL INFLUENCE</td></tr>
<tr><td colspan="3">Objects of influence: economic entities, able-bodied population, objects of social infrastructure, social and economic sphere of municipal districts (Red Army, Petrovsky, Novouzensky, Turkovsky, Baltaysky, Voskresensky)</td></tr>
<tr><td colspan="3">The expected results:</td></tr>
<tr><td colspan="2">1. Reduction of migration outflow due to accounting of the major attracting factors: level of income, existence of health service, general education organizations</td><td>2. Fixing of the population in the village due to creation of new and additional jobs on the basis of branches of agrarian and industrial complex</td></tr>
<tr><td colspan="3">Reduction of outflow of working-aged population on 1009 people (70.1 %) and creation of 726 additional jobs</td></tr>
</table>

Source: it is developed by authors.

Basis of the economic module – fixing of experts and able-bodied population by means of creation of new and additional jobs in the village due to implementation of investment projects in the directions in crop production and livestock production, branches of processing of production of agrarian and industrial complex taking into account climatic and other features of municipal districts, the scientifically based system of agriculture and placement of production, national cultural values and traditions.

Monitoring of efficiency and realization of the mechanism of regulation of migration of able-bodied population in the territory of the Saratov region, we suggest to see off the interdepartmental commission on development of rural territories created on the

basis of the regional Ministry of Agriculture. The measures entering the organizational module will allow to reduce outflow of the population in the explored municipal districts by 1,009 people or for 70.1%. By means of use of the economic module of the social and economic development of municipal districts developed according to regional Strategy and implementation of priority investment projects in branches of agrarian and industrial complex, 726 additional jobs will be created.
The developed mechanism of regulation of labor migration of country people will allow to introduce, on condition of its constant application and improvement, these system actions for other areas, considering their specifics and Development strategies on prospect. Thus, use of the offered mechanism will allow to provide conditions for fixing of able-bodied population in municipal districts of area and to reduce migration.

CONCLUSIONS

The mechanism of regulation of migration of working-aged population of rural territories combines elements of strategic planning of development of the rural territories and modeling repellent (unemployment, low level of income, bad condition of social infrastructure, etc.) and attracting factors of migration (availability of vacancies in labor market, good living conditions and so forth) which will allow to fix the population in the village. The mechanism is developed on the basis of municipal districts from groups of various types, according to the Concept of migration policy of the Saratov region (safe, border, partially depressive, depressive) and includes organizational and economic modules on reduction of migration outflow due to improvement of social conditions and to preservation of stable earnings, creation of new and additional jobs. As a result of operation of the mechanism in these areas migration outflow will be reduced by 1,009 people (for 70.1%) and 726 jobs are created. The developed recommendations have universal character.

REFERENCES

[1]Everett, S., Lee, A., 1966, Theory of Migration//Demography, Vol. 3, No. 1., pp. 47 – 57.
[2]Filatova, Yu. M., 2015, A research of the evolution of scientific views on international labor migration, Bulletin of Tula State University, 4(1): 216 – 222.
[3]Khrustalyov, E.Yu, Slavyanov, A.S., 2014, Labor migration and problems of innovation development, Forecasting problems, 1(142): 79 – 86.
[4]Iontsev, V.A., Ivahnyuk, I.V., 2012, Role of International Labour Migration in Russian Economic Development, CARIM-East of RR [2012/04], Robert Schuman Centre for Advanced Studies, San Domenico di Fiesole (FI): European University Institute.
[5]Lewis, W.A., 1979, The Slowing Down of the Engine of Growth//The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel.
[6]Massey, D. A., 2002, Synthetic theory of international migration//World in the mirror of international migration. No. 10., p. 143–153.
[7]Osipov, G.V., Rybakovsky, L.L., 2010, Demographic perspectives of Russia. Moscow: Ekon-Inform, p. 340
[8]Ravenstein, E., 1885, The Laws of Migration//Journal of the Statistical Society. 1885. No. 46., p. 167–235.
[9]Ravenstein, E., 1889, The Laws of Migration: Second Paper//Journal of the Royal Statistical Society. 52: 241–305.
[10]Resolution of the Government of the Saratov Region dated 02.08.2013 N 375-P "On approval of the Concept of migration policy in the Saratov region for the period until 2025", HTTP://docs.cntd.ru/document/933022559, Accessed on 18 June 2019.
[11]Ryazantsev, S.V., Tkachenko, M.F., 2010, World Labor Market and International Migration. Moscow: Ekonomika, p. 303.
[12]Smelov, P.A., 2018, External labor migration in the Russian Federation, Statistics and Economics, 15(6): 80 – 87.
[13]Stouffer, S., 1940, Intervening Opportunities: A Theory Relating Mobility and Distance//American Sociological Review. No. 5. p. 845 – 867.
[14]Tabasaranskiy, R.S., 2016, Labor migration in conditions of globalization: main problems, Social politics and sociology, 2(115): 147 – 154.

[15]UN Recommendations on Statistics of International Migration (Rev. 1), 1998.
[16]Zayonchkovskaya, Z., 2007, Russia's Search for a New Migration Policy./European View. Vol. 5, Spring 2007. Europe and Immigration.//Forum for European Studies. Brussels: 137–145.
[17]Zelinsky, W., 1971, The hypothesis of the mobility transition//Geographical Review. Vol. 61, No 2., p. 219-249.
[18]Zipf, G., 1949, Human Behavior and the Principle of Least Effort. Cambridge: Addison-Wesley Press. 573 p.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

WORKING CAPITAL MANAGEMENT VS. PROFITABILITY OF MILK PROCESSING COMPANIES

Zbigniew GOŁAŚ

Poznań University of Life Sciences, Faculty of Economics and Social Sciences, Department of Finance and Accounting, 28 Wojska Polskiego Street, 60-637 Poznań, Poland, Phone/Fax: (+48) 61 846 6359, E-mail: zbigniew.golas@up.poznan.pl

Corresponding author: zbigniew.golas@up.poznan.pl

Abstract

This paper analyzes the relationships between the efficiency of working capital management and the return on assets of milk processing companies. Working capital management was assessed for efficiency based on the Days Sales of Inventory (DSI), Days Sales Outstanding (DSO), Days Payable Outstanding (DPO) and the Cash Conversion Cycle (CCC). The study was based on micro-data for dairy companies from 2007–2016 retrieved from the EMIS database. Based on panel regression models, it was concluded that an improvement in working capital management has a positive effect on the return on assets. The parameters of the models clearly showed that an increase in the DSI, DSO, DPO and CCC resulted for the dairy companies in a reduction in the return on operating assets.

Key words**:** *working capital, return on assets, panel models, milk processing*

INTRODUCTION

The economic and financial condition of companies is determined by a number of factors, including the policy for working capital management as an aspect of major importance. As shown by multiple studies, an excessive level of current assets inflates the costs of liquidity, and therefore has an adverse impact on profitability. Conversely, if insufficient, current assets may result in a considerable increase in the risk of losing financial liquidity and, as a consequence, in a series of barriers to smooth business operations [4, 27, 29]. This means that each company should optimize the amount of, and the sources of financing for, current assets. The above also involves the need for working capital management, i.e. making decisions to find the right balance between two contradictory objectives: the capacity to generate value for the owners, and the liquidity of the company [1, 4, 11, 15, 25, 26, 27].

Therefore, the purpose of this paper is to assess the efficiency of working capital management, as illustrated by the example of the domestic food companies active in milk processing. The following steps will be taken in the pursuit of that goal: reviewing the literature on the subject; describing the source materials and research methods; and analyzing the differences between the metrics of current capital management and their quantitative relationships with the profitability of dairy companies.

Literature review

The Cash Conversion Cycle by Richards and Laughlin [24] is commonly used in assessing the efficiency of the working capital. That concept is underpinned by the analysis of three sub-metrics, i.e. the Days Sales of Inventory (DSI), Days Sales Outstanding (DSO) and Days Payable Outstanding (DPO) which are combined into a single synthetic measure, the CCC. The above indicators (cycles) were used in the vast majority of empirical research as the basis for assessing the productivity of working capital.

The relationships between working capital and profitability in the Belgian economy were investigated into by Deloff [9] who used a panel analysis of non-financial companies and panel regression methods to prove that companies with long CCC, DSI, DSO and DPO periods attained lower rates of return (measured with operating profit) than those

with shorter cycles. Similar conclusions were drawn by Lazaridis and Tryfonidis [16]. Their study revealed a statistically significant and negative relationship between profitability and the duration of all of the above cycles except for Days Payable Outstanding (DPO).

The objective of research undertaken by Gill et al. [14] in the US was to enhance the findings by Lazaridis and Tryfonidis [16]. Generally, they ended up with similar conclusions which confirmed the negative relationship between longer cycles and the profitability and value of businesses.

A reference to the findings by Lazaridis and Tryfonidis [16] was also made by Dong and Su [11] who compared them against the outcomes of their own research into Vietnamese companies. Once again, it confirmed the negative impact of long DSI, DSO and CCC periods, and a positive relationship between DPO and firms profitability.

A strong negative relationship between the determinants of working capital management and business profitability was also indicated by Raheman and Nasr [22]. Based on a multidimensional analysis of Egyptian companies, they found that an extension in the CCC results in a decline in profitability. In turn, in the group of Indian entrepreneurs, the relationships between the duration of working capital cycles and profitability were examined by Ramachandran and Janakiraman [23]. Based on estimated regression parameters, they found profitability to be positively correlated to Days Sales Outstanding (DSO) and Days Payable Outstanding (DPO), and negatively correlated to Days Sales of Inventory (DSI) and the Cash Conversion Cycle (CCC).

The purposefulness of research into the trends followed by working capital management and their impact on financial performance of companies is also strongly emphasized by Padachi [21] who analyzed this issue using the example of the small and medium enterprises sector in various parts of the economy. As shown by his research, a high level of stocks, receivables and payables involved lower rates of return on assets.

In turn, Mohamad and Saad [18] focused their analyses on the variation in the market value, return on capital and return on assets in the context of working capital cycles. They found both positive and negative relationships between the variables used and the value and profitability of companies. However, the general conclusion was that the extension of the Cash Conversion Cycle had a negative impact on the assessment on financial standing measured with various profitability ratios.

A research into the productivity of working capital was also carried out in Japan [19] and extended over production, trade and service companies. The researchers demonstrated a negative relationship between the conversion cycle and the return on investments in small, medium and large companies and in all industries, except for trade and consumption services. This served as a basis for concluding that capital managers should seek to improve profitability by shortening the Cash Conversion Cycle, through a more efficient conversion of and/or reduction in receivables, and by extending the deadlines for supplier payments.

Generally, quite similar conclusions were drawn from the research by Lyroudi and Lazaridis [17] carried out with Greek food companies. Their findings clearly indicated a significant, positive and non-linear relationship between the Cash Conversion Cycle and the rates of return.

MATERIALS AND METHODS

The literature review presented above suggests that a significant and generally positive relationship exists between the efficiency of working capital management (measured with the Cash Conversion Cycle) and financial performance at company level. This paper verifies the above hypothesis based on 2007–2016 financial reports of 98 Polish milk processing companies [20], as published in the Emerging Markets Information Service (EMIS) database [12]. The analysis of the efficiency of working capital management was based on

management efficiency ratios for stocks, receivables, operating payables and on the cash conversion ratio, calculated as follows [4, 30]:

$$DSI_{j,t} = \frac{\text{average level of inventory} \times 365}{\text{operating costs}}$$

$$DSO_{j,t} = \frac{\text{average amount of short} - \text{term receivables} \times 365}{\text{sales proceeds}}$$

$$DPO_{j,t} = \frac{\text{average amount of payables} \times 365}{\text{operating costs}}$$

$$CCC_{j,t} = DSI_{j,t} + DSO_{j,t} - DPO_{j,t}$$

where:
$DSI_{j,t}$ - Days Sales of Inventory,
$DSO_{j,t}$ - Days Sales Outstanding,
$DPO_{j,t}$ - Days Payable Outstanding (refers to operating payables for supplies and services),
$CCC_{j,t}$ - Cash Conversion Cycle (in days).
In turn, the financial performance of companies was assessed based on the return on operating assets ($ROA_{j,t}$), calculated as follows:

$$ROA_{j,t} = \frac{EBITDA_{j,t} \times 100}{average\ amount\ of\ OA_{j,t}}$$

where:
$EBITDA_{j,t}$ - operating profit + depreciation in company j in year t;
$OA_{j,t}$ - operating assets (property, plant and equipment + intangible assets + long-term receivables + long-term deferred charges + short-term receivables + stocks).
The Days Sales of Inventory (*DSI*) is the number of days between subsequent stock replenishment operations, or the number of days cash is tied up in stocks [4, 27, 30]. When interpreting that ratio, limit values are not specified because the *DSI* is usually characteristic of the industry concerned. However, the shorter the DSI for different types of stocks, the better the assessment of corporate management efficiency [4, 27, 30]. In turn, the Days Sales Outstanding (*DSO*) means the number of days between sale and payment; in other words, it shows the degree to which the company credits its customers. The *DSO* depends on many factors and therefore standard values are usually not defined. Nevertheless, some authors attempt to do so. It is estimated that the *DSO* for Polish industrial companies should be ca. 60 days [27].
In turn, the Days Payable Outstanding is a metric of the deadline for payables; from the perspective of liquidity risk, it should preferably be extended as it reduces the demand for working capital. However, in a well functioning company, rather than being extended without reason, the deadline should be synchronized with the operating cycle. According to the relevant literature, a company finds itself in an advantageous situation if the *DPO* is ca. 55 days [10], although in practice it varies strongly across industries.
The operating cycle defined as the Days Sales of Inventory plus Days Sales Outstanding (in a case where sales receivables are not financed with payables) determines the Cash Conversion Cycle in a company [4, 10, 27, 30]. A positive trend in the *CCC* is not as pronounced as in the case of other cycles; it is favorable when fluctuating around zero [30]. A short conversion cycle may result from a situation where the operating cycle is short while the *DPO* is quite long. For the company, these are beneficial circumstances since it is financed by its suppliers [4, 10, 27, 30]. However, an excessive delay in payments could result in a situation where the company does not have enough cash to meet its maturing liabilities. In turn, a long conversion cycle caused by the combination of a long operating cycle and a short *DPO* could have the following consequences: growing volumes of stocks kept in warehouses; problems involved in debt recovery; and the suppliers being unwilling to grant credit to the company, which could result in bankruptcy [4, 27, 30].
Regression analysis tools were also used in assessing the efficiency of working capital management. Their purpose was to determine the strength and direction of impact of particular sub-cycles and of the synthetic cycle of working capital on the efficiency of

dairy companies measured with the return on non-financial assets (*ROA*). Panel regression methods were used, and the parameters of regression equations which address separately the *DSI*, *DSO*, *DPO* and *CCC* were estimated in order to determine the strength and direction of impact of working capital management on the return on assets. Also, a set of control variables which are generally regarded as important determinants of operational profitability of businesses were used in testing this relationship. According to the literature, these are usually variables referring to the return on sales, sales volume, assets structure, financial liquidity, company age and company size, and the variability of various other financial indexes [cf. 4, 5, 9, 13, 16, 19, 21, 28].

The system method proposed by Arellano and Bover [2] and Blundell and Bond [6], based on the generalized method of moments, was used to estimate the parameters of dynamic models. The concept of that method consists in estimating a system of equations, i.e. equations with variables both in level and in difference. Structural parameters will be estimated using a dedicated observation matrix which replaces the independent variables correlated to the random effect with adequately defined instruments [6, 7, 8].

In the case of first-order difference equations and level equations, these are the lagged variables and lagged first differences, respectively [3].

Models estimated as shown above are assessed with the Sargan test and the Arellano–Bond test [3, 7, 8].

The Sargan test verifies the suitability of introducing additional instruments. The null hypothesis is the absence of correlation between instrumental variables and the random effect. If the correlation does not exist, the model can be found to be specified correctly. In turn, the Arellano–Bond test is used to verify the hypothesis on the absence of autocorrelation of second-order random effect in first-order difference equations [2, 3, 6, 7, 8].

Dynamic panel regression methods were used to determine the strength and direction of impact of working capital management on the return on assets of dairy companies.

An estimation was performed of four regression equations which take into account the cycles of different components of working capital (stocks, receivables, payables) and the cash conversion cycle which provides a synthesis of the management policy for working capital.

Also, the following set of control variables ($x_{jt}^{T}\beta$) was used in testing the relationship between financial performance and working capital management performance:

$ROS_{j,t}$ - return on sales in company *j* in year *t*,

$CR_{j,t}$ - current ratio in company *j* in year *t*,

$TA_{j,t}$ - logarithmized value of assets in company *j* in year *t*,

$SFA_{j,t}$ - share of property plant and equipment in assets of company *j* in year *t* in (%),

$AGE_{j,t}$ - age of company *j* in year *t* ,

$\Delta S_{j,t}$ - growth rate of sales proceeds in company *j* in year *t*/(*t–1*) (%)

The inclusion of the above variables had an effect on the structure and estimation of the following dynamic regression models for the return on operating assets:

$$ROA_{j,t} = \alpha_0 + \gamma ROA_{j,t-1} + x_{jt}^{T}\beta + DSI_{j,t} + (\alpha_j + \varepsilon_{jt}), \quad j = 1, \dots \dots N, \;\; t = 1, \dots \dots T.$$

$$ROA_{j,t} = \alpha_0 + \gamma ROA_{j,t-1} + x_{jt}^{T}\beta + DSO_{j,t} + (\alpha_j + \varepsilon_{jt}), \quad j = 1, \dots \dots N, \;\; t = 1, \dots \dots T.$$

$$ROA_{j,t} = \alpha_0 + \gamma ROA_{j,t-1} + x_{jt}^{T}\beta + DPO_{j,t} + (\alpha_j + \varepsilon_{jt}), \quad j = 1, \dots \dots N, \;\; t = 1, \dots \dots T.$$

$$ROA_{j,t} = \alpha_0 + \gamma ROA_{j,t-1} + x_{jt}^{T}\beta + CCC_{j,t} + (\alpha_j + \varepsilon_{jt}), \quad j = 1, \dots \dots N, \;\; t = 1, \dots \dots T.$$

where:

$x_{jt}^{T}\beta$ - set of control variables,

α_j: group effect (constant over time),

ε_{jt}: random effect.

RESULTS AND DISCUSSIONS

Table 1 shows the basic descriptive statistics for the level and variation in working capital cycles in dairy companies covered by this study. The data suggests that the average duration of the Cash Conversion Cycle did not exceed 2 weeks (13.2 days) in the study period. This means that generally, dairy companies quite quickly recovered the amounts of money invested in their business operations. Another finding is that the Days Payable Outstanding (41.8 days) and the Days Sales of Inventory (21 days) had, respectively, the strongest and the weakest impact on the conversion cycle.

Table 1. Differences in the working capital cycle (days) and return on assets (%) between dairy companies covered by this study[1]

Working capital cycles	Descriptive statistics[1]						
	$\bar{x}$	Min	Max	V	Med	Q_1	Q_3
DSI	21.0	4.2	266.9	78.4	17.7	12.5	22.9
DSO	33.9	4.5	125.6	39.1	31.4	25.2	40.7
DPO	41.8	6.2	393.5	55.1	37.9	32.0	45.9
CCC	13.2	-319.6	162.9	187.1	12.9	3.1	23.1

[1]DSI - Days Sales of Inventory (days), DSO - Days Sales Outstanding (days), DPO - Days Payable Outstanding (days), CCC - Cash Conversion Cycle (days), $\bar{x}$ – mean, Min - minimum value, Max - maximum value, V - coefficient of variation (%), Med - median, Q_1 - first quartile , Q_3 - third quartile.
Source: own calculations.

However, the descriptive statistics shown in Table 1 also reflect considerable differences in working capital cycles between dairy companies. This is especially true for the Cash Conversion Cycle and the Days Sales of Inventory. The above conclusion is supported by the analysis of minimum and maximum values and, most of all, by the coefficient of variation (V) which is as much as 187% for the Cash Conversion Cycle and 78.4% for the Days Sales of Inventory. In turn, as regards the median, the conclusion is that all cycles of the working capital - other than the Cash Conversion Cycle - were longer than the average duration. These relationships reflect a right-side asymmetry in the distribution of objects in the sample, i.e. the prevalence of DSI, DSOs and DPOs with an above-average duration.

Table 2 presents the estimation results for the equations of return on operating assets. The two-step generalized method of moments was used for that purpose. The Arellano–Bond autocorrelation test results presented in the Table clearly show that moment conditions used in the estimation process are correct for all models. The empirical values of that test (AR-2) indicate that second-order autocorrelation is not present in the model. Therefore, the instruments used in estimations are adequate. The Sargan test which verifies the suitability of additional instruments also indicates that the model was specified correctly. This is because the data suggests that correlation between instrumental variables and the random effect does not exist in any of the models, which is consistent with the null hypothesis.

The analysis of structural parameters of the above regression models allows the following conclusions to be drawn:

(1)Negative regression coefficients of the Days Sales of Inventory (*DSI*), Days Sales Outstanding (*DSO*), Days Payable Outstanding (*DPO*) and Cash Conversion Cycle (*CCC*) clearly suggest a negative impact of the extension of these periods on the return on operating assets in milk processing companies.

(2)The regression parameters for variables corresponding to particular cycles of the working capital suggest a similar, quite moderate but negative impact of the extension of these periods on the return on assets. A 10-day extension of the Days Sales of Inventory (*DSI*) and of the Days Sales Outstanding (*DSO*) had a similar effect on the return on operating assets of dairy companies, resulting in a reduction by 0.44 to 0.49 percentage points, on average. Conversely, extending the

deadline for operating payables had a relatively smaller impact on the reduction of the return on assets: a 10-day extension translated into a reduction by only 0.6 percentage points.

Table 2. Parameters of dynamic models of return on operating assets[1]

Variables and tests	Model 1	Model 2	Model 3	Model 4
ROA_{t-1}	-0.029 (0.000)	-0.031 (0.000)	-0.029 (0.000)	-0.025 (0.000)
Constant	6.945 (0.000)	5.713 (0.000)	5.787 (0.000)	5.368 (0.000)
TA	-0.237 (0.000)	-0.204 (0.049)	-0.223 (0.002)	-0.232 (0.001)
SFA	-8.126 (0.000)	-7.371 (0.000)	-7.994 (0.000)	-7.396 (0.000)
CR	-0.284 (0.022)	-0.289 (0.034)	-0.286 (0.032)	-0.208 (0.049)
ROS	2.818 (0.000)	2.823 (0.000)	2.815 (0.000)	2.791 (0.000)
AGE	0.010 (0.002)	0.013 (0.000)	0.016 (0.000)	0.015 (0.000)
ΔS	3.651 (0.000)	4.288 (0.000)	4.681 (0.000)	4.868 (0.000)
DSI	**-0.044 (0.000)**			
DSO		**-0.049 (0.000)**		
DPO			**-0.006 (0.038)**	
CCC				**-0.025 (0.000)**
AR-2 test	-0.529 (0.597)	-0.563 (0.573)	-0.534 (0.593)	-0.518 (0.604)
Sargan test	34.46 (0.399)	40.89 (0.194)	38.04 (0.290)	37.27 (0.321)

[1]The values in brackets indicate the level of significance of the variables or tests. AR-2 is a serial correlation test of second order using residuals of first differences, asymptotically distributed as N(0,1) under null hypothesis of no serial correlation. Sargan test is a test of over-identifying restrictions distributed asymptotically under null hypothesis of validity of instruments such as *Chi*-squared.
Source: own calculations.

(3)Similar conclusions can be drawn from the analysis of the regression coefficient for the Cash Conversion Cycle (*CCC*), i.e. the variable which synthetically reflects the efficiency of working capital management. In the light of estimation results, a 10-day extension of the Cash Conversion Cycle translated into a reduction of the return on operating assets of dairy companies by 2.5 percentage points.
(4)Changes in other factors, i.e. control variables, had the strongest and diversified impact on the return on operating assets in the milk processing sector. Also, it is fairly clear that these variables had a much stronger impact on the return on assets than the DSIs.
(5)The direction of the impact of control variables on the return on assets is largely consistent with other empirical studies which clearly suggest that this category of financial performance is strictly and positively correlated with the return on sales (*ROS*), company age (*AGE*) and growth in sales proceeds (*ΔS*). Furthermore, as confirmed by model parameters, an excessive company size (measured as the value of assets, *TA*); inflexible assets characterized by a large share of property, plant and equipment (*SFA*); and a conservative liquidity management policy (whose characteristics include a high current ratio, *CR*) also have an adverse effect on the improvement in the return on assets.

CONCLUSIONS

The level of current assets determines both the profitability and liquidity of a company, and should therefore be reasonably managed and aligned with the financing capabilities. This means the need for an effective working capital management process which consists in shortening the operating cycle and the Cash Conversion Cycle. The quantitative relationships between the duration of cycles of working capital components and the return on assets clearly suggest that the shorter the cycles, the higher the rates of return. The Days Sales of Inventory and Days Sales Outstanding had the strongest impact on the return on operating assets in dairy companies, whereas the Days Payable Outstanding had the smallest impact. This means that in the dairy industry, a rational stock management policy and the policy for granting credit to

customers are the main drivers of improvement in working capital efficiency.

REFERENCES

[1]Afza, T., Nazir, M., 2009, Impact of aggressive working capital management policy on firms' profitability. The IUP Journal of Applied Finance, 15(8): 20-30.
[2]Arellano, M., Bover, O., 1995, Another look at the instrumental variables estimation of error-components models. Journal of Econometrics, 68: 29-51.
[3]Bal-Domańska, B., 2011, Ekonometryczna identyfikacja konwergencji regionów szczebla Nuts-2 państw Unii Europejskiej (Econometric identification of convergence of Nuts-2 level regions of European Union countries). Acta Universitatis Lodziensis, Folia Oeconomica, 253: 9-23.
[4]Bieniasz, A., Gołaś, Z., 2011, The Influence of Working Capital Management on the Food Industry Enterprises Profitability. Contemporary Economics, 5(4): 68-81.
[5]Banos-Caballero, S., Garcıa-Teruel, P., Martınez-Solano, P., 2012, How does working capital management affect the profitability of Spanish SMEs? Small Business Economics, 39:517–529.
[6]Blundell, R., Bond, S., 1998, Initial Conditions and Moment Restriction in Dynamic Panel Data Models. Journal of Econometrics, 87: 115-143.
[7]Dańska-Borsiak, B., 2009, Determinanty TFP według działów przemysłu w Polsce. Dynamiczna analiza panelowa. (TFP determinants by industry sectors in Poland. Dynamic panel analysis). Acta Universitatis Nicolai Copernici, 389: 115-124.
[8]Dańska-Borsiak, B., 2011, Konwergencja czy dywergencja polskich województw. Zastosowanie dynamicznych modeli panelowych. (Convergence or divergence of Polish provinces. The use of dynamic panel models). Acta Universitatis Lodziensis, Folia Oeconomica 253: 41-54.
[9]Deloof, M., 2003, Does working capital management affect profitability of Belgian firms?. Journal of Business Finance & Accounting, 30(3-4): 573-588.
[10]Dobija, M., 1997, Rachunkowość zarządcza. PWN, Warszawa (Managerial Accounting. PWN, Warsaw).
[11]Dong, H.P., Su, J., 2010, The relationship between working capital management and profitability: a Vietnam case. International Research Journal of Finance and Economics, 49: 59-67.
[12]Emerging Markets Information Service (EMIS) - https://www.emis.com/, Accessed on 25 June 2019.
[13]García-Teruel, P.J., Martínez-Solano, P., 2007, Effects of working capital management on SME profitability, International Journal of Managerial Finance, 3(2), 164-177.
[14]Gill, A., Biger, N., Mathur, N., 2010, The relationship between working capital management and profitability: evidence from the United States. Business and Economics Journal, 10: 1-9.
[15]Karaduman, H.A., Akbas, H.E., Caliskan, A. O., Caliskan, Durer, S., 2011, The relationship between working capital management and profitability: Evidence from an emerging Market. International Research Journal of Finance and Economics, 62:61-67.
[16]Lazaridis, I., Tryfonidis, D., 2006, Relationship between working capital management and profitability of listed companies in the Athens stock exchange. Journal of Financial Management and Analysis, 19(1): 26-35.
[17]Lyroudi, K., Lazaridis, I., 2000, The cash conversion cycle and liquidity analysis of the food industry in Greece. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=236175, Accessed on 10 June 2019.
[18]Mohamad, N., Saad, N., 2010, Working capital management: The effect of market valuation and profitability in Malaysia. International Journal of Business and Management, 5(11): 140-147.
[19]Nabone, H., Abdullatif, M., Al Hajjar, M., 2011, Cash conversion cycle and firm's performance of Japanese firms. Asian Review of Accounting, 19(2):147-156.
[20]Operation of dairies and cheese making, class 10.51. NACE Rev.2, 2008, Statistical classification of economic activities in the European Community, Methodologies and working papers. Eurostat, European Commission.
[21]Padachi, K., 2006, Trends in working capital management and its impact on firms' performance: An analysis of Mauritian small manufacturing firms. International Review of Business Research Papers, 2(2): 45-58.
[22]Raheman, A., Nasr, M., 2007, Working capital management and profitability – case of Pakistani firms. International Review of Business Research Papers, 3(1): 279 – 300.
[23]Ramachandran, A., Janakiraman, M., 2009, The Relationship between working capital management efficiency and EBIT. Managing Global Transitions, 7(1): 61–74.
[24]Richards, V., Laughlin, E., 1980, A cash conversion cycle approach to liquidity analysis. Financial Management, 9:32-38.
[25]Sharma, A., Kumar, S., 2011, Effect of working capital management on firm profitability empirical evidence from India. Global Business Review, 12(1): 159-173.
[26]Shin, H.H., Soenen, L., 1998, Efficiency of working capital management and corporate profitability. Financial Practice and Education, 8(2): 37-45.
[27]Sierpińska, M., Jachna, T., 2004, Ocena przedsiębiorstwa według standardów światowych. PWN, Warszawa. (Company assessment according to global standards. PWN, Warsaw).
[28]Thapa, P.D.P., 2013, How does profitability get affected by working capital management in food and beverages industry?. Journal of Advanced Research in Management, vol. IV, 2(8): 79-88.

[29]Van Horne, J., Wachowicz, J., 2004, Fundamentals of Financial Management (12 ed.), New York, Prentice Hall.
[30]Wędzki, D., 2009, Analiza wskaźnikowa sprawozdań finansowych. Oficyna Ekonomiczna, Kraków (Ratio analysis of financial statements. Oficyna Ekonomiczna, Cracow).

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

RURAL DEVELOPMENT IN BULGARIA: SOME FACTORS AND CONDITIONS FOR SUCCESS

Hristina HARIZANOVA-BARTOS[1], Zornitsa STOYANOVA[1], Tsvetana HARIZANOVA-METODIEVA[2]

[1]University of National and World Economy, Bulgaria Sofia 1700, Studentski grad, Emails: h.harizanova@gmail.com; zstoyanova@unwe.bg
[2]Institute of Animal Science – Kostinbrod, Bulgaria, 2232, Email: ts_harizanova@abv.bg

Corresponding author: h.harizanova@gmail.com

Abstract

The rural development in Bulgaria is an important issue for decent live in the country. Direct and indirect impact on rural Bulgaria is observed from the implementation of different policies. The main aim of the study is to trace the changes in some of the main economic activities which are contributing to the development of the municipalities. The following approach will be used to achieve this goal: 1) Literature review of relevant theories concerning economics of rural development. On this stage factors concerning the rural economy growth will be explained; 2) According to the findings on theoretical level will be performed analysis in dynamics of indicators related to municipality development. As well we will analyze the change in the enterprises' number and sectors where they operate in order to outline the perspectives and importance for rural areas of each sector. For reaching this purpose will be prepared an analyses of the investment of the enterprises in Tangible fixed assets. Bulgaria as a member of EU is a receiver of RDP funding which as well reflect on business development in rural areas. Some relationships between RDP and economical sectors in rural Bulgaria are outlined in the paper. 3) According to the results of the analysis general conclusions will be outlined.

***Key words*:** *rural development, enterprises Bulgaria, RDP*

INTRODUCTION

Several factors (economic, social, infrastructure and environment) and their level of success influence on rural development [8]. Rural development according to same authors has to reach the positive trends in demography indicators in the group of young population, increased number of economic activities, positive social live, cultural events and good political environment. For better entrepreneurship businesses which have geographical preposition [1] and advantage according to other areas and also to use the capacity of the local people and their knowledge for developing traditional activities (as crafting, tourism, etc.) [18] in rural areas have to be supported. Development of markets is also factor that influence on development of business structures in rural areas [7], where the small traditional farmer's market could support local business to increase their popularity.

Factors which reflect on areas and economic activities defined in traditional descriptive terms are: level of population density, the rate of population, loss or gain, settlement size, local economic structure and landscape [24].
The most common outline concerning development of the municipality can be defined as social development and economic development [12]. To support this development authors pointed that this can happen by developing infrastructure and decreased stress of the social system. Linkage can be found between fixed cost invested by economical activities and sustainability on municipal level [13]. The establishment of connected with agriculture industry and investment in such a sector can contribute to added value of the products, and development of infrastructure including social one. Furthermore, the authors define that there is existing linkage between cross-section evidence of economic sectors and income per capita of the territory where the factories are operating [19].

In some studies, the factors which have strong effect on municipality development are directed to innovations in SMEs (pointed as the most important for sustainability of rural areas) [22]. The consideration of the factors by those authors are: the market scope, firm's market orientation and presence of strategic, managerial and marketing changes. In addition, for the successful development is important as well the implementation of innovations to the market and presence of skilled workers [23].

The summarization related to economic climate and economic benefits of entrepreneurship development according some authors [15] are: job generation, productivity growth, innovation and economic growth. The primary objective of the municipality potential is to support the possibility of increasing its competitiveness on the regional and federal level by supporting business which can create higher labour potential [16].

In this regard the essential element of the European agricultural model is rural development policy that have significant impact on rural development. The Rural Development Program (RDP) is the main opportunity to overcome the recent problems in rural areas and the differences between the development of rural and urban municipalities [4]. The RDP strives to maximize its support for the country's regional development. It implements targeted measures for achieving sustainability of agricultural holdings not only through agricultural production but also through the implementation of alternative activities, upgrading of skills and development of human capital [5]. Other authors [21] also analyse the impact of RDP on improving the economic and social development in rural areas, focusing on the impact of RDP measures on priority areas such as: improving employment and qualification of employed, level of income, added value, improving quality of life etc. On the other hand, for better results from RDP is important the correct implementation of the measurement and a proper level of control [14]. Furthermore, if the level of control is sufficient and the procedures are clear this will attract more beneficiaries through RDP, which will reflect on higher level of employment and building a social buffer in case of economic crisis [6]. With the support of RDP, progress in sectoral integration is observed mainly by thematic expansion and the continuity of established and important measures is monitored [20]. Measures implemented in rural areas may support variety of investments that will influence on regional development. These investments could be in physical, human and natural capital. From other point of view, the RDP measures support capacity building that stabilise, modernize or restructure the rural economy and use purposefully the available territorial assets [25].

Some authors state that RDP influence on rural municipalities development by supporting projects to improve infrastructure, roads, water and sewage systems, start-up of small businesses, rural tourism and other activities [9].

Specific of the rural economy is the presence of economic activity of micro and small enterprises that have the potential to stimulate the economy and investment activity. Policies providing business support in rural areas influence on business climate as investing in diverse non-farming activities [11].

The RDP for the programming period 2014-2020 is regional strategy for development of rural regions [3]. In this regard, the financial instruments offered under the Program are the financing mechanism for farmers and enterprises [2]. RDP provides an opportunity for companies in Bulgaria to invest in fixed assets, and through the development of their depreciation policy, to use initial investments for constantly upgrade their assets in order to increase their competitiveness [9].

MATERIALS AND METHODS

The main aim of the study is to trace the changes in some of the main economic activities which are contributing to the development of the municipalities in rural Bulgaria. In this manner the relationship

between rural development and RDP program will be examined. The rural economy is developing under the conditions of favourable influence of major macroeconomic factors that support the sustainability of business and the economy. The investments of economic sectors in this study will be measured by the expenditures in Tangible fixed assets.

The study is divided into several parts: 1) Literature review of relevant theories concerning economics of rural development; 2) Analysis of dynamics of indicators related to municipality development; 3) Analysis of the relationship between RDP and Tangible fixed assets in main sectors in Rural Bulgaria.

The interconnection between RDP disbursements over the period 2008-2017 and the values of some indicators obtained as a total amount for rural municipalities in the country is presented through correlation analysis.

On this bases some conclusions are made.

Some of the presented results are disseminating the findings of the national project Sustainable multifunctional rural areas: reconsidering agricultural models and systems with increased demands and limited resources [10].

RESULTS AND DISCUSSIONS

Dynamics in enterprises (in numbers) by sectors in Rural Bulgaria

The change of number of enterprises per rural municipalities (average) in Bulgaria shows that it is following an upwardtrend and from 354 in 2008 they increase to 463 in 2017. The increase is at a rate of 0.4% to 3.6% over the years compared to the previous years. 91 from all the rural municipalities (39%) had more than 500 enterprises per municipality in 2008, while in 2017 these municipalities decreased to 67 (29%). Between 200 and 499 enterprises were active in 91 rural municipalities in 2008, and in 2017 the number of municipalities decreased to 86 (they decreased by 2%). The municipalities with less than 200 enterprises are 51 in 2008, and they increase with 12% in 2017.

Figure 1 presents the enterprises' in the municipalities in rural Bulgaria for the period 2008-2017.

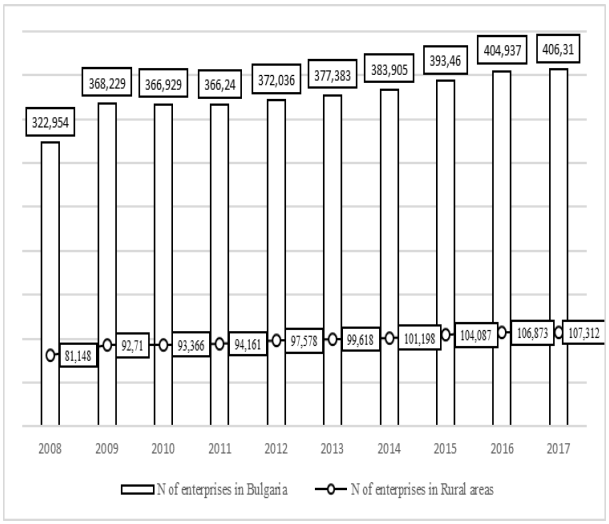

Fig. 1. Enterprises' number in rural Bulgaria - changes 2008-2017
Source: Own finding based by data of [17].

Figure 2 presents the average number of enterprises of one rural Bulgarian municipality for the period 2008-2017. The average number of enterprises is also increasing value.

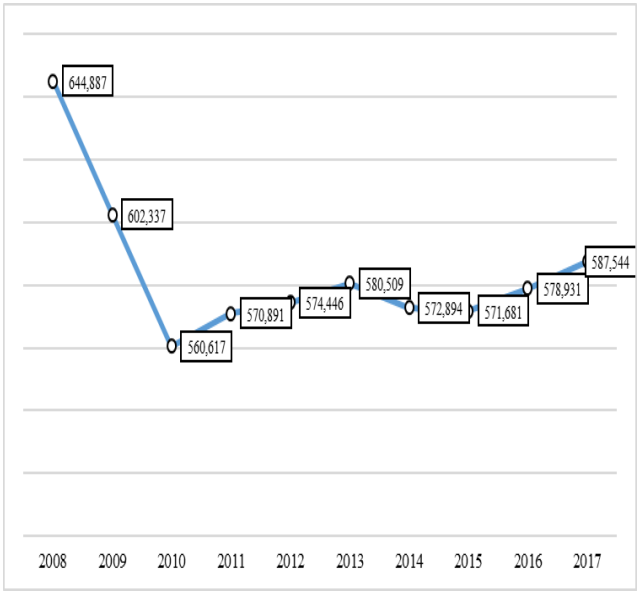

Fig. 2. Average number of enterprises of one rural municipality in Bulgaria – changes 2008-2017
Source: Own finding based data of [17].

The distribution between the numbers of enterprises per one rural municipality is presented in Table 1.

The distribution of enterprises by economic activity during the period 2008-2017 is maintained by sectors that have significant number of enterprises (Table 2).

Table 1. Changes of number of enterprises per one municipality in the period 2008-2017

Enterprises	2008	2017
Over 500 enterprises per rural municipality	91	67
Between 200 and 499 enterprises per municipality	91	86
Under 200 enterprises per municipality	51	79

Source: Own finding based by data of [17].

In 2008 and 2017 the most enterprises are observed in the following sectors - Trade and repair of motor vehicles and motorcycles, Agriculture, forestry and fisheries and manufacturing, Hotels and restaurants.

Table 2. Distribution of enterprises by economic activity during the period 2008-2017, %

Structure	2008	2017
Trade. Car and motorcycle repair	44	38
Manufacturing	12	9
Hotels and restaurants	12	10
Agriculture	7	13
Transport, storage and mail	6	7
Construction	5	3
real estate operations	4	4
Human health and social work	4	3
Professional activities and research	3	4
Other activities	3	4
Creating and distributing information and creative products. Telecommunications	1	1
Administrative and support activities	1	2
Culture, sport and entertainment	1	1
Mining and quarrying	>1	>1
Production and distribution of electricity, heat and gaseous fuels	>1	1
Water supply. Sewage services, waste management and recovery	>1	>1
Education	>1	>1

Source: Own finding based by data of [17].

44 % of enterprises in 2008 operates in the trade sector. They decrease to 38% in 2017. In the sector of agriculture, forestry and fisheries, enterprises are 7% in 2008 and 13% in 2017. The enterprises in processing industry are 12 % from all the enterprises in rural areas and in 2017 they decrease to 9%. In the hotel and restaurant sector, the share of enterprises is 12% in 2008 and 10% in 2017.

The sectors in which enterprises are from 1 to 7% of all enterprises in rural municipalities in 2008 and in 2017 are related to the electricity, information and telecommunications, administration, culture, sports and entertainment, human health and social work, other activities. In some economic sectors as those connected with water and waste, mining and education, enterprises are below 1% during the period 2008 - 2017.

Dynamics in the employment in Rural Bulgaria

Social, economic, and demographic processes in the rural economy determine employment as well the demand for skilled labor. In the regions - South-West and South-Central where investment activity is high, there are conditions for new employment. In rural areas, employment has been rising steadily since 2010, but it is lower than the general level of the country.

Figure 3 illustrates the change between 2008 and 2017 in total number of employed people in rural areas and the change in population in working age.

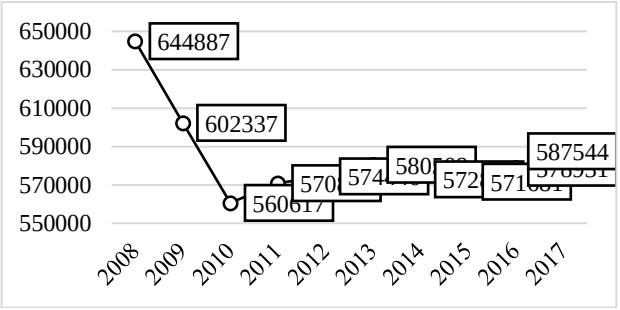

Fig. 3. Dynamics of employed people in rural Bulgaria 2008-2017
Source: Own finding based by data of [17].

There is a positive trend last 7 years, because the number of employed persons are increasing although the negative trend of population in Bulgaria. The explanation of non-migrating of the people can be explained by the increased role of some economical activities in rural areas. This process is

observed better through combination of employed persons and population in working age for the period where we found positive trends (Fig. 4).

The data confirms that even The negative population trends is observed, but there is increase in the number of employed person.

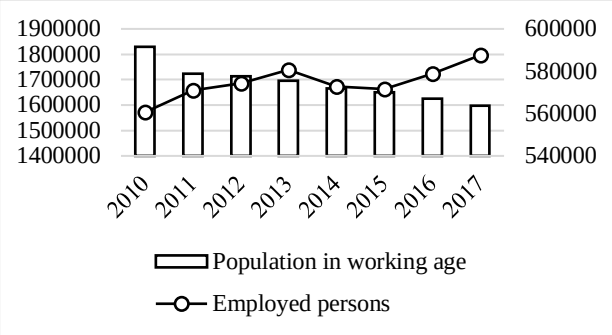

Fig 4. Population in working age and employed persons in rural Bulgaria – changes 2008-2017
Source: Own finding based by data of [17].

Acquisition of tangible fixed assets (TFA) in rural Bulgaria

The level of the usage of TFA have significant impact on the increase of the production. The cost of acquisition of TFA is one of the main indicators of investment activity. Expenditure on the acquisition of TFAs in rural municipalities for 2017 is about 1/5 of the total amount in Bulgaria and the structure is shown in Fig.5.

Figure 5 presents the distribution of expenditure on the acquisition of TFAs in rural municipalities invested during the period 2008-2017.

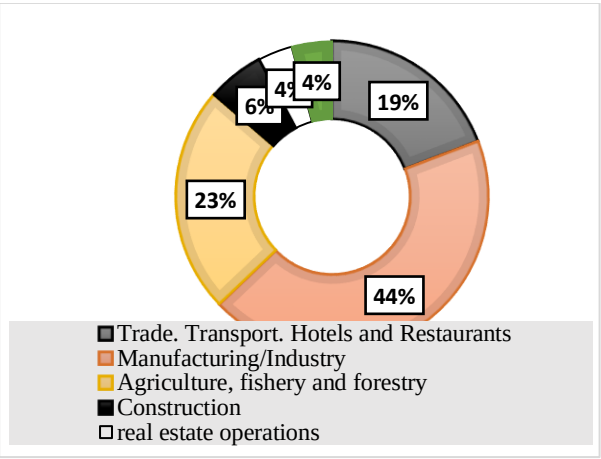

Fig. 5. Expenditure on the acquisition of TFAs in rural municipalities - distribution for the period 2008-2017
Source: Own finding based by data of [17].

The acquisition cost of fixed assets in the industrial sector (excl. Construction) - 43.667% is with the largest share, followed by sector of agriculture (23.490%), trade, transport, hotels and restaurants (19.205%).

The highest expenditures for the acquisition of TFA in rural municipalities are observed in 2008, followed by 2015, 2014 and 2012. The lowest value of the indicator is measured in 2010, 2011, 2016 and 2013. Overall, increasing tendency is observed in rural municipalities of the cost of acquisition of fixed assets.

Correlations between the cost of acquisition of fixed assets in rural sectors and paid measurements under the RDP programs-2007-2013 and 2014-2020

This analysis examines the correlation (interconnection) between RDP disbursements over the period 2008-2017 and the values of some indicators obtained as a total amount for rural municipalities in Bulgaria. Confidential statistics is not included in the calculated indicators value.

We assumed that the RDP disbursements had an impact on the surveyed indicators not only in the year in which they were disbursed but also in the next few years. Therefore, we calculated the correlations between the studied indicators and:

- RDP disbursements during the current year (RDP0);
- disbursements under the RDP one year before the current year (RDP-1);
- disbursements under the RDP two years prior to the current year (RDP-2);
- disbursements under the RDP three years prior to the current year (RDP-3);

The first current year is 2008 and the last is 2017.

According to the data in Table 3, it is observed a positive correlation between the RDP funds paid and the cost of acquiring TFAs in rural municipalities in the agriculture, forestry and fisheries sector.

The effect of disbursed funds in the agricultural sector is visible in the year of disbursement, and the correlation is decreasing three years after disbursement, which we believe is because farmers invest

the disbursed funds in their business asap after they are received.

Table 3. Correlations between the cost of acquisition of fixed assets in rural sectors and paid measurements under the RDP programs- 2007-2013 and 2014-2020

Type of economic activity	RDPt0	RDPt-1	RDPt-2	RDPt-3
Agriculture, forestry and fisheries	0.809	0.551	0.614	0.357
Industry	-0.229	-0.101	0.282	-0.262
Construction/building thousands of BGN	-0.388	-0.364	0.250	0.375
Trade, transport, hotel and restaurant business	-0.125	0.353	0.915	0.842
Creation and dissemination of information and creative products, telecommunications	-0.138	0.250	0.566	0.908
Financial and insurance activities	-0.070	0.073	0.044	-0.038
Real estate operations	-0.531	-0.291	-0.122	-0.458
Professional and research activities, administrative and support activities	0.160	0.592	0.469	0.702
Government, education, human health and social activities	-0.235	-0.134	0.157	0.651
Culture, sports and entertainment, housekeeping, other activities	0.500	0.087	0.513	0.552

Source: Own finding based by data of [17].

The other sectors where are observed a moderate to high positive correlation between the disbursements of R&D investments and the costs of acquiring TFA are: Trade, transport, hotels and restaurants; Creation and dissemination of information and creative products, telecommunications; Professional and scientific activities, administrative and support activities; Government, education, human health and social work; Culture, sports and entertainment, housekeeping, other activities.

CONCLUSIONS

Based on the literature review and prepared analysis could be made some general conclusions:

-Rural development is influenced on the improvement in demography indicators, increased number of economic activities, social success, cultural events, good political environment, entrepreneurship that take into account geographical preposition and the region advantages, the use of the capacity of the local people and their knowledge for developing traditional activities.

-RDP could solve most of the recent problems in rural areas and the differences between the development of rural and urban municipalities and to maximize its support for the country's regional development, because the RDP's measures are related to economic sustainability of agricultural holdings not only through agricultural production but also through the implementation of alternative activities, upgrading of skills and development of human capital.

-The number of enterprises in rural municipalities in Bulgaria is following an upward trend. 39% from the municipalities had more than 500 enterprises per municipality in 2008, while in 2017 these municipalities decreased to 29%.

-The distribution of enterprises by economic activity during the period 2008-2017 shows that in 2008 and 2017 the most enterprises are observed in the sectors Trade and repair of motor vehicles and motorcycles, Agriculture, forestry and fisheries and manufacturing, Hotel and restaurant.

-In the regions - South-West and South-Central is observing high investment activity and this create conditions for new employment. Economic, social and demographic processes in the rural economy determine employment and the demand for skilled labor and the employment has been rising steadily since 2010 even the negative population trends.

- The level of the usage of TFA and the cost of acquisition of TFA have significant impact on the investment activity. RDThe acquisition cost of fixed assets in the sectors of industry, followed by agriculture, trade, transport, hotels and restaurants are with the highest share. Overall, the tendency is to increase the cost of acquisition of fixed assets in rural municipalities.

-RDP disbursements had an impact on the surveyed indicators not only in the year in which they were disbursed but also in the next few years.

-There is a positive correlation between the RDP funds paid and the cost of acquiring TFAs in rural municipalities. The effect of disbursed funds in the agricultural sector is visible in the year of disbursement, and the correlation is decreasing three years after disbursement. The explanation about this is because farmers invest the disbursed funds in their business asap after they are received. The other sectors where are observed a moderate to high positive correlation between the disbursements of R&D investments and the costs of acquiring TFA are: Trade, transport, hotels and restaurants; Creation and dissemination of information and creative products, telecommunications; Professional and scientific activities, administrative and support activities; Government, education, human health and social work; Culture, sports and entertainment, housekeeping, other activities.

Factors influencing on rural development are mainly connected with economic development of the areas. On the first place of importance is the infrastructure development, followed by developed markets and quality of working force. In order to succeed the business in rural areas it should be innovative on one hand, but as well to be orientated to the traditional products. The geographical prepositions should be used and the production to be typical for the area and like this to attract new buyers or visitors. The development of the sectors should be innovative and to keep the low level of environmental stress. All this can be implemented by RDP for the next programming period 2021-2017 if the measurements are directed to sectors which can bring added value and create new jobs and professions.

REFERENCES

[1]Aleksandrova-Zlatanska, S., 2019, A territorial approach for economic development of rural areas. case of Bulgaria. Scientific Papers Series-Management, Economic Engineering in Agriculture and Rural Development, Vol.19(3) : 39-47.

[2]Alexandrova, S., Nikolov, D., 2015, RDP Financial Instruments - Opportunity for Sustainability of Financing in Agriculture, Bulgarian journal of agricultural economics and management, Vol. 60 (4): 53-62.

[3]Atanasova-Chopeva, M., 2013, Some trends in the development of demographic potential in Bulgarian villages till 2020 on national and regional level. Bulgarian journal of agricultural economics and management, Vol. 58 (1).

[4]Atanasova-Kalaydjieva, T., 2010, Problems in rural development. Management and sustainable development, Vol. 27 (3-4).

[5]Banchev, S., Paligorov, I., Kostov, G., 2010, Opportunities of forestry sector for Bulgarian rural development. Management and sustainable development, Vol. 25 (1).

[6]Borisov, P., Radev,T., Nikolov, D., 2019, Young Farmers and New Entrants in Bulgarian Agriculture – Profiling their Challenges and Needs. Bulgarian journal of agricultural economics and management, Vol. 64 (2).

[7]Branzova, P., 2018, Development of the farmers' markets in Bulgaria Petia Branzova. In Proceedings of the International scientific and practical conference "Bulgaria of regions", Vol. 1.

[8]Czapiewski, K., 2006, Rural areas of success – in search of definition and measures, Europa XXI, 15, IGiPZ PAN, Warszawa, 77–86.

[9]Dimitrova, I., 2015, Investment in Financing and Depreciation Policy in Agricultural Enterprises. Scientific Papers of the University of Ruse, Vol. 54 (5.1.) : 70-75.

[10]Doytchinova, ,J., Miteva, A., Harizanova-Bartos, H., Stoyanova, Z., et. all. (2017). DN 15/8 11.12. 2017 Sustainable multifunctional rural areas: reconsidering agricultural models and systems with increased demands and limited resources. SOFIA: UNWE.

[11]ENRD, 2017, Working Document 2014-2020 Rural Development Programmes' support for Rural Businesses, Analysis of selected RDP Measures.

[12]Frolova, E., Vinichenko, M., Kirillov, A., Rogach, O., Kabanova, E., 2016, Development of social infrastructure in the management practices of local authorities: trends and factors. International Journal of Environmental and Science Education, Vol. 11(15): 7421-7430.

[13]Haggblade, S., Hazell, R., Dorosh, R., 2007, Sectoral growth linkages between agriculture and the rural nonfarm economy. Transforming the rural nonfarm economy: Opportunities and threats in the developing world, 141-182.

[14]Jetcheva-Radeva, I., 2018, Financial Corrections and Control of Program for Rural Development. In Regional Economy and Sustainable Development, Conference Proceedings 2017, No. 1, 414-423. Research Institute, University of Economics-Varna.

[15]Kokovikhin, A., Ogorodnikova, E., Williams, D., Plakhin, A., 2017, Institutional factors in the evaluation by the entrepreneur of municipality investment climate. Economy of region, Vol. 1(1): 80-92.

[16]Kozlova, O., Lavrentyev, A.,Lobareva, N. , 2011, Formation factors of the employment potential of municipality. Economy of region, Vol. 1(1): 115-122.
[17]Mishev et al., 2020, Project of Socio-economic analysis for rural development (2020), prepared by the University of National and World Economy, preliminary draft published - 24.01.2020.
[18]North, D., Smallbone, D., 2006, Developing entrepreneurship and enterprise in Europe's peripheral rural areas: some issues facing policy-makers. European Planning Studies, Vol. 14(1): 41-60.
[19]Perlín, R., Šimčíková, A., 2008, Criteria of a successful rural municipality. Europa XXI, 17, 29-43.
[20]Piorr, A., Viaggi, D., 2015, The spatial dimension of Public Payments for Rural Development: Evidence on allocation practices, impact mechanisms, CMEF indicators, and scope for improvement, Ecological Indicators Journal, Vol. 59 : 1-5.
[21]Popov, R., Ivanov, B., Yovchevska, P., Atanasova, M., Malamova, N., Sokolova, E., Mitov, A., 2013, Common Agricultural Policy and Rural Development in Bulgaria. Bulgarian journal of agricultural economics and management, Vol. 58 (5-6).
[22]Radas, S., Božić, L., 2009, The antecedents of SME innovativeness in an emerging transition economy. Technovation, Vol. 29 (6-7): 438-450.
[23]Raspe, O., Van Oort, F., 2006, The knowledge economy and urban economic growth. European Planning Studies, Vol. 14(9): 1209-1234.
[24]Stathopoulou, S., Psaltopoulos, D., Skuras, D., 2004, Rural Entrepreneurship in Europe: A Research Framework and Agenda. International Journal of Entrepreneurial Behaviour & Research, Vol. 10(6): 404-425.
[25]Zasada, I., Reutter, M., Piorr, A., Lefebvre, M., Gomez y Paloma, S., 2015, Between capital investments and capacity building—Development and application of a conceptual framework towards a place-based rural development policy. Land Use Policy, Vol 46: 178-188.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

DETERMINANTS OF MARKET PARTICIPATION AND PARTICIPATION DECISION AMONG TEFF PRODUCERS IN HORO BULUK DISTRICT OF HORO GUDURUWOLLEGA ZONE, ETHIOPIA

Seid HASSEN[1], Rijalu NEGASH[2], Mulubrihan BAYISSA[2]

[1]Wollega University, Department of Agricultural Economics, P.O. Box 38, Ethiopia, Phone: +251920416030, Email: muhabbaa60@gmail.com
[2]Jimma University, Department of Agricultural Economics and Agribusiness management, P.O.Box 78, Ethiopia, Phones: +251917820457, +251913296787, Emails: rijalunegash@yahoo.com, mulubaytu@gmail.com

Corresponding author: mulubaytu@gmail.com

Abstract

Teff is very essential cereal crop in Ethiopia, especially in Horo Buluk district. It is produced for food and income generating by majority of the respondents. This study was aimed to analyzing factors affecting market participation and participation decision of teff producers in Horo Buluk district. This research was employed the first hand data that gathered from 190 randomly chosen teff producers and double hurdle model was employed to classify the determinants of market participation decision and intensity of participation. In the first hurdle, age, educational status of the household head, perception of farmer on lagged teff market price, number of oxen, chemical fertilizer used, cooperative membership, farm size allocated to teff and family size were found to influence the participation in teff sales considerably. In the 2nd hurdle; schooling level of the household head, number of oxen owned, chemical fertilizer employed, size of land covered by teff and distance from nearest market were found to have significant role in intensity of participation. Working towards improving rural education system, scaling up the family planning program; enhancing access to market and institutional services; and assist the producers to enhance land productivity, where possible, by intensifying farm practices through provision of sustainable and timely availability of inputs are strategies to increase farmers' participation in teff marketing.

Key words**:** *Double hurdle, Horo Buluk, market participation, Smallholders, teff*

INTRODUCTION

Agriculture persists to dominate the national economy of Ethiopia, accounting for 36.3% of GDPand over 70% of exports earning (UNDP, 2018) [21]. It also generates employment of 73% to thetotal population and supplies 70% of the raw-material requirements of local industries (UNDP, 2016) [20]. The sector also serves as a spring board to bring about structural transformation in the long run through contribution to industrial growth MoFED (2010) [17]. In the country agriculture is dominated by smallholder producers which cover 95% of the total land employed under agriculture which contributes 90% to the whole agricultural outputs. This indicates that smallholder producers are dominantly contributing to the overall agricultural production in the country. (MoARD, 2010; Gebreslasie and Bekele, 2012) [12,16].

Teff is among less utlized stple crops that can contribute to food security and crop diversification. About 6.8 million smallholder farmers produce it and its production has experienced significant growth from year to year. Total teff produced in quintal by smallholder reached 52,834,011.56 in 2018 showing 5.24% increment from 50,204,400.47 of 2017 (CSA, 2018) [11]. Horo Guduruwollega zone is one of potential teff producer zone in Oromia region. The production of the zone in 2018 was 910,650 quintal from 51,348.5 hectare with 17.7 quintal productivity and also in Horo Buluk about 104,419.37 quintal was produced from 5,321 hectare with the productivity of 19.62 quintal per hectare (Nigus G. *et al*., 2019) [6].

In recent years, teff has been internationalized and has become an export commodity, given

its nutrition value, thereby boosting its level of commercialization beyond the domestic market (Alemu and Birhanu, 2018) [7]. Among the cereals, teff is the most widely marketed in Ethiopia with 27 percent of teff output sold (CSA 2014) [9]. The CSA (2016) [10] estimated that on average, 28.11 percent of all teff produced at household level was sold.

The product have unique characteristics; due to shortage of marketing system frequently result in lesser producers' price, inadequate way in to market facilities, limited information of product market, inadequate infrastructural, absence of institutions who help the sector and intricacy in transportation services are among the main challenges for the reason to little involvement of smallholder producers in trading their products. Moreover, the amount of teff which the farmers actually sell in the market in the study area is changing sometimes going up and the other time getting down depending on situations. It is obvious that it is getting higher during harvesting period and getting down other time. This is therefore; recognizing determinant factors hindering the actual size of teff soled in the market do have absolute worth for preparation of guiding rules in the area of agricultural commodities marketing as well as pricing and also can be used as widely expansion target for the country at national level. Thus, it is very use full to study determinant factors obstructing teff market participation and quantity of marketed surplus in the study area.

MATERIALS AND METHODS

This part deals with, sampling technique, techniques of data assembly, and the way of data analysis and description of variables hypothesized were projected.

Types, Sources and Techniques of data Gathering

The study engaged both quantitative and qualitative types of data collected from both primary and secondary sources. The primary data from farmers was gathered focusing on factors affecting the market participation decision, proportion of teff produce and sold. Secondary data on socio-economic data of the district, crops types produced and livestock resource, trends in agricultural production.

Sampling Method and Sample size determination

In order to select sample respondents two stage sampling procedures were used. Framers that were producing teff were the population of this research. First of all four teff producing kebeles (Peasant Associations) from eleven rural kebeles of the district were chosen at random. Secondly from the selected kebeles, teff Producer farm households were identified in coordination with development agents. In this level a total of 190 teff producer farm households were chosen at random from the selected sample kebeles by using simple random sampling system (Table 1). The maximum numbers of respondents were determined by using a formula developed by Yamane (1967). To find out the required sample size, 7% level of precision is used.

$$n= \frac{N}{1+N(e)^2} \quad = \frac{2714}{1+2714(0.07)^2} \quad =189.8088 \sim 190$$

Table 1. Sample of selected district's kebeles teff producing farmers' households

S.no	Name of Kebeles'	HH NO	Proportion	Sample respondents
1	Bone Abuna	790	29	55
2	Rifenti Chabir	509	19	36
3	Gudina Abuna	627	23	44
4	Abile Egu	788	29	55
Total	4	2,714	100	190

Source: HBOARD (2018) [14].

Data analysis technique

Both descriptive statistics and econometric models were engaged to analyze the data gathered from respondents.

Descriptive statistics

T-test and Chi square were used to see the relative disparity in the case of market participants and non-participants of teff selling. Percentages, means, and standard deviations were engaged throughout investigating and illustrating marketing facilities, services and household behaviour.

Econometric analysis

Different market participation researches have used the Tobit model to estimate market participation interaction with few dependent variables. Tobit model is also statistically restrictive as it takes inconsideration that the same set of variables decides on both the chance of participation decision and level of involvement. For this work, double hurdle model was chosen as it allows the peculiarity between market participation decision and level of participation on teff through two stages. That means it is possible to analysis the factors affecting participation and volume of sale separately by using probit for market participation decision and truncated for size of sale.

The universal form of double hurdle model for producers' market participation and degree of participation are explained as follows separately.

$$d^* = wi`\beta + vi, vi \sim N(0,\sigma 2) \; di = \begin{bmatrix} 1 if d^* i > 0 \\ 0 if d^* i \le 0 \end{bmatrix} (1)$$

$$y^* = xi`\delta ui, ui \sim N(0,\sigma 2) \; yi = \begin{bmatrix} y^* if y^* > o and d^* > o \\ 0 if y^* \le 0 \end{bmatrix} \quad (2)$$

Where:

d^*i is a unrecognizable variable describing the i^{th} household decision to engage in the teff market as seller (d_i),

y^*i is a latent variable describing the i^{th} household extent of participation in the teff market

y_i is the actual size of teff sold to the market by the household i which is observable variable.

W'i and X'i are vectors of variables illustrating the participation decision and level of participation decision respectively,

β and δ are vectors of parameters to be estimated,

v_i and u_i are error terms assumed to be independent and normally distributed.

RESULTS AND DISCUSSIONS

Demographic and socio-economic characteristics of the households

As it is illustrated in Table 2 and 3 below that 81% the respondents were male headed and 18% were female headed households. Regarding market participation, 82% of market participant were male headed, whereas 18% were female headed. In the other way around, 79% of non-market participants were male headed households, whereas 21% of non-market participants were female headed households. The chi-square result in Table 2 showed that Lagged market price is statically significant at 1%. This point out those who perceive lagged price as high participate in teff marketing more by increasing their cultivation.

Table 2. Chi^2/Fisher's exact-test for dummy variables

Variables		Participant		Non-participant		Total sample		X^2-value
		N	%	N	%	N	%	
Sex of HH Head	Male	105	82.03	49	79.03	154	81	0.2446
	Female	23	17.97	13	20.97	36	19	
Member to cooperative	Yes	58	45.31	24	38.71	82	43.15	0.7423
	No	70	54.69	38	61.29	108	56.84	
Lagged market price	Low	22	17.19	43	69.35	65	34.21	50.5044***
	High	106	82.81	19	31.65	125	65.78	
Credit use	Yes	60	46.88	38	61.29	98	51.57	3.4753 ***
	No	68	53.13	24	38.71	92	48.42	

Source: Own computation (2019).

Note: *** shows 1%, 5 significance level.

Mean-comparison test for Demographic and socio-economic Characteristics of respondents

Two-group mean comparison test of continuous variables were used in order to confirm that there was a significant mean difference among market participants and non-participants. On average the respondents' formal schooling completed was 4.88 years with a standard deviation of 3.62. Average education level of participants and non-participants were 6.76 and 1.07 respectively which indicates existences of the mean difference in educational level of household head among market participant and non-participant and statistically significant at 1 %.

The family sizes of the respondents were between two and eleven with average family number of 4.96 and 1.85 a standard deviation. This number is almost parallel with national number of average family size which is 5.32 persons per the household (CSA, 2011) [8]. The average family number of participants and non-participants were also different. It is 4.46 for participants and 5.98 for non-participants. This shows that, there is mean difference among them at 1% significance level.

The ages of all respondents were between 27 and 65 years with average age of 46.54 years and standard deviation of 6.74. Mean age of participant and non-participants were 48.43 and 42.64 respectively which is statistically significant at 1%.

Table 3. T-test for continuous variables

	Participant		Non-participant		Total sample		t-value
	Mean	S.D	Mean	S.D	Mean	S.D	
Age of HH Head	48.43	6.49	42.64	5.48	46.54	6.74	-6.0403***
Family size(AE)	4.46	1.75	5.98	1.62	4.96	1.85	5.7120***
Education level of HH Head	6.76	2.78	1.07	1.37	4.88	3.62	-15.348***
Non /off farm income	1,178.37	3,329	3,892.22	4,485.58	2,092.51	3,961	4.7066***
Chemical fertilizer used	150.703	8.6935	36.2903	1.55515	113.368	97.16	-9.1131***
Farm size allocated to teff	1.43	0.72	0.30	0.18	1.06	0.80	-12.0252***
Distance from nearest market	72.10	23.74	105	7.49	82.86	25.24	10.6647***
Number of oxen	4.1	2.38	0.88	0.92	3.05	2.53	-10.2458***
Live stocks excluding oxen	10.04	7.95	2.44	3.71	7.56	7.73	-7.1449***
Number of extension contact	8.35	4.50	3.11	2.72	6.64	4.70	-8.4436***

Source: Own computation (2019).
Note: ***, shows 1%, significance

Determinants of Teff Market Participation Decision

The outcomes of first-stage probit model for factors affecting teff market participation decision of the respondents were given in Table 4. From the fourteen explanatory variables, eight variables were found to determine the probability of participating in teff market significantly. These are: Age, family size, perception on lagged market price, education, number of oxen and farm size allocated to teff, cooperative membership and chemical fertilizer applied.

Age of the household head (AGE)

It was linked with the probability of market participation positively at 10% significance level. The age of respondents were taken as a proxy for experience in farming. This implies that aged households are believed to be wise in resource allocation, risk management and have more contact which allows trading partners be find out at lower cost than younger households due to the experience they achieved. Therefore, the marginal effect the result shows a year increased in the age of respondents increases the probability of participation in teff market by 0.48 %. This output confirms the findings of Abera (2015) [3].

Education level of household's head

The outcome of the analysis shows that schooling status of the household head was positively significant at 1%. This shows that the household head attained higher schooling stage gain knowledge and gets information about the market. For this reason, the

possibility of participation increases. The marginal effect shows that as the household head get educated more the possibility of market involvement increases by 2%. Which is similar with the findings of Abayneh and Tefera (2013) [2].

Farm size Allocated to Teff:

The analysis shows, it was positively and significantly correlated with the prospects of market participation at 5% significance level. The marginal effect indicates that adding one more hectare of land for teff would increase the chance to be partcipated by 11.2%; this is similar with the outputs of Getahun (2018) [13].

Family Size (adult equivalent): The output of the analysis shows it have negative and significant impact on teff market participation decision at 5% significance level. The marginal effect shows, as the family member increased by one, the chance of market participation decreases by 1%. The result is true becouse household with more family member consume more output produced and less amout is available for market. This is inline with result of Getahun (2018) [13].

Table 4. First hurdle analysis output of teff market participation decision

Independent variables	Coef.	Robust Std. Err.	z	P>z	Marginal effect
Sex of household head	.1969483	.6668633	0.30	0.768	.0069722
Age of household head	.1358761**	.0550088	2.47	0.014	.0048102
Family Size	-.2968211*	.1531388	-1.94	0.053	-.0105078
Cooperative membership	1.026705**	.4749638	2.16	0.031	.0363466
Education level of household	.587452***	.2047993	2.87	0.004	.0207965
Non –farm income(log)	.0226681	.0396634	0.57	0.568	.0008025
Farm size allocated to teff	3.161087**	1.259203	2.51	0.012	.1119065
Distance from market	.0232876	.0276916	0.84	0.400	.0008244
Perception on lagged price	1.378877**	.5852284	2.36	0.018	.048814
Number of oxen	1.281665***	.2673497	4.79	0.000	.0453726
Livestock excluding oxen	-.0201611	.0371851	-0.54	0.588	-.0007137
Number of extension visit	.1599102	.1040907	1.54	0.124	.005661
Credit use	-.1258487	.5342351	-0.24	0.814	-.0044552
Chemical fertilizer used	.0458213**	.0190901	2.40	0.016	.0016221
_cons	-16.00599	5.395281	-2.97	0.003	
Wald $\chi 2$ (14) = 80.78 Log likelihood=-12.31535 Prob.> $\chi 2$=0.000.					

Source: model output (2019).

Note: "*", "**" and "***" represent significance levels at 10, 5 and 1% respectively.

Perception on Lagged Market Price: It influences the households' decision to take part in teff marketing positively at 5% significance level. This means, as the farmers distinguished the price of teff during the past years was higher; the decision to take part in teff marketing will increase by 4.88%. This result verifies the economic theory of product price is a motivation for farmers in order to produce more products which will be presented for non farming communities. This finding is in line with the anticipation and

result of Musah et al. (2014) and Abera (2015) [3, 18].

Membership in Cooperative (MCOOP):
It has positive and significant influence on households' decision to join teff marketing at 1% significance level. Which means those who are members of the cooperative could have better access to market information, inputs, extension services and technical advice. This could be results in raising the probability of cooperative members' involvement in teff marketing. Thus, being a member of cooperative increases the chance of participation in teff market by 3.63% which is in line with the results of Adeoti et *al* (2014) and Abera (2015) [3, 5].

Number of Oxen Owned (NOXEN): The analysis shows that it was positively and statistically significant at 1%. This means, the household with higher number of oxen were expected to participate more than those who have less number. This is as hypothesized that the number of oxen owned supplements the chance to be a seller. As ox is a very important asset for smallholder farm households, it has direct contribution to produce more products that will be taken to the market. Therefore, as a single ox is added to the numbers of oxen owned the likelihood of participation in teff market increase by 4.53 %. This is verifying the finding of Abera (2015) [3] that say asset endowments have higher probability of market participation.

Chemical fertilizer used (CFU)
Chemical fertilizer influenced market participation decision significantly and positively. The result showed that as use of chemical fertilizer increase by one kilogram, probability of market participation increase by 0.16%.Chemical fertilizer was an important input for crop production as most of the soils were deficient in their fertility status. Increases in use of this most important input for better yield may force farm households to be more market participants. This result is in line with the findings of Ademe *et al*., (2017) [4] who found increase in fertilizer use increase productivity which leads increment of possibility to output market participation.

Determinants of Volume of *Teff* Market Participation

Education level of the Household Head: It was estimated to have positive and significant influence on the amount of teff market participation at 1%. The estimated coefficient reveal that as the household head education level increased by one grade; the volume of teff sold increases by 0.64 quintal which is parallel with the result of Getahun (2018) [13].

Farm size allocated to teff (FRSATT): It was estimated to have positive relation. The possible explanation could be as more farm land is allocated to teff, the bigger volume of teff will be produced which in turn results in higher amount of the product will be available for market. As a land under teff production increased by one hectare the volume of teff to be sold will be increased by 5.97quintals.This finding is similar with findings of Adeoti *et al.,* (2014) and Abera (2015) [3, 5].

Oxen owned (NOXEN): Oxen are one of the most important inputs for crop production in the country in general and in the study area in particular. As it was hypothesized, the number of oxen owned by the household heads influenced the size of teff taken to the market positively and significantly at 5% significance level. The result shows that a unit increase in a number of oxen increases the size of teff marketed by 0.6 quintals. This is due to the fact that as oxen are the main sources of traction power for the producers, growth in the number of oxen increases the production of teff. This result verifies the finding of (Kefyalew, 2012) [15].

Distance to the Nearest Market (DSMK): This is the minutes taken to the nearest marke on foot. It was negatively influenced the amount of teff traded to the market at 1% significance level. This means as the distance to the nearest market place increases by one minute the producer will decrease the volume of teff marketed by 0.1 quintal; which is similar with the findings of Tadesa (2018) [19].

Chemical fertilizer used Chemical fertilizer influenced market participation level significantly and positively. The result showed that as use of chemical fertilizer

increase by one kilogram, intensity of participation increase by 0.025 quintal. Chemical fertilizers were an important input for crop production as most of the soils were deficient in their fertility status. Increases in use of this most important input for better yield may force farm households to be involved more in teff market. This finding is in line with the work of Abafita *et al*., (2016) [1] who found that fertilizer user households produce more and sell more of their output.

Table 5. Second hurdle (truncated regression) result of intensity of teff market participation

Variables	Coef.	Robust Std. Err.	z	P>z
Sex	-1.186517	.9559061	-1.24	0.215
Age	.0269557	.0495428	0.54	0.586
Family Size	-.3089506	.2134191	-1.45	0.148
Cooperative membership	.4047133	.8617989	0.47	0.639
Education level	.6447521***	.2504887	2.57	0.010
Non –farm income(log)	-.0718919	.0447298	-1.61	0.108
Farm size allocated to teff	5.97159***	1.210616	4.93	0.000
Distance from market	-.1046103***	.0282073	-3.71	0.000
Perception on laggeprice	-.4939238	.8841469	-0.56	0.576
Number of oxen	.6060612**	.2969649	2.04	0.041
Livestock excluding oxen	.0381414	.0839133	0.45	0.649
Number of extensions visit	-.0605567	.1140835	-0.53	0.596
Credit use	.0136984	.7868398	0.02	0.986
Chemical fertilizer used	.0249267***	.0069204	3.60	0.000
_cons	4.246396	4.180616	1.02	0.310
/sigma***	3.848801	.2813077	13.68	0.000
Number of observations				128
Truncated observations				62
Wald $\chi 2$ (14), Pr> $\chi 2$				737.77***
Log likelihood				-332.625

Source: model output (2019),
Note: ***, **, * shows 1%, 5%, and 10% significance level

CONCLUSIONS

In Horo district Teff is an essential crop for both consumption and sale. It covers the largest portion of available land and produced primarily for market as a source of income and next for family feed. Teff market participation and level participation were influenced by various factors in the double hurdle model. These are: previous teff price, adult equivalent family size, age of household head, cooperative membership, and education level, farm size allocated to teff, number of oxen owned and chemical fertilizer applied influence farmers' decision to participate in teff marketing. Whereas, land size allocated to teff, family size, distance from nearest market, number of oxen, size of livestock excluding oxen and Chemical fertilizer used were influencing the degree of teff market participation significantly. Finally, based on the outcome of the study, the following points were forwarded: rural education system and family planning program needs to be stronger. Access to market and institutional services as well as supports given to enhance land productivity also needs to be built well through intensifying farm practices through timely and sustainable provision of inputs for

producers and building the capacity of others stakeholders.

REFERENCES

[1]Abafita, J., Atkinson, J., Kim, C.S., 2016, Smallholder Commercialization in Ethiopia: Market Orientation and Participation. International Food Research Journal, 23(4):1797- 1807.
[2]Abayneh, Y., Tefera, T., 2013, Factors influencing market participation decision and extents of participation of haricot bean farmers in Meskan District, Ethiopia. Int J Manag Dev Stud, 2(8):17-25.
[3]Abera, S., 2015, Econometric analysis of factors affecting haricot bean market outlet choices in MisrakBadawacho district, Ethiopia. International Journal of Research Studies in Agricultural Sciences, 2(9): 6-12.
[4]Ademe, A., Legesse, B., Haji, J., Goshu, D., 2017. Smallholder farmers' crop commercialization in the highlands of Eastern Ethiopia. Review of Agricultural and Applied Economics, 20(2): 30 - 37.
[5]Adeoti, A.I., Oluwatayo, I.B., Soliu, R.O., 2014, Determinants of market participation among maize producers in Oyo state, Nigeria. British Journal of Economics, Management and Trade, 4(7):1115-127.
[6]Belayneh, N.G., Tegegne, B., Ademe, A., 2019, Determinants of Smallholder teff Producers Market Participation in Merhabete District, Amhara Region, Ethiopia. International Journal of Agricultural Economics. Vol. 4, No. 4, 2019, pp. 135-143.
[7]Alemu, D., Berhanu, B., 2018, The Political Economy of Agricultural Commercialization in Ethiopia: Discourses, Actors and Structural Impediments. Working Paper WP/14.
[8]CSA (Central Statistical Agency). 2011. Population survey report, Addis Ababa Ethiopia.
[9]CSA (Central Statistical Agency) (2014). Agricultural Sample Survey 2013/2014. Report on area and production of major crops, Addis Ababa.
[10]CSA (Central Statistical Agency). 2016. Agricultural Sample Survey 2015/2016: Report on area and production of major crops, volume-I. Addis Ababa, Ethiopia.
[11]CSA. 2018. Agriculture Sample Survey 2017/2018. Report on Area and Production of Major Crops. Statistical bulletin No.586. Addis Ababa Ethiopia, Volume I
[12]Gebreslassie, T., Bekele, A., 2012, A Review of Ethiopian Agriculture: Roles, policy and small-scale farming systems. Country analysis: Ethiopia and D.R. Congo, 37.
[13]Getahun, A, 2018, Determinants of commercialization and market outlet choices of tef: the case of smallholder farmers in Dendi district of Oromia, central Ethiopia, Haramay University, Ethiopia.
[14]HBOARD (Horro-Buluk Office of Agriculture and Rural Development), 2018.
[15]Kefyalew, G., 2012, Smallholder Farmers Participation in Production and Marketing of Export Potential Crops: The Case of Sesame in Diga District, East Wollega Zone of Oromia Regional State. An MSc Thesis Presented to Addis Ababa University, Ethiopia.
[16]MoARD (Ministry of Agriculture and Rural Development), 2010, Ethiopia Agricultural Sector Policy and Investment Framework: Ten-year Road Map (2010-2020).
[17]MoFED (Ministry of Finance and Economic Development), 2010, Growth and Transformational Plan (GTP 2010-2015). Addis Ababa. Ethiopia.
[18]Musah, A. B., Yawbonsu, O. A, Seini, W., 2014,Market Participation of Smallholder Maize producers in the Upper West Region of Ghana. African Journal of Agricultural Research, 9(31): 2427-2435.
[19]Tadesa, E., 2018, Determinants of commercialization of teff crop in Abay Chomen District, Horo Guduruwallaga zone, Ethiopia. Journal of Agricultural Extension and Rural Development, 12(10): 251-259.
[20]UNDP (United Nation Development Programme), 2016. African EconomicWebsite, https://www.et.undp.org/content/dam/ethiopia/docs/Ethiopia_African%20Economic%20Outlook_2016_WEB.pdf , Accessed on 25/06/2018.
[21]UNDP (United Nation Development Programme), 2018. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2018/04/Ethiopia%E2%80%99s-Progress-Towards-Eradicating-Poverty.pdf, Accessed on 15/07/2018.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

SOCIO-ECONOMIC IMPLICATIONS OF FERTILIZERS USE IN AGRICULTURE - FOOD SECURITY AND SAFETY APPROACHES

Raluca Andreea ION

Bucharest University of Economic Studies, Department of Agro-food and Environmental Economics, 6 Piata Romana, 1st district, Bucharest, 010374 Romania, Phone: +40213131900, Email: raluca.ion@eam.ase.ro

Corresponding author: raluca.ion@eam.ase.ro

Abstract

The article analysis the relationship between the fertilizers use in agriculture and their effects on agricultural output and human health, in the global context of food security and safety and overpopulation. The research question is whether to use fertilizers to increase the agricultural output and ensure food security for a growing population or not, because chemical fertilizers are affecting food safety since they are transmitted through food to human body and they cause health problems. The aim of this paper is to assess the effects of the fertilizers use on human health, using the simple regression model. The main findings show that fertilizers use directly impacts human health. The relevance of the study lies in its capacity to inform people about the effects of the fertilizers use on human health, so they could make informed choices on the food they consume.

Key words**:** *food safety, food security, overpopulation, human health, sustainability*

INTRODUCTION

Nowadays, the relationships between food issues and other global emergencies become more complex in the context of overpopulation, climate change and resource scarcity. Food security and safety are ones of the world problems connected to other related problems [2]: demographic growth, poverty, energy, natural resources, environment, world trade and the monetary system.

Food security, as a global emergency, become a challenge in terms of population growth to 9 billion people expected to be the world inhabitants in 2050 [13]. In this context, agricultural output should increase by 70%, as reported by FAO [5]. Considering that the current agricultural areas are already under cultivation and the attempt to include more areas in agricultural system become a problem for the environment, the solution for increasing the agricultural production is to produce food in intensive systems, using chemical substances, such as fertilizers, in order to obtain higher yields [10].

The chemical substances used in agriculture are fertilizers, pesticides and veterinary medicine substances. They are used to grow yields and to ensure food security for a growing population, but they remain in food as residues, they affect food safety and, as such, human health. Thus, this paper investigates the effects of the fertilizers used in agriculture for obtaining higher agricultural outputs on human health, trying to answer the question whether to use fertilizers to increase yields and ensure food security or not, because chemical fertilizers are affecting food safety since they are transmitted through food to human body and they cause health issues.

Considering this, the research starts from the assumption that fertilizers use in agriculture is in between food security and safety. Ensuring food security and improved nutrition is the double-pronged goal of sustainable development, put forward at the 2030 Agenda for Sustainable Development of the United Nations [16]. While food security has been the topic of debate in numerous reports and scientific papers for many years, food safety has been less explored and analysed. As other author found [11], Romania is a country where macroeconomic indicators show that food security has been achieved, but it still battles with poverty, which leads to imbalanced diets, especially in rural areas.

Under this context, the use of chemical fertilizers is needed, in order to increase the agricultural output and to ensure food security. But fertilizers are transmitted through food into human body and cause health problems.

The objective of the research is to establish the direction and the intensity of the relationships between chemical fertilizers used in agriculture, agricultural output and human health. In pursuing this, statistical data for the three variables are analysed with simple regression model, using informatics programs. The data are retrieved from the FAO statistical databases and the National Institute of Statistic in Romania and they refer to the last fifteen years.

The amounts of chemicals administrated to agricultural crops need to rise in the future, in order to feed 9 million people, as expected to be in 2050. [5] FAO reported that the yearly cereal production will need to increase to about 3 billion tons, from 2.1 billion and meat production will need to increase by 200 million tons to achieve 470 million tons. This increase implies changes in agricultural technology, including fertilizers, pesticides and land uses [1].

The relationships between world emergencies are discussed in many papers: climate change affects food security, food safety and human health, overpopulation and over production putting pressure on natural resources and food security [8], [9]. Food Standard Authority from U.K. classifies the factors affecting food safety into three categories: the food microbiological content, the concentrations of chemical elements and the levels of radiation [7].

This piece of research focuses on the second factor, namely the presence of chemicals in food: fertilizers, pesticide and veterinary medicine residues, natural, environmental and process chemical contaminants, including particulate matter and polluted air. The abundance of pests and weeds, as a result of climate change, modifies the use of chemicals and fertilizers on crops [14]. These changes in technologies lead to higher quantities of chemicals administrated to crops and found, finally, in food [12].

Food can be contaminated by microbial pathogens, parasites, chemical contaminants and bio toxins. Studies [18] estimated that, worldwide, 600 million people fall ill after eating contaminated food and 420,000 die every year. In Romania, 1,694,876 cases of digestive diseases were reported in 2016 [15].

It is estimated that the amounts of chemical substances will raise, considering the need to produce more food for a growing population. They will be found, finally, in food products. These results of the research drive to the need of answering the questions whether there is a relationship between chemical substances used in agriculture, as a result of overpopulation needing more food, and human health? and if yes, what is its direction and intensity?

This paper starts from the hypotheses that H1: Fertilizers use increases agricultural output and ensure food security for a growing population and H2: Changes in fertilizers use as a result of overpopulation needing more food affects food safety and causes health problems.

H1 has been discussed in many papers [3], [4], and the results are obvious – the agricultural output increases as a result of fertilizers use. A report of the WHO [17] sustained that contaminated food causes more than 200 diseases – ranging from diarrhoea to cancers. In this study, digestive diseases are considered for explaining the effects of chemical residues in food to human health.

The paper is structured into four parts. After the introduction, including the problem statement and the research hypotheses, Section 2 presents the methodology and the data, while Section 3 analyses the results of the regression models. Finally, in Section 4, the results are discussed, the hypotheses are validated, and the conclusions are drawn.

MATERIALS AND METHODS

For validating the hypotheses expressed before, the relationships between variables corresponding to the use of fertilizers in

agriculture, to the agricultural output and to human health are analysed.

The variables corresponding to the use of fertilizers in agriculture are the amounts of Nitrogenous (N fertilizers), Phosphorous (P fertilizers) and Potassium (K fertilizers) fertilizers administrated to crops in Romania, in the period 2002-2016. Figure 1 shows the dynamics of the fertilizers use in agriculture. Positive trends can be observed from 2006 to 2016. In 2016, the quantity of N fertilizers stabilized to 25.4 kg, the quantity of P fertilizers to 9.3 kg and the quantity of K fertilizers to 3.2 kg of active substance per hectare of agricultural land.

The variable corresponding to the agricultural output is the level of yields. The maize crop has been chosen, because it occupies the largest areas under cultivation in Romania (2.6 million hectares, out of 8.4 million hectares under cultivation). Its trend is oscillatory in the period under analysis, between 1.7 tons and 4.7 tons per hectare.

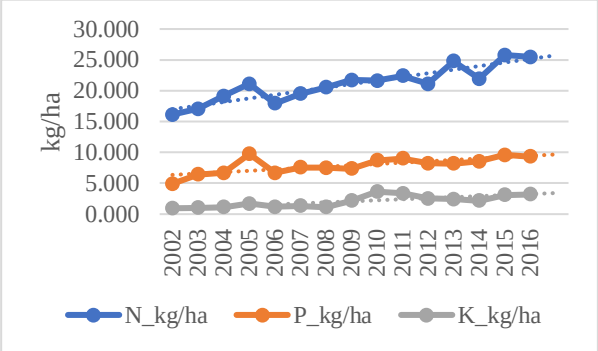

Fig. 1. Dynamics of fertilizers use in agriculture in Romania, 2002-2016 (kg active substance per hectare of agricultural land)
Source: FAOSTAT, 2019 [6].

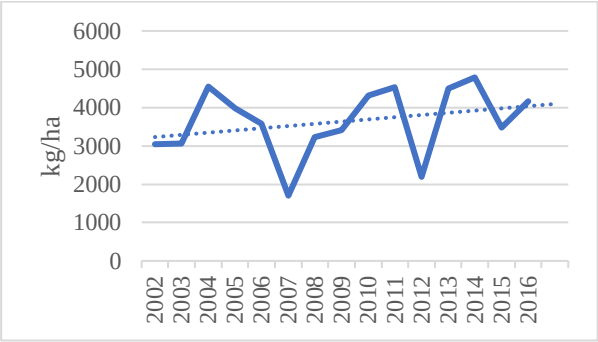

Fig. 2. Maize yield in Romania, 2002-2016 (kg/ha)
Source: FAOSTAT, 2019 [6].

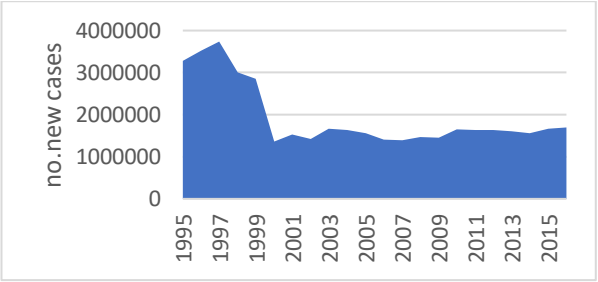

Fig. 3. New cases of digestive disease in Romania, 1995-2016
Source: National Institute of Statistics, Romania.

The variable corresponding to human health is the number of new cases of digestive diseases. Digestive diseases have been considered because it has been demonstrated in a report of the WHO [17] that chemical poisoning, including chemical fertilizers poisoning, may cause nausea, stomach cramps, vomiting, diarrhoea, weakness, headache, confusion, excessive sweating etc. all of these being symptoms of digestive diseases. Data on digestive diseases have been retrieved from the National Institute of Statistic of Romania database (Figure 3).

RESULTS AND DISCUSSIONS

Firstly, the variables are tested for normalization. The results for Digestive diseases are as follows: the mean ($\bar{x}$) registered a value of 1,564,091 new cases, the median (μ) registered 1,610,523 new cases, the maximum (max) registered 1,694,876 new cases, the minimum (min) registered 1,399,424 new cases. The Skewness value is -0.741, meaning that the sample is negatively skewed and strives towards left. The Kurtosis value is 1.6261 and it indicates a normal distribution. The probability is 0.41974, which is greater than 0.05, meaning that the null hypothesis of a normal distribution is accepted.

When testing the variable consumption of N fertilizers, the mean ($\bar{x}$) is 294,194 tons, the median (μ) is 296,055 tons, the maximum (max) is 357,352 tons, the minimum (min) 239,071 tons. The Skewness value of 0.256577 means the sample is positively skewed and strives towards right. The Kurtosis value is 2.1346, indicating a normal

distribution. The probability of 0.7288, which is greater than 0.05, means that the null hypothesis of a normal distribution is accepted.

The results for the variable consumption of P fertilizers are as follows: the mean (x̄) registered a value of 110,284 tons, the median (μ) registered 113,035 tons, the maximum (max) registered 138,137 tons, the minimum (min) registered 72,996 tons. The Skewness value is -0.2925, meaning that the sample is negatively skewed and strives towards left. The Kurtosis value is 2.4442, closed to the value of 3, and it indicates a normal distribution. The probability is 0.8158, which is greater than 0.05, meaning that the null hypothesis of a normal distribution is accepted.

The test of normality for the variable consumption of K fertilizers retrieved the following results: the mean (x̄) is 28,886 tons, the median (μ) is 29,606 tons, the maximum (max) is 51,500 tons, the minimum (min) 14,056 tons. The Skewness value of 0.35772 means the sample is positively skewed and strives towards right. The Kurtosis value is 2.1346, indicating a normal distribution. The probability of 1.73355, which is greater than 0.05, means that the null hypothesis of a normal distribution is accepted. As seen, all the variable tested have a normal distribution.

Secondly, the graphical rendering is tested, in order to have a better perspective over the variables. The graphs for the variables digestive diseases and the use of N fertilizers and the correlogram are presented in Figure 4. It can be noticed that the two variables have registered a likely trajectory. The current dataset has a positive trend, indicating a direct influence of N fertilizers use over the new cases of digestive diseases.

The graphs for the variables digestive diseases and the use of P fertilizers and the correlogram are presented in Figure 5. It can be noticed that the two variables have registered almost the same trajectory. The current dataset has an ascendant trend, indicating a direct influence of P fertilizers use over the new cases of digestive diseases.

The graphs for the variables digestive diseases and the use of K fertilizers and the correlogram are presented in Figure 6. It can be observed that the two variables have registered a likely trajectory. The current dataset has an ascendant trend, indicating a direct influence of K fertilizers use over the new cases of digestive diseases.

Thirdly, the stationarity of the variable is tested. The values of the variable new cases of digestive diseases have been tested using Dickey-Fuller test.

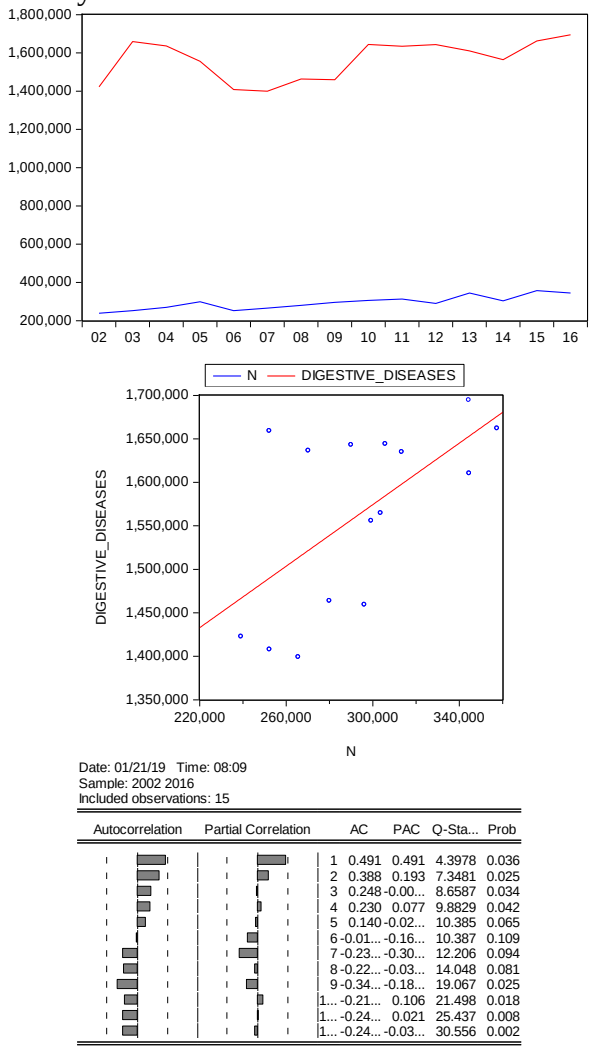

Fig. 4. Correlations between new cases of digestive diseases and the use of N fertilizers
Source: results of the regression model.

The probability of t-statistics is 0.014, bellow 0.05 and the value of t-Statistic is over the three critical values, except 1% value, meaning that the data are stationary. When testing the values of the variable the use of N fertilizers, the probability of t-statistics is 0.0065, bellow 0.05 and the value of t-

Statistic is over the three critical values, meaning that the data are stationary. The values of the variable the use of P fertilizers are tested. The probability of t-statistics is 0.0326, bellow 0.05 and the value of t-Statistic is over the three critical values, except 1% value, meaning that the data are stationary. When testing the values of the variable the use of K fertilizers, the probability of t-statistics is 0.2000, over 0.05, showing a limit of the research.

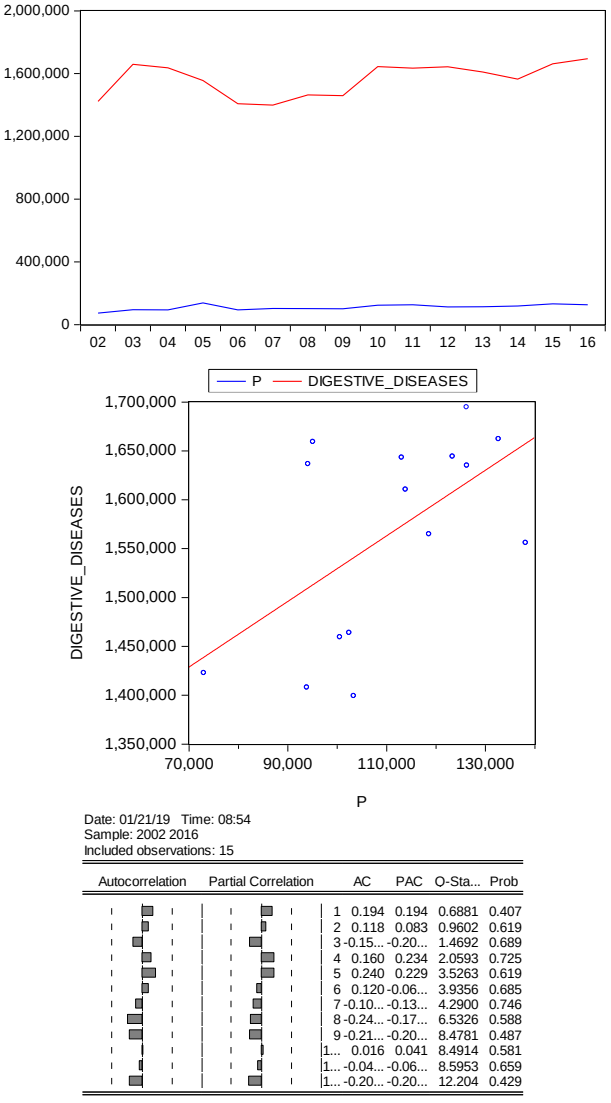

Fig. 5. Correlations between new cases of digestive diseases and the use of P fertilizers
Source: results of the regression model.

The fourth step is to test the causality between variables using the Granger Test. The probability of F-Statistic is 0.3553, higher than 0.05, meaning that there is no causality relation between the variable N fertilizers use and the variable new cases of digestive diseases. When testing the causality between the variable P fertilizers use and the variable new cases of digestive diseases, the probability of F-Statistic is 0.4041, indicating no causality between variables. Finally, when testing the causality between the variable K fertilizers and the variable new cases of digestive diseases, the probability of F-Statistic is 0.8421, meaning that there is no causality relation between variables. For the model's accuracy, there must not be any preexistent causality.

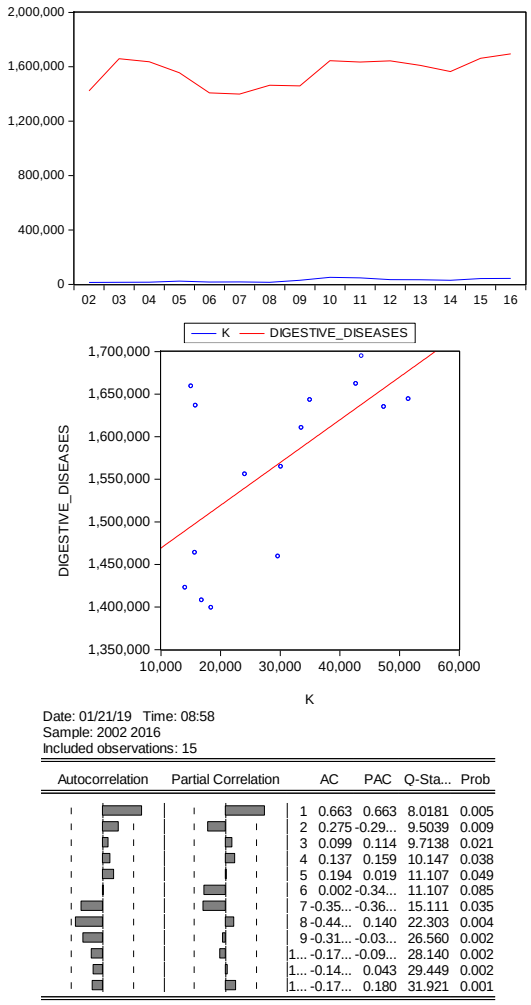

Fig. 6. Correlations between new cases of digestive diseases and the use of K fertilizers
Source: results of the regression model.

The following step is to set up the linear model of simple regression. The probability afferent of F-statistic test is 0.0173 for the variable N fertilizer use and 0.0001 for the constant which are below 0.05 resulting that the model is valid. The R-squared value is

0.364, resulting the low capacity of the independent variable to explain the endogen variable. Durbin – Watson is 1.2844, closed to the value of 2, resulting that the errors are not correlated. The model explaining the relationship between digestive diseases and the use of N fertilizers is: digestive_diseases = 0.603*N, meaning that 1 unit change in the level of N fertilizers use will lead to 0.603 changes in the level of digestive diseases.

When analysing the variables P fertilizers use and the new cases of digestive diseases, the probability of F-statistic test is 0.0270 for the variable P fertilizers use and 0 for the constant, meaning that the model is valid. The value of R-squared is 0.323, resulting the low capacity of the independent variable to explain the dependent one. Durbin – Watson is 1.06, closed to the value of 2, resulting that the errors are not correlated. The model explaining the relationship between digestive diseases and the use of P fertilizers is: digestive_diseases = 0.569*P, which means that one-unit modification in the quantity of P fertilizers use leads to 0.569-unit modification in the number of digestive diseases.

When testing the variables K fertilizers use and the new cases of digestive diseases, the probability of F-statistic test is 0.0133 for the variable K fertilizers use and 0 for the constant, meaning that the model is valid. The value of R-squared is 0.386, resulting the low capacity of the independent variable to explain the dependent one. Durbin – Watson is 1.144, closed to the value of 2, resulting that the errors are not correlated. The model explaining the relationship between digestive diseases and the use of K fertilizers is: digestive_diseases =0.622*K, meaning that one unit change in the level of K fertilizers use will lead to 0.622 unit changes in the level of digestive diseases.

Finally, the model's validity is tested with the heteroscedasticity test, applied for residual values with the White Test probability. The value of the probabilities for F is 0.1155, for Chi-Square is 0.1037 and for the second Chi-square is 0.3288, all above 0.05, meaning that the errors are homoscedastic for the model showing the relationship between N fertilizers use and new cases of digestive diseases. The value of the probabilities for F is 0.3523, for Chi-Square is 0.3021 and for the second Chi-square is 0.6340, all above 0.05, meaning that the errors are homoscedastic for the model showing the relationship between P fertilizers use and new cases of digestive diseases. The value of the probabilities for F is 0.0695, for Chi-Square is 0.0678 and for the second Chi-square is 0.2035, all above 0.05, meaning that the errors are homoscedastic for the model showing the relationship between K fertilizers use and new cases of digestive diseases. The test for the residual values autocorrelation show that the Prob Chi-square is higher than 0.05, meaning that the residues are not correlated in time and the model is valid.

The forecasts for the following period of time (Figure 7) show that the new cases of digestive diseases fall as a result of N and P fertilizers changes, and they remain constant as a result of K fertilizers modification.

The forecasts for maize yields for the following years show that the yield is constant, as a result of N and P fertilizers changes and slightly rises as a result of K fertilizer variability (Figure 8).

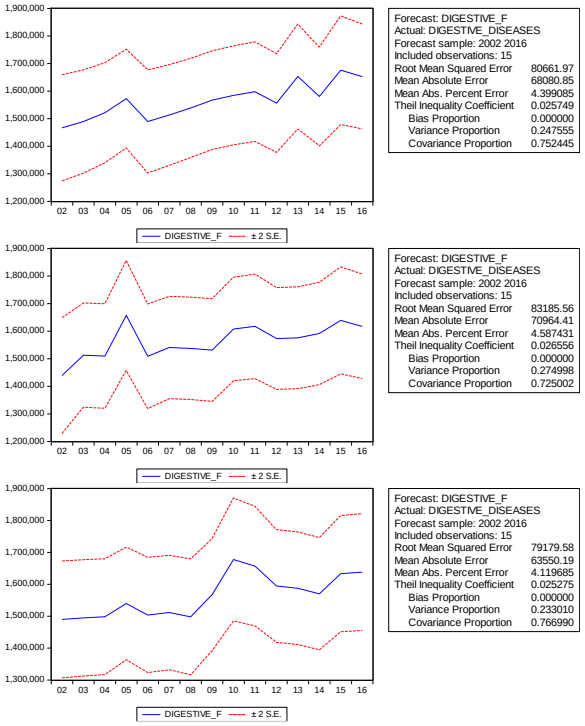

Fig. 7. Forecasts for new cases of digestive diseases, depending on the variability of N, P and K fertilizers' use

Source: results of the regression model.

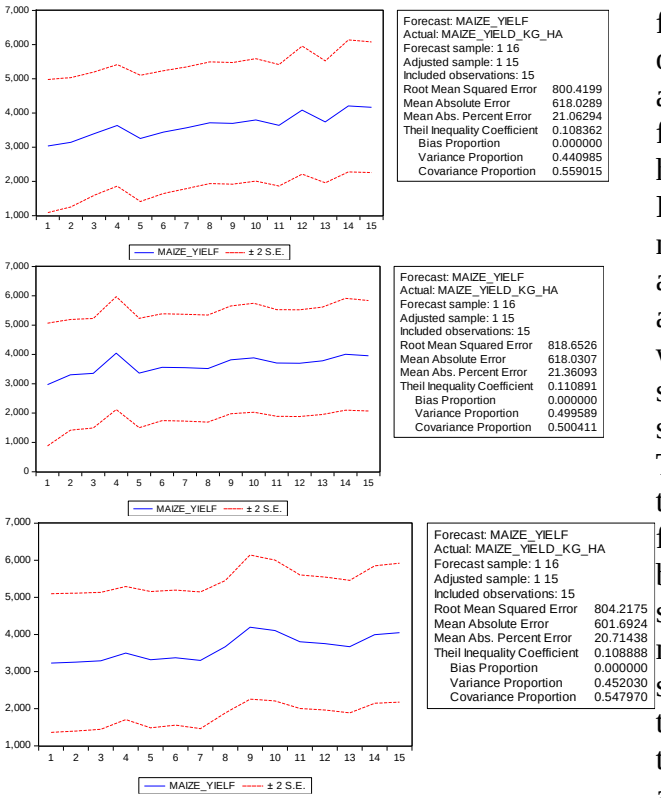

Fig. 8. Forecasts for maize yields, depending on the variability of N, P and K fertilizers' use
Source: results of the regression model.

CONCLUSIONS

Fertilizers use in agriculture impacts human health. The hypotheses of the research, arguing that H1: Fertilizers use increases agricultural output and ensure food security for a growing population and H2: Changes in fertilizers use as a result of overpopulation needing more food affects food safety and causes health problems are validated.

The results are sustained by other reports [17] arguing that diarrheal disease is the most common illness resulting from the consumption of contaminated food, affecting 550 million people to fall ill and 230,000 deaths every year. Moreover, the Food Standards Authority report in 2010 found that the presence of chemicals in food: fertilizers, insecticides, fungicides and herbicides, and veterinary medicine residues, natural, environmental and process chemical contaminants, is a factor affecting food safety.

Bearing in mind the need to increase the agricultural output by 70 percent until 2050, actions are needed to ensure food security so that every human being has access to adequate food. One solution to increase the agricultural output is to encourage and finance the agricultural research that should focus on finding solutions to increase yields without harming the environment or human health. Fertilizers management should be oriented to natural methods and materials, using lower amounts of chemical substances. Smart agriculture, with its machineries equipped with sensors that administrate chemical substances only if needed, could represent a solution for the future.

The relevance of the results lies in the fact that people can make informed choices on food they consume. In Romania this is even a bigger problem with the agricultural products sold on the fresh agricultural producers' markets, where the control of chemical substances administrated to crops are difficult to be done. Bearing in mind that the share of this market in total agricultural output sold on all markets is high, the issue of selling unsafe agricultural products grows in significance.

The research has its limitations. Not all digestive diseases are caused by contaminated food intake. There are other causes for digestive problems. We recommend that future research should consider only those cases of digestive diseases caused by food poisoning.

ACKNOWLEDGEMENTS

This work was supported by a grant of the Ministry of Research and Innovation, CNCS - UEFISCDI, project number PN-III-P4-ID-PCCF-2016-0166, within the PNCDI III project "ReGrowEU - Advancing ground-breaking research in regional growth and development theories, through a resilience approach: towards a convergent, balanced and sustainable European Union".

REFERENCES

[1]Bran, M., 2012, Agro-Biodiversity Between Abundance of Products And Environment Quality, Quality – access to success, 13(S1): 52 – 57.

[2]Bulgaru, M., 2003, Mileniul III. Disperare și speranță, O nouă paradigmă a dezvoltării. [Millennium III. Despair and hope, a new paradigm of

development]. Bucharest: Revista Romana de Statistica.
[3]Dobre, I., Bran, M., 2015, Variant Method - A Tool For Establishing The Relationships Between Wheat And Nitrogen Based Chemical, In 2nd International Multidisciplinary Scientific Conference on Social Sciences and Arts SGEM2015, Book 2, Vol. 3, No. SGEM2015 Conference Proceedings, doi:10.5593/SGEMSOCIAL2015/B23/S7.128.
[4]Dobre, I., Soare, E., 2015, Optimal Resource Allocation in Romanian Farms- analysis of the Mathematical Correlation Between Nitrogen-based Chemical and Corn, Agriculture and Agricultural Science Procedia, 2015, 6: 666-673.
[5]FAO, 2018, How to Feed the World in 2050?, http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf, Accessed on Dec. 5, 2019.
[6]FAO, 2019, FAOSTAT databases.
[7]Food Standard Authority, 2010, Food and Climate change: A review of the effects of climate change on food within the remit of the Food Standards Agency.
[8]Gerlach, C., 2015, Famine responses in the world food crisis 1972–5 and the World Food Conference of 1974, European Review of History: Revue européenne d'histoire, 22(6).
[9]Hoffmann, U., ed, 2013, Trade and Environment Review 2013: Wake up before it is too late: Make agriculture truly sustainable now for food security in a changing climate, Geneva, Switzerland: United Nations Conference on Trade and Development..
[10]Ion, R.A., 2018a, Pesticides Use In Agriculture And Human Health In A Global Context. Evidence From Romania, Proceedings of the International Scientific Conference: Sustainable Agriculture And Rural Development In Terms Of The Republic Of Serbia Strategic Goals Realization Within The Danube Region - support programs for the improvement of agricultural and rural development December, 2018: 701-715.
[11]Ion, R.A., 2018b, Beyond Macroeconomics of Food and Nutrition Security, International Journal of Sustainable Economies Management. 7(4): 13-22.
[12]Ion, R.A., 2018c, Assessment of Climate Change Implications on Food Safety and Human Health, 1st International Conference on Economics and Social Science, The Bucharest University of Economic Studies, Bucharest, April 16-17, 2018.
[13]Ion, R.A., Popescu, D.C., 2013, Population Versus Food In The Context Of Food Security Worldwide, International scientific meeting: Sustainable agriculture and rural development in terms of Republic of Serbia strategic goals implementation within Danube Region, Thematic Proceedings, 557-572.
[14]Miraglia M., Marvin, H.J., & Kleter, G.A, 2009, Climate change and food safety: An emerging issue with special focus on Europe, Food Chemical Toxicology 47: 1009-1021.
[15]National Institute of Statistics, Romania. Tempo online data base. 2018.
[16]UN, 2015, Transforming our world: the 2030 Agenda for Sustainable Development. A/RES/70/1. http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E, Accessed on Nov.2, 2019.
[17]WHO (World Health Organization), 2015, WHO Estimates of the Global Burden of Foodborne Diseases. Geneva: WHO, http://apps.who.int/iris/bitstream/10665/199350/1/9789241565165_eng.pdf?ua=1, Accessed on Nov.2, 2019.
[18]WHO (World Health Organization), 2017, Global Health Observatory data repository. Geneva: WHO. http://apps.who.int/gho/data/node.main.156?lang=en., Accessed on Nov.2, 2019.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

FACTORS FOR SMALLHOLDERS PERSISTENCE IN RURAL MALAYSIA: EVIDENCE FROM RICE FARMING COMMUNITY IN SELANGOR STATE

Khairul Hisyam KAMARUDIN[1], Mohamad Fadhli RASHID[2]

[1]Universiti Teknologi Malaysia, Faculty of Technology and Informatics Razak, Jalan Sultan Yahya Petra, Kuala Lumpur, 54100, Malaysia, Phone/Fax: +60322031350; E-mail: khisyam.kl@utm.my
[2]Universiti Teknologi Malaysia, Faculty of Built Environment and Surveying, 81310 Johor Bahru, Johor, Malaysia, Phone/Fax: +60135156005; E-mail: pku.fadhli@gmail.com

Corresponding author: pku.fadhli@gmail.com

Abstract

This paper examines the factors of smallholders' persistence in the rural area of Malaysia based on a case study of rice farming community in Parit 6 (East) village in the state of Selangor, Malaysia. Information for this paper are derived from in-depth interviews with key informants and series of field observation conducted in July and August 2017. The findings from the fieldwork highlights four major factors for smallholders' persistence which are strongly associated with strong and influential internal and external support systems including; (1) strong engagement and supports from various government agencies which include systematic distribution of subsidy and development grants, and development of irrigation infrastructure, (2) legality of land ownership, (3) farmers' ability in utilizing capital to expand local economic and improve quality of life and, (4) diversification of economic activities through farming and non-farming projects. The paper could offer valuable insights particularly in understanding some of the underlying factors for smallholders' persistence and sustainability particularly in the case of rice farming community in rural areas.

Key words**:** *smallholders, rural, persistence, sustainability, rice farming*

INTRODUCTION

There is an estimation of 500 million small-scale agriculturalists (also known as smallholders) in the world today and majority of them are found in various Asia countries [4], [10]. The stereotypical image of smallholders in Asia, as stated by Elson [1] might best be described as related to greenery of rice paddy fields, whereby old farmers with their wives working under the heat of the sun while their buffalos were relaxingly under a big shaded tree. In reality however, are far more complex. According to Ngah, Saad & Kamarudin [6], smallholder literally means the small size of land holding, but to quantify the size of land considered small is very subjective (and to some extent, become troublesome). In general terms, smallholder agriculture in Malaysia can be attributed primarily to family farming and/or village-based farming activities. Traditionally, when farmers open or clear land for occupation and/or farming, the practice was to divide the parcel of landholdings of around one to two hectares [3].

The traditional practices of land division in Malaysian villages provide some ideas on the size of land holding among smallholders. For instance, in Sabak Bernam, Selangor, the standard lot size of a rice field is 3 acres (1.2 hectares) [7]. Meanwhile, in Parit Tengah, Johor, the Indonesian migrants who opened the village have divided the land parcels into 5 acres (approximately 2 hectares) for each person [6]. With continuity of government intervention in developing smallholders since independence, the official definition did emphasise on those owning agriculture land up to anywhere between four to forty hectares [3].

Thompson [12] used different approach in defining smallholders, i.e. denoted smallholders using few Malay terminological terms including *petani* (farmer), *peladang* (one who works the field), *pekebun* (one who

works the orchard), and *peneroka* (pioneer). The second Malay terminological term is the word *kecil* (small). Prior to merging or adding up these two terms (i.e. farmers and small) hence becoming *pekebun kecil* or *petani kecil* (smallholder). Thompson [12] also highlighted another popular term for smallholders and has been widely portrayed in television dramas, up until children storybook, school textbook and novel describing rural landscape in Malaysia – i.e. rural villager or "orang kampung" (village person).

In the 1960s, classic Malay novel by Shahnon portraying rural scenes in Baling, Kedah describe peasants as poor, with only one or two relung (furnases) (1.42 acres) of paddy land and living in places that lack facilities and infrastructure [11]. The orang kampung was also portrayed as humble and polite, having strong community ties, and living in harmony with nature. The villages in those days had clean running rivers and abundant forest resources, on which peasants depended for income.

A family-based farming system, in some places, as described by Shahnon and Thompson, could remain as a dominant economic activity. While in other places where the commercial agriculture projects emerged and spreading, transforming rural landscape into vast plantation areas. Modernization of rural agriculture sector driven by private entities and/or government link companies with aims at attaining massive production of a purely commercial crop has weakening and marginalizing the already disadvantage rural and traditional smallholders [12].

Despite adversity and gloomy future that they might face, there are some cases of rural communities and smallholders which remain persist and able to sustain their function to serve the community development. To some extent, smallholders have transformed their nature of works and business models by not competing with larger corporations, but to explore niche areas as to maintain viability and survivability of small-scale farming activities including in farming and non-farming projects.

It is quite interesting to learn how smallholders persisted particularly in the context of fast-growing economies such as Malaysia. This paper investigates the factors of smallholders' persistence and transformation in the rural areas of Malaysia based on a case study of rice farming community in Parit 6 (East) village in the state of Selangor. Based on the fieldwork results, the role of various government agencies related to agriculture development is quite prominent in providing a very much needed support and assistance (financial and non-financial) to smallholder, together with other internal factors including the ability of local farmers to diversify their economic base and source of income by having few jobs in agriculture-related projects as well as involvement in non-farming activities.

MATERIALS AND METHODS

Study Area

This study was conducted in Sabak Bernam District, Selangor state. It is worth mentioned that Selangor is the most advanced state in Malaysia and Sabak Bernam is considered as "the least developed district within the most developed state" with large areas predominantly of agriculture land use and having a high percentage of rural population [8]. According to the Department of Statistics, Sabak Bernam District covered an area of 101,700 hectares and inhabited by 108,893 people in 2015 [5] and located 130km from Kuala Lumpur, the capital city of Malaysia. Ngah et al. [7] in their study on rice farming activities in Sabak Bernam elaborated that the district was fast developed and transformed into a major rice cultivation area and among local communities often considered their district as "the rice bowl for the state of Selangor".

The rice farming community which identified and selected as case study is Parit 6 (East) village in Sabak Bernam, Selangor state (Fig. 1). A fieldwork and data collection process were conducted in Parit 6 (East) village in July 2017 and a follow up interview on September 2018. Researchers have interviewed the head of the village to better

understand the history of the village and development of socio-economic activities in the village with particular focus on smallholders' issues and achievements.

Fig.1. Location of Parit 6 (East) village, Selangor state, Malaysia.
Source: Kamarudin & Ngah [3].

Parit 6 (East) village is headed by *Tok Sidang* (head of village) Mohd Yasin. Based on latest village report, Kampung Parit 6 (East) is inhabit by 80 families with population of 280 people. The village is divided into four sub-blocks (or sub-clusters) labelled as E9, E10, E11 and E12 (refer to Fig. 2) and micro management for each block is carried out by block leader and they will be reporting to the head of village. There will be between 50 to 52 rice plots for each block and each rice plot come is size 3 acre. In total, the head of village will be responsible to monitor and regulate all activities in all four blocks or approximately 200 rice plots.

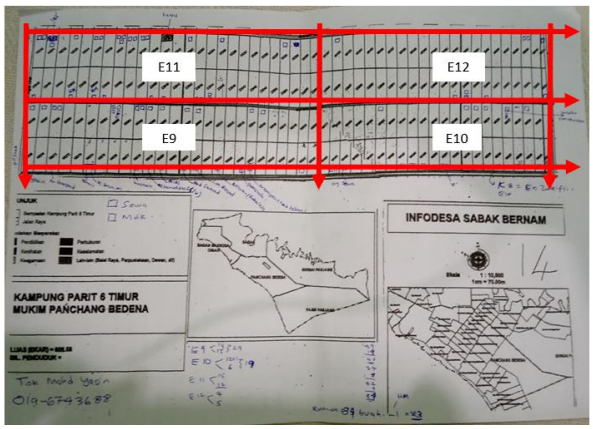

Fig.2. Map showing the four blocks (sub-cluster) of Parit 6 (East) village – labelled as E9, E10, E11 and E12. Each block is led by a block leader.
Source: Research fieldwork [9].

Data Collection and Analysis

This study utilizes qualitative method for data collection and analysis namely; in-depth interview with key informants and field observation. In-depth interviewing is an intensive individual interview process and involves a certain style of social and interpersonal interaction between researcher and respondents [2]. This qualitative research techniques allows for a more detail (in-depth) information and complete picture of situation of smallholders' development and transformation taken place in the study area (site observation) and the underlying factors for their persistence.

Series of random in-depth interviews was conducted with involvement of head of households (HoH) - mainly rice farmers and operators in agriculture-related projects. Researcher refers to the base map initially provided by Tok Sidang and updating the map via field observation (village walkabout) to include the location of each house and public amenities for each sub-block (E9 to E12).

Based on walkabout process, higher concentration of houses located in sub-blocks E9 and E11 because proximity to the main road to Sabak Bernam town centre. In Parit 6 (East) village, a total of 30 smallholders (HoH) were interviewed as respondents and each interview session took about 30 to 45 minutes. As for data analysis, descriptive statistics was used to explain the situations of smallholders in the study area. The qualitative data from field interviews and field observation were integrated into supporting the discussions related to the situations and possible factors which contributed to smallholders' persistence.

RESULTS AND DISCUSSIONS

Profile of Respondents

All respondents (i.e. head of households) interviewed were Malays and consisted of 28 male (93%) and 2 females (7%). As presented in Figure 3, the largest sub-group of respondents is from the age range of 50 to 59 years (43.3%), followed by those of over 60 years (26.4%), and the age range 40 to 49

years at 20%. Younger respondents, aged below 40 years represent 10% of the total respondents. The result indicated a larger percentage of respondents within the age group of 50 years and above with nearly 70% of total respondents.

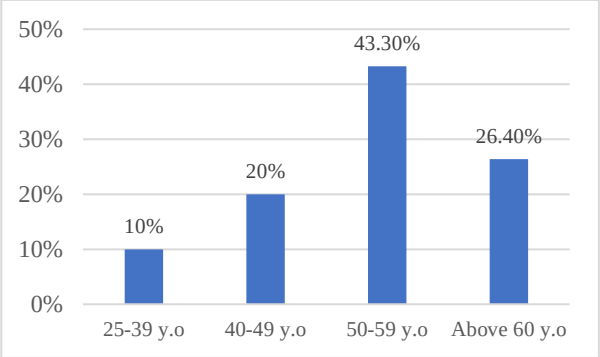

Fig.3. Respondents age categories in Parit 6 (East) village (n=30).
Source: Research fieldwork [9].

Survey results regarding respondents' place of birth and/or origin indicated that majority of respondents were born and raised in the village (83.3%), as compared to only 10% who have moved into the village due to marriage and work requirement (Fig. 4). The remaining 6.7% of the respondents were born and raised at the nearby village with close assess to the study area.

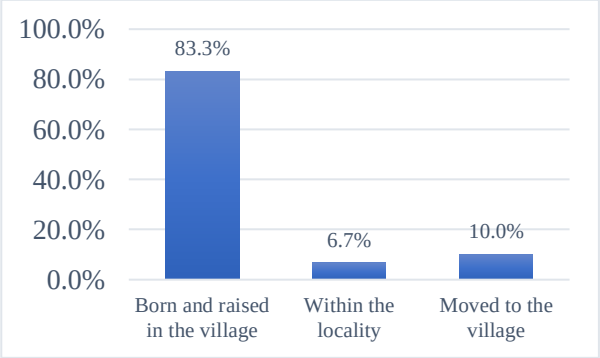

Fig.4. Respondents place of birth (n=30). Source: Research fieldwork [9].

Respondents Occupations

The survey findings (Fig. 5) revealed that there were four main types of jobs in the study area. Approximately 43.3% of the respondents interviewed are involved only in farming activity their main source of income, followed by 26.7% working or having both farming and non-farming activities. There are also two other types of occupation i.e. "involvement in non-farming job" and "farming and agriculture workers, which shared the same percentage of 6.7%. The remaining 16.6% are currently unemployed or not active working mostly due to health issue and they received financial assistance from their children that working somewhere else [9].

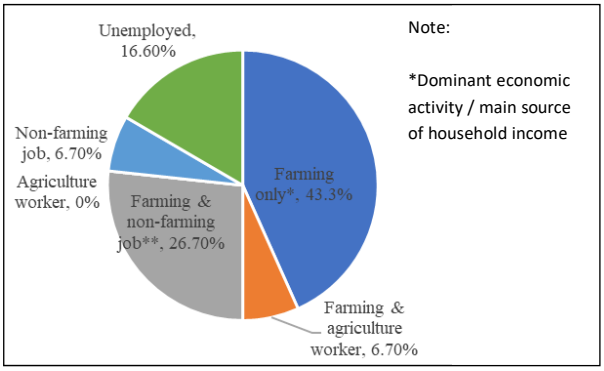

Fig.5. Respondents main occupation (n=30).
Source: Research fieldwork [9].

Land Status and Ownership

Analysis of data has indicated that 70.0% of respondents owned equal/similar acreage of agriculture land i.e. of 3.0 to 5.0 acre of rice plot as compared to other members of the community (Table 1). Meanwhile, only 20.0% are owns smaller land acreage when compared to others and the remaining 10.0% of the respondents possess a slightly bigger land acreage in comparison to others. The results can be interpreted as a positive sign that all respondents in Parit 6 (East) village owned an agriculture land which they can work and/or utilise for socioeconomic activities.

Another interesting result is the renting of agriculture land from other people for rice cultivation, which account for 1/3 (or 33.3%) of respondents in the study area. The interview with the head of village also revealed that many local farmers with strong capitals and manpower resources often rented vacant plots from their neighbors, which in most cases, are the elderly farmers with no capability or successor to continue the rice cultivation process. The rental agreement normally covers a long duration between 6 to 10 cultivation periods (or between 3 to 5 years) [9]. Renting out agriculture land is a preferable choice among ageing farmers since

the practice enable them to receive steady annual income from rental regardless the amount of productivity or income generated by its tenant during the agreement period.

As for land that legally owned by the respondents, the analysis revealed that majority of respondents (66.7%) owned agriculture land of size between 1.0 to 5.0 acre, while the remaining 33.3% owned more than 5.0 acre of land. A point raised by the head of the village had provided a good reference in clarifying the persistent factor for smallholders in Parit 6 (East) village. In this light, the relation to the previous information i.e. ability to rent agriculture land from others indicated the presence of a group of smallholders that expanding rice cultivation activities into a sizeable land hence will enjoy better income per season because they produce more outputs during rice harvesting season [9].

Table 1. Land status and ownership (n=30)

Matters related to land ownership	**Parit 6 (East) village**	
	Frequency	**Percentage**
Bigger land acreage than others	3	10.0%
Equal land acreage with others	21	70.0%
Smaller land acreage than others	6	20.0%
Total	**30**	**100.0%**
Having land renting from others	10	33.3%
Land owned under TOL	0	0.0%
Land occupied without legal right	0	0.0%
Land in the process of application for ownership	0	0.0%
Having abandon land	1	3.3
Land as main source of income	29	96.6%
Earning income from land	29	96.6%
Land legally owned		
None	0	0.0%
Less than 1 acre	0	0.0%
1 to 5 acres	20	66.7%
More than 5 acres	10	33.3%
Total	**30**	**100.0%**

Source: Research fieldwork [9].

Situations of smallholders and contributing factors to their persistence

Based on the in-depth interview, researchers have identified the first factor which contribute towards smallholders' persistence in Parit 6 (Timur) is pertinent role played by various government agencies to ensure rice farmers will receive proper assistance. This factor had been highlighted in the early section of this paper. As mentioned by Tok Mohd Yasin, these agencies have established strong bond and connection with local farming communities of Panchang Bedena, Sungai Besar. Among agencies which playing crucial role is Agriculture Department of Sungai Besar. The agency is functioned for monitoring the overall situation of rice cultivation and farming progress, controlling plant diseases, disseminating aids particularly fertilizers and pesticides under government subsidy scheme and introducing new variations of rice seeds.

Another agency is the Integrated Agriculture Development Agency (IADA) which functioned as provider for physical infrastructure to support and foster rice cultivation process in Panchang Bedena. The main infrastructure project is the building of irrigation system and upgrading the system, and organising specific projects related to rice farming communities. The third agency is Drainage and Irrigation Department of Sungai Besar (DID) which functioned to control the canal or irrigation system, conduct monitoring of flood gates and disseminating irrigation schedule to farming communities before new cultivation season begin.

The second factor is related to legality of land ownership. As a result from cross-reference with all block leaders of Parit 6 (East) village, all rice plots were already given an individual land title. Legality of land will allow all smallholders in Parit 6 village to receive systematic assistance from various government agencies as previously mentioned, and enjoyed subsidy schemes for smallholders. Further observation has been carried out to determine the extent to which the legality of land ownership might shape farmers' well-being and contribute towards the third factor i.e. forming wider opportunity for local wealth creation.

Based on interview, there are some characteristics of local people who we considered as "wealthier farmer" in the village particularly those who earn much higher income than the average of households in the village. First characteristic is the wealthier farmers they owned and/or capable to rent bigger number of rice plots. According to respondents, the operating cost for rice cultivation is relatively high. For instance, an

average cost for a plot (3 acre) is approximately RM3,000 for the owner, and the cost will double for those who renting the plot (RM3,000 for rental and RM3,000 for operating cost). On the other hands, the average gross income per plot per season (6 months) could fetch up to RM10,000, or between RM7,000 to RM4,000 of net income per plot per season. Should a person or a family owned/rented more than one plot, for instance, owner of five rice plots, they should have greater capability to develop the plots with rice cultivation, hence generating more income per season.

In some cases, whereby farmers were unable to cultivate their plots, Local Farmers Association (Pertubuhan Peladang Kawasan) and other local cooperation/associations will step in and offer their service to rent these "soon-to-be abandon plots". In return, the agencies will take some percentages from harvesting to cover wage and other operational costs. This symbiotic relationship between local farmers and agencies is crucial to be maintained for local farmers to address the issue of abandonment of rice plots.

Another characteristic of wealthier farmer is a person with strong capital. Basically, there are three ways a person with strong capital can utilize their financial strength. Firstly, the person himself owned large rice plots and they also a farmer. Having said that, these farmers are capable to invest their money, energy and time in many rice plots. By the end of the season, they will enjoy greater amount of harvest, hence will generate more income per season than those who are farming a smaller number of plots. Secondly, they can rent some of their rice plots to other farmers and keep only few plots for themselves (self-sufficient) and at the same time they also own a company that offer farming services (function similar to farming contractor) to fellow farmers. Their services could include ploughing tractors, harvesting machines, and/or supplying workers.

Thirdly, is through ownership of agriculture land outside the village, particularly a small-scale palm oil plantation. Ownership of palm oil could strengthen farmers' cash flow since income from plantation (harvesting and selling of palm oil fruits) can be carried out on monthly basis. The fourth factor of smallholders' persistence resulted from the field study is someone with diversification of types of jobs, whereby they shall be able to diversify their source of income. For instance, there are farmers who cultivating their own rice plot (or renting other plots) and at the same time offering farming services to fellow farmers during rice cultivation season. Some of them are also creating extra job and earning stable supplementary income by participating in homestay (agritourism projects) and vegetables farming (planting banana, cucumber and pumpkin) to be supplied to local markets (Fig. 6).

Fig.6. Diversification of source of income has largely contributed towards higher monthly earning among farmers in Parit 6 (East) village. Source: Research fieldwork [9].

On contrary to characteristics of wealthier farmer, for local farmer who living at par or below average income of households in the village, and those with less asset and ownership of rice plot (only one plot, or sharing the plot due to inheritance issue) often be associated with low income and poverty. To sustain their livelihood, some of them make a living by working in their rice plots and at the same time they will engage with local contractor as contract workers for different rice plots. Should they have free time or when work at the rice farm is less, some of them work at local palm oil plantation and/or at construction site. This is because the nature of rice farming that only provide income to farmers after 6 months i.e. after harvesting/selling of rice. Therefore, within that 6 months, many of these "average or poor farmers" utilize their time and energy with various type of jobs. Beside lack of land ownership is a characteristic of poor farmer,

there is another group of household that is currently living at par of below average village income namely the single mothers that not only owned less rice plot but they also worker at rice plots with low wages (because they have to divide time for working and to take care of family).

CONCLUSIONS

From the beginning of this study, author has encountered some difficulties to clarify and define smallholder which across Malaysia, retain the image and perception of small family farms or of small-scale, community-centric village agriculture. Throughout the study of which this paper is a product, smallholder wanted to be addressed as small-scale farming with a vital part to play in rural agricultural sector everywhere across the nation. The rice farming community in Selangor state which selected as the case study in this paper demonstrate that smallholders remain a vital part of agriculture and, even more so, in rejuvenating rural society. Yet beyond this it is also evident that the important role played by many government agencies in assisting the transformation of smallholders in Malaysia in general, and in Parit 6 (East) village in particular. There is no doubt that the government is committed to continue the process of modernizing the agriculture sector, and smallholders.

It is also evident in case of Parit 6 whereby the majority of smallholders remain determined to maintain landholdings, regardless of the challenges they face. Aging farmers might limit some of them from working full-time on the farm. However, there was a great opportunity for farmers to generate income via rental of rice plots, or in other words, they will keep land ownership for future generation rather than sell it to the highest bidders. Smallholders will also benefit from the arrival of enthusiast newcomers that could be along new ideas and innovative approaches in making agriculture sector more profitable and create attractive jobs for youths including in agritourism and small and medium enterprises, and the government's continuous effort to provide assistance and targeted subsidies.

ACKNOWLEDGMENTS

The author would like to thank Assoc. Prof. Dr. Eric C. Thompson from the National University of Singapore (NUS) for funding this study under research grant titled "Asian Smallholder: Transformation and Persistence" (R-111-E00-147-112). Sincere appreciations to TPr. Dr. Ibrahim Ngah of Universiti Teknologi Malaysia for monitoring and guiding the fieldwork and data collection process in Parit 6 (East) village and for making the publication of this research project possible.

REFERENCES

[1]Elson, R.E, 1997, The End of the Peasantry in Southeast Asia: A Social and Economic History of Peasant Livelihood, 1800-1990s, Palgrave Macmillan, London.

[2]Johnson, J.M., 2002, In-depth interviewing, in: Gubrium, J.F., Holstein, J.A. (Eds.), The Sage Handbook of Interview Research, Sage Publication, London, p. 103-120.

[3]Kamarudin, K.H., Ngah, I., 2018, Smallholders Transformation and Persistence in the Fast-Growing Economies of Malaysia, Association of Asian Studies (AAS) Annual Conference 2018, March 22-25, Washington D.C: Marriot Wardman Park Hotel.

[4]Lowder, S.K., Jakob, S., Terri, R., 2016, The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide, World Development, 2016, 87, 16-29.

[5]MDSB Sabak Bernam District Council / Sabak Bernam Municipal Council), 2015, 2015/2016 Annual Report, MDSB Publication, Sabak Bernam (Majlis Daerah Sabak Bernam/ Sabak Bernam Municipal Council), 2015, Laporan Tahunan 2015/2016, Penerbitan MDSB, Sabak Bernam).

[6]Ngah, I., Saad, H., Kamarudin, K.H., 2013, Socio Economic Transformation of Rice Cultivation Area in Sabak Bernam, Malaysia, The 4th Rural Research and Planning Group (RRPG) Workshop and Annual Meeting, "Rural Transformation and Institutional Development", 9-10 September 2013, ITB Bandung.

[7]Ngah, I., Kamarudin, K.H., Thompson, E.C., Rashid, M.F., 2018, Smallholders Transformation and Persistence in the Fast Growing Economies of Malaysia. The International Conference Sustainable Rural & Regional Development, December 2018, Magelang City.

[8]PLANMalaysia (Department of Town and Country Planning Malaysia), 2015, Draft Selangor State Structure Plan 2035, (Deraf Rancangan Struktur Negeri Selangor 2035), JPBD Selangor, Shah Alam.
[9]Research Fieldwork in 2017.
[10]Samberg, L.H., James, S.G., Ramankutty, N., Herrero, M., Paul, C.W., 2016, Subnational Distribution of Average Farm Size and Smallholder Contributions to Global Food Production, Environmental Research Letters, 11(12):1-12.
[11]Shahnon, A., 2008, Weltanschauung A Creative Journey (Weltanschauung Suatu Perjalanan Kreatif), DBP Publications, Kuala Lumpur.
[12]Thompson, E.C., 2007, Unsettling Absences: Urbanism in Rural Malaysia, NUS Press, Singapore.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

HERITABILITY OF TRAITS OF THE TYPE LINEAR ASSESSMENT AND THEIR GENETIC ASSOCIATION WITH COW'S MILK YIELD OF UKRAINIAN DAIRY BREEDS

Leontii KHMELNYCHYI, Victoria VECHORKA, Anatolyi SALOHUB, Serhii KHMELNYCHYI, Igor RUBTSOV

Sumy National Agrarian University, Department of Animal Breeding and Selection and Aquatic Bioresources, 160, H. Kondratiiev St., Sumy, Ukraine, Emails: khmelnychy@ukr.net; vvvechorka@gmail.com; salogyb_a_m@ukr.net; serhiokh@ukr.net; rubtsov_igor@mail.ru

Corresponding author: khmelnychy@ukr.net

Abstract

The heritability of linear type traits and phenotypic correlations between them and milk yield of cows of Ukrainian Red-and-White (URW) and Black-and-White (UBW) dairy breeds was evaluated. Cows firstborn were estimated on the 100-point scale by such group traits: dairy type, body, limbs, udder and final score. 18 individual descriptive traits have been taken into account on a 9-point scale. By reliable significance confirmed sufficient degree of genetic determination group and most descriptive linear traits of URW cows (h^2 = 0.288-0.426 and h^2 = 0.161-0.422) and UBW (h^2 = 0.262-0.453 and h^2 = 0.128-0.434) testifying about feasibility and efficiency of mass selection dairy cattle by conformation. A reliable level (P <0.001) of positive correlation was determined between traits of dairy type URW and UBW (r = 0.412 and 0.468), body (r = 0.433 and 0.487) and udder (r = 0.453 and 0.474) and milk yield for 305 days of lactation. A reliable positive correlation was found between the final score and the yield value (r = 0.465 and 0.494). Lower correlation was found between limb condition and milk yield in URW and UBW cows, respectively (r = 0.122; P <0.01 and r = 0.205; P <0.001). Positive genetic association with milk yield was determined by the following descriptive traits of the type in URW and UBW, respectively: height (r = 0.312 and 0.278), body depth (r = 0.288 and 0.404), angularity (r = 0.504 and 0.486), rump width (r = 0.252 and 0.374), pelvic limb posture (r = 0.354 and 0.384), front udder attachment (r = 0.466 and 0.455), rear udder attachment height (r = 0.325 and 0.373), central ligament (r = 0.278 and 0.267) and locomotion (r = 0.286 and 0.275). A negative and reliable correlation was found between the trait of fatness (BCS) and yield, which was -0.366 and -0.389, respectively (P <0.001). Reliable correlation variability of group and most descriptive conformation traits with milk yield for the first lactation confirmed the possibility of unilateral breeding of dairy cattle by type.

Key words**:** *correlation, conformation traits, linear type estimation, Ukrainian Red-and-White dairy breed, Ukrainian Black-and-White dairy breed*

INTRODUCTION

The success of breeding in dairy cattle by conformation largely limited by degree of heritability - the relative proportion of genetic variability in the overall phenotypic diversity of body parts of conformation type such population. Since quantitative traits that have been determined by polymeric (additive) genes inherited by intermediate type, selection for them was significantly complicated. Linear traits of dairy cattle type belong to quantitative traits of polygenic heritability, so the efficiency of selection aimed at genetically improving the population of animals by conformation will largely depend on their degree of heritability (Burkat et al., 2004; Polupan, 2007; Dubin, 2006) [4, 6, 23].

Heritability coefficients have always been a mandatory component in determining selection indexes of breeding value. Their use in practical breeding allowed breeders faster will reach its goal, provided purposeful selection of animals according to indicators of conformation traits with high heritability coefficients (Burkat et al., 2004; Gritsenko, 2005) [4,10]. When calculating the heritability coefficient always determined only that portion of genetic variance, which was due to the additive effect of genes and the basis for all breeding programs. When conducting in-depth selection and breeding work, was necessary to clearly know the proportion of

genotype influence and environment on the formation of each trait - from the total variability of traits was necessary to exclude the impact of environment. Thus, the animal's genotype determined the body's response to environmental conditions, that is, not finished level of trait development, but the norm of genotype reaction to environmental conditions was inherited by descendants. Conditions have changed - the reaction norm will inevitably change. So, heritability has always manifested itself in specific conditions. Outside the environment, heritability is only an abstract concept.

Holstein Association USA experts believe that the heritability of 0.10 and below should not expect significant genetic progress. Heritability of individual and group traits of linear estimation Holstein breed cows for type according to their report (Linear type evaluations, 1999) ranging from 0.11 to 0.42, which gives reason to expect the possibility of effective selection for conformation [21].

Numerous studies of dairy cows estimated by linear classification method revealed a wide range of variability of heritability coefficients for group as well as by individual descriptive traits of the conformation. The width of variability spectrum of the values heritability coefficients of linear body parts of conformation and udder was recorded from quite low ($h^2 = 0.04$) to very high ($h^2 = 0.74$), depending on the influence of paratype factors, the degree of herd consolidation by conformation, efficiency of selection of bull-sires estimated by conformation type of their daughters, breed and method of calculation (Burkat et al., 2004; Furaeva, 2014; Shuklina et al., 2015; Boyko et al., 2015; Gritsenko, 2005; Eaglen et al., 2013) [3, 4, 7, 9, 10, 28].

The effectiveness of selection substantially depended on an equally important parameter of population genetics - correlation. About breeding importance of the association between linear traits of the conformation and milk productivity was well known from the research results. (Burkat et al., 2004) [4]. Breeding efficiency increasing significantly when there is a high degree of positive correlation between two traits. For example, between milk yield and height (r = 0.388) (Shevchenko, 2012) [27], rear posture (r = 0.349), rear width (r = 0.244) (Devyatkina et al., 2010) [5], attachment front udder parts (r = 0,38), teats length (r = 0.74) (Efimova et al., 2017)[8], body depth (r = 0.326) (Khmel'nychyi et al., 2017) [15], angularity (r = 0.377), pelvic limbs posture (r = 0.392), locomotion (r = 0.355) (Khmel'nychyi et al., 2012) [16], rear udder parts width (r = 0.30) (Smotrova et al., 2019) [29]. The situation changed if they dealing with two desirable traits, between which there was a negative correlation. For example, between milk yield and hoof angle (r = -0.40), central ligament (r = -0.06) (Efimova, et al., 2017) [8], udder depth (r = -0.47) (Eaglen et al., 2013) [7], body condition score (r = -0.211) (Khmel'nychyi et al., 2012) [16], rump position (r = -0.09) (Smotrova et al., 2019) [29]. In this case should lead the selection by two traits that will deter in some extent the effect of selection.

Given the importance of heritability of the conformation linear traits and their association with milk yield in the breeding system of dairy cattle of Ukrainian dairy breeds, we have been tasked to investigate these significant population-genetic parameters.

MATERIALS AND METHODS

Research were conducted in herds of breeding farms of Cherkasy and Sumy regions of Ukraine for breeding cows of Ukrainian Red-and-White (n=895) and Black-and-White (n=1,155) dairy breeds.

Cows firstborn were estimated using method of linear classification (Khmelnychyi et al., 2008) [13] according to the latest ICAR guidelines (Eaglen et al., 2013) [7] at the age 2-4 months after calving on two systems, 9-point, with a linear description of 18 conformation body parts, and a 100-point scale based on four groups of linear conformation traits.

The assessment on the 9-point scale consisted of linear description of 18 conformation body parts: animal height (AH), chest width (CW), body depth (BD), angularity (A), rear posture

(RP), rear width (RW), hock angle (HA), pelvic limb posture (PLP), hoof angle (HA), attachment front udder parts (AFUP), attachment height rear udder parts (AHRUP), central ligament (CL), udder depth (UD), front teats position (FTP), rear teats position (RTP), teats length (TL), locomotion (L), and body condition score (BCS). The average expression of trait was evaluated in five points, deviation in the direction of impairing development decreased the score (minimum number of points - 1), provided improving development of trait to the desired, the score increased to 9 points.

According to a 100-point classification system, the assessment was carried out visually, taking into account four complexes of breeding features characterizing: dairy type expression, body development, condition of limbs and morphological udder qualities. The complex of features included linear body parts that were functionally interconnected. Each conformation complex was estimated independently and had its own significant coefficient in the overall assessment of animals: dairy type (DT) - 15%, body (B) - 20%; limbs (L) - 25% and udder (U) - 40%.

The total type assessment was determined by the formula:

$$FS = (DT \cdot 0.15) + (B \cdot 0.20) + (L \cdot 0.25) + (U \cdot 0.40)$$

The coefficient of linear phenotypic correlation was determined by the Pearson formula:

$$r_{xy} = \frac{\Sigma(x_i - \bar{x}) \times (y_i - \bar{y})}{\sqrt{\Sigma(x_i - \bar{x})^2 \times \Sigma(y_i - \bar{y})^2}}$$

where: x_i – value for variable *X;*
y_i – value for variable *Y;*
$\bar{x}$ – average for *X;*
$\bar{y}$ – average for *Y.*

The heritability (h^2) of linear traits was evaluated as calculating the father's influence force indicator (η_x^2) in a one-factor variance complex (Plohinskij, 1964) [22] according to the formula:

$$h^2 = \eta_x^2 = \frac{C_x}{C_y}$$

where:
C_x – factorial variance;
C_y – total variance.

The reliability of obtained data was evaluated by calculating the errors of statistical values (*S.E.*) and Student's reliability criteria (td) for correlation analysis and Fisher (F) for variance analysis. The probability level was classified by comparison with standard criteria values. The results were considered statistically significant for the first – P <0.05 ([1]), the second – P <0.01 ([2]), and the third – P <0.001 ([3]) probability thresholds. Statistical processing of experimental studies was performed by the methods of mathematical statistics using formulas given by (Merkur'eva, 1970) [17] in Microsoft Excel.

RESULTS AND DISCUSSIONS

Determined values of heritability coefficients of the conformation traits of Ukrainian Red-and-White and Black-and-White dairy breeds were higher than in other studies (Salohub et al., 2010; Salohub et al., 2011; Furaeva, 2014; Bohlouli et al., 2015) [2, 9, 24, 25] (Table 1). Heritability coefficients of the conformation complexes of Ukrainian Red-and-White dairy breed did not significantly differ in the degree of variability and value compared to peers of Ukrainian Black-and-White. This was especially true of group traits that characterize dairy type of cows (h^2 = 0.435 and 0.453), udder (h^2 = 0.426 and 0.432), and final score (h^2 = 0.417 and 0.423). This level of additive genetic influence allowed obtain sufficient breeding effect as a result of animals selection on group linear traits of type.

Descriptive traits differed by higher variability, which ranged in animals of Ukrainian Red-and-White dairy breed from 0.154 (hoof angle) to 0.422 (angularity) and in animals of Ukrainian Red-and-White dairy cattle from 0.128 (udder depth) to 0.34 (angularity). The results obtained coincide with similar ones in the studies of dairy breeds of different breeding countries (Furaeva, 2014; Kern et al., 2014; Shuklina et al., 2015; Karymsakov, 2019) [9, 11, 12, 28].

At the same time, the obtained level of heritability coefficients for the most important traits, which positively correlated with milk yield (height, body depth, angularity, rump width, front and rear udder attachment, central ligament and locomotion), allowed to expect a selective improving effect of the conformation in the result of selection.

Table 1. Heritability (h^2) linear conformation traits of firstborn cows of Ukrainian Red-and-White and Black-and-White dairy breeds and their correlation (r) with milk yield for 305 days of lactation

Linear type traits	Ukrainian Red-and-White Dairy breed		Ukrainian Black-and-White Dairy breed	
	h^2	r	h^2	r
Traits that characterize: Dairy type	0.435[3]	0.412[3]	0.453[3]	0.468[3]
Body	0.321[3]	0.433[3]	0.294[3]	0.487[3]
Limbs	0.288[2]	0.122[2]	0.262[2]	0.205[3]
Udder	0.426[3]	0.453[3]	0.432[3]	0.474[3]
Final Score	0.417[3]	0.465[3]	0.423[3]	0.494[3]
Stature	0.337[3]	0.312[3]	0.365[3]	0.278[3]
Chest Width	0.241[3]	0.096[1]	0.279[3]	0.101[1]
Body Depth	0.311[2]	0.388[3]	0.282[2]	0.404[3]
Angularity	0.422[3]	0.504[3]	0.434[3]	0.486[3]
Rump Angle	0.268[3]	0.083	0.237[2]	0.082
Rump Width	0.286[2]	0.352[3]	0.251[2]	0.374[3]
Rear Legs Side view	0.161[1]	0.133[1]	0.131[1]	0.133[1]
Rear Legs Rear view	0.194[1]	0.354[3]	0.172[2]	0.384[3]
Hoof angle	0.154[1]	0.127[1]	0.133[1]	0.086
Front Udder Attachment	0.387[3]	0.466[3]	0.384[3]	0.455[3]
Rear Udder Parts Height	0.285[2]	0.325[3]	0.278[2]	0.373[3]
Central Ligament	0.277[2]	0.278[3]	0.285[2]	0.267[3]
Udder Depth	0.207[1]	-0.075	0.128	-0.084
Front Teat Position	0.277[2]	-0.212[2]	0.232[2]	-0.177[2]
Rear Teat Position	0.263[2]	-0.089[1]	0.217[2]	-0.135[1]
Teat Length	0.313[3]	-0.083	0.277[3]	-0.074
Locomotion	0.322[3]	0.286[3]	0.304[3]	0.275[3]
Body condition score	0.223[3]	-0.366[3]	0.235[2]	-0.389[3]

Note: [1] - $P < 0.05$; [2] $P < 0.01$; [3] $P < 0.001$
Source: Own calculations.

Lower heritability coefficients by descriptive traits that characterize limbs and level of their reliability in animals of evaluated breeds showed low efficiency of selection at this stage of breeding on these sufficiently substantive traits, which significantly influenced the duration of productive use of cows in industrial conditions (Zavadilová et al., 2009; Sawa et al., 2013; Khmel'nychyi and Vechorka, 2018) [14, 26, 30].

From the beginning of linear classification methodology, evaluation of cows by conformation type was based on the correlative variability of the development of individual body parts and group traits of the conformation with features of milk productivity, economic use, productive longevity, reproductive ability and health. The level and direction of association between type assessment and economically useful traits made it possible to navigate the

selection situation in the herd or breed, to determine the prospect of selection in order to improve the conformation of dairy cattle animals. These factors lead to numerous studies aimed at identifying such associations.
According to results of research found sufficient level for effective breeding of cows, of estimated URW and UBW breeds by type and a highly reliable level (P <0.001) of positive correlation between group traits characterizing dairy type of cows (r = 0.412 and 0.468), body development (r = 0.433 and 0.487) and morphological udder traits (r = 0.453 and 0.474) and milk yield per lactation. A significant positive correlation was also found between the final type score and the yield value (r = 0.465 and 0.494). A slightly lower correlation existed between limb condition and milk yield in URW and UBW cows, respectively (r = 0.122; P <0.01 and r = 0.205; P <0.001).
An important condition of ICAR (Ladyka et al., 2010) [19] is that each of approved linear traits should describe a unique cow body part that was not described in combination with other linear traits. These traits are called descriptive. The variability of correlations between the assessment of descriptive body parts and milk yield was significantly different from groups, but for most of them it was positive with high reliability.
Positive genetic association with milk yield was observed by the following conformation descriptive traits of estimated URW and UBW cattle: height (r = 0.312 and 0.278), body depth (r = 0.288 and 0.404), angularity (r = 0.504 and 0.486), rear width (r = 0.252 and 0.374), pelvic limbs posture (r = 0.354 and 0.384), front udder attachment (r = 0.466 and 0.455), rear udder attachment height (r = 0.325 and 0.373), central ligament (r = 0.278) and 0.267) and locomotion (r = 0.286 and 0.275). Negative and reliable correlation was found between the BCS trait (fatness) and milk yield, which was -0.366 and -0.389, respectively (P <0.001). The existence of a negative link between BCS (fatness) and milk yield has been reported in other studies on dairy cattle (Berry et al., 2004; Zink et al., 2014; Ladyka et al., 2017) [1, 18, 20, 31]. Thus, the genetic association of descriptive linear traits of the conformation with dairy productivity was one of the main factors for successful selection of dairy cattle.

CONCLUSIONS

The results obtained by linear classification of firstborn cows of Ukrainian Red-and-White and Black-and-White dairy breeds, reliable heritability coefficients of group and descriptive traits indicating about the perspective of efficiency animal selection by conformation.
Reliable positive correlation between group and most descriptive traits of linear classification and level of yield per lactation was determined in firstborn cows of the control breeds, indicating about effectiveness of breeding animals by conformation type, which will directly affect to increase their milk productivity.

REFERENCES

[1]Berry, D.P., Buckley, F., Dillon, P., Evans, R.D., Veerkamp, R.F., 2004, Genetic relationships among linear type traits, milk yield, body weight, fertility and somatic cell count in primiparous dairy cows. Irish Journal of Agricultural and Food Research 43: 161–176.
[2]Bohlouli, M., Alijani, S., Varposhti, M. R., 2015, Genetic relationships among linear type traits and milk production traits of Holstein dairy cattle. Ann. Anim. Sci., 15(4): 903–917.
[3]Boyko, O.V., Sotnichenko, Yu.M., Tkach, Ye. F., 2015, Uspadkuvannya ta spivvidnosna minlyvist statey eksteryeru koriv molochnykh porid [Heritability and correlation variability of the conformation traits cows of dairy breeds]. Breeding and genetics of animals, Issue 49, pp. 69–76.
[4]Burkat, V.P., Yu. P., Polupan, I.V. Yovenko, 2004, Liniyna otsinka koriv za typom [Linear estimation of cows by type]. Agrarian science, pp. 88.
[5]Devyatkina, G.S., Molchanova, N.V., Sel'tsov, V.I., Sulima, N.I., 2010, Lineynaya otsenka korov cherno-pestroy porody i ee svyaz' s molochnoy produktivnost'yu [Linear estimation of cows of Black-and-White breed and its association with milk productivity]. Bulletin of Peoples' Friendship University. Series: Agronomy and Livestock, issue 2, pp. 59-64.
[6]Dubin, A.M., 2006, Populiatsiino-henetychni osnovy v selektsii velykoi rohatoi khudoby za typom budovy tila [Population-genetic bases in breeding cattle by body type]. Lugansk: "Elton", pp. 247.

[7]Eaglen, S.A.E., Coffey, M.P., Woolliams, J.A., Wall, E., 2013, Direct and maternal genetic relationships between calving ease, gestation length, milk production, fertility, type, and lifespan of Holstein-Friesian primiparous cows. J. Dairy Sci., 96:4015–4025.

[8]Efimova, L.V., Kulakova, T.V., Ivanova, O.V., Ivanov, E.A., 2017, Vzaimosvjaz' mezhdu priznakami linejnoj ocenki jekster'era i molochnoj produktivnost'ju korov [The relationship between the traits of linear assessment of the conformation and milk production of cows]. Bulletin of Novosibirsk State Agrarian University, Issue 3(44), 115–124.

[9]Furaeva, N.S., 2014, Osobennosti ekster'era molochnogo skota yaroslavskoy porody. Vestnik APK Vekhnevolzh'ya [Features of the conformation of dairy cattle of Yaroslavl breed]. Bulletin of agricultural sector of the Upper Volga, Issue 4 (28), pp. 44-49.

[10]Gritsenko, S.A., 2005, Nasleduemost' razlichnykh khozyaystvenno-poleznykh priznakov korov cherno-pestroy porody zony Yuzhnogo Urala [Heritability of various economically useful traits of Black-and-White cows of the southern Urals zone]. News of the Orenburg State Agrarian University, Issue 8(1), pp. 76–79.

[11]Karymsakov, T.N., 2019, Fenotipicheskie i geneticheskie pokazateli ekster'ernykh priznakov golshtinizirovannogo molochnogo skota Kazakhstana [Phenotypic and genetic features of the conformation traits of holsteinized dairy cattle in Kazakhstan]. Scientific notes of Kazan State Academy of Veterinary Medicine named after N.E. Bauman, V. 240(4), pp. 101-105.

[12]Kern, E.L., Cobuci, J.A., Costa, C.N., McManus, C.M., Campos, G.S., Almeida, T.P., Campos, R.V., 2014, Genetic association between herd survival and linear type traits in Holstein cows under tropical conditions. Italian J. Animal Science.13:3419.

[13]Khmelnychyi, L.M., Ladyka, V.I., Polupan, Yu.P., Salohub, A.M., 2008, Metodyka liniinoi klasyfikatsii koriv molochnykh i molochno-miasnykh porid za typom [The method of linear classification cows of dairy and dairy-beef breeds by type]. Sumy: “Mriya–1”, pp. 28.

[14]Khmel'nychyi, L.M., Vechorka, V.V., 2018, Vplyv otsinky liniynykh oznak typu, yaki kharakteryzuyut' stan kintsivok, na tryvalist' zhyttya koriv ukrayins'kykh chervono-ryaboyi ta chorno-ryaboyi molochnykh porid [Impact of assessment linear type traits characterizing condition of limbs, on longevity cows of Ukrainian Red-and-White and Black-and-White dairy breeds*]*. Bulletin of Sumy National Agrarian University. Series "Animal Husbandry", Issue 2(34), pp. 20–26.

[15]Khmel'nychyi, L.M., Salohub, A.M., Khmel'nychyy, S.L., Loboda, A.V., 2018, Spivvidnosna minlyvist' ta uspadkovuvanist' liniynykh oznak ekster"yeru koriv sums'koho vnutrishn'oporodnoho typu ukrayins'koyi chorno-ryaboyi molochnoyi porody [Correlative variability and heritability of conformation linear traits cows of Sumy intrabreed type of Ukrainian Black-and-White dairy breed]. Bulletin of Sumy National Agrarian University. Series: "Animal husbandry", Issue 2(34), 92–96.

[16]Khmel'nychyi, L.M., Shkurat, A.O., Khmel'nychyi, S.L., 2012, Populyatsiyno-henetychni parametry liniynykh oznak ekster"yeru koriv otsinenykh za metodykoyu liniynoyi klasyfikatsiyi [Population genetic parameters of linear conformation traits of cows estimated by the method of linear classification]. Scientific Bulletin "Askania-Nova". "PIEEL", Issue 5(2), 166–175.

[17]Merkur'eva, E. K., 1970, Biometriya v selektsii i genetike sel'skokhozyaystvennykh zhivotnykh [Biometrics in the selection and genetics of farm animals]. M.: Kolos – Moscov : Kolos, 423.

[18]Ladyka, V.I., Khmelnychyi, L.M., 2017, Selektsiia koriv za typom v aspekti zberezhennia henofondu buroi khudoby [Breeding of cows by type in the aspect of preservation of the gene pool of brown cattle]. Ahrarna nauka ta kharchovi tekhnolohii. Vinnytsia, Issue 5(99), pp. 81–87.

[19]Ladyka, V.I., Khmel'nychyi, L.M., Burkat, V.P., Ruban, S.Yu., 2010, Reyestratsiya ICAR. Dovidnyk – Registration ICAR. Reference book. Sumy National Agrarian University, pp. 457.

[20]Ladyka, V.I., Khmelnychyi, L.M., Vechorka, V.V., Khmelnychyi, S.L., 2017, Stan ta perspektyva selektsii buroi khudoby Sumskoho rehionu za molochnoiu produktyvnistiu ta eksteriernym typom [Status and prospects of selective breeding brown cattle in Sumy region for dairy productivity and conformation type]. Visnyk Sumskoho *NAU*, Issue 7(33), pp. 3–17.

[21]Linear type evaluations. Holstein type-production. Sire Summaries. 1999. Issue 3, pp. 10-16.

[22]Plohinskij, N.A., 1964, Nasleduemost' – Inheritance. Novosibirsk, pp. 196.

[23]Polupan, Yu.P., 2007, Subiektyvni aktsenty z deiakykh pytan osnov selektsii ta porodoutvorennia [Subjective accents on some questions of the basis of selection and breed formation]. Breeding and genetics of animals. K.: Agricultural science, Issue 41, pp. 194–208.

[24]Salohub, A.M., Khmelnychyi, L.M., 2011, Osoblyvosti uspadkovuvanosti ta spoluchnoi minlyvosti oznak eksterieru koriv ukrainskoi chervono-riaboi molochnoi porody [Features of heritability and correlative variability of the conformation traits of cows of Ukrainian Red-and-White dairy breed]. Collection of scientific works of Vinnitsa NAU. Series: Agricultural Sciences, Issue 8, pp. 59–62.

[25]Salohub, A.M., Ladyka, V.I., Khmelnychyi, L.M., 2010, Uspadkovuvanist eksteriernoho typu koriv ukrainskoi chorno-riaboi molochnoi porody. Faktory eksperymentalnoi evoliutsii orhanizmiv: zb. nauk. pr. NAN Ukrainy, NAAN Ukrainy, AMN Ukrainy, Ukr. T-vo henetykiv i selektsioneriv im. M.I.Vavilova [Heritability of the conformation type of cows of Ukrainian Black-and-White dairy breed. Factors of experimental evolution of organisms: Coll. scientific works of NAS of Ukraine, NAAS of Ukraine, AMS of Ukraine, Ukr. Society of Genetics and Breeders of M.I. Vavilova]. *K.*: Logos, Issue 8, pp. 429-433.

[26]Sawa, A., Bogucki M., Krwhel-Czopek S., Neja W., 2013, Relationship between conformation traits and lifetime production efficiency of cows. Life Sciences. 85-084.
[27]Shevchenko, A.P., 2012, Uspadkovuvanist ta spoluchna minlyvist liniinykh oznak koriv sumskoho vnutrishnoporodnoho typu ukrainskoi chorno-riaboi molochnoi porody [Heritability and connective variability of cows linear traits of Sumy intrabreed type of Ukrainian Black-and-White dairy breed]. Bulletin of Sumy National Agrarian University. "Livestock series", 10(20), pp. 88–90.
[28]Shuklina, A.Yu., Mel'nikova, N.L., 2015, Otsenka korov-pervotelok cherno-pestroy i ayrshirskoy porod po morfofunktsional'nym svoystvam vymeni [Assessment of firstborn cows of Black-and-White and Ayrshire breeds by morphofunctional properties of the udder]. Bulletin of Novgorod State University, Issue 86(1), pp. 88–92.
[29]Smotrova, E.A., Abramova, N.I., Berezina, V.V., Krysova, E.V., 2019, Ekster'ernye priznaki ayrshirskikh korov raznykh regional'nykh populyatsiy i ikh svyaz' s molochnoy produktivnost'yu [Conformation traits of Ayrshire cows of different regional populations and their relation with milk production]. Genetics and Animal breeding, Issue 2, pp. 17-23.
[30]Zavadilová, L., Němcová, E., Štípková, M., Bouška, J., 2009, Relationships between longevity and conformation traits in Czech Fleckvieh cows. Czech J. Anim. Sci., 54(9): 387–394.
[31]Zink, V., Zavadilová, L., Lassen J., Štípková, M., Vacek, M., Štolc, L., 2014, Analyses of genetic relationships between linear type traits, fat-to-protein ratio, milk production traits, and somatic cell count in first-parity Czech Holstein cows. Czech J. Anim. Sci., 59(12): 539–547.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

TECHNICAL AND ECONOMIC PARAMETERS OF EVALUATING THE LOGISTICS SYSTEM EFFICIENCY OF THE STATE FOOD AND GRAIN CORPORATION OF UKRAINE

Volodymyr KOLODIICHUK[1], Yuriy DUBNEVYCH[2]

[1]Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies 50, Pekarska Street, Lviv, 79010, Ukraine. Phone+380679315424, E-mail: V-A-K@ukr.net. [2]Lviv National Agrarian University, 1, V. Velykoho Str., Dubliany, Zhovkva district, Lviv region, 80381, Ukraine. Phone+380973061552, E-mail: dubnevych@ukr.net

Corresponding author: V-A-K@ukr.net

Abstract

The article identifies that the logistics system of the vertically integrated Public Joint Stock Company "State Food and Grain Corporation of Ukraine" is the most exemplary in the grain subcomplex of AIC. The work outlines the research phases of the casual dependencies of the technical and economic parameters of the corporate's logistics system efficiency and proposes a methodological toolkit for creating a common base for comparing the diverse activity of the corporation's affiliations through the use of logistical grain equivalent. It is substantiated to choose the operating profitability as an integral indicator of the logistics system efficiency for the enterprises of the grain subcomplex of AIC. The suggested integral indicator allows eliminating the investment and financial activity of affiliations from the evaluation orbit, in order to focus on the implementation of logistical functions related to the transition and modification of the grain flow. According to statistical study results of certain parameters dependencies the suggested regression models can be used to predict unknown values of the indicators of logistics systems efficiency as far as the enterprises of the grain subcomplex of AIC are concerned.

Key words**:** *Grain subcomplex of Agroindustrial Complex (AIC), logistics system, efficiency, correlation and regression analysis, integral evaluation*

INTRODUCTION

In order to develop the grain subcomplex of AIC there's a need for a strong theoretical foundation that actualizes scientific research, mainly in the sphere of scientific and methodological support of the functioning of all its structural elements. Logistic activity seems to be a powerful technology to increase the efficiency of producing grain and its process agrifood as it can integrate all elements of the grain subcomplex of AIC into a single chain and create potential not only for the internal production and consumption of its strategically important products, but also trigger powerful export grain flows. Scientist N.I. Chuhraj rightly remarks in [9, p. 236] that "...the major contradiction of integration processes can be solved by aligning vertical integration with strategic objectives of the state's economic policy..."

Foreign scientists such as C. Benson, R.H. Green [4], C. K. Eicher, J. M. Staatz [12], W. B. Eide [11] and others researched the economic problems of grain production in their works. Despite considerable scientific and practical achievements in the field of identifying the development problems of the grain complex were made by Ukrainian scientists such as V.I. Boyko [7], M.H. Lobas [21], P.T. Sabluk [24], L.M. Hudolij [14] and others, the issues of the effective functioning of integrated structures still remain unresolved, since these researches were mainly based on individual constituent elements of the grain subcomplex of AIC, or on fragmentary relations between the production and processing enterprises.

Comprehensive management of all elements of the researched subcomplex presupposes the use of a systematic approach viewing the grain flow in the context of logistics. The very logistics, in our opinion, is "…capable of consolidating individual components of the economic mechanism and ensuring a structural and functional balance and an

effective institutional environment. By managing logistic flows, it is possible to create an optimal cause and effect relation of elements, which eventually will form an effective system ... " [16, p. 347].

Logistics systems were researched by foreign scientists such as D.J. Bowersox, D.J. Kloss [6], J.R. Stoke, D. Lambert [25], M.R. Linders [20] as well as Ukrainian scientists - O.P. Velychko [26], V.S. Kravtsiv [18], Ye.V. Krykavs`kyj [19], N.I. Chuhraj and others. Although such researches are mainly based on macro- and meso-levels, where logistics systems incorporate individual elements that are integrated in order to implement logistic or marketing functions, as, for example, presented in the work of N.I. Chuhraj [9]. In particular, the author dwelled on "…the ways to implement a vertical marketing integration strategy by entering the maritime industry", which, based on a situational analysis of NIBULON's experience of building an effective product supply chain, proved "…the possibility of implementing business projects in logistical maritime infrastructure at the agricultural markets in the conditions of Public-Private Partnership…" [9, p. 235].

Micro level researches are presented in the works of V.I. Perebyjnis [23], M.A. Oklander [22], who viewed internal logistics systems as a set of production units of an enterprise, interconnected by technological operations. The management of the logistics chain formed in such a way significantly differs from the management of corporate integrated structures in terms of content and characteristics.

It is recommended to use mathematical methods of statistical data processing to make criteria-based decisions on improving the efficiency of logistics systems in the grain subcomplex of AIC [2, 3, 5, 10, 13]. Knowing the degree of change in the summarizing indicator given the change in the actual indicator, it is possible to determine the scope of impact of the latter on the economic result. The same approach can be used for the calculation of reserves for improving the efficiency of vertically integrated structures in the grain subcomplex of AIC, however for the correct calculation of the consolidated indicators, it is necessary to take into account the peculiarities of accounting and analytical support of all integrated elements' activity.

MATERIALS AND METHODS

The purpose of the article is to develop a methodological toolkit enabling to research the dependencies of the technical and economic parameters of evaluating the logistics system efficiency through the scope of creating a common basis for comparing its elements and determining the integral indicator as based on the example of PJSC "State Food and Grain Corporation of Ukraine" (SFGCU), being a corporation that exemplifies the logistics system in the grain subcomplex of Ukraine's AIC.

To achieve this purpose, we had to solve the following tasks: to determine and evaluate the parameters and regularities of the grain logistics system functioning based on dialectical method of objective reality perception and using the general scientific methods of analysis and synthesis. With the help of monographic method we were also researching the structure and directions of the functioning of the most powerful vertically integrated state operator in the grain subcomplex of AIC - Public Joint Stock Company "State Food and Grain Corporation of Ukraine".

Criteria-based decision-making is preceded by the use of an economic and statistical method, which includes correlation and regression analysis to investigate the casual dependencies between the efficiency indicators of the logistics systems of corporations within the grain subcomplex of AIC as well as the formation of economic and statistical characteristics.

RESULTS AND DISCUSSIONS

The logistics system of the grain subcomplex of AIC [16] incorporates elements (subsystems) that ensure the transition of material (grain) flow by means of logistics chains from the primary source of raw material (the field) to the end consumers of finished products (sectoral enterprises of food

industry, animal husbandry of AIC, etc.) and modify the grain flow by means of applying certain operations to it in the functional areas of the elevator and processing industries. Grain from the producer under the influence of spatial and time parameters undergoes certain stages on its way to the end consumers, involving in such a way a considerable number of infrastructure elements. A linearly ordered set of these elements, that is, participants of the logistics chain to strengthen their efforts to achieve the ultimate synergistic effect – acquisition of financial resources for sold finished products. Such condition of extended production reproduction is a common purpose and responsibility for each element of the logistics chain, since any failure in the discreteness of material flows and discrepancies in the specified time and space parameters will lead to a common loss of each participant, regardless of the quality and completeness of assigned to them functions.

In our opinion, the logistics system can be best demonstrated in the case of the most powerful state operator in the grain storage market - PJSC "SFGCU", which encompasses 10% of all elevator capacities of Ukraine and provides port transshipment of 6% of grain for export. As a vertically integrated national operator, the corporation holds 10% of the domestic market share for cereals, flour and compound animal feed.

Based on the consolidated financial statements of the securities issuer, as announced by the object of the research on the official website *http://www.pzcu.gov.ua*, one can see that as of the beginning of 2019 the Company unites 55 branches and its elevator capacities are able to provide storage for cereals and oilseeds in the amount of 3.75 million tons. The State Food and Grain Corporation of Ukraine includes 16 processing enterprises, capable of processing about 700 thousand tons of cereals and producing seven types of flour per year with a total volume of 649.5 thousand tons, five types of cereals with an annual volume of 30.5 thousand tonnes and 160 thousand tonnes of compound animal feedstuff. The corporation also includes 2 port elevators based in Odessa and Mykolaiv with the total capacity of export transhipment comprising 2.75 million tons of grain cargo per year.

The activities of PJSC "SFGCU" include all stages of grain flow through the logistics chains, as the corporation purchases grain, ensures its processing, port transhipment for export, utilizing linear and port elevators, mills, compound feed mills and cereal factories. Therefore, by researching the efficiency of the logistics system of PJSC "SFGCU", we will be able to develop appropriate criteria for efficiency enhancement in the whole grain subcomplex of Ukraine's AIC, which incorporates 761 certified enterprises in the storage and food processing market alone [15].

The system of performance indicators of PJSC "SFGCU" provides for calculating the partial efficiency of the use of certain production factors, the interaction of which generally forms an integral effect. Direct analysis of the use of production factors of the researched corporation involves the research of the quantitative and qualitative parameters of capital assets both in terms of their availability and degree of use, as well as the efficiency of the use of current assets and workforce.

The capacity of the logistics system is determined by the parameters of the technical means that ensure the transition and modification of the material flow all the way from the primary source of raw materials to the consumers of final products. On the other hand, the modification of the material flow and its origin complicates the integral evaluation of the logistics system efficiency, that is to compare different products of grain processing, as well as the conditions of its processing, in the situation when the owner of the grain uses only the services of the corporation (for storage, processing, etc.) and the cost of raw materials is not reflected in the corporate reporting. Therefore, in order to conduct the technical and economic evaluation of the logistics system efficiency, it is necessary to define a common basis for comparing the numerous and diverse

affiliations of the corporation, and for this purpose we recommend the use a natural indicator, which we called ***the logistical grain equivalent***.

The use of logistical grain equivalent allows to figuratively convert all grain production into grain through the normative conversion factors of bread products into grain equivalent (Table 1). This natural indicator characterizes the annual quantity of all grain (in thousand tons) which passed through the logistics chains in the researched system, and in the calculation of partial indicators of its efficiency enables to rightfully take into account all grain production and grain in comparable units, regardless of their source of origin and designated purpose.

Table 1. Bread Products Conversion Factors

Bread products expressed in terms of flour, cereals	**Ratio**
Bread and flour products	0.736
Flour of all kinds	1
Cereals of all kinds	1
Peas, beans, other legumes	1
Pasta products	1.031
Semi-finished foods and culinary products from cereals and pasta	0.7
Bread products (flour, cereals) expressed in terms of grain equivalent	**1.330**
including semolina	1.368

Source: Based on data of industry enterprises.

In the process of analyzing the intrasystem factors' impact on improving the logistics systems efficiency in the grain subcomplex of Ukraine's AIC, it is recommended to use modern mathematical methods of statistical data processing, which provide for the necessary mathematical tool and appropriate software for PCs. This toolkit can provide computer support as the solution to a key problem in any research: how it is possible, based on partial results of statistical observation of analysed events or indicators, to identify and describe the relationships that exist between them [2]. The very problem of statistical study of dependencies is primary in analyzing dependencies of key performance indicators of the logistics systems that operate in the grain subcomplex of Ukraine's AIC.

In order to research the dependencies of the main technical and economic parameters of PJSC "SFGCU"'s logistics system efficiency, let's look at its functioning by means of a set of variables presented in Fig. 1.

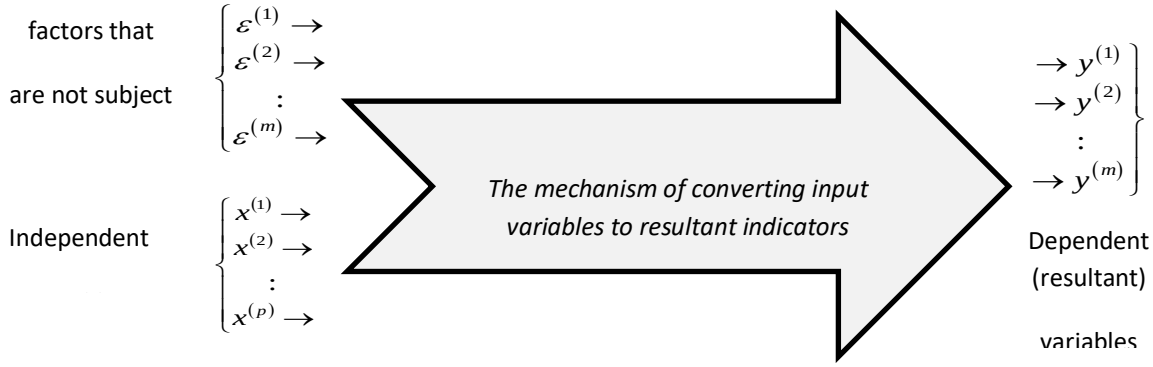

Fig. 1. General Diagram of Variables Dependencies of the Logistics Systems Efficiency During Statistical Research. Source: Created by authors.

The significance of the items included in Fig.1 is the following one:

$x^{(1)}$, $x^{(2)}$, …, $x^{(p)}$ stand for input variables that describe the operation conditions of the researched object's logistics system, provided

that some of them are usually subject to partial control (in economic and mathematical models they are called argument-factors, exogenous, independent),

$y^{(1)}, y^{(2)}, \ldots, y^{(m)}$ stand for output variables that characterize the efficiency of the functioning of the researched object's logistics system (in economic and mathematical models they are called endogenous, dependent, resultant),

$\varepsilon^{(1)}, \varepsilon^{(2)} \ldots, \varepsilon^{(m)}$ stand for latent random residual components, which reflect the influence of unaccounted "input" factors, as well as deviations during measurement of the resultant variables (in economic and mathematical models they are called residuals).

The task of the statistical research of dependencies of the technical and economic parameters of the logistics system efficiency at the PJSC "SFGCU" can be formulated as follows:

based on the results of *n* measurements of variables

$$\left\{x_i^{(1)}, x_i^{(2)}, \ldots, x_i^{(p)}; y_i^{(1)}, y_i^{(2)}, \ldots, y_i^{(m)}\right\}, \quad i = 1, 2, \ldots, n \tag{1}$$

to construct such vector-valued function on specific research objects

$$f\left(x^{(1)}, x^{(2)}, \ldots, x^{(p)}\right) = \begin{pmatrix} f^{(1)}(x^{(1)}, \ldots, x^{(p)}) \\ f^{(2)}(x^{(1)}, \ldots, x^{(p)} \\ \ldots\ldots\ldots\ldots\ldots \\ f^{(m)}(x^{(1)}, \ldots, x^{(p)} \end{pmatrix}, \tag{2}$$

which could best reinstate the values of the resultant (predicted) variables $Y = \left(y^{(1)}, y^{(2)}, \ldots y^{(m)}\right)'$ based on the corresponding values of the independent variables $X = \left(x^{(1)}, x^{(2)}, \ldots, x^{(p)}\right)'$.

The line at vectors stands for their transportation operation. This means that *Y* and *X* are respectively *m*- and *p*-dimensional vector columns.

It is worth noting that the functions *f(x)*, which within the context of this general formulation of the matter describe the behaviour of the conditional average values $y_{cp}(X)$ of a specific predicted performance indicator, are called regression functions. Their model looks as follows:

$$y = f\left(x^{(1)}, x^{(2)}, \ldots, x^{(p)}; \theta\right) + \varepsilon, \tag{3}$$

where ε stands for a residual of the component, which causes a possible deviation in determining a specific indicator of the logistics system efficiency *y* based on known factor values $x^{(1)}, x^{(2)}, \ldots, x^{(p)}$,

$f(X;\theta)$ stands for a function of a specific known parametric family $F = \{f(X;\theta)\}$ for which, however, the numerical values of the parameters (constants included in its equation) are unknown.

Analysis of the scientific literature with regard to the solving of typical practical matters with the help of a tool for statistical research of dependencies [2, 5, 10, 13] allows to state that the whole process of statistical research of dependencies between the indicators of logistics systems efficiency can be decomposed into the following iteratively interconnected main phases:

(i)Preliminary
(ii)Information
(iii)Correlation analysis
(iv)Identifying of the general type of regression function (feature class) within the scope of which the relationship between variables will be investigated
(v)Analysis of multicollinearity of independent variables and selection of the most informative ones
(vi)Calculation of unknown parameters' estimates that are part of the researched regression equation
(vii)Accuracy analysis of the constructed equations of the statistical relationship between the researched variables.

It should be noted that:

-First of all, the research part that integrates phases 4-7 is called a regression analysis.

-Secondly, the basic phases of correlation and regression analysis have powerful computer support by means of existing statistical packages of applications, so they can be fully automated [2].

-Thirdly, given the proper software use phases 5-7 can be implemented simultaneously.

During the preliminary phase in terms of our research object O_1 (PJSC "SFGCU") we

identify a corresponding set of "input" (explanatory) and "output" (resultant) variables according to type (1) (Table 2).

During the second phase of the research, using the information resource http://www.smida.gov.ua, we received a full statistical overview of the type (1) about the activity of our object of interest. As a result of this work, a specific vector of "input" and "output" indicators was identified for PJSC "SFGCU", which characterize its activity based on a sample selection of 48 observations:

$$Oi \leftarrow\rightarrow \left(x_{it}^{(1)}, x_{it}^{(2)}, ...x_{it}^{(5)}; y_{it}^{(1)}, y_{it}^{(2)}, ..., y_{it}^{(5)}\right),$$

$$i = 1; \quad t = 1,2,...,48.$$

Table 2. Set of Variables Necessary to Evaluate the Logistics System Efficiency

Analyzed variables	Identification of a variable	Name of a variable
$x^{(1)}$	*X1_VOF*	Average monthly value of capital assets, USD
$x^{(2)}$	*X2_CHP*	Number of employees, persons
$x^{(3)}$	*X3_FOP*	Payroll, USD
$x^{(4)}$	*X4_MAZ*	Material costs, USD
$x^{(5)}$	*X5_FOZ*	Capital equivalent, USD / per unit of labour
$y^{(1)}$	*Y1_LZE*	Logistical grain equivalent (annual amount of grain that passed through the logistics chains in the researched corporation), thousand tons
$y^{(2)}$	*Y2_PLS*	Estimated capacity of the logistics system, thousand tons / month
$y^{(3)}$	*Y3_FMP*	Capitalization ratio, USD / t
$y^{(4)}$	*Y4_PRP*	Workforce productivity, t / person
$y^{(5)}$	*Y5_KLP*	Coefficient of logistics capacity utilization

Source: Created by authors.

Please note that the linear dependencies of the type (3) are the simplest for econometric researches. In many cases, with the help of taking logarithms nonlinear dependencies can go along with the linear type (3). This approach to data modification during regression analysis helps avoiding problems associated with the lack of normal distribution for the analyzed variables, which may result in distortion of the regression results.

Our task is to minimize the impact of such data, preferably without excluding them. The most common way to do this is to take logarithms of variables. This research uses decimal logarithms and as a result of such transformation equal distances on the logarithmic scale at the point of output correspond to equal percent increases rather than equal increases in values.

The phases (3-7) of researching dependencies of the technical and economic parameters of evaluating the logistics system efficiency were implemented on a personal computer using StatSoft's *STATISTICA* package.

Based on the results of the research, the following conclusions can be drawn:

(a)There exist quite a strong correlation between the researched variables of the PJSC "SFGCU"'s logistics system efficiency based on the data of paired correlation coefficients. The graphical analysis of paired correlation fields (data visualization) using a matrix scatter diagram (Fig. 2) allows, first and foremost, to determine the class of linear regression functions $\left(f(x) = \theta_0 + \theta_1 x^{(1)} + ... + \theta_p x^{(p)}\right)$ necessary to investigate the correlations of the analyzed variables, and secondly, to identify and remove anomalous observation points (emissions) from the statistical data pool.

(b)The presence of multicollinearity between the independent variables implies the selection of the most informative of them using *Forward stepwise* (multistep inclusion method).

(c)Calculation of unknown parameters' estimates of regression equations allows us to identify the most significant independent variables that have impact on the performance indicators of the logistics system functioning in PJSC "SFGCU" as well as to present the regression models given below.

(d)The analysis of the obtained regression equations accuracy on the basis of the values of the determination coefficients of (R^2), *F*-criterion and its significance level *p*, as well as the research of the residuals of the regression models with graphical visualization of the scatter diagram of the residuals give us grounds to claim that the linear regression models describe conclusive correlations between variables.

$$
\begin{aligned}
&Y1\_LZE = -1{,}055 + 0{,}631 \times X3\_FOP + 0{,}222 \times X4\_MAZ;\\
&Y2\_PLS = 1{,}363 + 0{,}097 \times X4\_MAZ + 0{,}373 \times X2\_CHP - 0{,}11 \times X3\_FOP;\\
&Y3\_FMP = 0{,}17 + 0{,}443 \times X5\_FOZ - 0{,}066 \times X4\_MAZ - 0{,}154 \times X3\_FOP;\\
&Y4\_PRP = 0{,}066 - 0{,}182 \times X4\_MAZ + 0{,}403 \times X3\_FOP - 0{,}335 \times X5\_FOZ;\\
&Y5\_KLP = -1{,}646 + 1{,}851 \times Y1\_LZE - 0{,}252 \times X4\_MAZ - 0{,}574 \times X5\_FOZ.
\end{aligned}
\qquad (4)
$$

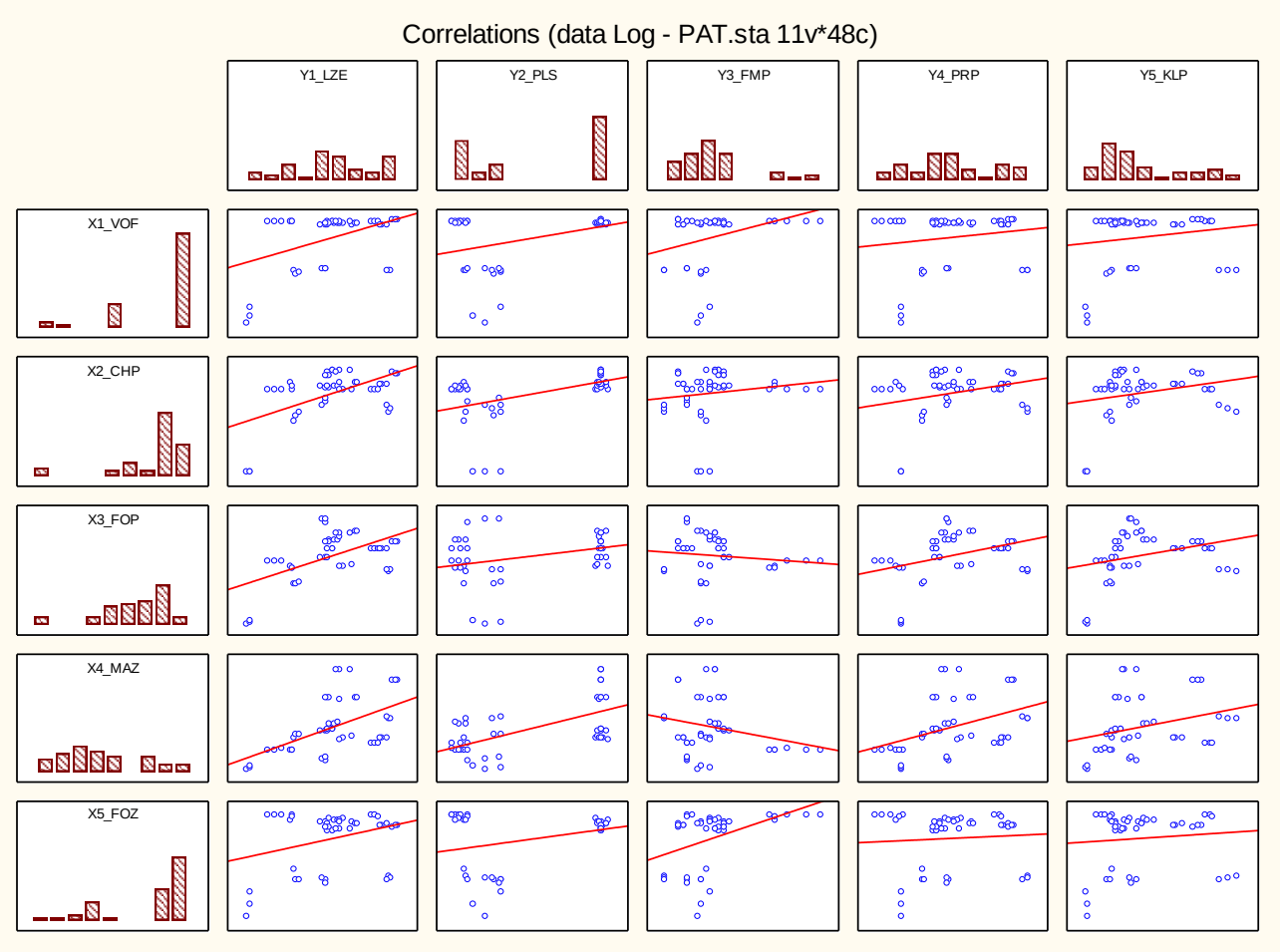

Fig. 2. Matrix Scatter Diagram
Source: Created by authors.

In particular, the linear regression functions indicate that the logistical grain equivalent developed by us is most influenced by the payroll and material costs (Table 3, Fig. 3).

The efficiency of the logistics system as an integral performance indicator is the ratio of the obtained synergetic effect of the whole system to the total costs of all elements of the logistics chain [17]. The efficiency of the logistics system is determined by synergies, which, due to the integrative properties, lead to the appearance of an additional effect in the form of logistical synergy.

Profitability is the most general characteristic of the enterprise's operating efficiency [1, 8]. The whole life of a business entity in a competitive environment depends on profitability. Herewith the following

indicators are important: profitability of property, profitability of production funds, product profitability (e.g. total sales or individual types), etc. (Table 4).

N=48	Regression Summary for Dependent Variable: Y1_LZE (data Log - PAT.sta) R= .62767486 R?= .39397573 Adjusted R?= .36704132 F(2,45)=14,627 p<,00001 Std. Error of estimate: ,18663 Beta	Std.Err. of Beta	B	Std.Err. of B	t(45)	p-level
Intercept			-1.055	0.803297	-1.31340	0.195705
X3_FOP	0.382838	0.134137	0.631	0.221025	2.85409	0.006503
X4_MAZ	0.341176	0.134137	0.222	0.087134	2.54350	0.014481

Source: Created by authors.

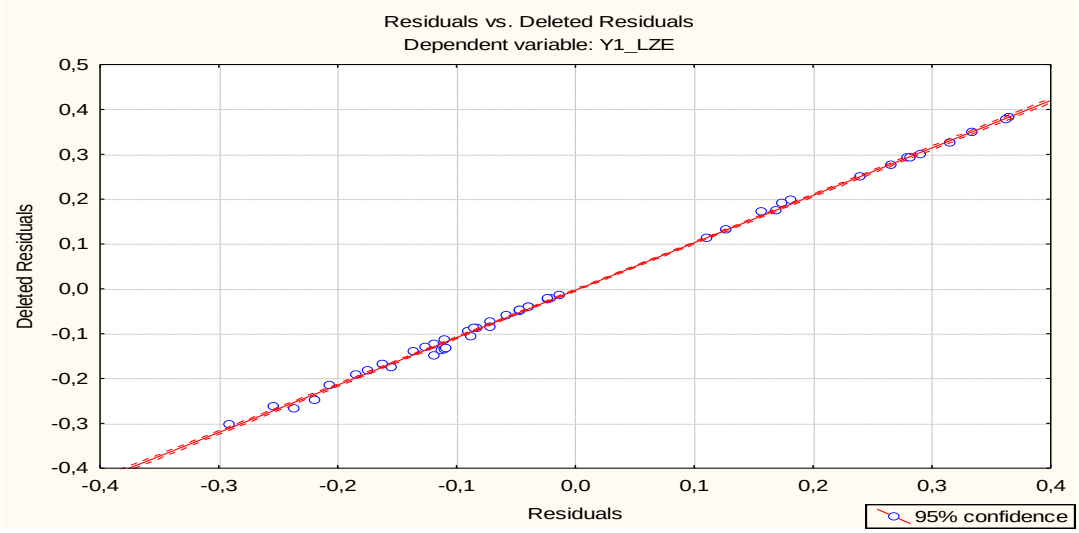

Fig. 3. Residuals and Deleted Residuals Scatter Diagram Y1_LZE.
Source: Created by authors.

Table 4. Profitability Estimation Indicators

No.	Indicator	Indicator description
	Expenditure-Related Indicators	
1	Product profitability	Shows how much gross profit is earned from USD 1 of expenses
2	**Operating Profitability**	**Shows how much operating profit is earned from USD 1 of operating expenses**
3	Profitability of ordinary operations	The amount of ordinary activity profit from USD 1 of ordinary expenses
4	Production costs coverage ratio	Shows the amount of production costs covered by UAH 1 of net income
5	Production costs return ratio	Shows the amount of production costs necessary to earn USD 1 in net income
	Income-Related Indicators	
6	Gross profit margin from product sales	Gross margin from USD 1 of product sales
7	Net profit margin from product sales	Net profit from USD 1 of net sales revenue
8	Income profit margin from operating activity	Profit from USD 1 of operating income
	Resources-Related Indicators	
9	Company profitability	Net profit from USD 1 of assets
10	Return on capital assets	Profit from USD 1 of capital assets
11	Return on Equity	Profit from USD 1 of equity
12	Profitability of the raised capital	Profit from USD 1 of raised capital

Source: Created by authors.

Having analyzed numerous approaches to generalized efficiency evaluation, we can conclude that it is most acceptable to use the operational profitability indicator as an integral indicator of the logistics system efficiency, which is calculated as follows:

$$Io = \frac{Po}{Cs + Ac + Sc + Oc} \times 100\% \quad (5)$$

where Io – income from operational activity (integral indicator)
Po – profit from operational activity
Cs – cost of sales (of works, services)
Ac – administrative costs
Sc – sales costs
Oc – other operational costs.

The integrated assessment of the logistics system efficiency in the grain subcomplex of AIC based on the use of operational profitability indicator will enable us to:

-Determine the profitability of the logistical functions, excluding capital assets and financial investments that are not part of cash equivalents

-Evaluate the efficiency of logistical functions of enterprises, eliminating the influence of the size and composition of equity and loan capital (financial leverage)

-Determine the profitability of services regardless of the origin of raw material (own or donor) based on the publicly available consolidated financial statements of the corporation

-Take into account the structure and range of all grain processing products.

Thus, in evaluating the logistics system of a vertically integrated corporation, an integral indicator stands for the operational profitability, which allows to compare the synergetic effect of the logistical functions implementation with the total costs of all elements of the logistics chain.

CONCLUSIONS

The suggested methodological toolkit for researching the dependencies of the technical and economic parameters of evaluating the efficiency of PJSC "SFGCU"'s logistics system presupposes the use of a logistical grain equivalent that allows to figuratively convert all grain production (flour, cereals, compound animal feed) into grain through the normative conversion factors of bread products into grain equivalent. This natural indicator characterizes the annual quantity of all grain (in thousand tons) which passed through the logistics chains in the researched system, and in the calculation of partial indicators of its efficiency enables to rightfully take into account all grain production and grain in comparable units, regardless of their source of origin and designated purpose of the grain masses.

The efficiency of the logistics system as an integral performance indicator is the ratio of the obtained synergetic effect of the whole system to the total costs of all elements of the logistics chain. The suggested integral indicator – operational profitability – allows to eliminate the investment and financial activity of affiliations from the evaluation orbit, in order to focus on the implementation of logistical functions related to the transition and modification of the grain flow.

Based on the results of the analysis of the statistical research of the dependencies of certain identified performance indicators of PJSC "SCPCU"'s logistics system, it is safe to state that our proposed regression models can be used for prediction (recovery by antilogarithmization: the results are being by inverse logarithm of the function of exponentials) of unknown or average values of certain indicators of the corporate's logistics system efficiency. In its turn, this research provides for a prospective analysis of the logistics systems efficiency in related enterprises of the grain subcomplex of Ukraine's AIC.

REFERENCES

[1]Andrijchuk,V.G., 2005, Efektyvnist diyalnosti agrarnykh pidpryemstv: teoriya, metodyka, analiz [Efficiency of Agricultural Enterprises Activity: Theory. Methodology. Analysis]. Kyiv : KNEU, 292 p. (in Ukrainian).

[2]Artemenko, V.B., 2003, Modelyuvannya i prognozuvannya ekonomichnyx ryadiv dynamiky : navch. pos. [Modeling and Forecasting of Economic Dynamics Series]. L`viv: Vy`d-vo L`viv. komercz. akad., 228 p. (in Ukrainian).

[3]Ayvazyan, S. A., Mhitaryan, V. S., 1998, Prikladnaya statistika i osnovyi ekonometriki: uchebn. dlya vuzov [Applied Statistics and Basics of Econometrics]. M. : YuNITI, 1022 p. (in Russia).
[4]Benson, C., Clay, E. J., Green, R. H., 1986, Food Security in Sub-Saharan Africa. IDS. Brighton: University of Sussex, p. 2-6.
[5]Bolch, B., Huan, Dzh. K., 1979, Mnogomernyie statisticheskie metodyi dlya ekonomiki: per. s angl. [Multidimensional Statistical Methods for Economics]. M.: Statistika, 317 p. (in Russia).
[6]Bowersox, D.J., Closs, D.J., 2008, Logistics: Integrated Supply Chain. Olimp-Biznes CJSC, Moscow, 640 p.
[7]Boyko, V. I., 2007, Zerno i rynok: monografiya. [Grain and Market: Monograph]. Kyiv: NNCz IAE, 312 p. (in Ukrainian).
[8]Cherevko, H. V., Horbonos, F. V. (Eds.), 2004, Ekonomika pidpryiemstv [Business Economics]. Lviv: Apriori, 384 p. (in Ukrainian).
[9]Chuhraj, N. I., 2014, Logistyka v diyalnosti vertykalnykh marketyngovykh struktur agrarnogo biznesu [Logistics in the Vertical Marketing Structures of Agricultural Business] Naukovyj visnyk Lvivs`kogo nacional`nogo universytetu veterynarnoyi medycyny ta biotekhnologij imeni S.Z. Gzhycz`kogo. [Scientific Bulletin of the Lviv National University of Veterinary Medicine and Biotechnologies named after S.Z. Gzhytskyj]: Vol. 16, № 1(58), p. 2. (pp. 235-243). (in Ukrainian).
[10]Drayper, N., Smit, G., 1973, Prikladnoy regressionnyiy analiz : per. s angl.[Applied Regression Analysis]. M. : Statistika, 392 p. (in Russia).
[11]Eide, W. B., 1990, Proceedings of the Agriculture, Nutrition Linkage Workshop, Virginia. Vol. 1, p. 35-36.
[12]Eicher, C. K., Staatz, J. M. (Eds.), 1990, Agricultural Development in the Third World. Baltimore : John Hopkins University Press, p.118.
[13] Geyecz, V. M., Klebanova, T. S., Chernyak, O. I. (Eds.), 2005, Modeli i metody social`no-ekonomichnogo prognozuvannya : pidruchnyk [Models and Methods of Social and Economic Forecasting]. Xarkiv : VD «INZhEK», 396 p. (in Ukrainian).
[14]Hudolij, L. M., 1997, Rozvytok rynku zerna v Ukrayini [Grain Market Development in Ukraine]. Ekonomika APK, № 9, p. 59-66. (in Ukrainian).
[15]Kolodiichuk, V., Dubnevych, Y., 2019, Technical and Technological Support for Grain Stocks Management of Agricultural Producers in the Conditions of Elevator Capacity Deficiency in Ukraine. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development. Vol. 19(3):319-327.
[16]Kolodiichuk, V. A., 2015, Efektyvnist` logistyky zerna ta produktiv jogo pererobky: monografiya. [Efficiency of Grain Logistics and Its Process Products: Monograph]. Lviv, Ukrainskyi Bestseler, 574 p. (in Ukrainian).
[17]Kolodiichuk, V. A., 2017, Management of Logistical Expences of the AIC enterprises. Scientific Bulletin of Polissia. 2017, № 2 (10). P. 2, p. 164-169.
[18]Kravtsiv, V., Kolodiichuk, V., Kolodiichuk, I., 2018, Greening of Transport and Logistical Systems of the Regional Agricultural Markets. Economic Annals-XXI: Journal. № 171 (5-6)', p. 38-43.
[19]Krykavs`kyj , Ye. V., Chornopys`ka, N. V., 2009, Logistychni systemy: navch. posib. [Logistics Systems]. L`viv: Vyd-vo NU "L`vivs`ka politexnika", 264 p. (in Ukrainian).
[20]Linders, M.R., Firon, H.E., 1999, Management of shipment and storage. Logistics. SPb.: Poligon, 768 p.
[21]Lobas, M. G., 1997, Rozvytok zernovogo gospodarstva Ukrayiny. [The Development of the Grain Economy of Ukraine]. Kyiv: NVAT "Agroinkom", 447 p. (in Ukrainian).
[22]Oklander, M. A., Xromov, O. P., 2004, Promyslova logistyka : navch. posib. [Industrial Logistics]. Kyiv : CzNL, 222 p. (in Ukrainian).
[23]Perebyjnis V. I., 2012, Logistychne upravlinnya zapasamy na pidpry`yemstvax: monografiya. [Logistical Inventory Management in the Enterprises: Monograph]. Poltava: PUET, 279 p. (in Ukrainian).
[24]Sabluk, R. P., Shpykulyak, O. G., 2008, Finansovi problemy rozvytku rynku zerna v Ukrayini. [Financial Problems of Grain Market Development in Ukraine]. Ekonomika APK, № 12, p. 69-75. (in Ukrainian).
[25]Stok, Dzh. R., Lambert, D. M., 2005, Strategycheskoe upravleny`e logystykoj [Strategic Logistics Management]. M.: Y`nfra-M, 797 p. (in Russia).
[26]Velychko, O., 2014, Fundamental Basis and Connection of Modern Business Logistics and SCM. Review of European Studies. Vol. 6, №. 4, p. 135-146.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

EFFICIENCY OF LOGISTICS CHAIN MANAGEMENT IN THE GRAIN PRODUCT SUBCOMPLEX OF THE AGRO-INDUSTRIAL COMPLEX OF UKRAINE

Volodymyr KOLODIICHUK[1], Heorhiy CHEREVKO[2], Iryna KOLODIICHUK[3], Roman POPIVNIAK[2]

[1]Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies 50, Pekarska Street, Lviv, 79010, Ukraine. Phone+380679315424, E-mail: V-A-K@ukr.net.
[2] Lviv National Agrarian University, 1, V. Velykoho Str., Dubliany, Zhovkva district, Lviv region, 80381, Ukraine. Phones: +380673034866, +380973061552, E-mails: gcherevko@ukr.net, popivniakr@ukr.net
[3]SI "Institute of Regional Research named after M. I. Dolishniy of the NAS of Ukraine", 4, Kozelnitska Street, Lviv, 79026, Ukraine. Phone +380678117182, E-mail: Ira1166@ukr.net

Corresponding author: V-A-K@ukr.net

Abstract

The results of improving of conceptual-categorical apparatus of the study of logistics systems and effective functioning of enterprises of grain products subcomplex of Agro-Industrial Complex (AIC) by clarifying and specifying the definitions of "logistics chain" and "efficiency of management of logistic chains" are presented in this article. It is proved that in order to adapt Ukrainian logistics systems to the level of world requirements, a qualitative assessment of the effectiveness of logistics chain management should be carried out using the a high-quality assessment of logistics chain management needs to be made using the World Bank's Logistics Performance Index (LPI). The results of the analysis of the impact of the relevant factors and the development of ways to activate the appropriate reserves on the management of logistics chains in the grain subcomplex are the basis for improving methodological approaches to identify opportunities to increase the efficiency of this process. The classification of factors of influence on the efficiency of functioning of logistic chains in the grain subcomplex of AIC is offered, and the division of microlevel factors into structural-organizational and functional-economic ones is substantiated. It is determined that the most characteristic factors of macro and meso level are the effectiveness of governmental regulation, the degree of involvement of the grain products subcomplex of agroindustrial complex in international logistics systems and the degree of development of the grain market infrastructure.

Key words**:** *logistics chain, management, grain products subcomplex of AIC, Logistics Performance Index, functional capacity*

INTRODUCTION

The development of the grain products subcomplex of AIC should have a strong theoretical foundation, which actualizes applied scientific research. Grain products subcomplex of agroindustrial complex is a set of functionally dependent agricultural and industrial enterprises that provide the formation of grain supply, its primary processing, storage, processing for flour, cereals, compound feeds, as well as sale, including for export, through mediocre involvement of relevant infrastructure elements and serves as a source of raw materials for food industry enterprises [10].

Effective technology of increasing the efficiency of grain production and production of its processing is logistic activity, which today can unite all elements of the grain products subcomplex of agroindustrial complex into a single chain and create conditions not only for the internal efficient production and consumption of its strategically important products, but also the formation of powerful efficient export grain flows. Logistics itself is able to consolidate all the constituent elements of the economic mechanism and to ensure the optimal structural and functional balance of the grain subcomplex of agroindustrial complex and its

effective internal and external institutional environment.

The retrospective analysis shows that there is a long period of formation of the historical image of Ukraine as a state, which is already integrated in the international logistics systems. During the time of Cossacks (XVI–XVIII centuries) the island of Khortytsya became the place of establishment of the Zaporozhian Sich, which, in addition to the defense-military, performed important trade and customs functions on the Dnieper waterway (known ancient route "from the Varangians to the Greeks"), actually representing a logistics center. Due to the fact that the Dnieper and its tributaries connected the countries of Northern and Western Europe with Crimea and Turkey, the Cossacks controlled the goods flows not only of Ukraine but also of Poland, Lithuania and the South of Russia. Thus, under the treaty of 1649, the Cossacks were granted permission by the Turkish Sultan to sail the Black Sea freely with all its ports, and were granted the privilege of free cooperation with the Turkish merchants, the creation in their ports of warehouses with goods, and also exempted for a hundred years from payment of duties and taxes to the Ottoman Empire [15]. The well-known Cossack boats(called "chaika",a seagull in English) served as vehicles, and the remains of the Cossack shipyard, where large boats were built, were found in Khortytsia. These facts testify to the objectively formed traditional geopolitical place of Ukraine in the network of logistics chains of global cargo flows.

Theoretical and methodological principles of logistic activity are the subject of study of foreign scientists D.J. Bowersox and D.J. Closs [4], M.R. Linders [13], as well as Ukrainian scientists – E.V. Krykavsky [12], A.P. Velychko [20] and others, who summarized relevant world experience and adapted it to the peculiarities of domestic realities, created the theoretical foundation for enriching and developing the logistical concept of managerial decision making. Comprehensive research on possible ways of solving problems of development of agrarian economy and grain production of Ukraine in the context of development of logistical bases of their functioning was carried out by V.I. Boyko [3], O.M. Shpychak [17], V.V. Yurchyshyn [21] and other scientists. Solving the problem of improving the efficiency of logistics chains requires identifying and maximizing the reserves of formation of potential opportunities for improving the end results. Since the classification of factors is the basis for the classification of reserves of this type, the purpose of this article is to determine the most significant factors influencing the efficiency of logistics chains in the grain products subcomplex of agroindustrial complex and the development of reserve-intensive directions of their involvement.

MATERIALS AND METHODS

To achieve this goal we solved the following tasks: based on the application of the dialectical method of cognition of objective reality and using the index method of analysis and method of comparison, the estimation of efficiency of logistics chains in Ukraine in terms of qualitative evaluation of the logistic component, the method adopted by the world Bank in the global rankings. Using heuristic decision-making methods, we have selected and appropriately classified factors that aggregate key influences on the logistics chains of the system under study. The study also used a monographic method for an in-depth study of the features of the influence of individual factors on the efficiency of logistics systems and to find ways to use appropriate reserves in the studied subcomplex of agroindustrial complex on the example of its individual enterprises. In order to carry out theoretical generalizations of the results of the research and to formulate conclusions and proposals, an abstract-logical method of scientific search was used.

RESULTS AND DISCUSSIONS

Dynamic state of the logistics system provides interaction of its elements , and achieving the desired end results requires the coherence and

purposefulness of the actions of these components. The existence of material, information, financial and service flows is possible in systems in which the elements, interacting with each other, create corresponding circuits. The logistics chain is a linearly ordered set of logistics process participants who carry out logistical operations to bring an external material flow from one logistics system to another under industrial use or to the end consumer under non-productive consumption. Logistics chain management efficiency is the ability to realize the objective function of a logistics system, which means delivering to the consumer the required quantity of products of appropriate quality at a certain place and in a set time with predetermined (mainly minimal) logistics costs [9]. Logistic system in the grain products subcomplex of agroindustrial complex is an aggregate of elements (subsystems) that provide the movement of material (grain) flow through the logistics chain from the primary source of raw materials (field) to end consumers of finished products (sectoral enterprises of food industry, animal husbandry complexes) and alter the grain flow in the process of applying to it operations in the functional areas of the elevator and processing industries. Grain from the producer under the influence of spatial and temporal parameters goes through certain stages (Fig. 1) on the way to end users, while attracting a significant number of infrastructure elements. A linearly ordered set of these elements is formed, that is, participants in the logistics chain, consolidates their efforts to achieve the final synergistic effect – obtaining financial resources for the final product sold. This condition of extended production reproduction for each element of the logistics chain is a common goal and responsibility, since any failures in the discreteness of material flows and their mismatch with the specified time and space parameters will lead to the total loss of each element, regardless of the quality and completeness of its performance of certain functions.

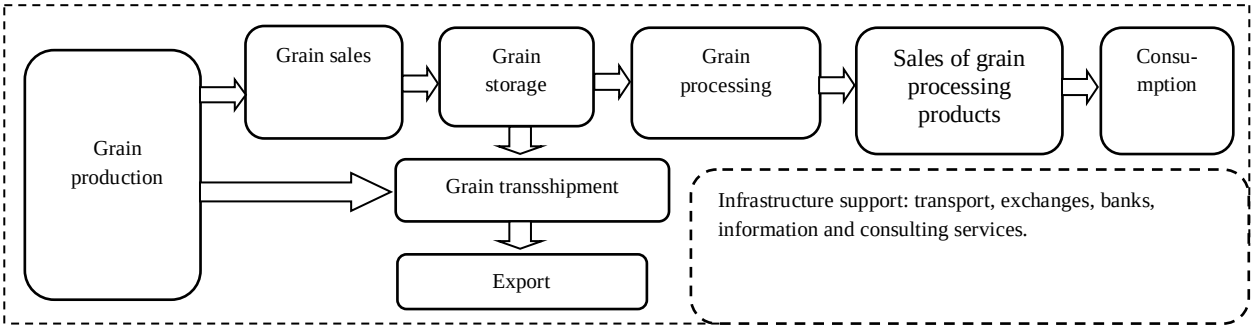

Fig.1. Schematic interpretation of logistics chains in the grain production complex of the agro-industrial complex.
Source: created by authors.

Functional areas of logistics in the grain production complex of the agro-industrial complex (Fig. 1) is the production of grain, its implementation by grain producers and, accordingly, the purchase of processors, storage of grain, with possible transshipment in ports for export, processing of grain mass for flour, cereals, feed, sale of processed products to the relevant areas of the food industry, for which it is a raw material. Each of the defined functional areas is formed by a set of elements (enterprises and organizations), which is the result of transformational processes in the economy, in order to create logistics chains for efficient movement of material flows from the primary source of raw materials to consumers of final products.

In international practice, the logistics Performance Index (LPI) is used to compare the efficiency of logistics systems between different countries as a result of the functioning of logistics chains [5].

The value in the range from 1 to 5 developed by the World Bank LPI are determined by the evaluation of the following characteristics: the

effectiveness of customs and border clearance procedures; quality of trade and transportation infrastructure (Infrastructure); the level of organizational simplification of international shipments based on competitive prices (International shipments); competence of logistics services (Logistics competence); opportunities for routing and tracking the passage of goods (Tracking & tracing); compliance with delivery dates (Timelessness). The higher the country's LPI, the more developed its integrated logistics system is and the more efficient its logistics chains are.

This index was first used in 2007 and in 2018, according to the results of the monitoring of trends and the degree of development of logistics, Ukraine took the 66th position among 160 countries in the world (Table 1).

The development of logistics in Ukraine is characterized by progressive dynamics, as evidenced by the national index of its efficiency. In 2014, the LPI reached 2.98 points, which secured a place in the world ranking between Argentina (2.99) and Egypt (2.97). Of course, the military actions in the East of Ukraine affected the decrease in the LPI (– 0.24 in 2016), but the assessment of the index in 2018 showed an improvement in the situation with the efficiency of logistics systems in the state. The most developed components of the domestic logistics system, according to experts of the World Bank, are the ability to lay routes and track the passage of goods (3.11 or 52th places), and, accordingly, the timeliness of their deliveries (3.42 or 56th place), and the least developed- the quality of trade and transport infrastructure (2.22) - 119th place among 160 countries in the world covered by the LPI rating research.

Table 1. Rating of Ukraine on the logistics efficiency Index (LPI) among 160 countries in the world (2018)

Rating indicators		2007	2010	2012	2014	2016	2018
Logistic Performance Index (LPI)	**place**	**73**	**102**	**66**	**61**	**80**	**66**
	index	***2.55***	***2.57***	***2.85***	***2.98***	***2.74***	***2.83***
Customs	place	97	135	88	69	116	89
	index	*2.22*	*2.02*	*2.41*	*2.69*	*2.3*	*2.49*
Infrastructure	place	74	79	70	71	84	119
	index	*2.35*	*2.44*	*2.69*	*2.65*	*2.49*	*2.22*
International shipments	place	83	84	83	67	95	68
	index	*2.53*	*2.79*	*2.72*	*2.95*	*2.59*	*2.83*
Logistics competence	place	90	77	61	72	95	61
	index	*2.41*	*2.59*	*2.85*	*2.84*	*2.55*	*2.84*
Tracking & tracing	place	80	112	50	45	61	52
	index	*2.53*	*2.49*	*3.15*	*3.2*	*2.96*	*3.11*
Timeliness	place	55	114	68	52	54	56
	index	*3.31*	*3.06*	*3.31*	*3.51*	*3.51*	*3.42*

Source: Prepared by the authors based on (LPI. Global Rankings, 2018).

To eliminate situational positions and random deviations of individual countries in the annual LPI ratings, consider the weighted average for the last four observations (LPI 2012, 2014, 2016, and 2018). In the world Bank's reporting, this indicator is called the Aggregated LPI (2018) and contains comparisons of 167 countries. Points for each year in each component, according to the World Bank methodology, were calculated with weight values: 6.7% in 2012, 13.3% in 2014, 26.7% in 2016, and 53.3% in 2018. Thus, the latest data have the greatest weight, which more fully reflects the objective state of modern logistics development in countries.

In table 2, we present the top five most developed countries in terms of logistics and the aggregate rating of Ukraine by estimated components [1]. Table 2 also includes rating indicators of countries bordering Ukraine, since neighboring countries are often participants in regional competition for global transit flows.

The Aggregated LPI indicates Ukraine's mediocre position among Eastern European countries, as it is inferior to Poland, Hungary, Slovakia and Romania, but ahead of post-Soviet countries-Russia, Belarus, and Moldova. The world ranking of Aggregated LPI is headed by Germany, which has efficient customs and border clearance (4.09), as well as the best infrastructure (4.38), while Belgium is characterized by extreme ease of organizing international transport (3.97) and timely delivery of goods (4.40).

Among non-European countries, Singapore has a high LPI rating (4.05 points, 5th place), and Afghanistan (2.04), Haiti (2.02) and Somalia (2.00) are recognized as the most unfavorable countries for logistics and forwarding companies, which close the global list.

Table 2. The ranking of countries (selectively) in terms of Aggregated LPI 2012-2018

Country	Place in the ranking	**Logistic Performance Index (LPI)**	**Customs**	**Infrastructure**	**International shipments**	**Logistics competence**	**Tracking & tracing**	**Timeliness**
Germany	1	4.19	4.09	4.38	3.83	4.26	4.22	4.40
Netherlands	2	4.07	3.97	4.23	3.76	4.12	4.08	4.30
Sweden	3	4.07	3.95	4.22	3.88	4.04	4.02	4.32
Belgium	4	4.05	3.74	4.03	3.97	4.10	4.11	4.40
Singapore	5	4.05	4.00	4.14	3.72	4.08	4.05	4.34
Poland	…31	3.50	3.26	3.17	3.57	3.49	3.49	3.94
Hungary	32	3.41	3.18	3.31	3.29	3.27	3.61	3.82
Slovak Republic	…47	3.17	2.94	3.09	3.19	3.13	3.02	3.45
Romania	…50	3.10	2.73	2.86	3.15	3.01	3.19	3.61
Ukraine	**…69**	**2.83**	**2.46**	**2.38**	**2.77**	**2.76**	**3.08**	**3.45**
Russia	…85	2.69	2.25	2.64	2.59	2.74	2.67	3.23
Belarus	…110	2.54	2.29	2.39	2.47	2.53	2.44	3.10
Moldova	…113	2.52	2.31	2.21	2.69	2.39	2.36	3.10

Source: Prepared by the authors based on (LPI. Global Rankings, 2018).

Therefore, the LPI indicator is an integral result of the functioning of logistics chains, which is estimated in the context of all components (Customs, Infrastructure, International shipments, Logistics competence, Tracking & tracing, Timelessness) and to increase it, it is necessary to use the appropriate reserves.

By reserves, we mean the difference between the actual result of the activity and its theoretical value, which is possible if the available resource potential is used as efficiently as possible. The reason for this gap is the influence of many factors that are internal and external to the object of study. Along with this, the combination of certain factors forms specific sources of reserves, which are identified by the results of economic analysis. The analytical study determines the factors that led to the deviation of the result, and identifies the most important directions for improving the system in relation to specific operating conditions.

The influence of factors in production and sales systems is characterized not only by direct, but also by indirect action through a system of more complex factors, which makes it necessary to divide them into explicit and hidden (latent). This section is also related to the complexity of cause-and-effect relationships that determine the nature of their detection. If the amount of explicit reserves can be set based on accounting, statistical and other reporting materials, then the amount of latent reserves, which are much larger, is based on the regular, system and complex analysis of changes in quantitative and qualitative parameters of production through the prism of cause-and-effect relationships.

Reserves are characterized by high dynamism, inexhaustibility and are inherent in all levels of the supply chain. The manifestation of the system properties occurs under the influence of numerous factors that are carriers of influence on the system, causing changes in its indicators.

Reserves act as the degree of possible or actual mobilization of individual factors, and this gives grounds to assert that the classification of factors is the basis for the classification of reserves.

Analysis of the effectiveness of logistics systems in the grain production complex of agro-industrial complex includes a set of elements that are interconnected and interdependent through the logistics chain and focus their activities on obtaining a synergistic effect. At the same time, there are too many mediocre or direct factors and their excessive detail will only complicate the study, without significantly affecting the final result.

To justify our approach in the process of detailing factors, we turn to such a concept of synergetics as a fractal [6, p. 35], that is," ... an object in which the parts are in some way similar to the whole, that is, the individual component parts are self-similar. An example of such an object is a tree branch: while each branch and each successively reduced branch are different, they are qualitatively similar in their structure to the entire tree. Such an object has a fractal dimension." Since the dimension depends on specific conditions, we consider the level of detail chosen by us sufficient for the organization of system studies of structures and functions in the grain production complex of the agro-industrial complex.

Conditionally, all the factors that influence the efficiency of the logistics chains in the grain production complex of the agro-industrial complex can be divided into unmanaged ones that are formed at the macro-and meso-level and require the company to adapt accordingly and managed from the management position of the business entity (micro-level) (Fig. 2).

In the structure of branches of the Ukrainian economy, the grain product subcomplex of the agro-industrial complex is an element of a higher-level system, which is characterized by relationships, structural and organizational integrity. Based on this, it is necessary to find out the set of external factors that affect the efficiency of the logistics chains. The most characteristic factors of influence include (Fig. 2.):

- efficiency of state regulation;
- degree of integration of the subcomplex into global logistics systems;
- level of development of infrastructure support for the grain subcomplex of the agro-industrial complex;

The legislative field regulates the boundaries and competencies of the logistics system and its elements. Indirectly, this factor determines the degree of integration of the national grain subcomplex into the world's logistics systems. The ratification of international agreements and the adoption of legislation adapted to world practice contributes to the international standardization of goods and services and, consequently, the integration of logistics elements into global logistics systems.

The effectiveness of state regulation also includes the state policy of licensing and quotas for foreign economic activity, as well as international obligations and policies of foreign countries regarding preferences for Ukrainian products. The high level of corruption in passing licensing procedures in Ukraine, based on existing legislative contradictions, requires reforming the public administration system, improving the legislative process and distancing it from business, as well as improving the effectiveness of numerous anti-corruption agencies in Ukraine, strengthening the personal responsibility of violators of current legislation and enhancing public control over the activities of customs and border services.

As you know, difficult socio-economic conditions in Ukraine in 2014 against the backdrop of a tense military-political situation and the annexation of Crimea, loss of control over the peninsula's grain terminals and instability and fighting in the South-Eastern regions of the state caused a temporary opening of the European market for Ukrainian

products. The European Union, according to the statement of the European Commission dated 11.03.2014, unilaterally granted Ukraine Autonomous trade preferences and the purpose of these measures was to unilaterally reduce or cancel EU customs duties on goods from Ukraine. The application of Autonomous trade preferences began in may 2014 and continued until November 1, 2014 and was extended until December 2015,until the Ukraine – EU free trade area Agreement has not entered into force as a part of the economic part of the Association Agreement between Ukraine and the European Union.

This friendly step of the European Union gave a significant boost to the development of Ukraine's export potential, especially the export of grain and products of its processing. In particular, in 2014, Ukraine ranked second among the world's countries in terms of grain exports, behind only the United States, and the domestic agricultural sector came out on top in terms of foreign exchange revenues to the state budget, ahead of the traditionally export-oriented metallurgical industry.

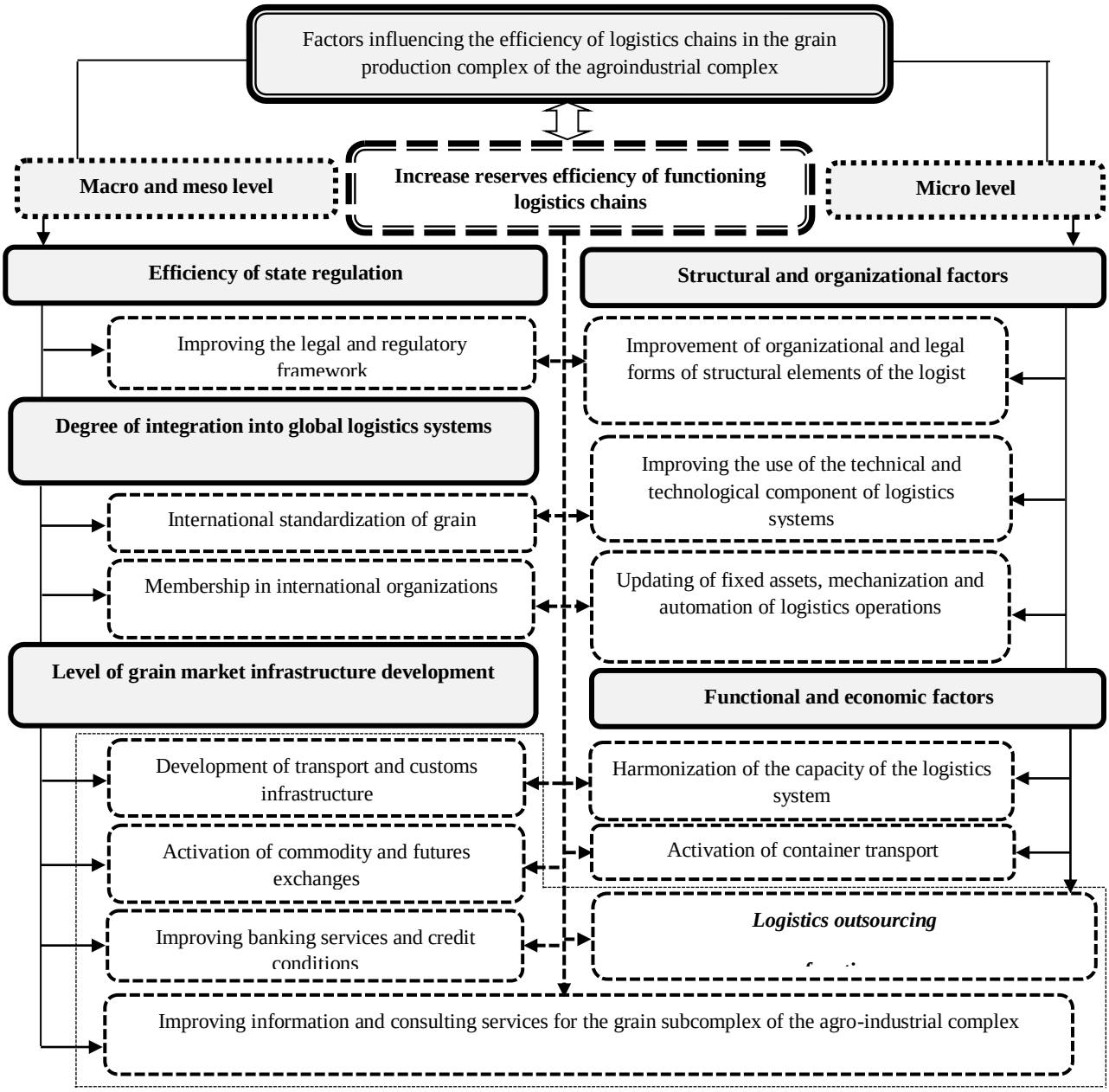

Fig.2. Factors of influence and reserves for improving the efficiency of logistics chains in the grain production complex of the agroindustrial complex
Source: created by authors.

But if in 2014 Ukraine exported 33.4 million tons of grain and products of its processing, in 2015 – 38.3, in 2016-41.5, in 2017 the volume of exports increased to 42.5 million tons [2, p. 40] and this despite the fact that the potential of domestic grain production shows a positive trend: in 2014, 63.9 million tons of cereals and legumes were produced, and in 2016 – 66.1 million tons., and in 2019, the grain harvest grew to a record 74 million tons, and the total revenue amounted to 18 billion US dollars. In calendar year 2018, Ukraine exported grain worth $ 7.2 billion, which is also a record figure and, naturally, the load on the logistics chain has significantly increased.

Full integration of Ukraine's grain market logistics into the global grain market is impossible if the international institutional environment and current rules are ignored, which requires bringing national standards into line with European standards for grain quality assessment.

To unify the quality indicators in the industry section, the corn trade Association was established in 1878, which is now known as the grain and feed trade Association (GAFTA), which defined international rules and principles of grain trade that helped to protect the interests of all participants in trading operations. The uniform rules of the organization are clear and acceptable for both sellers and buyers, and do not require discussions during each transaction. Today, 80 % of the world's grain and feed trade takes place using standard GAFTA contract forms, and the Association itself unites 1,700 members from 90 countries of the world. The principle of the GAFTA system approach to the organization and operation of logistics systems is implemented by the trade security system (GTAS), which covers the entire supply chain - from the agricultural enterprise to the final consumer in any country of the world and establishes uniform rules, thus providing a common international platform for international trade in grain and feed. Since the grain and feed trade Association (GAFTA) plays an important regulatory and supporting role for its members in the system of global grain flows, joining this organization will give national traders a qualitatively new level of functioning of logistics chains [14].

The efficiency of a logistics system depends on the level of development of its infrastructure environment. The infrastructure elements of the grain market and its processing products include transport, commodity and futures exchanges, banking institutions and structures that provide information and consulting services for the grain subcomplex of the agro-industrial complex, as well as insurance, consulting companies, logistics centers, trading houses, road facilities, customs crossings, port and railway infrastructure, and so on. However, the quality of trade and transport infrastructure, which positions Ukraine on the 119th place of the global LPI rating (Table. 1), is the least developed component of domestic logistics. The efficiency of logistics chains is hampered by significant wear and tear and an insufficient number of vehicles and infrastructure facilities.

For example, railway transport is dominant in providing internal grain flows in 2018, 14.5 thousand grain wagons (hoppers) were estimated, with an average age of approximately 26.4 years and only 84% are in satisfactory working condition. The average annual level of cargo routing in Ukraine is only 11 %, which ensures the turnover of wagons within four days and satisfies only 50-60 % of agrotrader requests during peak loads on the grain market. For example, in the United States, the level of rail routing for grain shipments reaches 95 % [18]. The shortage of hoppers forces traders to use road transport to ensure port transshipment of grain, but the average cost of transporting a ton of grain, compared to rail transport, will increase from $ 10 to $ 41.3, and the use of modern heavy grain carriers and the practice of overloading other vehicles significantly destroys Ukrainian roads, since 74 % of them are designed for a maximum load on the car's axle of 6 tons and a total weight of no more than 24 tons. As a result, the problematic issues of functioning of logistics chains are the poor quality of roads, of which 51.1 % do not meet the requirements of international

standards for evenness, 39.2 % - strength, and the average speed of traffic on roads is 2-3 times lower than in Western European countries [16]. One of the reasons for this is that Ukraine provides for an administrative fine of $ 63 for exceeding the weight parameters of vehicles, while in Romania - $ 519-927, Hungary - $ 1,113, and in the UK - $ 6,862 and the carrier in Ukraine is more profitable to save on cyclical traffic by paying a low fine. But in addition to the destruction of roads, the overload of worn-out vehicles increases the risk of their operation and the anthropogenic impact on the environment [11].

The effective use of railway transport in logistics chains on the grain market, especially in ensuring international transit flows and high transport speeds, is hampered by the technological features of the national railway. In Ukraine, the width of railway tracks is 1,520 mm, while in Western Europe the track has 1,435 mm, which requires reloading or replacing the wheels of cars and this causes additional organizational difficulties, time delay and additional costs.

The construction of Euro-tracks in Ukraine is hampered by the following problems:

1)lack of appropriate rolling stock for the width of the European tracks (1,435 mm), as well as a fleet of corresponding locomotives, repair facilities for European track and adapted locomotive depots;

2) the length of domestic rails does not allow to develop high speeds, since the Azovstal Metallurgical plant still produces 25-meter rails, while in Europe the average length of the rail is 100 meters. According to the Ukrainian Institute of the future [7], in order to switch to the European standard, only the Azovstal Metallurgical plant in Ukraine should work on this project for 15-20 years. Thus, the project to build the Euro-track together with the rolling stock will cost $18 billion, which is extremely expensive for the national economy.

The transition of material flows from a dynamic state to a static state is provided by grain storage capacities, which is an integral element of logistics systems. Table 3 presents the logistics characteristics of certified elevators in the regions of Ukraine, which includes storage technologies and physical parameters of cargo transportation in the context of transport modes that provide the dynamics of logistics chains.

The physical and moral obsolescence of the majority of domestic elevators built during the Soviet era significantly hinders the development of logistics in Ukraine and reduces the capacity of logistics chains. For example, in the grain market, most elevators use floor-mounted grain storage technology compared to the tower (Table 3), and this significantly limits the intensity of cargo handling of grain masses. Thus, the average intensity of loading grain into railway cars at large grain elevators in Ukraine is about 12 cars per day, while the optimal one is 54 cars or more [8]. Another problem with elevators is outdated receiving devices that are not able to accept heavy-duty grain trucks, which increases the harvesting time.

So, the factors of macro-and mesolevels functioning of logistics chains create an appropriate environment in which specific economic entities implement their logistics functions. The most significant groups of intra-system factors that influence the efficiency of logistics chains in the grain production complex of the agro-industrial complex include structural, organizational, and functional-economic factors (Fig.1).

The logistics system is formed by organizational structures that are in functional relationships with each other and ensure the movement of material, information, financial and service flows along the logistics chains. The degree of coherence of the entire system depends on the organizational and legal forms of the elements of the formed chain, since various corporations, cooperative associations, vertically integrated agricultural holdings, financial and industrial groups, etc. in addition, there are also structures consolidated around certain ideas or resources that provide end-to-end control of entire functional areas of the material flow from the primary source of raw materials to the final consumer of the finished product. Low-power

enterprises, on the contrary, are more prone to disorganization in system interaction with other elements of the system, since input and output flows for them are predominantly stochastic.

Table. 3. Logistics characteristics of certified grain-saving capacities in Ukraine -Total capacity, of which Storage (t), (as of 01.01.2018)

Region	**Total capacity, thousand tons**	**Storage, thousand tons**		
		outdoor	in silos	in bags
Crimea	988,100	256,400	731,700	0
Vinnytsia	2,376,480	1,043,590	1,302,890	30,000
Volyn	286,820	170,420	116,400	0
Dnipropetrovsk	2,139,430	933,650	1,205,780	0
Donetsk	1,155,033	357,000	798,033	0
Zhytomyr	574,200	214,500	359,700	0
Zakarpattia	19,800	19,800	0	0
Zaporizhzhia	1,356,500	700,850	655,650	0
Ivano-Frankivsk	112,900	40,100	72,800	0
Kyiv	1,498,754	601,150	897,604	0
Kirovohrad	1,621,820	809,700	789,120	23,000
Luhansk	947,900	459,300	488,600	0
Lviv	328,000	199,450	128,550	0
Mykolaiv	1,977,481	1121935	855,546	0
Odesa	2,860,134	1,130,550	1,728,384	1,200
Poltava	2,696,471	993,900	1,656,593	45,978
Rivne	366,500	100,500	266,000	0
Sumy	1,515,440	629,680	848,760	37,000
Ternopil	709,800	333,300	370,700	5,800
Kharkiv	2,201,700	1,021,900	1,179,800	0
Kherson	1,470,921	762,901	708,020	0
Khmelnytskiy	1,053,400	526,400	480,000	47,000
Cherkasy	1,829,823	874,713	890,110	65,000
Chernivtsi	203,700	58,200	65,500	80,000
Chernihiv	1,196,700	600,465	406.235	190,000
Total	**31,487,807**	**13,960,354**	**17,002,475**	**524,978**

Source: Compiled from reports of enterprises.

The presented features explain the desire of dynamically developing companies to take control of all enterprises that ensure the movement of material flow through logistics chains. Over time, the owner of a processing plant will become increasingly interested in controlling the supply of raw materials for its own production by building branches or purchasing complete enterprises, or controlling their activities through the acquisition of equity stakes in the stock market. On the other hand, the position of the processor in the market will be more definite and predictable if it has its own sales network. Thus, the growth of the Corporation's scale of activity is due to attracting new investors by issuing, placing and selling shares, or through the mechanism of reorganization of the joint-stock company by merging or joining, it is motivated by the desire of corporate owners to gain maximum control over all enterprises that are involved in moving the material flow from the raw material base to the final consumer through the system of processing, storage, distribution, and trade. Accordingly, the effectiveness of the logistics system will depend on the degree of coherence of its constituent elements, and this degree is largely determined by the organizational and legal form of each participant in the logistics chain.

The material and technical base of enterprises and the degree of its use has a significant impact on production efficiency. The process of improving and developing the material and technical base can be extensive by building the capacity of fixed assets and intensive – by improving the efficiency of their use.

Among the functional and economic factors (Fig. 1) improving the efficiency of logistics activities in the grain production complex of the agro-industrial complex, we allocate

reserves related to the harmonization of the capacity of the logistics system, activation of container transport and outsourcing of logistics functions.

Table 4. Logistics characteristics of certified grain-saving capacities in Ukraine -Reception capacity (t), (as of 01.01.2018)

Region	**Receiving power, thousand tons / day**	**Reception, thousand tons / day**			
		Road transport	railway transport	ships	barges
Crimea	66,140	40,410	26,700	2,000	6,000
Vinnytsia	115,490	101,600	24,460	0	0
Volyn	15,190	10,350	5,540	0	0
Dnipropetrovsk	92,970	63,730	30,140	0	0
Donetsk	62,280	41,590	30,650	0	0
Zhytomyr	25,170	22,300	5,620	0	0
Zakarpattia	570	150	420	0	0
Zaporizhzhia	61,238	47,080	15,408	0	0
Ivano-Frankivsk	5,800	3,800	2,000	0	0
Kyiv	87,236	56,656	23,420	0	0
Kirovohrad	71,390	62,050	15,290	0	0
Luhansk	27,000	18,720	11,270	0	0
Lviv	13,530	9,730	4,160	0	0
Mykolaiv	149,070	94,450	37,420	10,000	11,000
Odesa	256,170	133,890	153,120	18,500	8,500
Poltava	135,032	116,092	25,940	0	0
Rivne	19,920	13,800	6,520	0	0
Sumy	64,690	50,710	15,980	0	0
Ternopil	26,350	21,650	4,840	0	0
Kharkiv	85,435	62,340	25,395	0	0
Kherson	65,930	50,370	14,060	800	2,900
Khmelnytskiy	53,170	41,920	13,860	0	0
Cherkasy	84,841	72,251	15,990	0	2,000
Chernivtsi	6,930	4,000	2,030	0	0
Chernihiv	41,490	30,930	11,160	0	0
Total	**1,633,032**	**1,170,569**	**521,393**	**31,300**	**30,400**

Source: Compiled from reports of enterprises.

The formation of logistics chains creates favorable conditions for the consolidation of efforts of all elements in the direction of creating a synergistic effect. The implementation of system functions will be effective if the nominal power of the entire system is provided. The total capacity of the system according to the “limiting factor " principle is determined by the parameters of the weakest link, and if in the logistics chain that provides the production of raw materials, their transportation, storage, processing, and sale of processed products, there are capacity constraints due to a lack of technical resources, organizational failures, or administrative barriers, then the entire system will certainly reduce its potential to the parameters of a weak link.

In the process of analyzing material flows, it is necessary to distinguish between their characteristics such as power and intensity. If power is determined by the volume of output that is moved per unit of time, then the intensity is the intensity of its movement. The first indicator depends on the capacity of the weakest link in the logistics system, and in conditions of discrete material flows, it is possible to increase the capacity of the system by increasing its intensity. For example, if the load capacity of vehicles does not provide transportation of all cargo volumes, it is necessary to increase the frequency of shipments. So, to evaluate the logistics system in the grain subcomplex of the agro-industrial complex, we introduce the concept of functional capacity, this means that it is

possible to move the corresponding amount of material flow due to the nominal power of the system components, or if it is insufficient – by increasing the cyclical movement of flows.

Table 5. Logistics characteristics of certified grain-saving capacities in Ukraine -Shipment capacity (t), (as of 01.01.2018)

Region	**Capacity of shipment, thousand tons / day**	**Shipment, thousand tons / day**			
		Road transport	railway transport	ships	barges
Crimea	65,805	16,675	17,820	37,000	7,000
Vinnytsia	82,500	46,230	42,340	0	0
Volyn	12,140	8,200	4,440	0	0
Dnipropetrovsk	83,845	43,260	41,585	3,000	3,000
Donetsk	57,190	23,880	25,410	13,000	3,000
Zhytomyr	24,280	15,330	11,180	0	0
Zakarpattia	350	150	200	0	0
Zaporizhzhia	53,848	31,320	21,568	2,160	5,960
Ivano-Frankivsk	3,800	1,860	1,940	0	0
Kyiv	80,083	38,765	47,198	0	0
Kirovohrad	62,290	41,010	28,940	0	0
Luhansk	22,545	12,725	12,730	0	0
Lviv	12,760	7,350	6,280	0	0
Mykolaiv	188,030	31,930	30,890	90,000	58,500
Odesa	300,870	82,630	109,740	201,600	26,500
Poltava	112,212	76,662	76,860	0	11,000
Rivne	16,460	8,650	8,110	0	0
Sumy	52,748	26,460	27,268	0	0
Ternopil	20,600	11,620	9,380	0	0
Kharkiv	70,564	31,964	42,050	0	0
Kherson	68,331	27,000	19,181	18,400	0
Khmelnytskiy	34,390	20,060	22,550	0	0
Cherkasy	74,881	43,511	33,970	0	5,000
Chernivtsi	5,110	2,380	2,730	0	0
Chernihiv	35,540	18,820	18,130	0	0
Total	**1,541,172**	**668,442**	**662,490**	**365,160**	**141,660**

Source: Compiled from reports of enterprises.

Ensuring optimal functional capacity of logistics chains can be achieved by using container transport of grain cargo using twenty - (TEUis a conditional global unit of measurement of the capacity of cargo vehicles) or forty-foot containers. We remind that one TEU is equivalent to the useful volume of a standard intermodal ISO container 20 feet long (6.1 m), 8 feet wide (2.44 m), and 8.25 feet high (2.59 m).

According to the operational data of the Ukrainian Sea Ports Authority (USPA), 1 million 3.5 thousand TEU containers were handled in the ports during the whole of 2019, which is more than 18% higher than in 2018, and for the second year in a row, Ukraine shows significant growth, this is several times higher than the global average in the container transport market.

According to USPA data, export and import of containers in 2019 were distributed almost equally, with a small advantage of imports – 48.6% and 46.8%, respectively. The positive dynamics of exports is provided by the containerization of food products and, first of all, grain cargoes. This is also facilitated by the introduction of an electronic consignment note and the launch of other digital services that can significantly speed up the speed of cargo transportation, as well as the inclusion of Ukrainian ports in the routes of ocean services (Bosphours Express Service, ZIM Med Pacific, ECUMED, Middle East).

The ports of Odesa, Pivdennyi and Chornomorsk became the leaders in container

transshipment, while the port of Pivdennyi increased the transshipment of container cargo in 2018 by 75%, and the port of Odesa-by 15%. In 2019, 15 powerful global shipping companies were present in Ukrainian seaports, with a total share of 99.5% in the global container shipping market. The top three are Maersk Line, CMA CGM, and MSC, which provided 53.5% of the total container market in Ukraine.

Ukraine ranks 61st in the world in terms of Logistics competence (Table 1), which is caused by the lack of competence of transport operators and customs brokers, as well as the underdevelopment of logistics outsourcing in the country. Qualitative changes in the information infrastructure have expanded the range of use of management tools, which is called the PL (*Party Logistics* – logistics side) concept, which is based on the degree of involvement of other companies to solve business problems in the interests and on behalf of the customer of logistics services.

The following functions are outsourced in international practice: warehousing – 73.7%; external transportation-68.4 %; cargo/payment processing – 61.4 %; internal transportation –56.1 %; cargo consolidation/distribution – 40.4%; direct transportation-38.6%.

In General, foreign industrial and commercial enterprises annually spend 120-140 billion euros on contract logistics, which indicates the scale of logistics outsourcing in the international economy.

In Ukraine, there are almost no 4PL and 5PL operators of logistics services, which is due to the non-availability of logistics outsourcing. In particular, in the state, 89% of the outsourcing market consists of transport services, 8% – storage, and only 3% – forwarding and supply chain management [19]. In the development of 4PL-and in the future 5PL-operators of logistics services, which are practically absent in Ukraine, as well as in improving educational services in the field of logistics, we see a way to improve the Logistics competence component in particular, and LPI-in General.

The implementation of the functional capacity of logistics chains is provided by the use of special systems for transport management, in particular, TMS (Transport Management System). This system provides comprehensive automation of transport management and helps to move cargo much more efficiently, and in combination with the warehouse management system, you can get a full-fledged supply chain management system that is necessary for making the right decisions that stimulate further reduction of logistics costs.

CONCLUSIONS

A linearly ordered set of participants in the logistics process forms logistics chains, the effectiveness of management of which is determined by the ability to implement the target function of the logistics system – to deliver to the consumer the necessary quantity of products of appropriate quality in a certain place and at a set time with the specified logistics costs.

To assess the effectiveness of logistics chain management, it is advisable to use an internationally recognized evaluation indicator - the logistics efficiency index (LPI), which was developed and implemented by the world Bank. The methodology takes into account the evaluation of six indicators: "*Customs*"; "*Infrastructure*"; "*International shipments*"; "*Logistics competence*"; "*Tracking & tracing*"; "*Timeliness*". The higher the country's LPI, the more developed its integrated logistics system is and the more efficient its logistics chains are. The most attractive components of the domestic logistics system are the ability to lay routes and track the passage of goods, and, accordingly, the timeliness of their deliveries, but there is a relatively insufficient quality of trade and transport infrastructure.

The development of measures to improve the efficiency of logistics chains in grain products subcomplex of agroindustrial complex must be preceded by an assessment of possibilities and ways of influence of factors macro-, meso – and microlevels of a system of generators

of its formation, which may result in an improvement in its performance. The factors selected on the basis of using heuristic methods for justifying decisions have a fractal dimension and, by aggregating key influences on the logistics system, are sufficient for organizing system studies of structures and logistics functions in the corresponding chain of the grain-product sub - complex of the agro-industrial complex.

REFERENCES

[1]Aggregated LPI, 2018. LPI Aggregated Rankings 2012-2018. The World Bank. https://lpi.worldbank.org/international/aggregated-ranking. Accessed on Jan. 14, 2020.

[2]Balansy ta spozhyvannya osnovnyx produktiv xarchuvannya naselennyam Ukrayiny`: stat. zb., 2018. [Balances and consumption of the main food products by population of Ukraine: stat. collection] 59 p. http://www.ukrstat.gov.ua/druk/publicat/ Arhiv_u/07/Arch_spog_zb.htm. Accessed on Jan. 8, 2020.

[3]Boyko, V.I., 2007, Zerno i ry`nok: monografiya. [Grain and Market: monograph] Kyiv: NNCz IAE, 312 p. (in Ukrainian).

[4]Bowersox, D.J., Closs, D.J., 2008, Logistics: Integrated supply chain. Olimp-Biznes CJSC, Moscow, 640 p.

[5]Connecting to Compete, 2014. Trade Logistics in the Global Economy. The Logistics Performance Index and Its Indicators. http://www.worldbank. org/content/dam/Worldbank/document/Trade/LPI2014. pdf. Accessed on Jan. 12, 2020.

[6]Grabar, I. G., Khodakivsky, E. I. (Eds.), 2003, Synergetyka ekonomichnyx system [Synergetics of economic systems]. Zhytomyr, 244 p. (in Ukrainian).

[7]Hyperloop and european gauge: why they are not profitable for Ukraine (2018). Ukrainian Institute for the Future. https://www.uifuture.org/ publications/news/ 24131-hyperloop-ta-eurokoliya. Accessed on Jan. 12, 2020.

[8]Kolodiichuk, V., Dubnevych, Y., 2019, Technical and technological support for grain stocks management of agricultural producers in the conditions of elevator capacity deficiency in Ukraine. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development. Vol. 19(3):319-327.

[9]Kolodiichuk, V. A., 2017, Management of logistics expences on the AIC enterprises. Scientific Bulletin of Polissia. 2017, № 2 (10). P. 2, p. 164-169.

[10]Kolodiychuk, V. A., 2014, Branch positioning of grain products subcomplex AIC in Ukraine. Economic Annals-XXI: Journal. № 9-10 (1). P. 45-48.

[11]Kravtsiv, V., Kolodiichuk, V., Kolodiichuk, I., 2018, Greening of transport and logistics systems of regional agricultural markets. Economic Annals-XXI: Journal. № 171 (5-6)', p. 38-43.

[12]Krykavs`kyj, Ye. V. Logistychne upravlinnya: pidruchnyk [Logistics management: a textbook]. L`viv: Vyd-vo NU "L`vivs`ka politexnika", 684 p. (in Ukrainian).

[13]Linders, M.R., Firon, H.E., 1999, Management of shipment and storage. Logistics. SPb.: Poligon, 768 p.

[14]Ob Assocyacyy GAFTA [About the GAFTA Association]. http://www.gaftakyiv. com. Accessed on Jan. 12, 2020.

[15]Oliinyk Ya.B., Smirnov I.G. 2011. Mizhnarodna logistyka: navchalnyj posibnyk [International logistics: training manual]. Obrii, Kyiv, 544 p. (in Ukrainian).

[16]Resolution of the CMU on October 20, 2010 № 2174-p "Pro sxvalennya Transportnoyi strategiyi Ukrayiny` na period do 2020 roku" [About approval of the Transportation strategy of Ukraine for the period until 2020]. https://zakon. rada.gov.ua/laws/show/2174-2010-%D1%80. Accessed on Jan. 12, 2020.

[17]Shpichak, O.M., Bodnar, O. V., 2014, Opty`mizaciya ry`nku zerna ta yiyi rezul`taty`vnist. [Optimization of the grain market and its effectiveness] Monitory`ng birzhovogo ry`nku. 2014, № 2, p. 22-28. (in Ukrainian).

[18]Study of Railroad Rates: 1985-2007 (2009). Surface Transportation Board. Office of Economics, Environmental Analysis & Administration Section of Economics. http://www.stb.dot.gov/stb/industry/1985-2007Railroad RateStudy.pdf. Accessed on Jan. 10, 2020.

[19]Tarnavska, N. P., Syvak, R. B., 2011, Innovacijne upravlinnya konkurentospromozhnistyu logistychnyx lancyugiv [Innovative management of the competitiveness of logistics chains: monograph]. Pidruchnyky i posibnyky, Ternopil, 240 p. (in Ukrainian).

[20]Velychko, O., 2014, Fundamental basis and connection of modern business logistics and SCM. Review of European Studies. Vol. 6, №. 4, p. 135-146.

[21]Yurchyshyn, V.V., 2009, Agrarna polity`ka Ukrayiny` na zlamax polity`chny`x epox: istory`ko-social`no-ekonomichni nary`sy`. 2009 [Agrarian Policy of Ukraine at the Breakthroughs of Political Epochs: Historical, Socio-Economic Essays] Kyiv: Naukova dumka, 366 p. (in Ukrainian).

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ECONOMICS OF SOIL CARBON SEQUESTRATION AND DEVELOPMENT OF LOW-CARBON LAND USE

Anatolii KUCHER[1,2]

[1]V. N. Karazin Kharkiv National University, 6 Svobody Sq., Kharkiv, 61022, Ukraine, Phone: +38 (057) 70-75-636; E-mail: kucher@karazin.ua
[2]NSC «Institute for Soil Science and Agrochemistry Research named after O. N. Sokolovsky», 4 Chaikovska st., Kharkiv, 61024, Ukraine

Corresponding author: kucher@karazin.ua

Abstract

This paper studied the economic assessment of soil carbon sequestration and financial support for development of low-carbon land use in Ukrainian agriculture in the context of climate change. Results of evaluation show that Ukraine plays a strategic role in the soil carbon sequestration in Europe. Ukrainian soils contribution is equal to one third of SOC sequestered in agricultural soils of the European Union. Economic assessment of stocks of SOC in Ukrainian soils indicates that its value is in the range from 14.4 thousand USD/ha (Gray forest soils) to 103.7 thousand USD/ha (Chernozem-meadow soils). The results of analysis revealed that for agricultural production and the formation of the economic fertility of soils in Ukraine, the effects of climate change on warming will be both positive and negative. Taking into account the international experience of adaptation of land use processes to climate change, the basis of strategy of adaptation of agriculture in the enterprises of Ukraine to warming is proposed to put the concept of low carbon land use. As a result of the study it was determined the macroeconomic assessment of the need of financial resource for development potential of low carbon land use in Ukraine for the period until 2030.

Key words**:** *soil organic carbon, climate change, low-carbon land use, Ukraine*

INTRODUCTION

In the world, the problem of the economics of soil carbon sequestration is an urgent one. This is evidenced by the fact that this issue is in the center of attention of the international scientific community. We agree that «Given the background of global warming, carbon emission reduction has become a topic of global importance. Land use change not only influences carbon storage in terrestrial ecosystems directly, but it also indirectly affects anthropogenic carbon emissions...» [6].

The study of the relationship between the dynamics of soil organic carbon (Hereinafter – SOC) and agricultural productivity, as well as the evolution of carbon prices has been investigated in many studies worldwide and at EU level. So, for example, in a recent book it is indicated that «almost all Chernozem will remain as arable land, but CO_2 emissions can cut, or reversed, by reducing energy consumption processes: biological nitrogen fixation instead of mineral fertilizers, crop rotation to reduce pesticide, use and zero tillage. Long-term field experiments on Chernozem in Canada comparing perennial cropping with wheat yielded a mean increase of SOC stocks in the 0–30 cm layer of 0.6 t C/ha per year; eschewing alternate years of black fallow in favour of continuous cropping increased stocks by 0.23 t C/ha per year; the increase from zero tillage was 0.14 t C/ha per year for the top 15 cm of the soil» [5].

In the paper by Ligthart and van Harmelen, the following shadow prices were found for SOC depletion: (i) abatement-based shadow prices (Pa) – 100 EUR/t of SOC and (ii) damage-based shadow price (Pd) – 28.6 EUR/t of SOC [13]. According to Berazneva et al., the steady-state shadow price for soil carbon ranges from 95 USD/t to 168 USD/t, indicating a significant opportunity cost for soil mismanagement [4]. The value of soil carbon substantially depends on the discount rate. The income provided by carbon payments could partially counteract

the effects of high discount rates [3].
The High-Level Commission on Carbon Prices, led by J. Stiglitz and N. Stern, concluded based on an extensive review that a range of 40–80 USD/t of CO_2e in 2020, rising to 50–100 USD/t of CO_2e by 2030, is consistent with achieving the core objective of the Paris Agreement of keeping temperature rise below 2 degrees, provided a supportive policy environment is in place [18]. The low and high values on carbon prices are extrapolated from 2030 to 2050 using the same growth rate of 2.25 % per year that is implicit between the 2020 and 2030, leading to values of 78 USD and 156 USD by 2050 [7].
Ukrainian scientists focus their attention mainly on the issues of perspectives of development of the land-rental relations development in agriculture of Ukraine [20] and methodological foundations of the organization and protection of lands in the context of the balanced nature use [19].
In Ukraine, environmental and economic issues of carbon dioxide emission and sequestration of organic carbon in the soil are investigated by scientists of the NSC «Institute for Soil Science and Agrochemistry Research named after O. N. Sokolovsky» (Hereinafter – NSC «ISSAR»), in particular, S. A. Baliuk et al. [2; 1], A. V. Kucher [11; 10], M. M. Miroshnychenko, O. P. Siabruk [15] et al. For example, according to M. M. Miroshnychenko, O. P. Siabruk, «the hydrothermal conditions of the warm period of the year are decisive in the formation of the CO_2 emission from chernozems. Due to the improvement of agricultural practices, emissions might be reduced but not more that by 15 % of natural factor contribution». In our previous studies, it is proposed author's scientific-and-methodical approach to quantitative economic (monetary) evaluation of the environmental effect from preventing carbon dioxide emissions from the soil of agricultural lands under different levels of anthropogenic pressure [12] and substantiates the ecological and economic aspects of development of low-carbon agricultural land use [11]. This article is a logical continuation of the author's systematic scientific research.

MATERIALS AND METHODS

The methodological basis of the study is a system-structural and interdisciplinary approaches. The database of the average content of humus in the soils of arable land in the regions of Ukraine, was used as the empirical basis. Humus contains on average 58 % of the organic carbon, therefore for their mutual conversion, we used a coefficient of 1,724 (Humus = 1.724 * SOC). The study used the following methods: economic-statistical and monographic (depth analysis of the issue under study); expert and calculation-constructive (economic assessment of stocks of humus and SOC in Ukrainian soils, determination of the main parameters of the need of financial resource for development potential of low carbon land use); grapho-analytic (for the visual representation of the obtained results); abstract-and-logical (theoretical generalization and formulation of conclusions); analysis and synthesis (justification and analysis of project indicators of potential of low carbon land use).

RESULTS AND DISCUSSIONS

Expert assessment of contribution of Ukrainian soils into global carbon sequestration

As known, 5 December 2017 (Marking World Soil Day), FAO has launched the most comprehensive global map to date showing the amount of carbon stocks in the soil. The map shows that globally, the first 30 cm of soil contains around 680 bln t of carbon – almost double the amount present in our atmosphere. This is a significant amount compared with the carbon stored in the whole vegetation (560 bln t). More than 60 % of the 680 bln t of carbon is found in ten countries (Russia, Canada, USA, China, Brazil, Indonesia, Australia, Argentine, Kazakhstan and Democratic Republic of Congo) [23].
In this context, it should be noted that for the first time a National digital map of soil organic carbon stocks in the 0–30 cm layer

with a resolution of 1 x 1 km was created at the NSC «ISSAR» (with FAO support) (Fig. 1). The National map was developed in accordance with GSP specifications and integrated into the FAO Global Soil Organic Carbon Map. The main sources of information on the content of SOC and humus on agricultural lands used for the preparation of the National map of Ukraine on SOC were as follows: database «Soil Properties of Ukraine», developed by the NSC «ISSAR»; materials of large-scale soil survey 1957–1961 years; materials of agrochemical certification of agricultural lands; database of ecological and agro-reclamation state of ameliorated soils, developed by the NSC «ISSAR»; data of research institutions of various ministries, departments and universities; data of stationary field experiments listed in State Register of Ukraine.

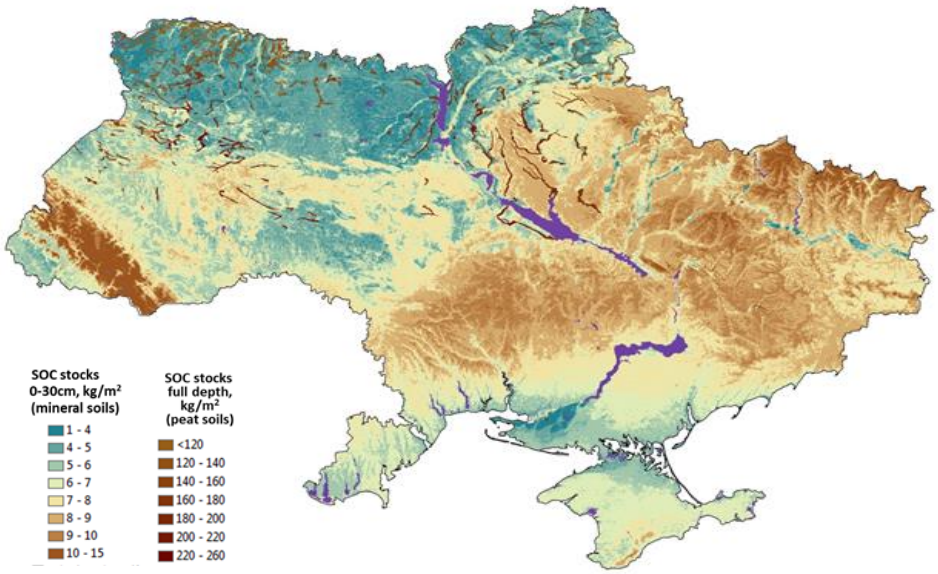

Fig. 1. National map of soil organic carbon in layer 0–30 cm of Ukrainian soils
Source*:* built by scientists of the NSC «ISSAR» [17], [22].

This map is the basis: firstly, to control the content and stocks of organic carbon in soils; secondly, for the sustainable management of soil organic carbon.

Soils of Ukraine are characterized, in general, by average (2–3 %) and high (3–4 %) humus content in arable layer. Soil area with this content is 16.4 mln ha, or about half of the arable land. Soils with low (1–2 %) and very low (<1 %) content of humus are distributed in the Polissya area, where soils of sandy and sandy granulometric soils are concentrated. The depth of the profiles of Ukrainian soils varies in very wide limits and for chernozem soils, depending on geographical, climatic and other factors, ranges from 50 to 150 cm [2].

Stocks of humus (SOC) in the main Ukrainian soils also vary widely: humus 100–720 t/ha, SOC – 58–418 t/ha (Table 1). Economic assessment of stocks of SOC in Ukrainian soils indicates that its value is in the range of 14.4–103.7 thousand USD/ha.

Table 1. Economic assessment of stocks of humus and SOC in Ukrainian soils

Type of soil	Humus content in arable layer, %	Stocks of humus in profile, t/ha	Stocks of SOC in profile, t/ha	Economic assessment of stocks of SOC in profile, thsd. USD/ha	
				min	max
Chernozems ordinary	3.5–5.7	200–550	116–319	28.8	79.2
Chernozems typical	2.5–6.0	300–600	174–348	43.2	86.4
Chernozems southern	3.0–3.5	200–250	116–145	28.8	36.0
Chernozems podzolized	2.6–4.5	220–350	128–203	31.7	50.4
Chernozem-meadow soils	3.0–7.2	360–720	209–418	51.8	103.7
Gray forest soils	1.3–3.5	100–230	58–133	14.4	33.1
Sod-podzolic soils	2.0–3.7	150–280	87–162	21.6	40.3

Source: [2], author's calculations.

According to preliminary expert estimates of NSC «ISSAR» researchers, the total SOC stocks in Ukrainian soils are about 7 Gt. This compares with $^1/_3$ of SOC in agricultural soils of the EU, which are estimated about 18 Gt in 0–30 cm layer [16]. There are estimates according to which organic carbon stocks in arable soils in Ukraine reach 5.12 Gt, including 2.47 Gt in the layer 0–30 cm. This is equivalent to 157 t per hectare, including 75 t/ha in the layer 0–30 cm [14].

Table 2 presents the results of stocks of SOC in the arable layer of soil (0–30 cm) of agricultural land by the regions of Ukraine and by two variants of land area. According to these estimates, the total stocks of SOC in arable layer of the surveyed area of agricultural land are 1305.7 mln t. Based on the assumption that in other (unsurvey) agricultural lands, the content of organic carbon in the soil is at the same level, we can conclude that the total stocks of SOC in arable layer of the total area of agricultural land are 2738.7 mln t (about 2.7 Gt).

Table 2. Assessment of stocks of SOC in the arable layer of soil (0–30 cm) of agricultural land in the regions of Ukraine according to the results of the 10th round of an agrochemical survey

Names of regions*	SOC content in arable layer, %	Stocks of SOC in arable layer, t/ha	Area of agricultural land, thsd. ha	including the area of the surveyed agricultural land, thsd. ha	Stocks of SOC in arable layer of the total area of agricultural land, mln t	including stocks of SOC in arable layer of the surveyed area of agricultural land, mln t
Vinnytsia	1.566	56.4	2,014.2	1,040.7	113.6	58.7
Volyn	0.905	32.6	1,047.6	390.1	34.1	12.7
Dnipropetrovsk	2.187	78.7	2,512.09	1,432.5	197.8	112.8
Donetsk	2.204	79.4	2,044.2	776.0	162.2	61.6
Zhytomyr	1.166	42.0	1,510.2	845.8	63.4	35.5
Zakarpattia	1.485	53.5	451.48	238.6	24.1	12.8
Zaporizhzhia	1.972	71.0	2,241.7	1,326.1	159.2	94.2
Ivano-Frankivsk	1.903	68.5	630.5	290.6	43.2	19.9
Kyiv	1.729	62.2	1,658.8	765.0	103.2	47.6
Kirovohrad	2.384	85.8	2,031.6	1,103.2	174.4	94.7
Luhansk	2.268	81.6	1,908.62	772.4	155.8	63.1
Lviv	1.549	55.8	1,261.2	497.6	70.3	27.7
Mykolaiv	1.879	67.7	2,005.97	1,473.2	135.7	99.7
Odesa	2.187	78.7	2,591.66	1,155.0	204.0	90.9
Poltava	1.845	66.4	2,165.5	774.3	143.8	51.4
Rivne	1.317	47.4	925.4	496.6	43.9	23.5
Sumy	2.030	73.1	1,697.5	785.0	124.1	57.4
Ternopil	1.816	65.4	1,046.12	497.7	68.4	32.5
Kharkiv	2.378	85.6	2,411.3	1,178.8	206.4	100.9
Kherson	1.421	51.2	1,969.4	1,300.1	100.8	66.5
Khmelnytskyi	1.717	61.8	1,568.14	953.5	96.9	58.9
Cherkasy	1.775	63.9	1,451.00	805.3	92.7	51.5
Chernivtsi	1.508	54.3	468.7	236.0	25.4	12.8
Chernihiv	1.398	50.3	2,067.6	653.0	104.1	32.9
Ukraine	**1.833**	**66.0**	**41,504.88**	**19,787.1**	**2,738.7**	**1,305.7**

Note. * Excluding the temporarily occupied territories of the Autonomous Republic of Crimea.
Source: formed and calculated by the author on the basis of data of State Institution «Soils Protection Institute of Ukraine» [24].

Potential of SOC stock increasing by using the best agricultural technologies and balanced application of fertilizers is quite high and amounts according to expert estimates of 0.1–0.3 % for the layer 0–30 cm in medium term (5–10 years).

Assessment of development potential of low carbon land use in Ukrainian agriculture in the context of climate change

According to the data of the Ukrainian Hydrometeorological Center, «in Ukraine the increase in average annual temperature is ahead of the indicator observed in the world. If starting in 1961, the global temperature increased by 0.8 degrees, in Ukraine this indicator is about 1.1 degrees. In the next ten years, it is possible to increase it by a further 0.2–0.5 degrees. If earlier Ukraine was a moderately cold country with an average annual temperature of 7.8 degrees, now this

indicator has grown to plus 9 degrees» [8]. Climate change, says M. Malkov, is largely anthropogenic – only up to 30 % are associated with natural changes, 70 % are dependent on human activity. According to him, agriculture also contributes to climate change due to the fact that emissions of greenhouse gases occur. In the total volume of emissions for agriculture, Ukraine accounts for 14 %. If soils are properly looked after, they absorb greenhouse gases, with incorrect management, on the contrary, they emit greenhouse gases [8].

Expected climate change will likely drive some part of Ukrainian agriculture to transformation in particular through substantial climate aridity strengthening over the vast majority of territories of Ukraine for 21st century, with a high probability of shift of bio-climatic zones at least for one gradation towards aridity (Fig. 2) [21].

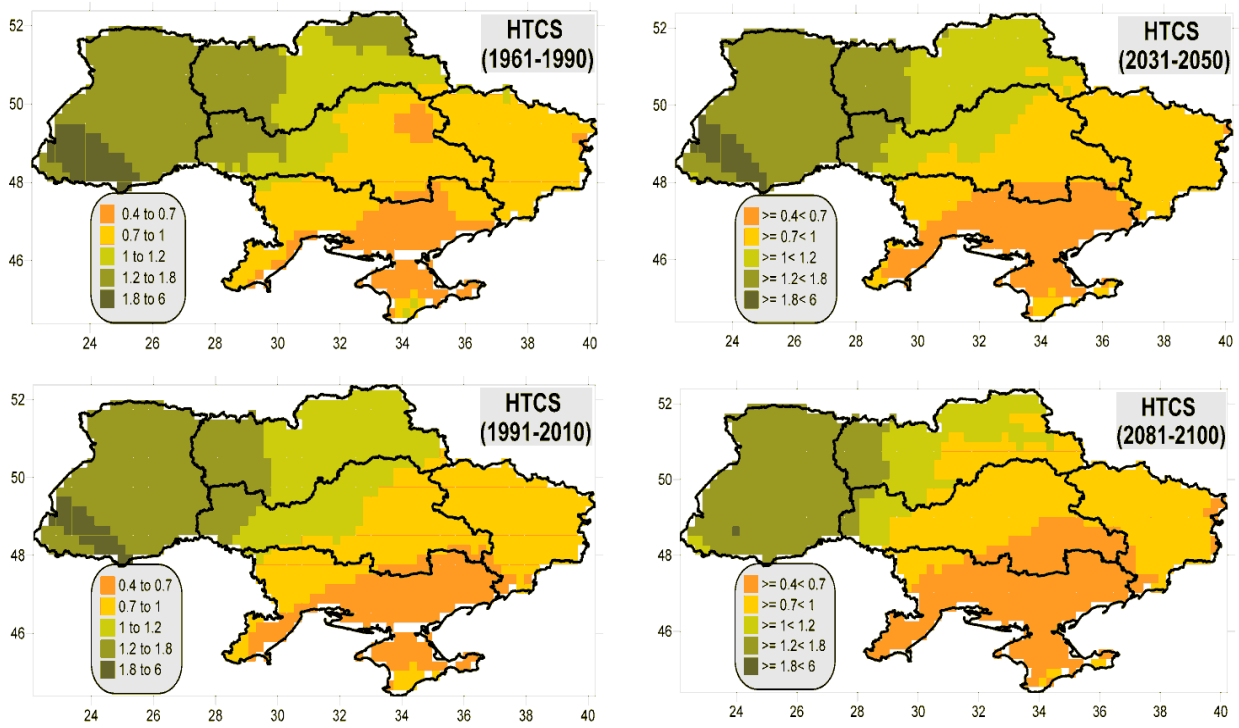

Fig. 2. Dynamics of Hydro-thermal coefficient by Selianinov (HTCS)
Source: [21].

For agricultural production and the formation of the economic fertility of soils in Ukraine, the effects of climate change on warming will be both positive and negative. A significant threat to agricultural production is climate variability, its increasing is expected, will accompany climate change. Taking into account the international experience of adaptation of land use processes to climate change, the basis of strategy of adaptation of agriculture in the enterprises of Ukraine to warming is proposed to put a number of strategic measures that would prevent the development of soil-degradation processes on the one hand, and on the other hand, – contributed to the reduction of greenhouse gas emissions during soil cultivation and increase carbon sequestration, and hence the humus in the soil, thus providing a rational land use (Table 2).

These measures should be considered not as self-sufficient, but as those that should be included in the general system of soil protection and low carbon development of the agrarian sector of the economy.

Strategic priorities for the development of low-carbon agricultural land use are proposed [9]:

-suspension of humus content reduction and achievement of its deficit-free balance through the use of traditional and non-traditional organic fertilizers (agrochemical

direction);
-reduction of anthropogenic load on soil cover by applying soil protective low carbon technologies, in particular, no-till (technological direction);
-optimization of the structure of land use by the removal of soil unproductive and degraded soil with their further afforestation or meadow (organizational direction);
-environmentalization of agrarian land use, in particular through the development of organic agriculture (ecological direction);
-development of agro-insurance and ecological insurance, in particular by developing and applying the mechanism of soil fertility insurance (economic direction).

Table 3. Macroeconomic assessment of the need of financial resource for development potential of low carbon land use in Ukraine for the period until 2030

Measures	Projected scope of measures			The estimated cost of the measures, mln USD		
	units	for year	all	USD/ha	for year	all
The annual measures – the running (current) costs						
Achieving a non-deficit balance of humus- content in the soil:	-	-		72.2	1,380.2	
- the use of traditional of organic fertilizers (2.0 t/ha)	mln t	38.8		20.1	388.0	
- the use of non-tradable part of crop (5.4 t/ha)	mln t	101.5		10.8	203.0	
- extraction and use of sapropel (2.4 t/ha)	mln t	46.0		40.8	782.0	
- extraction and use of peat (0.02 t/ha)	mln t	0.29		0.5	7.2	
Disposable measures – the investment costs						
Expanding the area of application of no-till technology	mln ha	0.5	5.0	64.0	32.0	320.0
Optimization of structure of land use:	-	-	-	55.5	7.25	72.5
- remove from cultivation of low productivity and degraded soils	mln ha	0.5	5.0	0.5	0.25	2.5
from them: for further use in pastures	mln ha	0.4	4.0	5.0	2.0	20.0
for further use in forestation	mln ha	0.1	1.0	50.0	5.0	50.0
Total investment costs	-	-	-	-	39.25	392.5
Transaction costs (30% of investment costs)	-	-	-	-	11.8	118.0
The total investment costs with transaction costs	-	-	-	-	51.05	510.5

Source: author's calculations.

It is clear that these strategic priorities for the development of low carbon agricultural land use do not exhaust the whole arsenal of low carbon measures, but only outline our strategic vision of priority ways to solve this problem.

CONCLUSIONS

The provision on the economic assessment of soil carbon sequestration and financial support for implementation of low-carbon land use in Ukrainian agriculture in the context of climate change was further developed. Results of evaluation of Ukrainian soils contribution into global carbon sequestration show that Ukraine plays a strategic role in the carbon sequestration in Europe. Her contribution is equal to one third of SOC sequestered in agricultural soils of the EU. According to our assessment, the total stocks of SOC in arable layer of the surveyed area of agricultural land (according to the results of the 10th round of an agrochemical survey) are 1,305.7 mln t. Based on the assumption that in other (unsurvey) agricultural lands, the content of organic carbon in the soil is at the same level, we can conclude that the total stocks of SOC in arable layer of the total area of agricultural land in Ukraine are 2,738.7 mln t. Economic assessment of stocks of SOC in Ukrainian soils indicates that its value is in the range from 14.4 thousand USD/ha (Gray forest soils) to 103.7 thousand USD/ha (Chernozem-meadow soils).
The results of analysis revealed that for agricultural production and the formation of the economic fertility of soils in Ukraine, the effects of climate change on warming will be both positive and negative. Taking into account the international experience of adaptation of land use processes to climate change, the basis of strategy of adaptation of agriculture in the enterprises of Ukraine to warming is proposed to put the concept of low carbon land use. As a result of the study it was determined the macroeconomic assessment of the need of financial resource for development

potential of low carbon land use in Ukraine for the period until 2030. The total average annual current costs for implementation of low-carbon land use in Ukrainian agriculture are equal to 1,380.2 million USD. The total investment costs with transaction costs for implementation of disposable measures of low-carbon land use in Ukraine for the period until 2030 are equal to 510.5 million USD.
The main results of the study can be used for (i) sustainable management of soil organic carbon and (ii) regulating the reproduction of organic carbon in the soil in the context of climate change.

ACKNOWLEDGMENTS

The publication contains the results of studies conducted by President's of Ukraine grant for competitive projects F75/192-2018 of the State Fund for Fundamental Research.

REFERENCES

[1]Baliuk, S. A., Kucher, A. V., 2019, Spatial features of the soil cover as the basis for sustainable soil management, Ukrainian Geographical Journal, 3: 3–14.
[2]Baliuk, S. A., Medvediev, V. V., Kucher, A. V., Solovej, V. B., Levin, A. Ja., Kolmaz, Ju. T., 2017, Control over organic carbon of soil in a context of food safety and climate fluctuation, Bulletin of Agricultural Science, 9: 11–18.
[3]Berazneva, J., Conrad, J., Güereña, D., Lehmann, J., 2014, Agricultural productivity and soil carbon dynamics: a bioeconomic model, http://www.juliaberazneva.com/wp-content/uploads/2014/10/Berazneva_JMP_10-31-2014.pdf, Accessed on 27.12.2019.
[4]Berazneva, J., Conrad, J., Güereña, D., Lehmann, J., Woolf, D., 2019, Agricultural Productivity and Soil Carbon Dynamics: A Bioeconomic Model, American Journal of Agricultural Economics, 101(4): 1021-1046.
[5]Boincean, B., Dent, D., 2019, Farming the Black Earth. Sustainable and Climate-Smart Management of Chernozem Soils. Springer, Cham, 226 p.
[6]Chuai, X., Huangab, X., Wangc, W., Zhaod, R., Zhanga, M., Wu, C., 2015, Land use, total carbon emissions change and low carbon land management in Coastal Jiangsu, China, Journal of Cleaner Production, 103: 77–86.
[7]Guidance note on shadow price of carbon in economic analysis. 2017, Shadow price of carbon in economic analysis Guidance note, http://pubdocs.worldbank.org/en/911381516303509498/2017-Shadow-Price-of-Carbon-Guidance-Note-FINAL-CLEARED.pdf, 27.12.2019.
[8]Holubeva, O., 2018, Climate change: How global warming threatens Ukraine, https://112.international/article/climate-change-how-global-warming-threatens-ukraine-28318.html, 27.12.2019.
[9]Kucher, A. 2017, Adaptation of the agricultural land use to climate change, Agricultural and Resource Economics: International Scientific E-Journal, 3(1): 119–138.
[10]Kucher, A., 2019, Sustainable soil management in the formation of competitiveness of agricultural enterprises, Academic publishing house «Talent», Plovdiv, 444 p.
[11]Kucher, A. V., 2015, Ecological and economic aspects of development of low-carbon agricultural land use. Smuhasta typohrafiya, Kharkiv, Ukraine. 68 p.
[12]Kucher, A., 2016, Environmental and economic assessment of CO_2 emissions from soils under different levels of anthropogenic pressure, Agricultural and Resource Economics: International Scientific E-Journal, 2(1): 45–64.
[13]Ligthart, T. N., van Harmelen, T. 2019, Estimation of shadow prices of soil organic carbon depletion and freshwater depletion for use in LCA, The International Journal of Life Cycle Assessment, 24(9): 1602–1619.
[14]Miroshnychenko, M., Khodakivska, O., 2018, Status of Black Soils in Ukraine, https://www.slideshare.net/ExternalEvents/status-of-black-soils-in-ukraine, 27.12.2019.
[15]Miroshnychenko M. M., Siabruk O. P., 2017, Dynamics of CO_2 emission from chernozems under agricultural use. Agricultural science and practice, no. 3, pp. 43–49.
[16]Pan-European SOC stock of agricultural soils, 2013, European Commission Joint Research Centre, http://esdac.jrc.ec.europa.eu/content/pan-european-soc-stock-agricultural-soils, 27.12.2019.
[17]Plisko, I. V., Bihun, O. M., Lebed, V. V., Nakisko, S. H., Zalavskyi, Yu. V., 2018, Creation of the Ukrainian national soil organic carbon stocks map, Soil Science and Agrochemistry, 87: 57–62.
[18]Report of the High-Level Commission on Carbon Pricing. 2017, Carbon Pricing Leadership Coalition, World Bank Group, ADEME, 68 p.
[19]Stupen, M., Stupen, R., Ryzhok Z., Stupen, O. 2019, Methodological foundations of the organization and protection of lands in the context of the balanced nature use, Scientific Papers: Series «Management, Economic Engineering in Agriculture and Rural Development», 19(1): 565–570.
[20]Stupen, R., Stupen, M., Stupen, O., 2018, Prospects of the land – rental relations development in agriculture of Ukraine, Scientific Papers: Series «Management, Economic Engineering in Agriculture and Rural Development», 18(3): 441–448.
[21]Shvidenko, A., Buksha, I., Krakovska, S. Lakyda, P., 2017, Vulnerability of Ukrainian Forests to Climate Change, Sustainability, 9(7): 1152.
[22]Viatkin, K., Zalavskyi, Yu., Bihun, O., Lebed, V., Sherstiuk, O., Plisko, I., Nakisko, S., 2018, Creation of the Ukrainian national soil organic carbon stocks map

using digital soil mapping methods, Soil Science and Agrochemistry, 2: 5–17.
[23]World's most comprehensive map showing the amount of carbon stocks in the soil launched, http://www.fao.org/news/story/en/item/1071012/icode, 27.12.2019.
[24]Yatsuk, I. P., 2018, Scientific research on monitoring and survey of Ukrainian agricultural lands by the results of 10th round (2011–2015), State Institution «Soils Protection Institute of Ukraine», Kyiv, Ukraine. 66 p.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ANALYSIS OF THE STATE OF CULINARY TOURISM IN BULGARIA

Ivanka LULCHEVA

Agricultural University - Plovdiv, 4000, 12, Mendeleev Blvd., Plovdiv, Phone: +359 (32) 654 200, Fax: +359 (32) 633 157, Bulgaria, Email: ivanka.lulcheva@yahoo.

Corresponding author: ivanka.lulcheva@yahoo.com

Abstract

The modern tourist is increasingly looking for a complex tourist product that will not only offer him something new, different, exotic and provoke his intelligent curiosity, but also affect all his senses and perceptions. It is this tourist demand that opens the market niche for the development of wine and culinary tourism. The purpose of this research is to study and establish the state of culinary tourism in Bulgaria. Our studies show that, combined with other types of alternative tourism, culinary tourism can contribute a great deal to increasing the interest of tourists - both domestic and foreign - to tourism in rural areas and, consequently, to the revitalization of these areas. In order to study the state and opportunities for the development of cultural tourism in Bulgaria, a survey was conducted in the period 06.2018 - 07.2018. 100 randomly selected tourists were surveyed. The study was carried out with the help of a travel agency from Plovdiv. The respondents were between 16 and 55 years old. The subject of the study are the seven most clearly identified culinary regions in the country: 1. The stretch of Stara Planina; 2. The Black Sea region; 3. The Danube region, including the arc from Vidin to Silistra; 4. Thrace, the Thracian plain; 5. The region of the Rhodope Mountains; 6. Western Bulgaria; 7. The region of Pirin Macedonia. In each of these culinary areas there is an inherited and distinct unique traditional cuisine, cuisine and food. A SWOT analysis of culinary tourism in these regions was carried out. As the strengths prevail and their influence is almost twice as strong as the weaknesses, and the opportunities for the development of culinary tourism are greater than the threats to it, it can be assumed that these culinary areas have all the necessary conditions for the development of culinary tourism. Tourists' interest in culinary tourism, especially combined with wine tourism, is increasing. The study and the analysis summarize the conclusions and recommendations for the further development of culinary tourism.

Key words**:** *culinary tourism, rural areas, Bulgaria*

INTRODUCTION

For millennia, man has wondered what he found in the surrounding countryside. The geographical location - mountainous, seaside or flat - affects the availability of one or the other food. That is why in different regions a specific way of eating is formed and distinguished, regional and national cuisine of individual nations is created, with its specific culinary and taste peculiarities. Formed eating habits of individual peoples have persisted for millennia, gradually changing with the introduction of new crops, fruit trees or animal breeds, new technologies for food preparation. Martinez et al define local food as "food produced, processed and distributed within a geographical boundary that consumers associate with their own community" [8].

Local produce adds authenticity to the tourist experience and provides motivation for visitors to come to a location [13].

The modern tourist is increasingly looking for a complex tourist product that will not only offer him something new, different, exotic and provoke his curiosity and intelligent curiosity, but also affect all his senses and perceptions. It is this tourist demand that opens the market niche for the development of wine and culinary tourism. It focuses on the demand and pleasure of prepared food and drink [7].

Food may also add value to a core tourism product and become the focus for special events. Additionally, food maybe used as a stand-alone niche attraction [6], referred to by tourism writers as gourmet tourism, cuisine tourism, culinary tourism, or food tourism [10].

Culinary tourism is considered to be a subspecies of cultural tourism since part of the knowledge of a culture is the knowledge of the cuisine of that culture. Culinary tourism is also considered to be a subset of rural tourism, since the practice of rural tourism is necessarily linked to the experience of specific local dishes and specialties. It is also traditionally accepted that wine tourism is a subspecies of culinary tourism. This interconnectedness of similar activities must necessarily be the basis for achieving greater impact than these activities - economic and social.

All this puts on the agenda the question of the development of these types of tourism in Bulgaria, moreover, that they take place mainly in rural areas. Rural areas are among the main directions of the European Union's policy, and Bulgaria is facing with high problems regarding the development of rural territory.

All this provokes our research interest in the state and opportunities for the development of culinary tourism in Bulgaria.

MATERIALS AND METHODS

In order to study the status and opportunities for the development of cultural tourism in Bulgaria, a survey was conducted in the period 13.06.2019 - 13.07.2019. A total of 90 randomly selected tourists were interviewed. The questionnaire consists of 10 questions. The study was carried out with the help of the Travel Agency "Veli Kazi Tour" - Plovdiv. The respondents were between 16 and 55 years old. Persons aged 16 to 29 predominate. (40% of the total number of respondents) and persons aged 30 to 45 years. (38% of the total) (Table 1).

The purpose of this study is to investigate and establish the status and development of culinary tourism in Bulgaria. Our studies show that, combined with other types of alternative tourism, culinary tourism can contribute a great deal to increasing the interest of tourists - both domestic and foreign - to tourism in rural areas and, consequently, to the revitalization of these areas.

To determine the object of this study, our previous research on the state and development of culinary tourism in Bulgaria has been used. Based on our study of the peculiarities of traditional cuisine and nutrition in individual regions, culinary zoning of the country has been carried out, it is conditionally divided into 7 culinary regions – 1. Along the Stara Planina Mountain; 2. The Black Sea region; 3. The Danube region, including the rainbow from Vidin to Silistra; 4. Thrace, Thracian Plain; 5. The region of the Rhodope Mountains; 6. Western Bulgaria; 7. The Region of Pirinska Macedonia. It is these culinary areas in the country that are the subject of this research, as they have the necessary conditions for the development of culinary tourism.

RESULTS AND DISCUSSIONS

The information from the processed survey cards makes it possible to draw a number of conclusions about the state and the development of culinary tourism in Bulgaria. When processing the survey data, the following results were obtained: Bulgarian and foreign tourists show interest in our past, traditions and customs, therefore almost every month are organized excursions with certain routes, prefer comfortable and simple places to visit and accommodation. The main requirement is the presence of local cuisine, rich in local specialties and dishes, natural foods and quality drinks. A large number of tourists prefer to participate in the preparation of food. What distinguishes culinary tourists from other types of tourists is that the motivation of culinary tourists to visit certain places is only or mainly the experience of “authentic” local dishes prepared on the spot. Attractive to tourists may be all or only the individual characteristics of the food - its type, origin, history, taste, method of preparation, method of serving, etc. [7].

Bulgarian and foreign tourists show interest in our past, traditions and customs, therefore almost every month are organized excursions with certain routes, prefer comfortable and simple places to visit and accommodation.

The main requirement is the presence of local cuisine, rich in local specialties and dishes, natural foods and quality drinks. A large number of tourists prefer to participate in the preparation of food.

Table 1. Number of respondents by age group

Age	Number of respondents
16-29	26
30-45	23
46-55	19
over 55 years	11

Source: Own calculation.

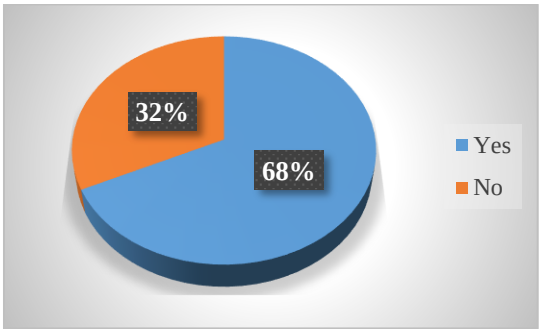

Fig. 1. Is this the first time you have participated in culinary tourism?
Source: Own calculation.

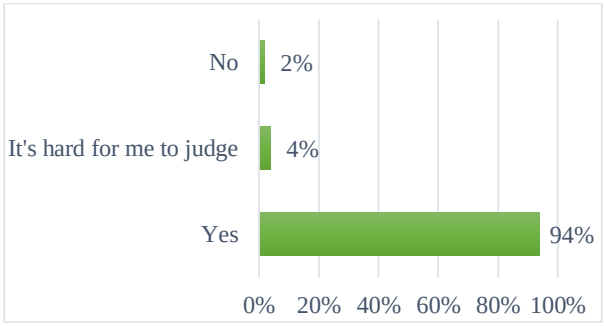

Fig. 2. Do you like traditional dishes and local specialties?
Source: Own calculation.

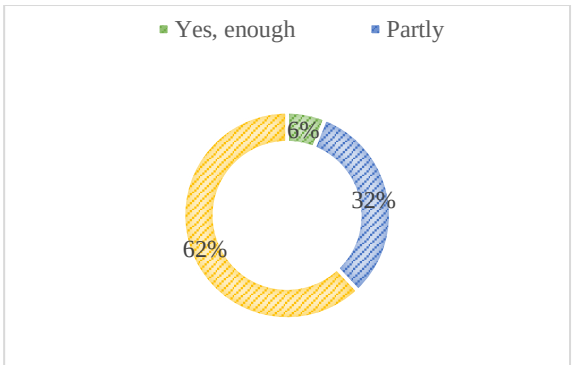

Fig. 3. Is culinary tourism sufficiently advertised and promoted?
Source: Own calculation.

The appropriate geographic position of the country and the wealth of tourist resources, together with preserved traditions in nutrition, favour the development of culinary tourism. Very often it is combined with other types of alternative tourism or with cultural-cognitive one. The survey shows that tourists show strong interest in these permanently established geographic areas where they "produce" and consume typical, unique local dishes. The raw materials for these dishes are only locally produced, from indigenous plant varieties and animal breeds. There are peculiarities in the technology of preparing the dishes that make them unique. A characteristic feature, for example, in the Rhodope cuisine is the total heat treatment of all products for one dish – and basic and spice. This results in the so-so "delicious bouquet" – a unique combination of the tastes of all the local ingredients in the dish, and this gives its unique taste, aroma, composition. Bulgarian cuisine has three very specific foods, which are very popular among foreign tourists and are wanted by them necessarily when they stay in the country. This is yogurt, white brine cheese and Bulgarian savory. All this confirms the unique characteristics of the regional kitchens: Rhodope, Thracian, Dobrudzhanska, Shopska and others.

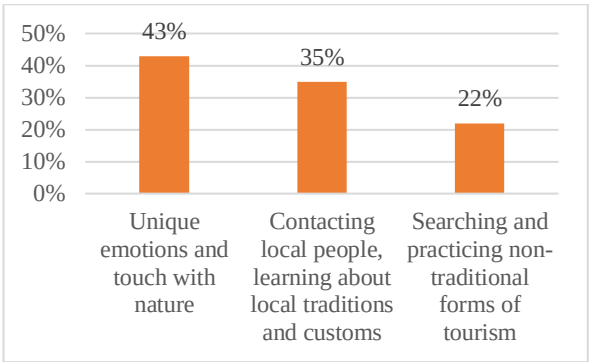

Fig. 4. What are your personal motivations for participating in culinary tours?
Source: Own calculation.

The growing interest in the unique specialities of the individual regional kitchens put the task to preserve not only the recipes for the preparation of local dishes, but also to preserve the local varieties of plant products

and animal breeds. This is a basic prerequisite for the development of culinary tourism.

Increasingly food is used in development initiatives to strengthen tourism destinations, and to create linkages of benefit to both the food production industry and the tourism industry [1], [5].

As noted by Du Rand and Heath the roots of food tourism lie in agriculture, culture and tourism" in that agriculture provides the product (food), culture offers the historical setting and authenticity, and tourism should provide infrastructure and services to combine all three components into a food tourism experience [2].

In the settlements in Bulgaria there are concentrated numerous architectural and cultural-historical monuments, national parks and reserves, predisposing to the combination of culinary tourism and other types of specialized tourism (ecological, rural, Hunting, cultural-cognitive, religious, etc.) [9].

A large proportion of respondents (30%) Be introduced to the specific destination for culinary tourism through acquaintances and the Internet. More than half of the respondents are familiar with the local unique nature, customs and culinary specialities, which provoked them to choose places in Bulgaria as routes for culinary tourism. The popularity and interest in culinary tourism is increasingly growing, in search of unique emotions from touching the nature and contact with local people, traditions and customs. It is therefore necessary to promote this type of tourism with much more expanded advertising. It is necessary to develop and conduct an aggressive marketing strategy that will contribute to the development of other alternative forms of tourism – eco, rural, wine, adventure, cultural, etc.

SWOT analysis of culinary tourism in Bulgaria

The analysis of the strengths and weaknesses of the culinary tourism in Bulgaria as well as the opportunities and threats for its development was carried out through a SWOT analysis.

Table 2. SWOT analysis of culinary tourism in Bulgaria

Strengths	**Weaknesses**
Tourist product, associated with one of the oldest traditions of the Bulgarian territory/wine/and the Bulgarian culinary dishes	No good infrastructure and urban planning in small settlements; Lack of good tourist markings; The local population is at a low level of education;
Year-round accessibility; Focus on relatively solvent tourists;	Migration of population from villages to cities;
Traditions in welcoming Bulgarian and foreign tourists;	In remote settlements there is no basic infrastructure such as roads, water and sanitation;
Ecologically clean environment;	There are no services in smaller municipalities-banks, ATMs;
Opportunities for qualification and retraining of personnel in tourism;	Tourist information centres do not work effectively.
Conditions for conducting different types of tourism;	No new additional services and attractions;
Attractive villages with private rooms and family hotels;	
Preserved local traditions, customs; Historical and architectural monuments;	
Opportunities	Threats
The development of alternative forms of tourism in all seasons of the year;	Unfocused targeting of the tourist product, leading to low efficiency;
To develop new culinary routes related to the lifestyle and customs of the local population; Attracting investors in the culinary areas;	Offering of low quality wine and gourmet tourist product;
Creating a content-rich tourist product, linking wine and gourmet tourism, both modern and in accordance with the established traditions;	
Clear positioning of the product through micro-targeting of the selected target markets, which know Bulgarian wines and food;	
Use the capabilities of communication media to create an emotional connection between product, destination and user;	
Providing support to tourists from target markets/Russia, Ukraine and Belarus/;	

Source: Own calculation.

The lack of specific statistics on this type of tourism does not allow an accurate assessment of its condition and development. The development of culinary tourism has been associated with the popular philosophy in recent decades to "flee" from unhealthy diets, but to prefer local, traditional for the region, locally produced food products.

From the analysis it becomes clear that culinary tourism in Bulgaria still does not have much experience, have established diverse, complementary activities, attractions and entertainments that enrich the main tourist product. The more complex, the better the product of culinary tourism. A part of the identified weaknesses of culinary tourism are determined first by the socio-economic situation – poor infrastructure, lack of financial resources for its modernisation and renewal; Projects are not being developed on the ground; Not encourage entrepreneurship, low level of information provision of tourist sites, etc. Another part of the weaknesses of the culinary tourism is conditional on the insufficient professional qualification of the managers and staff in the sector. Threats to the development of culinary tourism can be an increase in taxes and fees, the emergence of strong competition, Poor road infrastructure, etc.

The economic and social benefits of the development of culinary tourism are: improvement of regional infrastructure; Supporting the development of tourism-related industries; Additional income for the local population; Promoting cultural diversity, preserving national heritage. In general, tourism has a multiplier effect and "…its growth stimulates the growth of other economic sectors" [11].

Culinary tourism is a niche market that has emerged in the hospitality industry in recent years. The most important element in servicing the tourist has not been displayed as a leading motive, stimulating the tourist to travel. But recently, there are more and more people willing to receive unique food and drinks in attractive conditions. Culinary art can be a factor to order culinary tourism among other types of tourism-holiday, ecological, health, spa, etc.

The various initiatives surrounding the development and implementation of food and tourism associations range from culinary tourism strategies to the integration of food into national tourism strategies. Integral to this is the establishment of food and tourism networks, tourism web sites and marketing initiatives dedicated to food, the development of culinary events including festivals, documentation of culinary heritage, and food related activities such as dedicated food tours and cooking holidays [3, 4].

The role of culinary tourism, which could fill the gaps between winter and summer tourist seasons, is particularly important. The traditional Bulgarian dishes can bring as many foreign guests as our ski resorts. Tripe soup, the native Mesna skara\Mix grilled, Banitsa, Shopska salad, Haidushki chevermeta, Rakiaand selected wines entice tourists to rest in Bulgaria. It is necessary to specify which resources related to wine tourism are unique regions and have a high attractiveness; Which events and holidays are best recorded in the national and local tradition and can be successfully integrated into the product of culinary tourism; How to enrich and diversify the product of culinary tourism, to increase its quality and attractiveness; How to attract new or higher solvent tourists. Good tourism management based on initiatives such as the creation of culinary routes could be an alternative for implementing strategies aimed at the social and economic development and promotion of particular areas, for example turning typical food from rural areas in certain regions into a marketable attraction [12].

CONCLUSIONS

On the basis of the SWOT analysis of the state of culinary tourism, the following can be summed up: since the strengths and their influence are dominated by almost twice as strong as the weaknesses, and also the opportunities for improving The state of culinary tourism is better than its threats, it can be assumed that the separate culinary

areas have conditions for the development of culinary tourism. Peculiarities of the regional gastronomy put the task, to preserve not only the recipes for the preparation of traditional and unique local dishes, but also to preserve the local varieties of plant products and animal breeds. Culinary tourism practice 11.7% of tourists, and the willing to do so are more than 15% of tourists. Culinary tourism would combine exceptionally well with wine tourism.

For further development of the cult tourism in Bulgaria it is necessary:

To specify which resources related to the development of culinary tourism are unique for the individual region and possess high attractiveness;

-To specify events and holidays related to culinary resources and the production of culinary products and dishes that fit best in the national and local tradition and can successfully integrate into the product of culinary tourism.

-To enrich and diversify the product of culinary tourism, to increase its quality and attractiveness. To attract new or higher solvent tourists;

-To improve the existing and create new Internet portals of the Bulgarian culinary tourism, for improvement of its information provision;

-Effective use of financial resources under European programmes to stimulate the cultivation of authentic, indigenous crop varieties and animal breeds and the production of typical local dishes;

-Development of specialized curricula and organization of training of professionals in the field of culinary tourism;

-Organizing culinary seminars and conferences, integrated wine and culinary courses, combined wine tasting with cheeses or sausages;

-More active participation in international tourism fairs and exhibitions.

REFERENCES

[1]Boyne, S., Hall, D., & Williams, F. (2003). Policy, support andpromotion for food related tourism initiatives: A marketing approach to regional development, Wine, Food and Tourism Marketing, pp. 131-154.

[2]Du Rand, Gerrie E., Ernie Heath, Nic Alberts, 2003, The role of local and regional food in destination marketing: A South African situation analysis, Journal of Travel & Tourism Marketing, Volume 14, Issue 3-4, Pages 97-112.Vol. 19(1):395-408.

[3]Hall, C. M., Mitchell, R., & Sharples, L., 2003, Consuming Places: The Role of Food, Wine and Tourism in Regional Development. Food Tourism around the World: Development, Management and Markets, London: Butterworth Heinemann, pp. 25-58.

[4]Hall, C. M., & Sharples, L.,2003, The Consumption of experiences or the experience of consumption: An introduction to the tourism of taste. Food tourism around the world: Development, management and markets, London: Butterworth-Heinemann, pp. 1-25.

[5]Hashimoto, A., & Telfer, D., 2003, Positioning an emerging wine route in the Niagara region: Understanding the wine tourism market and its implications for marketing. Wine, food and tourism marketing, pp. 61-76.

[6]Jones, A., & Jenkins, I., 2002, A taste of Wales - Blas Ar Gymru: Institutional malaise in promoting Welsh food tourism products. Tourism and gastronomy, London:, Routledge, pp. 115-131.

[7]Lulcheva, I., The potential of culinary tourism for rural development. Infrastructure and Communications, Sofia, 2015, V, CN. 10, 242 – 252.

[8]Martinez, S.; Hand, M.; Da Pra, M.; Pollack, S.; Ralston, K.; Smith, T.; Vogel, S.; Clark, S.; Lohr, L.; Low, S.; et al. 2010 Local Food Systems Concepts, Impacts, and Issues. Economic Research Report 97; U.S. Department of Agriculture, Economic Research Service: Washington, DC, USA.

[9]National Strategy for Regional Development (NSRF) of the Republic of Bulgaria for the period 2012 – 2022. www.mrrb.bg

[10]Okumus, B., Okumus, F., & McKercher, B. (2007). Incorporating local and international cuisines in the marketing of tourism destinations: The cases of Hong Kong and Turkey. Tourism Management, 28, 253-261.

[11]Popescu, Agatha, Daniela Plesoianu, 2019, Comparison regarding the tourism impact on the economy of Bulgaria and Romania. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 19(1):395-408.

[12]Sánchez-Cañizares, Sandra María, Tomás López-Guzmán, 2012, Gastronomy as a tourism resource: profile of the culinary tourist. Current Issues in Tourism, Volume 15, Issue 3, Pages 229-245.

[13]Sims, R. (2009). Food, place and authenticity: local food and the sustainable tourism experience. Journal of Sustainable Tourism, 17(3), 321-336.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

STUDY OF THE CONSUMER INTEREST OF CULINARY TOURISM IN BULGARIA

Ivanka LULCHEVA

Agricultural University - Plovdiv, 4000, 12, Mendeleev Blvd., Plovdiv, Phone: +359 (32) 654 200, Fax: +359 (32) 633 157, Bulgaria, Email: ivanka.lulcheva@yahoo.com

Corresponding author: ivanka.lulcheva@yahoo.com

Abstract

Culinary tourism, like any type of tourism is an economic activity, but it is part of the culture of the defined region. Therefore, practicing culinary tourism should be perceived primarily as a cultural enrichment of the individual person. The aim of the research is to establish the degree of interest in the practice of culinary tourism in Bulgaria; Preferences in a particular culinary area; Expectations from practicing culinary tourism. In order to achieve this objective, it is necessary to carry out the following tasks: To prepare an inquiry card; To conduct the survey among consumers; To carry out statistical treatment and analyse the results of the survey; To summarize conclusions. To achieve the purpose of the survey was conducted questionnaires – in person and through online form (inquiry card), in the period 05.11.2018 – 22.12.2018 year, among 104 people aged 18 to 51 years. The questionnaire contains 20 questions of different types – open, closed, multivariate. From the analysis of the results of the study, the following are summarized: respondents practice different types of tourism, and culinary is also present in their preferences. Through an appropriate advertising and marketing strategy, this interest can be strengthened and more actors attract. Respondents would visit each of the tourist areas in Bulgaria for culinary tourism, but as the most preferred they have defined the Rhodopi region. Respondents would be motivated to travel if it offered them a new, different experience; has a good quality/price ratio; It is related to the consumption of traditional as well as unique food and drinks. They are interested in local traditions, lifestyle and culture and would visit festivals, holidays, and domestic/traditional restaurants. The vast majority of respondents believe that the best advertising of culinary tourism can be accomplished through specialized sites, radio and television. They like long weekends outside their own location; The most preferred period for participation in culinary tourism is from 1 to 3 days. For a period of such a duration would allocate between 150 and 300 BGN, this amount does not include the cost of transport and accommodation. Respondents are young people, mostly women, most – family, highly educated and most of them live in a big city; Decide to participate in culinary tourism independently

Key words**:** *culinary tourism, study, interest, culinary area*

INTRODUCTION

Bulgaria has a rich traditional food culture characterized by a variety of local foods and food preparation technologies. The process of transforming plant species into emblems that play an important role in building local identity and the specific taste of the place takes a long time [3]. Over the centuries a large number and various factors influenced the culinary characteristics of the different regions, so separate, different, unique culinary cultures were formed [10]. It is the uniqueness of the preserved food tradition that can be used to create a marketing concept for the development of culinary tourism in the country and in the different regions. There are also unique local, genuine and fresh food and agricultural products and raw materials left over from all organic farming [11].

Culinary tourism, like any type of tourism is an economic activity, but it is part of the culture of the defined region. Therefore, practicing culinary tourism should be perceived primarily as a cultural enrichment of the individual person. All the tourists want to get acquainted and taste the specific local cuisine and traditional foods [6]. Culinary tourism includes cultural experiences, acquaintance of traditions, lifestyle and cultural identity of the destination in which it is practiced. In economic terms, culinary tourism contributes to the sustainable development of the region [2]. In general, tourism has a multiplier effect and "…its

growth stimulates the growth of other economic sectors"[7].

Tourism provides an additional sales outlet for food producers and tourism-related spending on locally produced food products helps to stimulate and revitalise local economies [1] .

There are many benefits to be had in linking food and tourism for all stakeholders concerned. Tourists may even be tempted to stay longer in one place because of the availability of food products and related activities [4]. Significant positive relationships were found between food image and visit intentions [8].

Food fulfils a functional need of tourists; hence it consists of a considerable part of tourism expenditure in both individual and organized travel [5]. Local produce adds authenticity to the tourist experience and provides motivation for visitors to come to a location [9].

The purpose of this study is to establish the degree of interest in the practice of culinary tourism in Bulgaria; Preferences to a particular culinary area; Expectations from practicing culinary tourism. To achieve this objective, it is necessary to carry out the following tasks: Prepare an Inquiry card; to poll users; To carry out statistical treatment and analyse the results of the survey; To summarize conclusions. The purpose of this study is to give an understanding of how to make culinary tourism more attractive and popular among the population and how its marketing needs to change in order to attract a particular tourist segment.

MATERIALS AND METHODS

To achieve the purpose of the survey was conducted questionnaires – personally and through online form (Inquiry card), inquiry was held in the period 05.10.2019 – 22.11.2019 year, among 104 people aged 18 to 51 years. Preparation of an inquiry card: The questionnaire contains 20 questions of different types – open, closed, multivariate. The existence of different types of questions provides the respondents with the freedom to express their opinion and ensures the adequacy and credibility of the results obtained. The questions included in the questionnaire are arranged in the following logical sequence:

•Questions №1 and №2 address the preferred types of tourism and their participation in culinary tourism;

•Question №3 Assesses how respondents perceive culinary tourism;

•Questions №4 and №5 provide information on preferred areas for tourism and in which of the regions respondents would return for culinary tourism;

•Question №6 looks for the respondents' personal experience of new routes for culinary tourism, including preferred places of eating;

•Questions №7, 8, 9 and №10 contain information on the factors that motivate people to practice culinary tourism; experience, the preferred activities for this type of tourism;

•Question №11 gives information about which way of advertising would be most appropriate for the promotion of culinary tourism;

•Questions 12, 13 information about the preferred duration of culinary tourism and the financial resources that respondents would allocate for participation in one.

•Questions 14, 15, 16, 17, 18, 19 and 20 participants examine the following signs: gender; Monthly income; Age Marital status; Level of education and domicile.

RESULTS AND DISCUSSIONS

The results obtained by the survey make it possible to analyse and summarize conclusions. Aggregated data are presented in tabular, graphical or analytical form. In the context of the survey, each of the respondents was given the opportunity to indicate/choose several types of tourism, which he most often practiced, according to his personal preference. All 104 respondents made this choice. The analysis of the results showed that 59% of respondents practiced the most common sea tourism. After him the popularity ranks mountain tourism, with 41% of respondents. For 34% of respondents the most

preferred is cultural tourism, almost the same number of respondents gave their preference for adventure and eco tourism. Culinary tourism occupies a position on an equal footing with urban, health and SPA tourism- with 22% responded. The survey shows that 34% of respondents have already taken part in culinary tours in the country, are relevant to culinary tourism and are potential participants in this type of tourism.

Fig. 1. Number of participants in culinary tourism
Source: Own calculation.

The question: "To what extent do you agree with the statement: Culinary tourism is..." illustrates the different forms of tourism related to food as a motive for taking a trip.
The highest proportion of respondents (36%) consider that culinary tourism is a journey to a particular destination, with all activities related to food and nutrition. For 20% culinary tourism means visiting a local farmers market, a restaurant or a culinary festival, which provides a "different" experience. For 28% of respondents, culinary tourism is part of other activities during the holiday. 13% of the respondents associate culinary tourism above all with a meal in a preferred restaurant during the holiday. 13% of the respondents associate culinary tourism above all with a meal in a preferred restaurant during the holiday. So are those who associate it with a trip to a destination, with a main motive to visit a certain culinary festival or farmer's market. For the rest, nutrition is not a leading motive for culinary tourism. The results are shown graphically in Fig.2 and 3.

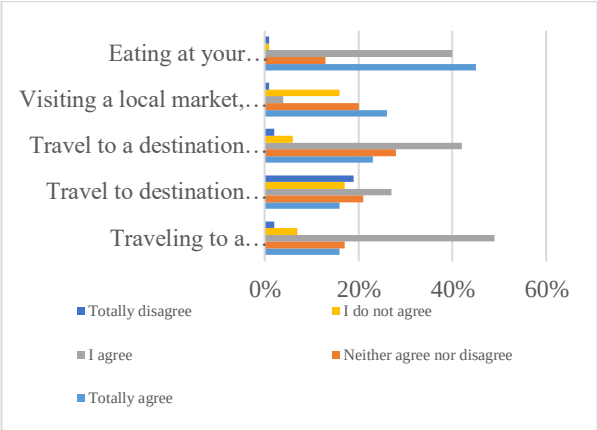

Fig. 2. Respondents' personal understanding of culinary
Source: Own calculation.

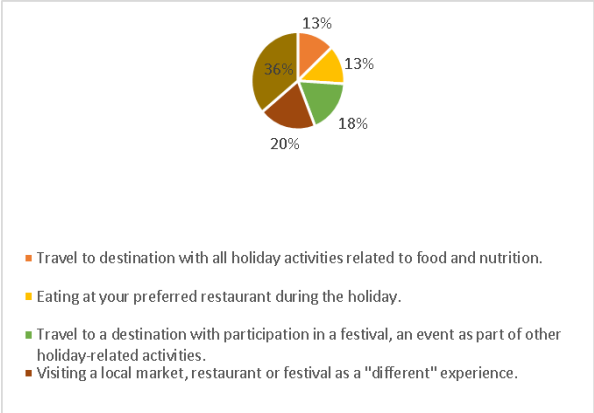

Fig. 3. Proportion of respondents who fully agree
Source: Own calculation.

Table 1. Personal understanding

№	Personal understanding
1.	Eating at your preferred restaurant during the holiday.
2.	Visiting a local market, restaurant or festival as a "different" experience.
3.	Travel to a destination with a festival/event as part of other holiday-related activities.
4.	Travel to destination with all holiday activities related to food and nutrition.
5.	Traveling to a destination with a primary motive for visiting a particular culinary festival/event or farmers' markets.

Source: Own determination.

Each of these areas has its admirers, but the respondents have the greatest desire to visit the Rhodopi region (20%), followed by Rila-Pirin region and Bourgas Black Sea coast (15%). The results are presented in figure 4 show the aggregate share of respondents, whether the answer "I have an exceptionally great desire to visit".

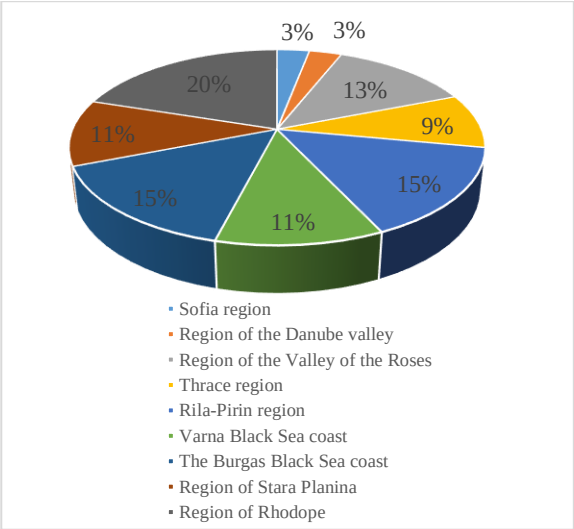

Fig. 4. Proportion of respondents who are extremely keen to visit a culinary area
Source: Own calculation.

The results of the answers to the question are analogous: "which area would you visit again for the purpose of culinary tourism?"
The biggest part is the share of the willing to the Rhodopi region. The results are reflected in Table 2.

Table 2. Proportion of those wishing to re-visit the region for culinary tourism

Region	The relative share of those who answered affirmatively
Sofia region	1%
Region of the Danube valley	6%
Valley of the Roses	9%
Thrace region	7%
Rila -Pirin region	11%
Varna Black Sea coast	13%
The Burgas Black Sea coast	12%
Region of Stara Planina	14%
Region of Rhodope	27%

Source: Own calculation.

Myson defined four types of motivators for taking a tourist journey: physical, cultural, interpersonal and motivators for status and Prestige. Physical motivators are related to ensuring residence in nature, at sea, new experiences and impressions. This includes visits to a particular destination because of a healthy lifestyle.
Cultural motivators aim to enrich knowledge and culture, so tourism and culinary arts belong to them. Travellers want to explore and learn more about culture, lifestyle and traditions in the region visited. Food and beverage, the technology of their production are components of every culture. Therefore, those who visit a particular destination due to a specific and unique dish, food, specialty or drink, actually enrich their culture and knowledge. With regard to interpersonal motivators, family gatherings or where one or more family members live in different territories, the visit during holidays, festivals, etc. is an opportunity for the family to gather and spend their time together.
The survey results show that all factors that would motivate people to participate in culinary tourism are considered important. The factor "opportunities for new emotions and experiences" with 82% of all answers stands out as the most significant. "The ratio: Quality/price" is an important factor for 80% of respondents. For 76% of respondents, the possibility of combining with another type of tourism is an attractive factor that will motivate them to embark on a journey. For 73% It is extremely important to have available accommodation and good infrastructure, and for 75% is an important factor in the availability of domestic restaurants. The factors "existence of country houses" and "image of the destination", respectively, 52% and 68% are the smallest share. The results are reflected tabular in Table 3.

Table 3. Degree of importance of the factors in choosing a destination

Factors:	Extremely important	Impor tant	I can not decide	Is not important	Insig nificant
Availability of farms or country houses	14.0%	38.0%	27.0%	20.0%	1.0%
Destination image	16.0%	52.0%	15.0%	13.0%	4.0%
Opportunities to participate in festivals, farmers' markets, culinary festivals and more.	26.0%	40.0%	23.0%	10.0%	2.0%
Avaiability of traditional (everyday) restaurants	29.0%	46.0%	15.%	8.0%	1.0%
Good infrastructure and availability of accommodation	31.0%	42.0%	14.0%	12.0%	1.0%
Opportunity to combine with other types of tourism	38.0%	38.0%	19.0%	4.0%	1.0%
Quality/price ratio of tourist services	45.0%	35.0%	13.0%	7.0%	1.0%
Opportunities for emotions and experiences	49.0%	43.0%	14.0%	1.0%	3.0%

Source: Own calculation.

In Table 3, there are the summarized the results of the answers to the question "what are the expectations of the respondents in their participation in culinary tourism". For 93% of the respondents, tasting food and drinks is the

most anticipated experience during participation in culinary tourism. Tasting unique food and drinks is waiting for 90% of the respondents; Overall, all responses are positive, with the weakest interest – 58% for participating in traditional culinary activities in the area.

Table 4. Respondents' expectations of participation in culinary tourism

Expectations:	Strongly wish	I have a desire	I can not decide	I have no desire	Totally not relevant to me
To participate in traditional culinary activities in the region	16.0%	42.0%	24.0%	14.0%	2.0%
To enrich my knowledge of the health effects of eating traditional dishes	24.0%	45.0%	14.0 %	10.0%	3.0%
For fun - to participate in traditional culinary events: estivals and holidays	28.0%	40.0%	23.0%	9.0%	0.0%
To enrich my knowledge of local life, culture, traditions and cooking	33.0%	51.0%	12.0%	6.0%	1.0%
To try unique foods and drinks	52.0%	38.0%	8.0%	2.0%	0.0%
To try foods and drinks specific to the area	60.0%	33.0%	7.0%	1.0%	0.0%

Source: Own calculation.

In Table 4, there are reflected in the results of a study on the desire to visit different types of activities when participating in culinary tourism. The most desirable activities related to tasting of traditional food and drinks (95%); In the second place, the replies indicate visits to culinary festivals/events and Food feasts (82%) and visit of traditional/residential restaurants (81%). With close results are the activities of visiting farmers ' markets (67%), visits to exposures related to life, culture and traditions (71%), and visiting a country house and preparing traditional food and drinks (71%). With relatively lower results are activities related to participation in traditional culinary activities (67%) and visiting small businesses (65%).
On advertising and promotion of culinary tourism, respondents believe that the best way is through publications on specialised sites and the Internet – 30% of respondents. In the second place they defined the TV and radio advertisement – 22%. The other listed ways of advertising share 8 to 17%. 10% of respondents indicated the personal recommendation as a reliable advertisement and promotion of culinary tourism. The results are presented in Fig. 5.

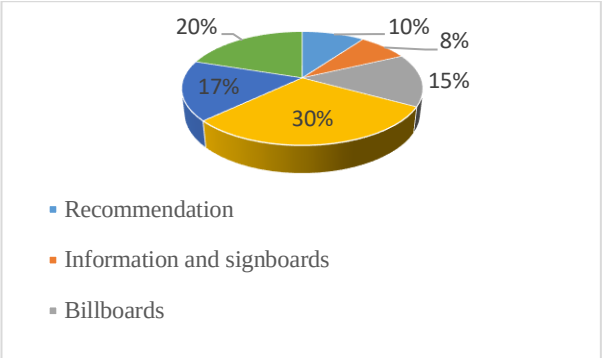

Fig.5 Ways to promote culinary tourism
Source: Own calculation.

Half of the respondents (52%) Choose the duration of the trip for the purpose of culinary tourism from 1 to 3 days; 42% prefer a period of 3 to 5 days – so "long weekend". A negligible number of respondents responded positively to the duration of culinary tourism with a period longer than 5 days (Fig. 6).

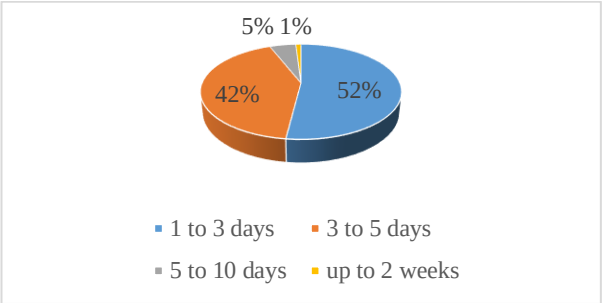

Fig.6. Preferences for the duration of culinary tourism
Source: Own calculation.

The financial means that respondents would allocate for culinary tourism lasting 1-3 days vary in different limits. 43% of respondents indicated that financial resources were needed within 150-300 BGN, 26% of them were willing to allocate more than 300 BGN. For culinary tourism (Fig. 7).

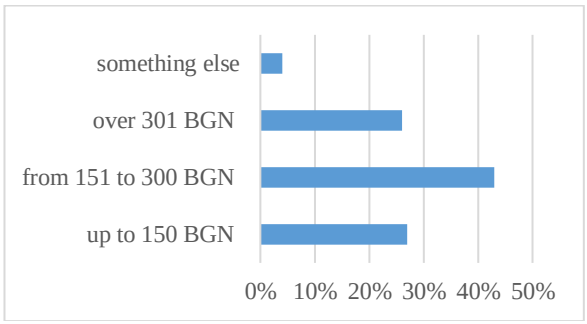

Fig.7. Amount of funds that respondents would devote to culinary tourism lasting 1-3 days
Source: Own calculation.

Respondents' profile: 40% of the total respondents were young people aged between 31 and 40 years; 26% were young people up to 30 years. 68% of respondents were women; 62% are married; The majority of respondents decide to travel independently, in another large part – 39%, decisions are taken by family Council. Respondents were highly educated (72%) And most of them live in a large city (69%).

CONCLUSIONS

From the analysis of the results of the study can be summarized the following:

-Respondents practice different types of tourism, and the culinary is also present in their preferences. Through appropriate advertising and marketing strategy, this interest can be strengthened and more participants are attracted.

-Respondents would visit each of the tourist areas in Bulgaria for culinary tourism, but as the most preferred they have defined the Rhodopi region.

-Respondents would be motivated to travel if it offered them a new, different experience; has a good quality/price ratio; It is associated with the consumption of traditional as well as unique of its kind food and drinks. Interested in local traditions, lifestyle and culture and would visit festivals, holidays, and domestic/traditional restaurants.

-The majority of respondents believe that the best advertisement for culinary tourism can be accomplished through specialized sites, radio and television.

-They enjoy long weekends outside their own location; The most preferred period for participation in culinary tourism is from 1 to 3 days. For a period of such a duration would allocate between 150 and 300 BGN, this amount does not include the cost of transport and accommodation.

-Respondents are young people, mostly women, most – family, highly educated and most of them live in a large city; Decide to participate in culinary tourism independently;

REFERENCES

[1]Boyne, S., Hall, D., & Williams, F. (2003). Policy, support and promotion for food related tourism initiatives: A marketing approach to regional development, Food and Tourism Marketing, New York: Haworth Hospitality Press., pp. 131-154.

[2]Du Rand,Gerrie E., Ernie Heath, Nic Alberts, 2003, The role of local and regional food in destination marketing: A South African situation analysis, Journal of Travel & Tourism Marketing, Volume 14, Issue 3-4, Pages 97-112.

[3]Ganeva-Raicheva, Valentina, D. Dimitrova, T. Ivanova, 2018, Plants and identity: from the biocultural characteristics of the valorisation of native plant resources, Bulgarski Folklor, 44(3).

[4]Hall, C. M., & Mitchell, R. (2006). Gastronomy, food and wine tourism. In D. Buhalis & C. Costa (Eds.), Tourism business frontiers: Consumers, products and industry, London: Butterworth Heinemann, pp. 137-148.

[5]Jones, A., & Jenkins, I., 2002, A taste of Wales - Blas Ar Gymru: Institutional malaise in promoting Welsh food tourism products. Tourism and gastronomy, London: Routledge, pp. 115-131.

[6]Lulcheva, Ivanka, 2018, Opportunities for the development of rural tourism in small settlements, Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 18(2): 283-287.

[7]Popescu, Agatha, Daniela Plesoianu, 2019, Comparison regarding the tourism impact on the economy of Bulgaria and Romania, Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 19(1):395-408.

[8]Shahrim, Ab Karim, Christina Geng-Qing Chi, 2010, Culinary Tourism as a Destination Attraction: An Empirical Examination of Destinations' Food Image, Journal of Travel & Tourism Marketing, Volume 19, Issue 6, Pages 531-555.

[9]Sims, R. (2009). Food, place and authenticity: local food and the sustainable tourism experience. Journal of Sustainable Tourism, 17(3), 321-336.

[10]Terzieva, V., Ivanka Lulcheva, 2014, National cuisines, traditions and specialties (Textbook), Academic Publishing "Paisiy Helendarski", Plovdiv, p.7-32.

[11]Tudorache, D., Sârbu, L. L., 2013, World promotion of organic farming. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 13(4): 291-294

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

MEASURING THE SATISFACTION OF CONSUMERS OF APPLE JUICE. CASE STUDY

Alina MARCUTA, Agatha POPESCU, Cristina TINDECHE, Carmen ANGELESCU, Liviu MARCUTA

University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax:+40213182888, Mobile:+40723 2923 41, Emails: alinamarcuta@yahoo.com, agatha_popescu@yahoo.com, tindeche_cristina@yahoo.com, angelescucarmen@yahoo.com, liviumarcuta@yahoo.com

Corresponding author: liviumarcuta@yahoo.com

Abstract

Starting from the important role that consumer perception plays in the success of a business, in this paper we set out to analyze their perception of the apple juice obtained from an agricultural farm in Dambovita county. The study was attended by 103 respondents who were asked a questionnaire consisting of 12 questions, the survey taking place face to face. The data were processed using statistical methods, being interpreted using the Likert scale and highlighting that the product is rated with an overall score of 4.08 points out of a maximum score of 5 points. Based on this study, the owners want to know both the consumers' perception of the apple juice they produce and market, as well as finding solutions to improve their marketing activity so that their products are as attractive as possible, and then to leads to increased market share and the profitability of the activity.

Key words**:** *quality, satisfaction, consumer, profitability*

INTRODUCTION

The quality of the products is one of the factors that influence the purchasing decisions of the consumers, and the success of the business depends on the perception of the customers regarding the services or products marketed, regardless of the sector of activity. Generally, customers are willing to pay extra to get better quality products, but they have become more informed, more demanding and more careful with the money they spend.

In order to improve the quality of a product, it is often not necessary to make large investments, but to change the way the production is obtained, the way it is presented or promoted.

In the case of agricultural products, the same principle applies to the quality of the products and their promotion. In general, however, small producers do not have the means to promote their products, so they face numerous barriers to marketing [2].

Producers who are not aware of the important role that customers have in developing their business and who focus only on production, will not get the expected results [1].

That is why the marketing strategies that are today in a continuous change have an important role, due to the shocking audience, but also due to the latest trends in the field. That's why the words that define the new marketing are creativity, targeting, multichanneling and data integration [11]. Also, the use of psychology in identifying consumer preferences will continue to be a challenge in identifying consumer preferences [9]. Also, personalizing the product, creating the brand, but also simplicity and authenticity can be advantages in attracting consumers [10].

Therefore, each manufacturer must try to identify what could be made of the product or product sought by the market.

And it should not be forgotten that the success and failure of a business can be influenced by many other factors, by preferences, but also by the whims of consumers, which in the end means demand and supply [3].

In this paper we set out to analyze consumers' perception of one of the most common products on the market, fruit juice.

Studies show that fruits and vegetables are important elements in the diet, they should be consumed daily in an amount of about 400 g, divided into 5 servings. And because most of the time this is not the case, for convenience or inactivity, fruit juices can be a solution in providing the necessary vitamins, carbohydrates, minerals and polyphenols. Moreover, juices can be easily purchased, transported, stored and consumed. Due to the pasteurization process they retain their properties and can be kept for a few days after opening.

As the data published by the National Institute of Statistics show, fruit consumption in Romania in 2015 was 87.8 kg / inhabitant. In 2016 it increased by 8.2 kg / inhabitant, and in 2017 the increase was only 0.1 kg / inhabitant in 2016 [4, 5]. A study by Havas Media shows that in 2017 the consumption of fruit juices increased by 3-5 liters/week compared to 2015 and 2016, demonstrating the increasing interest of the market towards this product.

However, this consumption should be analyzed in correlation with the production of fruit and fruit juices. Although the Romanian orchards benefit from favorable conditions for obtaining high yields, the areas cultivated with fruit trees have decreased compared to the 1980s, when they occupied almost 290 thousand hectares, currently reaching an area of about 138 thousand hectares [6].

Statistical data show that the average area of an agricultural holding holding apple orchards is 2 to 5 ha [7]. Under these conditions, the competitiveness of such a farm depends to a large extent on the ratio between the production that is intended for fresh consumption and that for processing. Although the processing industry, for both fruits and vegetables at the level of Romania is about 160,000 to/year, there is still potential for development in this sector.

Due to the fact that Romania imports high quantities of fruits and vegetables, which compete with domestic production, and the producers face problems related to marketing, they have resorted to processing as a way of absorbing excess production.

One of the causes of their problems is the lack of vertical integration to ensure the relationship between producers and processors. Another element is that related to the perishability of fruits, which causes the producers to resort to finding solutions to reduce losses.

Therefore, due to the perishability of the production, its low quality, the low prices of capitalization, but also the lack of possibilities of capitalization, the producers in this sector have invested in small processing factories through which fruit production is transformed into juices.

This is also the case of a family farm in Dambovita county, which has a surface of 3.2 ha with fruit trees, of which 92% are apples and which also has a natural apple juice factory with a capacity of 1,000 l / hour. In addition to the fruits obtained from its own production, the farm produces juice and fruits purchased from the area that is located in a fruit basin.

Analyzing the production of apples, we find that in the county of Dambovita it has had an oscillating evolution in recent years. If the production level was 96.6 thousand tons in 2007, in 2008 it decreased to 39.6 thousand tons, and in 2014 it was 41.6 thousand tons. One of the causes was the climatic conditions. Then in 2015 and 2016, production increased, reaching 63.1 thousand tons in 2017 (Fig.1).

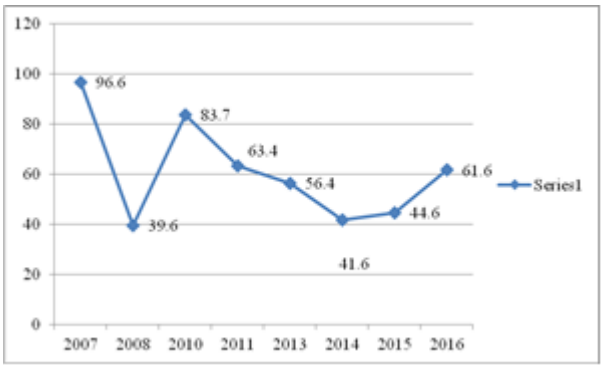

Fig. 1. Evolution of apple production in 2007-2016 (thousands of tons)
Source: Own calculation [8].

The manufacturing technology used in the processing plant involves washing, chopping, pressing, pasteurizing and packing. The

packaging is done in plastic bottles, as well as through the bag-in-box system. Juices do not contain preservatives, additives or flavors. In addition to apple juice, other juices are obtained that contain combinations between apples and other natural juices (pears, carrots, beets, etc.).

Since the producers are permanently interested in increasing the quality of the products they market, the improvement of their marketing activity, during the period September - November 2019 they conducted a survey among the buyers who bought the apple juice both directly from the factory and among the buyers from fairs and exhibitions through which their products were marketed.

MATERIALS AND METHODS

The objective of this paper is to analyze the satisfaction of the customers regarding the consumption of apple juice. In this respect, the respondents were asked a questionnaire consisting of 12 questions, as follows:

(i) How often do you buy apple juice?
(ii)What kind of natural juices do you prefer?
(iii)What fruit additions would you like in apple juice?
(iv)What are the reasons why you buy apple juice?
(v)What would be the element on which you intervened, in order to improve the quality of the apple juice?
(vi) How satisfied are you with the taste of the product?
(vii)How satisfied are you with the product packaging?
(viii)How satisfied are you with the price of the product?
(ix)How satisfied are you with the value for money of the product?
(x)How satisfied are you with the overall quality of the apple juice?
(xi)Would you recommend the product to other consumers?
(xii)Do you still purchase our product?

The questionnaire also included demographic data regarding the respondents, namely: sex, age, education, income and environment.

The research was based on the application of the questionnaire and on the analysis and interpretation of the data.

For the demographic data, the frequencies and the percentage were calculated, and for the determination of the monthly income and the age, the mean squared deviation and the statistical mean were used.

Thus the mean squared deviation was determined based on the formula:

$\delta_2 = \sum_{i=1}^{n} \frac{(xi-\bar{x})2}{n-1}$ [12]

The statistical average was calculated using the formula:

$$\bar{X} = \frac{\sum_{n=1}^{n} \mathrm{xi}}{\mathrm{n}}$$

The other information regarding the satisfaction of consumers regarding the quality of apple juice and which were based on questions with a favorable or unfavorable answer was analyzed and processed. The 5-level Likert Scale was used (highly satisfied, satisfied, satisfactory, neither satisfied or dissatisfied, dissatisfied, highly dissatisfied).

RESULTS AND DISCUSSIONS

The sample to which the questionnaire on the satisfaction of the consumers of natural apple juice was applied comprised 103 people, who purchased different types of apple juice during the period September - November 2019.

The socio-demographic characteristics of the interviewed consumers are presented in Table 1.

Out of the total 103 people, 60% were women and 40 men. In those regarding age, the highest weight was held by persons between 35-45 years (37.86%), followed by those aged 55-64 years (33.98%). The average square deviation was 13.25.

Of the total number of interviewees the majority have secondary studies (51.46%), followed by those with university studies (37.86%) and those with high school studies (10.68%).

As far as incomes are concerned, most of those who buy apple juice are those with incomes over 4,000 lei (41.75%). The calculated deviation was 13.05.

Analyzing the residence environment we find that 66% of the buyers come from the urban area and 34% from the rural area.

Table 1. The socio-demographic characteristics of the interviewed consumers

	Frequency	Percentage
Gender		
Female	41	39.81
Man	62	60.19
Age		
18-34	12	11.65
35-54	39	37.86
55-64	35	33.98
65 and over	17	16.50
Education level		
Gymnasum	11	10.68
Secondary	53	51.46
University	39	37.86
Monthly income level (lei/month)		
1000-2000	12	11.65
2001-3000	21	20.39
3001-4000	27	26.21
over 4000	43	41.75
Residence environment		
Urban	68	66.02
Rural	35	33.98

Source: Own calculation.

Regarding the frequency of consumption of apple juice, 26% of the respondents replied that they consume it frequently, 17% very often, and 57% occasionally.

Regarding the assortments of preferred apple juices 52% preferred the simple apple juice, and 48% appreciated that I prefer the apple juice with different fruit additions.

For the question of why other fruit additions prefer consumers to be added to apple juice, 28% prefer the addition of clams, 24% the addition of pears, 18% the addition of carrots, 14% the addition of red beets, and 16% do not know. The answer regarding the element on which the product should be intervened, 61% of the respondents appreciated the quality of the product (color, taste, etc.), 17% the quality of the packaging, 9% the weight, and 3% do not know. From the analysis of the data regarding the satisfaction of the consumers regarding the taste of the product, it is found that the average obtained is of 4.46 points out of a maximum of 5 points.

Thus 68% of buyers are highly satisfied, 14% satisfied, and 15% undecided (Table 2).

Table 2. Customers' satisfaction regarding with taste the products

	Highly satisfied	**Satisfied**	**Neither satisfied or dissatisfied**	**Dissatisfied**	**Highly dissatisfied**		
	5	4	3	2	1	**Total**	**Score**
Frequency	70	14	15	4	0	103	4.46
Percentage	68	14	15	4	0	100	

Source: Own calculation.

Analyzing consumers' perception of the product packaging it is found that only 41% of the respondents are very satisfied with its design, and 26% are satisfied, which resulted in a score of 3.96 points granted to this criterion. Thus, it is found that a fairly large weight, 33% consider that the appearance of the packaging is not very attractive (Table 3).

Table 3. Customers' satisfaction regarding with product packaging

	Highly satisfied	**Satisfied**	**Neither satisfied or dissatisfied**	**Dissatisfied**	**Highly dissatisfied**		
	5	4	3	2	1	**Total**	**Score**
Frequency	42	27	22	12	0	103	3.96
Percentage	41	26	21	12	0	100	

Source: Own calculation.

The next criterion analyzed was the one regarding the price of the product, the question referring rather to how fair the price is and not to its level, considering that the juice marketed is 100% natural. Therefore 78% of the buyers consider it to be the right one, 13% are undecided, and 5% consider the price high or very high. The score obtained for this criterion was 4.02 points (Table 4).

Table 4. Customers' satisfaction regarding with product price

	Highly satisfied	Satisfied	Neither satisfied or dissatisfied	Dissatisfied	Highly dissatisfied	Total	Score
	5	4	3	2	1		
Frequency	45	35	13	5	5	103	4.02
Percentage	44	34	13	5	5	100	

Source: Own calculation.

From the analysis of the degree of customer satisfaction regarding the quality-price ratio resulted in a score of 3.69 points.

It is found that 69% of buyers consider this report to be correct, while 20% consider it rather high (Table 5).

Table 5. Customers' satisfaction regarding with quality-price ratio

	Highly satisfied	Satisfied	Neither satisfied or dissatisfied	Dissatisfied	Highly dissatisfied		
	5	4	3	2	1	**Total**	**Score**
Frequency	38	33	12	11	9	38	3.69
Percentage	37	32	12	11	9	37	

Source: Own calculation.

Responses regarding the overall quality of apple juice revealed a score of 4.28 resulting from the appreciation of 78% of buyers (Table 6).

Table 6. Customers' satisfaction regarding with quality of apple juice

	Highly satisfied	Satisfied	Neither satisfied or dissatisfied	Dissatisfied	Highly dissatisfied		
	5	4	3	2	1	**Total**	**Score**
Frequency	65	15	14	7	2	103	4.28
Percentage	63	15	14	7	2	100	

Source: Own calculation.

To the question regarding the recommendation of the product and to other buyers the answer was 72% affirmative and 28% negative, the reasons being generally the price (for the negative answers) or the taste (for the affirmative answers).

Table 7. The global score for apple juice

Analyzed quality criteria	Score
Taste quality	4.46
The quality of the packaging	3.96
The price of apple juice	4.02
Quality-price ratio	3.69
The quality of apple juice	4.28
The global score for apple juice	4.08

Source: Own calculation.

From the centralization of the scores regarding the satisfaction of the consumers regarding the apple juice, a general score of 4.08 was obtained (Table 7), which shows that the apple juice is appreciated by the interviewed consumers.

CONCLUSIONS

The present paper is a proposal to analyze the satisfactory clients regarding the quality of the natural juice of simply obtaining an operating family from Dâmboviţa county.

The conclusions of care were clear regarding the conduct of a consumer opinion poll on the juice of only one of the following aspects:

•Customers appreciated with the highest score the taste quality, as well as the overall quality of the apple juice;

•The ratio between quality and price was considered to be a good one, but the score obtained was the lowest for the analyzed criteria. The price could be considered high compared to other products on the market, but the fact that the product is 100% natural leads to the conclusion that it is correct;

•Customers appreciated with the highest score the taste quality, as well as the overall quality of the apple juice;
•The ratio between quality and price was considered good, but the score obtained was the lowest for the analyzed criteria. The price might be considered high compared to other products on the market, but the fact that the product is 100% natural leads to the conclusion that it is correct;
•The production and marketing of apple juice is a way of capitalizing on both low quality production, but also a way of capitalizing on production, when selling prices for apples are low.
•Capitalizing on apple production by this means is an example of integrating agricultural production and increasing the incomes of small producers.

REFERENCES

[1]Bratucu, G., Bratucu, T.O., Analysis of the system of factors that influence the behavior of the individual consumer, Journal of Management and Marketing, pp.11-26, http://www.managementmarketing.ro/pdf/articole/58.pdf, Accessed 8.01.2020
[2]Cetina, I., Goldbach, D., Manea, N., Popescu, L., 2018, Marketing strategies for Romanian traditional products, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 18(2):93-100.
[3]Hotca, M., 2017, Economic gastronomy, http://www.mihaihotca.ro/index.php/2017/12/29/gastronomia-economica-afacerilor/, Accessed 14.01.2020.
[4]INSSE, 2016, Consumer availability of the population in 2016, http://www.insse.ro/old/sites/default/files/field/publicatii/disponibilitatile_de_consum_ale_populatiei_anul_2016.pdf, Accessed 17.01.2020.
[5]INSSE, 2017, Consumer availability of the population in 2017, http://www.insse.ro/cms/sites/default/files/field/publicatii/disponibilitatile_de_consum_ale_populatiei_anul_2017.pdf, Accessed 12.01.2020.
[6]INSSE, 2017, Statistical Yearbook of Romania 2017, http://www.insse.ro/cms/files/Anuar%20arhive/serii%20de%20date/2017/anuarul_statistic_al_Romaniei_2017.pdf, Accessed 17.01.2020.
[7]INSSE, 2016, Structural survey in agriculture, http://www.insse.ro/cms/files/Publicatii_2017/28.Ancheta_structurala_in_agricultura_2016/ancheta_structurala_in_agricultura_2016_vol2_2.pdf, Accessed 12.01.2020.
[8]INSSE, 2018, Statistical Atlas, Fruit Production, http://www.insse.ro/cms/ro/content/atlas-statistic-fructe, Accessed 21.01.2020.
[9]Marcuta, L., Marza, B., Marcuta, A., 2018, The role of neuromarketing in identifying consumer preferences, Innovative business development—a global perspective, Publishing House Springer Link, pp.143-150.
[10]Marcuta, L., Marcuta, A., Marza, B., 2014, Modern Tendencies in Changing the Consumers' Preferences, Procedia Economics and Finance, Vol.16, pp. 535-539.
[11]Tudose, C., 2017, Trends in e-mail marketing since 2018, https://romaniancopywriter.ro/trenduri-in-e-mail-marketing/, Accessed 17.01.2020.
[12]Turdean, M.S., Prodan, L., Statistics, http://file.ucdc.ro/cursuri/F_1_N13_Statistica_Prodan_Ligia.pdf, Accessed 10.01.2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

USE OF SENSORY ANALYSIS TO APPRECIATE THE QUALITY OF APPLE JUICE

Liviu MARCUTA, Letitia PURDOIU, Serban PURDOIU, Valentina TUDOR, Alina MARCUTA

University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax:+40213182888, Mobile:+40723 2923 41, Emails: liviumarcuta@yahoo.com, purdoius@yahoo.com, letitiapurdoiu@yahoo.com, valentina_tudor@yahoo.com, alinamarcuta@yahoo.com

Corresponding author: alinamarcuta@yahoo.com

Abstract

In a period when competition is increasing, and the quality of food is an important element that the consumer takes into account in the choices he makes, sensory analysis is a useful tool for any manufacturer. Thus sensory analysis is a method of establishing consumer preferences regarding a particular product starting from the use of the senses: taste, smell, hearing, sight, tactile feeling. In this way, it can contribute to the evaluation of the taste quality of a product, but also to its differentiation in relation to the competition, to its positioning on the market, to the identification and transposition of tastes, all of which result in increasing the quality and satisfying the taste of the consumers. The present paper aims to analyze consumers' preferences regarding the apple juice product, the methods used being the Likert scale and the rank ordering method. In this way we managed not only to measure the level of consumer satisfaction, but we could also classify the apple juice assortments, in relation to the intensity of the sensory characteristics that were the basis of the case study.

Key words**:** *sensory analysis, quality, consumer, competition*

INTRODUCTION

The importance of using sensory analysis for the appreciation of food products has emerged since the use of information resulting from microbiological and physico-chemical analyzes were no longer sufficient to make decisions regarding the production and marketing process.

Sensory analysis is based on the ability of the sensory organs to appreciate different characteristics of the products, thus using taste, smell, sight and taste. In this way one can appreciate both the taste quality of a product, but different defects of it can be identified. By using the sensory analysis it can be achieved to improve the quality of the products, both from the point of view of content, as well as from the organoleptic point of view, it can prolong the life cycle of a product, it can select, evaluate and control the raw materials used, the new trends can be identified and understood or the return on investments in the field of development research can be increased. Moreover, the sensory analysis has lately become an important tool for the marketing activity, because it offers a better knowledge of consumer behavior, and at the same time, a means of quality assurance.

Even though we have listed only some of the advantages of using sensory analysis, we consider that these are solid arguments for the development of this sector which can add value to the activities carried out in the activity of food production and marketing [2].

Specialists believe that the correct use of sensory analysis can lead to a quick, easy and cheap control of the quality of raw materials and finished products.

The appreciation of the quality of the food products is achieved by decomposing the properties of a product into several components that are measured by awarding scores, percentages, etc., the sensory qualities being appreciated by summing these values.

Sensory value is expressed by attributive quality characteristics, which cannot always be determined by objective means, so it can be said that there is a high degree of

subjectivity in the consumer's perception of sensory quality [9].
There are a variety of methods of sensory appreciation of food products, some of them analytical, and others preferential, some aiming to describe quality, others to order products in relation to quality or to differentiate quality [1]. In the category of differential methods are the rank ordering methods, quality description methods and preferential methods. However, any of the methods would be used, it must contribute to the continuous improvement of foodstuffs both from the composition point of view and from the organoleptic point of view.
In the present paper we set out to analyze four types of apple juice obtained in a farm in the county of Dambovita, county in which the areas cultivated with apples is over 12,800 ha. The productions obtained at the level of 2016 and 2017 are presented in table 1, finding that apple production represents 75% of the total fruit production of this county in 2016 and 58% in 2017.
In the conditions in which part of this production cannot be capitalized as such due to the low quality, and on the other hand the need to diversify the activities in the farms [3] (in this case finding an increase of consumption demand for natural juices) the producers turned their attention to the creation of small fruit processing factories and their transformation into juices. In this way the income obtained from the agricultural activities can contribute to the increase of the well-being of the rural households [8].

Table 1. Evolution of fruit production in Dambovita county (tons)

Year	2016	2017
Total fruit production	34,393	76,096
Apple production	25,930	43,809

Source: INSSE [4], Own processing.

Apple juice is part of the category of fruit juices that are non-alcoholic drinks, which can be obtained from different species of fruit, by pressing or grinding [5].
Apples contain on average: 84 - 93% water, 0.3% ash, 8.30% reducing sugars, 1.60 - 4% sucrose, 0.90 - 1.70% cellulose, 0.50% pentose, 0.40% lignin, 0.20% free acids, 0.60% combined acids, 0.4% pectin [6].
The juices can be obtained either by the extraction of the cellular juice from the fruits, the process being the pressing or diffusion, in which the crushed fruits have a weaker flavor, but have a higher content of pectins and polyphenols. From the point of view of yield, it is higher at diffusion extraction, as compared to that by pressing [7, 10].
Depending on the filtration method, you can get clear or cloudy natural juice. Natural juice-cloud is not filtered and contains pulp particles that will later deposit [12].

MATERIALS AND METHODS

Because in this paper we set out to analyze what is the satisfaction of the clients regarding the different types of apple juice, as well as their classification according to the intensity of the characteristics, we have chosen as methods of analysis and interpretation of Likert scale and the order of ranks.
The Likert scale is used to analyze the different types of questions used in the survey of the respondents regarding the characteristics of a product, being frequently encountered in marketing studies, as well as in customer satisfaction research. Customer satisfaction and measuring this satisfaction is an important element of the Quality Management System. The degree of difference can be appreciated through the scale, but it does not measure the specific difference between the measured sizes.
The method consists of assessing each characteristic of the product starting from a set of questions formulated in a questionnaire consisting of sentences with favorable or unfavorable answer to the analyzed stimulus. Generally the scale has 5 values, but it can go up to 7 or 9. Depending on each feature, a score is calculated, eventually establishing a global score.
Scale levels are assigned scores between 2 and - 2, so that positive or negative values can have similar meanings.
The calculation of the score, for each characteristic is done as follows:

Score $_{characteristic}$ = (no. attribute views 1 x (+2) + no. attribute views 2 x (+1) + no. attribute views 3 x 0 + no. attribute views 4 x (-1) + no. attribute views 5 x (-2))/ no. respondents.
The overall score is determined as follows:

$$\text{Overall score} = \Sigma \frac{\text{feature score}}{\text{no. characteristics}}$$

The second method used in assessing the quality of apple juice is the ordering of ranks, according to which one can appreciate complex characteristics of the product, such as appearance, taste, color, etc.
Through the method, the respondents are asked to rank the products according to the evaluated criteria [11], resulting in a number of ranks equal to the number of analyzed products. Subsequently, these rank ranks are attached to values.
The overall score or average is an arithmetic mean of the scores or averages calculated for each product analyzed.

RESULTS AND DISCUSSIONS

The case study involved analyzing the quality of four types of apple juices, the first represented by apple juice without the addition of other fruits, the second represented by apple juice mixed with gout, the third represented by apple juice mixed with beet. red and fourth represented by apple juice and pears.
Each of the 4 kinds of apple juice was tasted by 103 untrained persons, the tasting taking place between September 25 - November 25, 2019 in fairs, as well as in the factory.
The study was carried out by applying a questionnaire.
The characteristics sought in appreciating the quality of the juices were: appearance, taste and color.
The first quality assessment method used the Likert scale.
Five levels of agreement, respectively disagreement were used, namely: total agreement, agreement, indifferent, total disagreement and disagreement.

The three characteristics of the first assortment of apple juice were analyzed by formulating the opinions that were centralized and presented in Table 2.

Table 2. Distribution of subjects' appreciation for apple juice

Product	Total agreement	Agree-ment	Indi-fferent	Disagree-ment	Total Disagreement
Color	72	17	2	12	0
Appearance	69	20	2	12	0
Taste	63	25	7	8	0

Source: Own processing.

Starting from the data presented in Table 1 regarding the respondents' ratings, scores were calculated for each of the characteristics. Thus the score for color was 1.44, for appearance 1.42, and for taste 1.39. The overall score calculated as the arithmetic mean of the three scores was 1.42.
The evaluation of the characteristics for the second product, apple juice with quince, is presented in Table 3.

Table 3. Distribution of subjects' appreciation for apple juice with quince

Product	Total agreement	Agree-ment	Indi-fferent	Disagree-ment	Total Disagreement
Color	84	7	5	7	0
Appearance	83	8	4	8	0
Taste	87	12	2	2	0

Source: Own processing.

According to the centralized data based on the answers offered by the 103 people, the three scores given for color, appearance and taste were: 1.63 (color), 1.61 (appearance) and 1.77 (taste). The overall score is 1.67.
For apple juice with red beet, the ratings are presented in Table 4.

Table 4. Distribution of subjects' appreciation for apple juice with red beet

Product	Total agreement	Agree-ment	Indi-fferent	Disagree-ment	Total Disagreement
Color	89	10	2	2	0
Appearance	88	9	4	2	0
Taste	59	27	10	9	0

Source: Own processing.

Red beet apple juice was rated with a score of 1.80 for color, 1.78 for appearance and 1.32 for taste. The overall score was 1.63.
The appraisals regarding apple and pear juice are presented in Table 5.

Table 5. Distribution of subjects' appreciation for apple juice with pears

Product	Total agreement	Agree-ment	Indi-fferent	Disagree-ment	Total Disagreement
Color	65	24	10	4	0
Appearance	64	27	8	4	0
Taste	82	15	5	1	0

Source: Own processing.

The calculation of the scores revealed a score of 1.45 for color, 1.47 for appearance and 1.73 for taste. The average of the three scores was 1.55.
The analysis of the three products in terms of overall score pointed out that the most appreciated was apple juice with pears, followed by apple juice with guts, apple juice with red beet, and finally the juice of apples.
And in terms of taste, the same hierarchy is maintained. However, if we analyse the consumers' preferences regarding color and appearance, the red beet juice is in the first place in the consumers preferences followed by the apple juice with the guts, the apple juice with pears, and the last place is the juice apples without additions.
Therefore, consumers are in agreement with the analyzed products, the overall picture being a positive one.
The second method used to assess consumer preference over the four types of apple juice was the rank ordering method.
Although in the case study there were only four categories of products under analysis, I preferred this method because it allows subjects both the comparison between products, but also their ordering.
The presentation of the samples was done concomitantly, the products being ordered according to rank taking into account the color the appearance and the taste.
The data used to calculate the averages regarding the characteristics are presented in Tables 6, 7, 8 and 9.

Table 6. Distribution of subjects' appreciation for apple juice

Product	Rang 1	Rang 2	Rang 3
Color	72	17	14
Appearance	69	20	12
Taste	63	25	8

Source: Own processing.

The averages calculated for the three characteristics were as follows: M color = 2.56, M appearance = 2.51 and M taste = 2.40.

Table 7. Distribution of subjects' appreciation for apple juice with quince

Product	Rang 1	Rang 2	Rang 3
Color	84	7	12
Appearance	83	8	12
Taste	87	12	4

Source: Own processing.

For apple juice with peel, the calculated averages were as follows: M color = 2.70, M appearance = 2.69 and M taste = 2.81.

Table 8. Distribution of subjects' appreciation for apple juice with red beet

Product	Rang 1	Rang 2	Rang 3
Color	89	10	4
Appearance	88	9	6
Taste	59	27	19

Source: Own processing.

For the third assortment of apple juice, the one with red beet, the calculated averages were: M color = 2.86, M appearance = 2.80 and M taste = 2.43

Table 9. Distribution of subjects' appreciation for apple juice with pears

Product	Rang 1	Rang 2	Rang 3
Color	65	24	14
Appearance	64	27	12
Taste	82	15	6

Source: Own processing.

The averages obtained for apple juice with pears were: M color = 2.50, M appearance = 2.46 and M taste = 2.74.
The test confirms the results that were obtained and measured using the Likert scale.

CONCLUSIONS

Although the Likert scale may have the disadvantage of the distortions due to the retention of the respondents regarding the value of the answers given, it still remains the most important scale of measuring the attitude of the customers regarding the product categories subject to their assessment.

The global score highlights that the apple juice brought to the market corresponds in terms of sensory characteristics.

Following the centralization of the results obtained by the rank ordering method, the following aspects have resulted:

•The best color score was obtained from apple juice with red beet, followed by apple juice with guts, apple juice without any other fruit, and on the fourth place was apple juice with pears.

•As regards the appreciation of the appearance, the same order of consumer preferences is maintained

•From the appreciation of the taste it turned out that the most appreciated assortment was the apple juice with guts, followed by the apple juice with pears, on the third place was the apple juice with red beetroot and the last place was the simple apple juice

•The products meet organoleptic requirements of consumers

•The present study was useful to the producers because according to the preferences of the consumers, the quantities that will be produced from each of the 4 assortments were established

REFERENCES

[1]Croitoru, C., 2013, Sensory analysis of agri-food products. Vol.1. Metrological, methodological and statistical elements, AGIR Publishing House, 117-245.

[2]Frone, F., 2012, Marketing (Basics of marketing), course support, http://www.manag usamv.ro/images/pdf/Mk.pdf, Accessed on 8.01.2020.

[3]Iagaru, R., Iagaru, P., 2012, The impact of the current situation on the development of non-agricultural activities in rural areas situated at the border of Sibiu, Scientific Works Agricultural Management, Vol.16(1), AGROPRINT Timisoara, Romania

[4]INSSE, 2018, Vegetable production at the main crops, ISSN 2066 – 4117, pp. 50-53.

[5]Jurubita, J., Visan, L., Pomohaci, N., 2002, Fruit Juice Technology, Nelmaco Publishing House, pp.123.

[6]Mihaly Cozmuta, A., 2018, Green apple juice, http://chimie-biologie.ubm.ro/Cursuri%20on-line/MIHALY%20COZMUTA%20ANCA/ALIMENTE%20CU%20DESTINATIE%20SPECIALA-FUNCTIONALE/Tehnologii%20ale%20produselor%20de%20origine%20vegetala/Sucul%20de%20mere%20verzi.ppt, Accessed on 08.01.2020.

[7]Lazăr, V., 2006, Technology for preserving and industrializing horticultural products, Academic Pres Cluj-Napoca Publishing House, pp 52-78.

[8]Marcuta, A., Marcuta, L., 2019, Analysis of agricultural entrepreneurial income and its role in agriculture financing. Case study Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 19(3):399-403.

[9]Onete, B.C., Voinea, L., Filip, A., Dina, R., 2014, Investigating the discrepancy between food attractiveness and the real nutritional profile - an essential condition for strengthening nutritional education and protecting consumer rights, Amfiteatru Economic Magazine, no. 36, vol. XVI, pp.381-396.

[10]Pichiu (Bogdanescu), D., 2018, Contributions to the methodology of obtaining the cider using varieties of apple cultivated in Romania, PhD thesis, University of Agricultural Sciences and Veterinary Medicine of the Banat "King Michael I of Romania" from Timisoara, pp. 72-85.

[11]Timiras, L.C., 2016, Marketing researches. Applications and case studies, Alma Mater Publishing House, 22-24.

[12]Technological process- Bioterra Natural (Procesul tehnologic, Bioterra Natural), https://bioterra-natural.ro/ro/procesul-tehnologic/, Accessed on 6.01.2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE RELATIONSHIP BETWEEN DEMOGRAPHY AND THE DEVELOPMENT OF SMART CITY. CASE STUDY - BUCHAREST

Liviu MARCUTA[1], Alina MARCUTA[1], Pompilica IAGARU[2], Romulus IAGARU[2], Levente DIMEN[3]

[1]University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax:+40213182888, Mobile: +40723 2923 41, Emails: liviumarcuta@yahoo.com, alinamarcuta@yahoo.com
[2]Lucian Blaga University of Sibiu, 10 Victoriei, Romania, Phone: +40269216062, Fax:+40269217887, Mobile:+40729950222, Email: romulus.iagaru@ulbsibiu.ro
[3]"1 Decembrie 1918", University of Alba Iulia, 5 Street Gabriel Bethlen, Alba Iulia, Romania, Mobile: +40745918966, Email: dimenlev@yahoo.com

Corresponding author: alinamarcuta@yahoo.com

Abstract

Statistics show that by 2050 there will be a doubling of the population of the globe, as the earth's surface undergoes numerous transformations that risk reducing the surface of living areas more and more (recent fire in Australia, melting glaciers, desertification, etc.). Under these conditions, the need to find intelligent solutions that contribute to solving the problems related to less and less available resources, to the needs of environmental protection, to ensuring comfort in urban agglomerations, to ensuring safety in these environments is becoming stronger, which requires ensuring an integrated management that responds to the modern demands of humanity, as well as solving these problems. This paper aims to analyze the relationship between demography and the development of smart cities. In this sense, the methodology consisted in the analysis of the specialized literature, as well as of the statistical data presented in different databases, which were the basis for the formulation of opinions and conclusions on how to modernize the cities that could thus become intelligent.

Key words**:** *demography, urbanization, smart cities*

INTRODUCTION

The notion of a smart city is no longer a new one, but the need to develop such cities appears as a necessity when the official reports show that 2050 is the year until 66% of the world's population will be an urban one. This increase generates new challenges, but at the same time it also offers new opportunities for development, given that the urban administration is currently facing problems related to social exclusion, polluted environment, migration, etc. In this sense, at the global level, measures have begun to be taken that will contribute to the increase of the well-being of the population on the one hand, and on the other hand to the protection of the limited resources available to the planet. If the SMART component seemed to me a possibility, then it became a necessity.

Moreover, there is no generally valid definition or single approach to smart city, given that each community has its cultural, historical, etc. characteristics. Each city has tried to adapt its existing means to the demands of its modernization and transformation into a smart city.

A smart city should have several components, namely: Smart People, Smart Economy, Smart Mobility, Smart Living, Smart Environment and Smart Governance. Of course, ensuring all these aspects is an ideal projection, but in practice as many of these elements can be achieved.

This could be achieved by applying the technology for the modernization of some areas related to: management of public transport, traffic and parking; the use of surveillance cameras to help ensure security (although there are quite a few contestants of this system considering that the right to intimidation of the person is violated); ensuring modern lighting systems to ensure the reduction of energy consumption;

ensuring waste recycling systems; adopting an intelligent infrastructure, both in terms of the system of buildings (residential, commercial), but also in terms of sewerage system, water, gas, garbage collection, asphalting, public cleaning, etc.); improvement of public administration systems; improvement of interaction systems with citizens; etc.

However, the achievement of these objectives depends on the human component, the need for the inhabitants of these cities to be technologized in the sense of producing this technology, in the sense of using this technology and in the sense of being involved in the transformation of the traditional world, in solving social problems through technology [14]. A second element is related to the smart economy which is based on innovation, which works under conditions of efficiency, which is based on innovative management principles, which benefits from fiscal facilities for the purpose of developing modern practices, which transform cultural differences. , national, etc. in advantages, which supports less conventional initiatives, which accepts diversification, which attracts foreign investments and discourages unfair competition.

Smart Mobility is a component not only useful, but necessary in an age of speed. Speaking of mobility, we talk not only about the mobility of the population between urban and rural areas, but also about the mobility between countries under the conditions of globalization, but also about the movement of people, vehicles, means of transport in smart cities, about ensuring easy traffic flows, about the use of vehicles using alternative energies, about providing bicycle lanes, and then about providing functional highway systems, an optimal railway system and proper air transport [5].

Smart Living, while at the same time balanced, it refers to the human, cultural, historical values, to the way in which intelligent citizens understand to get involved in the life of the community and manage to collaborate with social partners. It also refers to health and well-being, how we have access to information and personal safety [5].

Smart Environment is closely related to notions such as circular economy or ecological economy. We find that promoting an economy based on resource consumption, increasing productivity at any price without protecting the environment has done nothing more than contribute to the degradation of the Planet. The traditional economy based on pollution, on the use of a cheap labor force, without thinking about the welfare of future generations is no longer sustainable. That is why a smart city is the one in which the reduction of pollution in all its forms (industrial, sound, light, etc.) is pursued, a city where there are sufficient green spaces, playgrounds, etc.

A last component is the Intelligent Governance which is based on e-Governance on transparency, collaboration, thinking about coherent strategies, respecting the citizen and his rights, ensuring access to data in real time, exchange. of quick information, of making available to citizens some systems for collecting information on their dissatisfaction, collecting suggestions, involving them in intelligent management.

In these circumstances, the European Union has expressed its wish to financially support the projects of smart urban development, initiating the process of identifying such solutions. Thus, the report entitled Mapping Smart Cities in the European Union was elaborated, which highlighted that out of the 468 cities with a population of over 100,000 inhabitants in the European Union (as of the report, 2011), 240 cities could be considered smart cities, they have at least one characteristic that fits them in this category [6].

Within this report Romania is in the middle category, which includes a range of 4-10 cities that can be considered to be smart. The case study exemplified the model of the city of Targu Mures.

In fact, an IDC study by Oracle shows that as far as Central and Eastern European states are concerned, they are behind Western Europe, with the digital transformation process taking place in 35% of organizations, with different

systems being different. implemented in another 34%.
Another smart city initiative belonged to the European Economic and Social Committee, which in 2015 laid the foundation for a strategy published in the report entitled Smart Cities as the engine of a new industrial policy in Europe, through which it pursued the development and support of Smart projects. City, by providing financial support from European funds for the purpose of investing through such projects. Between 2014 and 2020, the Innovation and Network Executive Agency, for example, had a budget of 33.4 billion euros [11].
And globally, more and more countries have initiated programs, strategies, action plans for smart development, making joint efforts and exchanges of information.

MATERIALS AND METHODS

Considering the ones presented above, we proposed that through this paper we analyze the relationship between demography and the development of smart cities, exemplifying for Bucharest, the capital of Romania.
The working methodology involved the analysis of bibliographic resources, the collection, processing and interpretation of data published in the statistics of the National Institute of Statistics, as well as statistics published by the City Hall of Bucharest. The processed results were analyzed and presented through the tables and graphs, based on them being formulated conclusions regarding the case study.

RESULTS AND DISCUSSIONS

In a study by Oracle on the advantages that the Internet of Things has over the development of smart cities, a study conducted for 100 cities in the world, Bucharest was ranked 66, which includes it in the category of advanced cities, due to the fact that progress has been made on the one hand, on the interconnection of the urban ecosystem, and on the other hand on accessing smart projects.

Starting from this fact in the present paper we want to analyze some of the indicators that can lead to considering a city as smart.
The city of Bucharest, is a city that is currently facing problems related to an old infrastructure, an increase in population fluctuation over the last 30 years and which has to adapt both this infrastructure to current needs, but which has to adapt to it local services for demographic changes and population modernization.

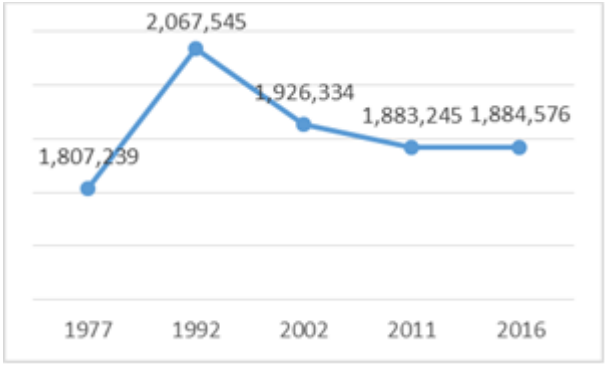

Fig. 1. Evolution of the resident population in Bucharest
Source: INSSE [3] - Own processing.

As you can see from Fig. 1, the population residing in Bucharest reached a maximum in 1992 when it registered 2,067,545 inhabitants. However, the number of those who lived in Bucharest on January 1, 2016 was 2,107,399, and on January 1, 2017, 2,102,912 were distributed as follows on the 6 sectors of the Municipality of Bucharest:

Table 1. The situation of the population of Bucharest in 2016-2017

Resident population	2016	2017
Total	2,107,399	2,102,912
Sector 1	246,738	247,580
Sector 2	374,754	372,149
Sector 3	474,162	472,693
Sector 4	321,873	321,917
Sector 5	298,929	298,924
Sector 6	390,943	389,649

Source: INSSE [2] – Own processing.

From the data of the National Institute of Statistics published in 2017 regarding the design of the population of Romania in territorial profile, it follows that according to

some scenarios, in the next 40 years, the population will decrease by 10% in the optimistic scenario (under the conditions in which "the decrease in Romania will be of 16%), with 15% in the average version (in the conditions where in Romania the decrease will be 21%), with 28% in the intermediate version in the conditions in which in Romania the decrease will be of 15%) and with 29 % in the pessimistic scenario (in the conditions in which the decrease in Romania will be 35%)".

Table 2. The projection of the resident population of Bucharest municipality on the horizon of 2060

	Alternative			
Year	Optimistic	Medium	Intermediate	Pessimistic
2020	1,843,913	1,838,680	1,842,470	1,838,447
2030	1,806,981	1,771,419	1,796,374	1,765,145
2040	1,731,658	1,647,515	1,706,446	1,628,331
2050	1,691,839	1,524,920	1,628,913	1,487,043
2060	1,658,793	1,384,622	1,501,507	1,310,277

Source: INSSE [3] - Own processing.

We find that in the future, the city of Bucharest will have a population decline as the population grows globally. This will happen, however, against the backdrop of the decline of the total population of Romania, but still attracting a significant percentage of it. The specialists consider that in the future the transformation into smart cities will spread, however, among the urban settlements of rank 2 and 3, but also in the rural areas.

Analyzing the situation of the population of the city of Bucharest by age groups, it is found that at the level of 2016 and 2017 "its highest share (67.1% in 2016 and 66.5% in 2017) was between 20-64 years old, while the population with the age between 0-19 years held the share of 16.9% in 2016 and 17% in 2017". The population over the age of 65 represented 16% of the total population in 2016 and 16.5% in 2017. What you can see is the weight reduced number of young people among the population of Bucharest.

Analyzing the population in relation to the average age in the 6 sectors of the Municipality of Bucharest in 2016 we find that this is on average 41.8 years for the total population, 40 years for men and 43.4 years for women (Fig. 2).

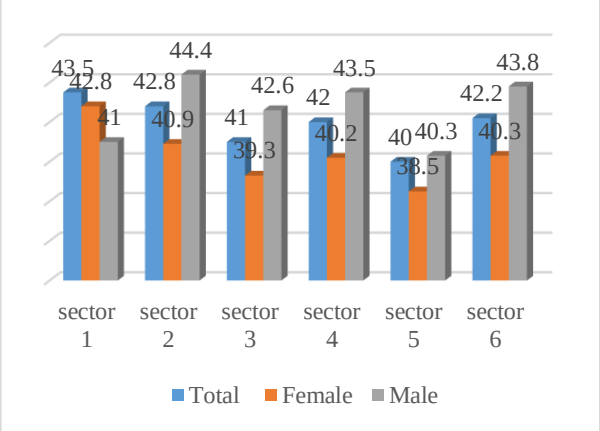

Fig. 2. Medium age of population by home, by sectors, in 2016

Source: INSSE [3] - Own processing.

At the level of 2017, the medium age for total sectors increased to 42.1 years, with 40.2 years for men and 43.7 years for women (Fig. 3).

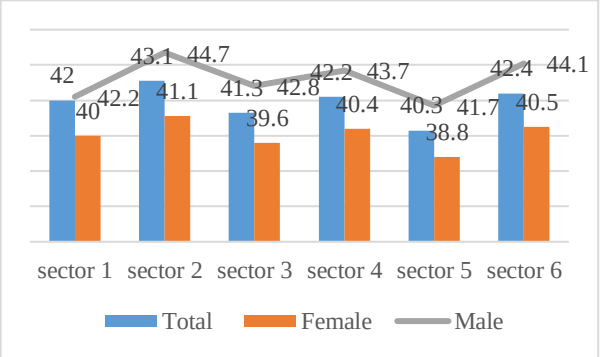

Fig. 3. Medium age of population by home, by sectors, in 2017

Source: INSSE [3] - Own processing.

But what has to be taken into account is the number of tourists who put pressure on the infrastructure of a city. Or according to the Global Mastercard Index of Urban Destinations 2019, which includes 200 cities, Bucharest was in 2017 and 2018 in the top of the European cities, considering that it has a great development potential. Thus the growth potential was over 10% in 2018, the number of tourists who resorted to accommodation services was over 1.4 million, compared to 1.1 million in 2017. The average length of accommodation, which for 2018 and reached 4.9 nights (Fig. 4). The same study also forecasts the increase in the number of foreign tourists for the next period, for both Bucharest and Romania [1].

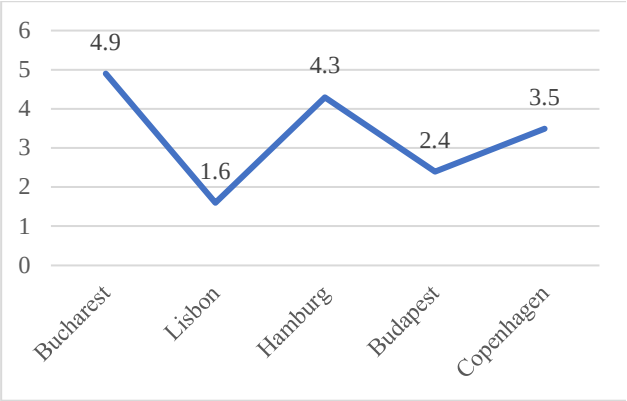

Fig. 4. Average length of stay for foreign tourists in 2018
Source: INSSE [2] – Own processing.

Next we will address issues related to what makes a city smart.

The public transport in Bucharest is realized through the network of trams, trolleybuses, buses and subways. According to the data provided by the Bucharest Transport Company [8] in 2018 the total number of public transport means was 1,930 vehicles increasing by 2% compared to 2017. Of these 25% were trams (486), 15% trolleybuses (297) and 60% buses (1,147). Currently in Bucharest there are 26 tram lines, 16 trolley bus lines and 121 bus lines that total 141 km of trams, 71 km for trolley buses and 471 km for buses. The length of the routes, expressed in double lines, is 268 km for trams, 146 km for trolleybuses and 1,342 km for buses [13].

In terms of communication with Bucharest travelers, an important aspect of smart cities, at the level of 2018 were registered a number of 10,981 messages, of which 7,622 (62%) were notifications, 1,002 (8%) requests for information, 609 (5%) proposals and suggestions, the difference being represented by returns, classifications, miscellaneous.

The Bucharest subway network, although it represents only 3.7% of the city's transport network, provides over 20% of the transport volume with a double track length of 69.5 km. [7].

Regarding the number of cars registered in Bucharest, the statistical data show that at the level of 2017 their number was 1,320,356, increasing by 4.64% in 2018. Forecasts show that although the number of inhabitants of the Municipality of Bucharest will decrease, the number of cars will be increasing. A forecast related to ensuring the connection between the capital of Romania and the airport area, shows that in 2040 the travel time (expressed in hours / day) could reach 3,000 thousand hours for cars, that of freight vehicles over 444 thousand hours, that of taxis at over 135 thousand hours and public transport at over 1,255 thousand hours. The data for 2050 shows the values could be 3,450 thousand hours for cars, for goods vehicles of 490 thousand hours, for taxis of 150 thousand hours, and for public transport over 1,303 thousand hours. The need for smart solutions appears to be a must again.

Regarding the number of cars registered in Bucharest, the statistical data show that at the level of 2017, their number was 1,320,356, increasing by 4.64% in 2018. Forecasts show that, although the number of inhabitants of Bucharest will decreased, the number of cars will increase. A forecast related to ensuring the connection between the capital of Romania and the airport area, shows that in 2040 the travel time (expressed in hours / day) could reach 3,000 thousand hours for cars, that of freight vehicles over 444 thousand hours, that of taxis over 135 thousand hours and public transport over 1,255 thousand hours. Data for 2050 show that the values could be 3,450 thousand hours for cars, for freight vehicles of 490 thousand hours, for taxis of 150 thousand hours and for public transport over 1,303 thousand hours. The need for smart solutions seems to be a necessity again.

The Master Plan of the Bucharest City Hall shows that in Bucharest and the surrounding areas, they produced, at the level of 2018, an amount of 1.1 million tons of garbage, which represents about 20% of the amount of garbage produced at the level of the whole country. 50% of it is household waste, and only 15% of the amount is recycled [9]. Of this quantity only 3% is represented by separate collection. It is thus found that the sorting objectives established at European level were not met, the quantity being exceeded by 25% in 2017. This is determined

by the weak existing infrastructure, but also by the lack of education of the inhabitants.

The Global Alliance of Health and Pollution report shows that in Europe, over 60% of pollution-related deaths are due to air pollution. Worldwide Romania ranks 45th in terms of pollution deaths, while Bucharest is the most polluted city in Romania.

Regarding the emissions of pollutants that are generated by the activities in the Bucharest area, the data show that for 2017 road traffic is the one that pollutes with NO_x and benzene in proportion of 66.31%, respectively 64.46%. The pollution with PM_{10} and $PM_{2.5}$ emissions is due to traffic in the proportion of 58.6%, respectively 47.3%, the rest being due to residential heating. Industry and services have a 25.5% contribution in terms of NO_x pollution [10]. There are many other materials that are polluting, such as plastic masses, which have to be eliminated even if they have advantages [13].

According to the European Union by 2050, the apartment plants, which, as noted, are an important source of pollution, must be eliminated.

Regarding the green spaces, a directive of the European Union stipulates that the surface of green spaces will be of 26m^2/ inhabitant. At the level of 2017 in Bucharest the area was 23m^2/inhabitant. Even though we are approaching the stability threshold, however, compared to 270m^2 / inhabitant in Prague for example, the distance is very large.

Speaking beyond smart technology, in Bucharest there are 4 applications: infoSTB, Traffic alert Bucharest, Parking Bucharest and Social alert Bucharest, which have the role of increasing the quality of the services offered to the inhabitants and visitors [12].

Thus we find that in Bucharest many aspects have been improved that can bring him closer to a smart city, but there are still many steps to be taken.

Among the measures taken and listed are: Sustainable urban mobility plan, which aims to achieve a sustainable and efficient transport system, which has foreseen about 7 billion euros, half of which will be devoted to the development of the metro network; extension of the water supply network, public lighting, sewerage (an increase of 35% of the lighting network in 2017, compared to 1997, of which 48% is underground; reducing electricity consumption and implicitly CO2 emissions by 33.5%; reducing CO2 emissions due to network losses by 71.46%; 8.7% use of LED lighting; use of Telemanagement software); ensuring efficient management in terms of public management; development of quality services; etc. [4].

Other measures involved improving the road system, intelligent traffic lights, traffic management; construction of underground and underground parking; rehabilitation and modernization of hospitals, educational institutions, etc.

In 2013 Bucharest was selected for the award of the scholarship "Challenging Smart Cities" by IBM. In 2018 the Bucharest City Hall has assumed the objective of transforming the city into a smart one, assuming the encouragement of the use of intelligent technologies in the life of human communities for the purpose of their sustainable development, in harmony with the nature and the environment. Furthermore, in 2018, the initiative to develop the Strategy for the development of a smart city Smart City Bucharest was launched.

By 2035 the municipality of Bucharest has proposed other measures to transform the city into a smart one. Of these we mention: the reduction by 2025 of the quantity of food wasted by 50%; preventing the occurrence of waste from printed paper; increasing the amount of separate collected waste to reach 75% by 2025 and 85% by 2035; separate collection of bio-waste will reach 65% by 2035; Thermal scaling installations of energy value wastes will be put into operation.

CONCLUSIONS

In conclusion, a smart city will have to be one that will provide efficient services, have good mobility, ensure safety and security, have a good image, be sustainable, all based on economic development.

Although in recent years in Bucharest progress has been made related to its

transformation into a smart city, it is still necessary to find solutions for the transformation of the Romanian capital and its proximity to the other European capitals.

In the same vein, one cannot talk about smart cities, without talking about inhabitants who must become smart themselves, before requesting this from the municipality. In these conditions, the relationship between demography and smart cities is a direct one.

Although the population of Bucharest will decrease in the coming decades, the need for modernization, the use of technology will be increasingly necessary.

Although we consider that this article has touched on important aspects regarding the transformation of Bucharest into a smart one, there are still many elements that have remained undisputed and will certainly be the subject of a future article.

REFERENCES

[1]Dorobantu, D.M., Marcuta, A., Marcuta, L., 2019, Globalization and tourism. Case study – Romania, Scientific Papers Series - Management, Economic Engineering in Agriculture and Rural Development 2019 Vol.19(3):197-202.

[2]INSSE, 2017, Population with domicile in Bucharest, Accessed on January 14th, 2020.

[3]INSSE, 2017, Projecting the population of Romania in territorial profile, Accessed on January 14th, 2020.

[4]Iuga, M., 2017, SMART utilities in Romania (Utilitati SMART in Romania), https://govnet.ro/uploads/files/42_MAGDALENA%20IUGA%20-%20PMB%20PRIMELE%20REZULTATE%20ALE%20UNUI%20PROIECT%20SMART%20CITY%20INTR-O%20CAPITALA%20EUROPEANA%20-%20PMB%20-%2024.05.2017.pdf, Accessed on January 10th, 2020.

[5]Kollar, M., Bubicco, R.L., Arsalides, N., 2018, Smart Cities, Smart Investment in Central, Eastern and South-Eastern Europe, European Investment Bank, https://www.eib.org/attachments/efs/smart_cities_smart_investments_in_cesee_en.pdf, Accessed on January 10th, 2020.

[6]Mapping Smart Cities in the EU, 2014, Directorate General for Internal Politicies, http://www.europarl.europa.eu/RegData/etudes/etudes/join/2014/507480/IPOL-ITRE_ET(2014)507480_EN.pdf, Accessed on January 10th, 2020.

[7]Metrorex, www.metrorex.ro, Accessed on January 10th, 2020.

[8]OAR, (The Order of Bucharest Architects, The House of Architecture) Report for Bucharest, 2018, https://www.oar-bucuresti.ro/documente/Raportul-pentru-Bucuresti_2018.pdf, Accessed on January 14th, 2020.

[9]PMB, Bucharest City Hall, Master Plan for the integrated waste management system in Bucharest, https://www3.pmb.ro/storage/proiecte/1541510102master-plan.pdf, Accessed on January 10th, 2020.

[10]PMB, Bucharest City Hall, Integrated Air Quality Plan in Bucharest 2018-2022, https://tpbi.ro/files/15/propunere_plan_integrat_calitate_aer_buc-ilovepdf-compressed.pdf, Accessed on January 14th, 2020.

[11]Puscasu, B., 2016, Little guide for cities that want to become (even more) smart, http://www.aapro.ro/doc/articole/2016-10-28/ghid-smart-cities-ro.pdf, Accessed on January 12th, 2020.

[12]STB, Bucharest Transport Company, 2018, Activity report, http://stbsa.ro/docpdf/RAPORT%20DE%20ACTIVITATE%202018.pdf, Accessed on January 10th, 2020.

[13]Tudor, V., C., Smedescu, D.I., Fintineru, G., Fintineru, A., Marcuta, A., Iova, R.A., Plasticulture: Diffusion of plastic materials in the agricultural sector, Plastic materials (Materiale Plastice, Edition: Volume 56, April, https://www.revmaterialeplastice.ro/Articles.asp?ID=5260, Accessed on January 14th, 2020.

[14]Vaduva, S., 2018, It can be a smart city without a tech population, Today Softwear Magazin, no. 67.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

RESEARCH ON THE SMALL PEASANT INDIVIDUAL HOUSEHOLDS IN ROMANIA WITHIN THE FRAMEWORK OF SUSTAINABLE AGRICULTURE

Ion MĂRUNȚELU

Transilvania University of Brasov, Department for Engineering and Management in Food and Tourisme, 149 Castelului Street, Brașov 500014, Romania, Phone: 0268472222;
E-mail: ion.maruntelu@unitbv.ro; i.maruntelu@yahoo.com

Corresponding author: ion.maruntelu@unitbv.ro; i.maruntelu@yahoo.com

Abstract

This paper represents a study on the evolution of agricultural holdings in small individual peasant households in Romania and their importance in sustainable agriculture. Agriculture is one of the basic branches of the national economy. Sustainable agriculture involves obtaining healthy and quality foods, conserving natural resources and preserving biodiversity. Small peasant households generally meet these requirements of sustainable agriculture, given that they generally have small areas of agricultural land near the house used mainly as family gardens that are worked more with hand tools or small machining which do not destroy soil structure by compaction, and chemicals for fighting diseases, pests and weeds are used little or no use. Also, natural fertilizers are usually used and the supplementation with macro and chemical microelements is done in balanced doses. Based on data from the Institute of Statistics, between 2002 - 2016 there is an increase of agricultural holdings in small peasant farms between 2002-2010 (in 2002 and 2010 the two General Agricultural Census took place) and a decrease between the years 2010-2016.

Key words**:** *small peasant individual households, General Agricultural Census, family of farmers, Romania*

INTRODUCTION

The development of agriculture, in the current context, cannot be judged only by the prism of agriculture as a basic branch of the national economy, but also by the social component, particularly important, represented by the traditional peasant households that ensure the subsistence of the rural population [2], as well as the involvement in the use of over 55% of the agricultural area of the country [7], [10].
Starting with the industrial revolution, we tried to restructure agriculture on industrial principles, excluding the fact that the two fields of activity are governed by different laws [1]. Treating the environment as a food-producing factory does not seem to be a sustainable and consequences-free solution. In the last decades, agricultural production has tripled [5], but the costs have decreased and the natural value of food has decreased.
The small peasant individual household had for centuries as main investment work, based on honest economic principles and based on a responsible morality in relation to the environment and society [15]. These qualities have ensured the survival of this form of peasant household, regardless of the external conditions and it is necessary to recognize the status of basic structure in the society [1]. The small peasant individual household constitutes the economic cell of the production, distribution and consumption of the goods in relation to the demands of the family, of one or more persons gathered for the same purpose [9]. This is characterized by the fact that he owns the land around the house or at a certain distance from the house [3].
Small peasant individual households have been known since the Dacia times, developing and modernizing in each historical stage [15]. An important element of small peasant households is the garden or land near the house where vegetables, flowers, herbs, vines, etc. are grown [5]. The basic feature of small peasant individual households is that, unlike large farms, they do not produce for the market in general, but for their own consumption [15]. Theoretically, a small peasant household can work wherever there is

a small area of land and has the following characteristics [2], [15]:
-Its members do not retire and work as long as life allows them to get the food they need for the family
-It is a simple form of circular economy.
The small peasant individual household is based on the work of a group that seeks to satisfy its consumption needs [1]. Regarding the optimal extent of the farm, the households establish it at the level of the most advantageous use of their own work [12]. The intensity of labor exploitation is established in order to obtain the maximum income per unit of work, without a lower limit, but with a relative upper limit established in the sense of satisfying the consumption needs of the family [2]. Thus, the peasant household in the Romanian village does not produce for the purpose of earning, but for the consumption of the family, being not a capitalist type enterprise [17]. In small peasant households, the social criterion is the main criterion according to which the efficiency of production is evaluated [6]. As such, there are triple interdependencies at the household level [15].

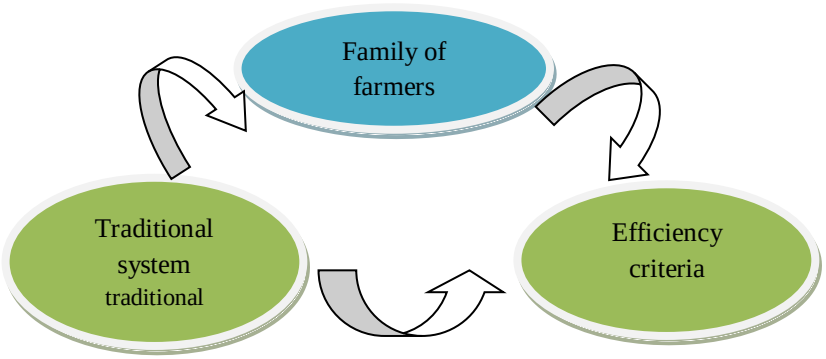

Fig.1. Ties of interdependence at the household level
Source: own processing from open source [15].

The small farm system within the small peasant individual household will last as long as the demand for food comes with priority from family members [2].
The small individual peasant households represented and still represent the backbone of the Romanian people, which meant continuity in traditions specific to the rural environment, generating environment for healthy agricultural-food products [15], [18]. It can be said that a small peasant household is a rural household, which has agricultural resources and has as a basic, complementary and additional concern, agricultural activity to produce basic agricultural products for family members and for those close to them [1], [2].

MATERIALS AND METHODS

Within European agriculture Romania ranks 6th in the EU in terms of agricultural area used [8],[10],[14].

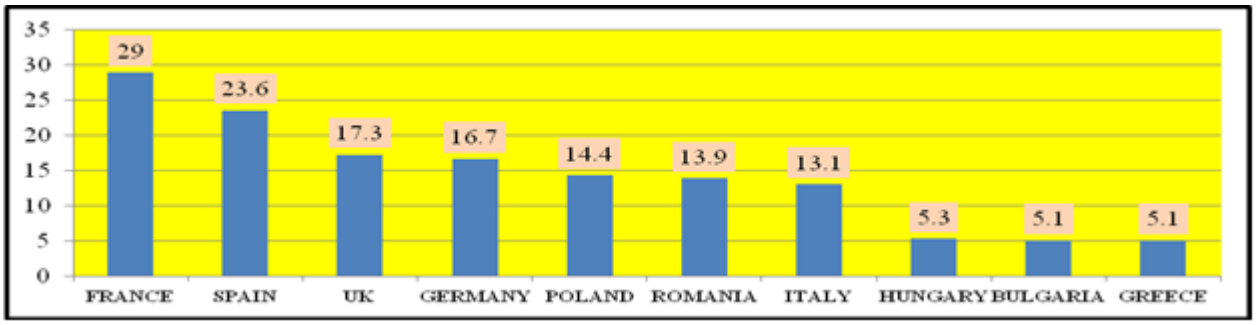

Fig.2.The first ten EU countries in terms of agricultural area used (million ha, 2013)
Source: processed data after Eurostat [7],]8], [9], [10], [17].

The agricultural areas of the small individual peasant households (family gardens) have a small percentage of the total agricultural area of Romania, according to the data from the National Institute of Statistics [3], [5], [13].

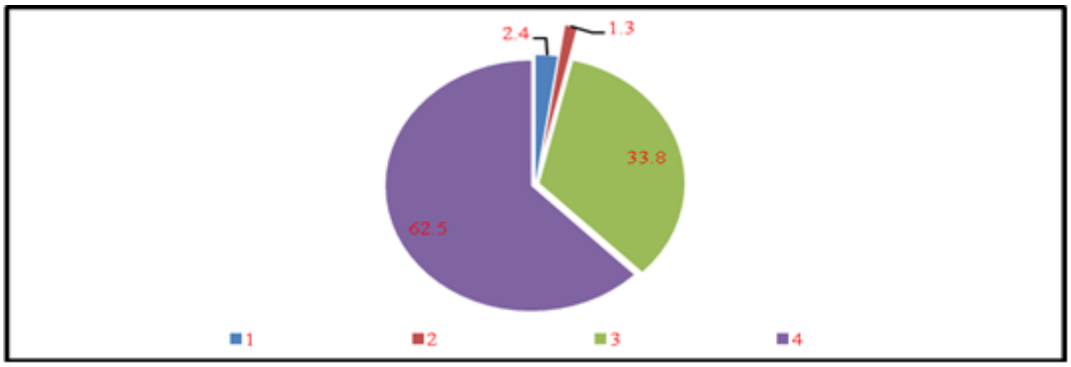

Fig.3. Distribution of the used agricultural area of Romania.
1 - permanent crops; 2- small peasant individual households (family gardens);
3 - pastures and meadows; 4 - arable land
Source: processed data after NIS [11], [12], [13]

The structure of the used agricultural area of Romania is similar to the one in the EU, where the arable land holds about 60%, the pastures and meadows 34%, the permanent crops 6,1%, and the family gardens 0,2% [9], [10], [16].
The structural analysis of the Romanian agriculture is very important to determine at what stage is this important branch of the Romanian economy [14].
The study is based on the statistical data provided by the General Agricultural Census of Romania from 2002 and 2010 [11], [12], [5].The study used the method of comparative analysis of the data provided by the two sources, based on absolute and relative deviations from the reference year 2002, the results obtained having the role of expressing the trends regarding the future of small peasant households in Romania in the medium and long term [4], [5].

RESULTS AND DISCUSSIONS

The study based on the results of the structural survey in agriculture conducted by the National Institute of Statistics presents the evolution in time by comparing the statistical data from 2016 with those of 2013, 2010 and 2002.
The comparative situation of the agricultural area used, respectively of the agricultural area owned by the individual small peasant households in Romania in the years 2002, 2010 and 2016 is presented in Table 1.

Table 1. Comparative situation of the agricultural area used in the years 2002, 2010, 2013 and 2016

Indicators	U.M	Total agricultural holdings			
		2002	2010	2013	2016
Number of agricultural holdings	thousands	4,485	3,859	3,630	3,422
The agricultural area used	thousands ha	13,931	13,306	13,056	12,503
Small peasant individual households (family gardens)	thousands ha	169	182	158	142

Source: Data processing from basis of data from Farm Structure Survey and Agricultural Census data base 2002-2016, NIS [3], [5], [11], [12], [13].

Analyzing the graphical representations it can be noticed a tendency of increase of the agricultural surfaces of the individual small peasant farms during the period 2002-2010, even in the conditions of the decrease of the number of agricultural holdings, but followed of a rapid decrease in the years 2010-2016 caused in particular by the migration from the

rural environment in the urban environment or even outside the country and also because of the aging phenomenon of the population in the rural area (Fig. 4, 5 and 6).

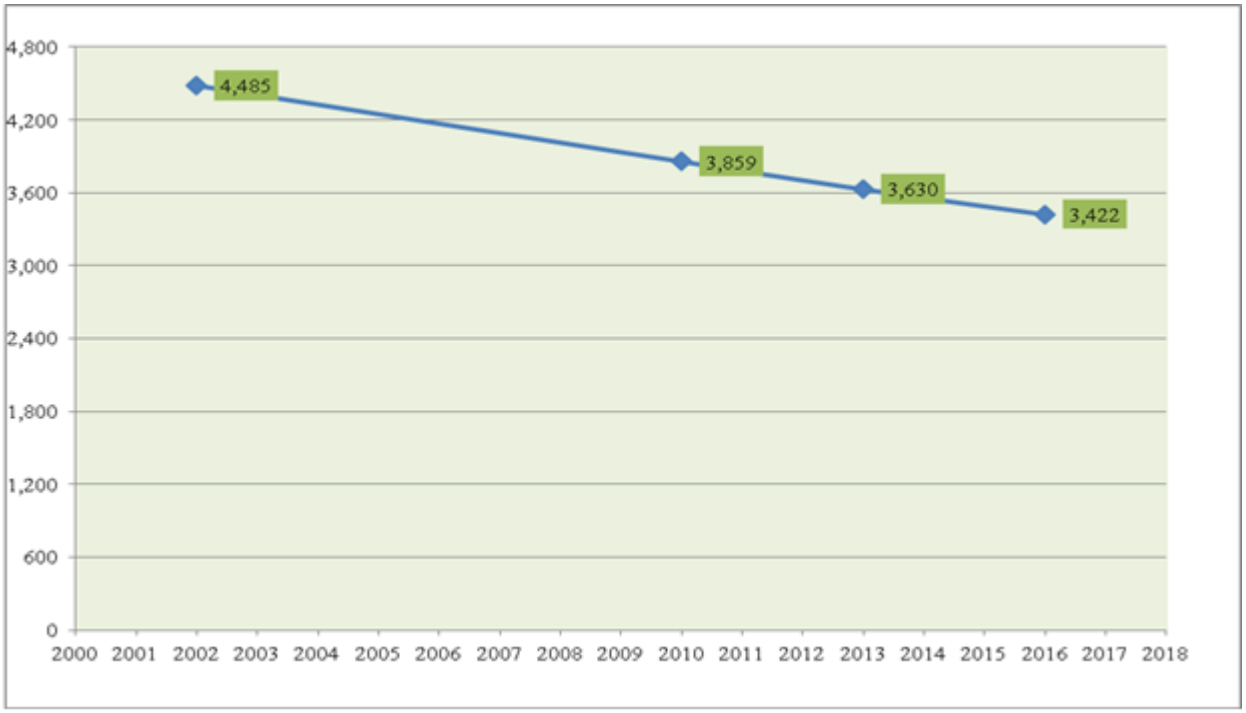

Fig.4. Evolution of the number of agricultural holdings (thousands)
Source: Own design based on the data from [3], [5], [11], [12], [13].

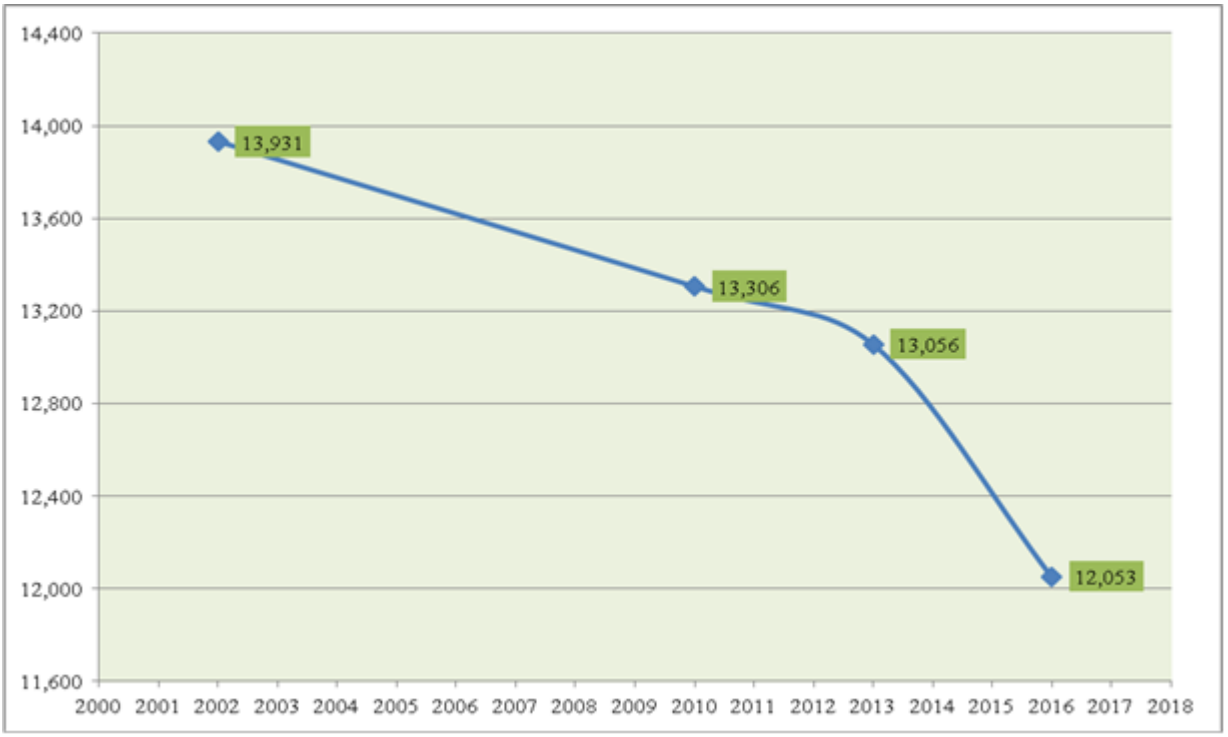

Fig.5. Evolution of the agricultural area used (thousands ha)
Source: Own design based on the data from [3], [5], [11], [12], [13].

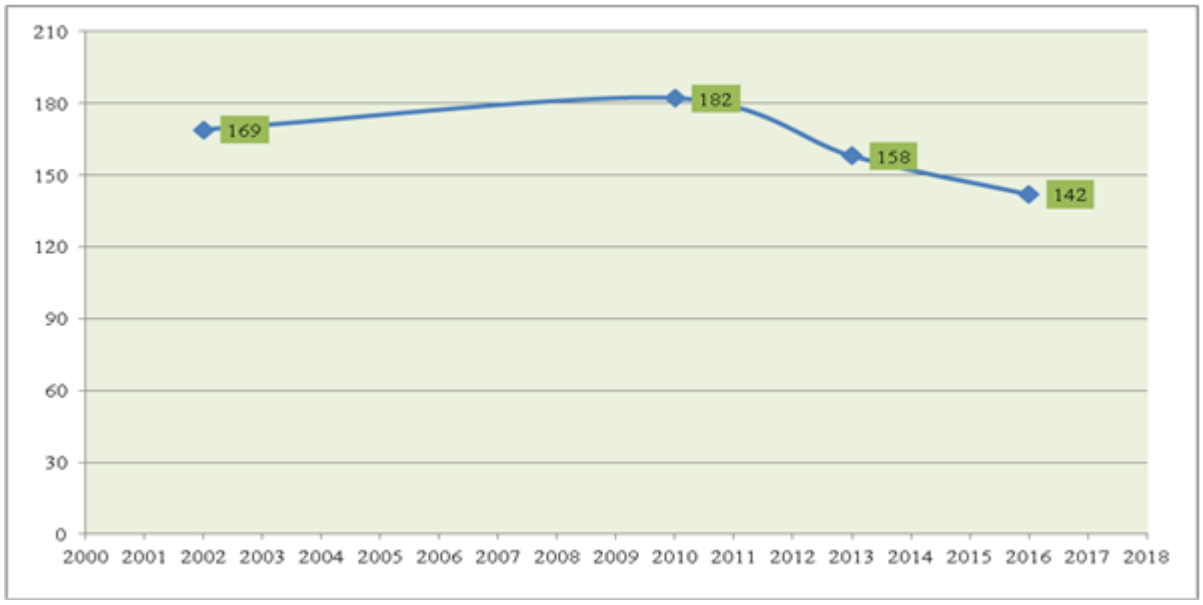

Fig.6. Evolution of small peasant individual households (thousands ha)
Source: Own design based on the data from [3], [5], [11], [12], [13].

CONCLUSIONS

For small peasant households, dependence on family work is a determining feature.

Small peasant individual households are involved in both the production and consumption processes. This dual character of small peasant households establishes the difference between the activity carried out in these households and other economic activities specific to the market economy.

The typology of small peasant individual households depends on their social, mono and multi-family or nonfamily structure, with one or more members, on the land resources, on the relief and agro meteorological conditions of the area, on the productive potential of the agricultural land and on the zoning and specialization of agricultural production.

Small peasant households ensure rural permanence by preserving traditions (economic, gastronomic, cultural, etc.) and rural heritage. The contribution of family farming to maintaining the specificity of the rural area is achieved through the use of sustainable, innovative agricultural practices and through the constant maintenance of biological diversity.

In view of the structure of property and households, but also other factors such as deindustrialization, migration of young people, against the background of population aging, the peasant household is threatened as an existence, many villages being depopulated. That is why it is necessary to rebalance, including by designing and applying the appropriate normative framework, the value, cultural and economic conditions, which in turn will rebalance the human option for living small individual peasant households.

REFERENCES

[1]ADEPT Foundation, 2011, How to live better from my farm (Cum sa traiesc mai bine din ferma mea), https://fundatia-adept.org/wp content/uploads/2018/05/ From-subsistence-to-profit-2011.compressed.pdf, Accessed on December 29, 2019.

[2]Anghelache, C., 2018, Structural analysis of the Romanian Agriculture (Analiza structurală a agriculturii românesti), Romanian Review of Statistics, Supplement No.2, pp.3-10, http://www.revistadestatistica.ro/suplimen /wp-content / uploads / 2018/02 / RRSS_02_2018_A1_RO.pdf, Accessed on December 27, 2019.

[3]Bularcă, E., Toma, E., 2018, Structural change in the romanian agriculture: implications for the farming sector, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.18(2): 59 – 66.

[4]Burcea, M., Stoicea, P, Iova, R.A., 2016, Research on the evolution and the structure of farms in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(2): 49 – 54.

[5]Bohatereţ, V.M., Brumă, I.S., 2015 - The future of the romanian rural household from the perspective of

agricultural censuses in –''Agrarian Economy and Rural Development - Realities and Perspectives for Romania '', the 6th edition, ISSN 2285-6404, pp.54-59

[6]Chițea , L., 2017, Households in the Romanian Rural Area -Theoretical Model, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.17(1): 81 – 89.

[7]Eurostat, Farm structure statistics, http://epp.eurostat.ec.europa.eu/statistics_explained/images/5/5a/ Agricultural_holdings%2C_2000-2010.png Accessed on January 7, 2020.

[8]Eurostat, Statistical Books. Agriculture, forestry and fishery statistics, 2016, Edition. Available on Eurostat website at: http://ec.europa.eu/eurostat, Accessed January 10, 2019.

[9] Grădinaru, I., Mocuța, D., 2017, Farm Structures in the European Union, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(1): 223 – 229.

[10]]MADR, 2015, General data about Romania's agriculture (Date generale despre agricultura Romaniei),https://www.madr.ro/docs/agricultur/aagricultura-romaniei-2015.pdf, Accessed on January 4, 2020.

[11]NIS, 2017, Press release no. 324/ 15 December 2017. Agriculture Field. Available on www.insse.ro/cms/sites/default/files/com_presa/com_pdf/asa_2016r_2.pdf., Accessed on January 5, 2020.

[12]NIS, 2010, RGA. Structural Survey in Agriculture 2007, 2013, 2016; Accessed on December 27, 2019.

[13]NIS, 2012, General Agricultural Census 2010, Vol. 1and2,Bucharest,http://www.insse.ro/cms/files/statistici/comunicate/com_anuale/RGA%202010/RGA2010_date%20statistice_e.pdf, Accessed on December 28, 2019.

[14]Popescu, A., 2013, Considerations on utilized agricultural land and farm structure in the European Union, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.13(4): 221 – 225.

[15]Popescu, G., Istudor, N., 2017, Gospodaria taraneasca in economia rurala (Peasant household in the rural economy), https://www.rndr.ro/documente/brosuri/Gospodaria-taraneasca-in-economia-rurala.pdf, Accessed on December 28, 2019.

[16]Popescu, A., Alecu, I.N., Dinu, T.A., Stoian, E., Ciocan, H., 2016, Farm Structure and Land Concentration in Romania and the European Union's Agriculture. Agriculture and Agricultural Science Procedia Volume 10, 2016, Pages 566-577.

[17]Popescu, M., 2010, Physical Size of Agricultural Holdings in Romania. Gaps between Romania and the European Union Member States. Institute of Agricultural Economics, Romanian Academy. Agricultural Economics and Rural Development, New Series, Year VII, no. 1, p.p.. 17–36.

[18]Rusu, M., Guram – Nica, L., 2017, Current situation and estimation of the financing needs to improve agricultural training of the farm heads, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol.17(1): 361 – 366.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

STRUCTURE OF THE PRIMARY SUPPLY FOR GRAPES IN THE REGION OF DEVELOPMENT SOUTH-WEST OLTENIA (2015-2017)

Dragoș Mihai MEDELETE, Radu Lucian PÂNZARU, Marius MILUȚ

University of Craiova, Faculty of Agronomy, 19 Liberty, 200421, Craiova, Romania, Phone: +40 741 180 976, Fax: + 40 251 418 475, Emails: medelete@yahoo.com, rlp1967craiova@yahoo.com

Corresponding author: rlp1967craiova@yahoo.com

Abstract

The paper purpose was to establish the position of South Western Oltenia region in the national grape supply. For the South-Western Region Oltenia, an average of the wine patrimony area of 32,866 Ha is noted, with the following weights: 32.50 and 67.50% of the gravel vines respectively hybrid ones (10,680 and 22,186 ha); 1.48 and 98.52% of the table grapes respectively wine (485.33 and 32,380.67 ha). The evolution of total production is uneven, the average of the period was 127,492.33 t, with the following weights: 34.66 and 65.34% grafted or hybrid vineyards (4,419.33 and 83,299 t); 1.54 and 98.46% of the table grapes respectively wine (1,958.33 and 125.534 t).
Region, does not in any circumstances achieve the national level of average production, the average of the period recorded 3,879 kg/ha, with different placements from it, by types of vines and production directions: 106.68 and 96.80% grafts and hybrid vineyards (4,138 and 3,755 kg/ha); 104.02 and 99.95% of the table Grapes respectively wine (4,035 and 3,877 kg/ha). The southwestern Region Oltenia, is at national level, an actor of average importance for the wine market, starting from the region's weights, on the global market, 18.48% under the Wine patrimony.

***Key words*:** *Surface, total production, medium production, vine types, grape types*

INTRODUCTION

The importance of wine production for the Romanian profile units is a polyvalent one: food, industrial, technical-technological, ambient, export products and profit source [8]. The wine sector is constituted in an alternative of reducing, at present, unemployment [5]. In the EU, Romania falls into the top five vine growers [9]. The importance of viticulture is enshrined at international level [7].
Vine, is a culture that is at the sharp mechanization of culture technologies, this aspect resulting in reduced production costs [6]. At the same time, the vine is a culture that can be affected by a multitude of diseases and pests [3]. The production of grapes is influenced by climatic conditions and the achievement of the activity [11]. Thus, drought periods influence production yield for mass grapes [12].
At the level of the wine-growing market, the offer is determined by the production potential, underlined by the actual quantities that can be obtained [1]. The wine market can be constituted in a factor of healthy growth, for the economic development of a region, where the vine is cultivated [2].
The quality of grape production is influenced by a number of endogenous and exogeneous factors [4].
The work, seeks to emphasize the location of the south-west Oltenia region in the national grape supply.

MATERIALS AND METHODS

In the drafting of the paper were extracted from the specific database [10]. Consequently, they were used: surface (ha), total production (t) and average production (kg/ha). These indicators are presented at the general level, by types of vines (i.e. hybrid, grafted) and types of grapes (wine and table, respectively). The indicators were mentioned both at regional level, but also for counties composing the region (Dolj, Gorj, Mehedinți, Olt and Vâlcea).
Data processing was performed after the related documentation, dynamic series with four third-party (years 2015, 2016, 2017 and

the average period) were established. Structures were formed at surface level and total production, and the comparison with reference levels (national and regional) for the average production on the productive unit was achieved.

The research method used is the comparison, carried out both in time (indices with the mobile base) and in space (analyses of the national and regional situation).

The work aims to highlight the position of the south-western Development Region Oltenia in the context of the existing national realities.

RESULTS AND DISCUSSIONS

Table 1 present the area of regional viticulture patrimony, by types of vines and production directions.

Table 1. Region South-West Oltenia. Area of wine patrimony

Specification	Year								Period average **			
	2015		2016			2017						
	Eff. (ha) *	Str. (%)**	Eff. (ha) *	Str. (%)**	2016/ 2015**	Eff. (ha) *	Str. (%)**	2017/ 2016**	Eff. (ha)	Str. (%)	average/ 2017	% compared to the national level
Total	32,760	100	33,090	100	101.01	32,748	100	98.97	32,866.00	100	100.36	18.48
Grafted Vineyards	10,540	32.17	10,898	32.94	103.40	10,602	32.37	97.28	10,680.00	32.50	100.74	11.58
Hybrid Vineyards	22,220	67.83	22,192	67.06	99.87	22,146	67.63	99.79	22,186.00	67.50	100.18	25.92
Table grapes	511	1.56	529	1.56	103.52	416	1.27	78.64	485.33	1.48	116.67	7.07
Wine grapes	32,249	98.44	32,561	98.40	100.97	32,332	98.73	99.30	32,380.67	98.52	100.15	18.94

Sources: *http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table (26.02.2019), **own calculation.

In the case of 2015, a total area of 32,760 hectares of vine plantations, of which 10540 ha grafted vineyards (32.17%), 22,220 ha hybrid vineyards (67.83%), is found. On production directions, the surfaces were 511 ha – table grapes (1.56%) and 32.249 ha – wine grapes (98.44%).

For the year 2016, the weights of 32.94 and 67.06% are found for grafted and hybrid vineyards, which held areas of 10,898 and 22,192 ha, so that the total viticulturally patrimony had an area of 33,090 ha. Of the total surface, the table grapes held 1.56% (529 ha) and the wine grapes 98.40% (32,561 ha).

At the level of 2017, a total area of 32.748 ha is found, of which 32.37% grafted vines (10.602 ha) and 67.63% hybrid vines (22,146 ha), respectively 1.27% table grapes (416 ha) and 98.73% wine grapes (32,332 ha).

The average of the period reached 32,866 ha, with the following weights: 32.50 and 67.50% of the grafted vineyards respectively hybrid (10,680 and 22,186 ha); 1.48 and 98.52% of the table grapes respectively wine (485.33 and 32,380.67 ha).

The evolution over time of the total vinicultural surface was uneven. Thus, in the year 2016 there is an increase of 1.01% when we are comparing to the first dynamical series term, in 2017 year a decrease of 1.03% compared to the previous term, and the average of the period exceeded by 0.36% the basis of comparison (year 2017).

With regard to areas occupied by grafted vineyards, a trend similar to that shown above is noted. The reference terms are overfulfilled in 2016 year as for the period average (with +3.40 and +0.74%), and recording decreases for 2017 year (-2.72%). If we take in consideration the dynamics of the surfaces of hybrid plantations, it is noted a decreasing evolution, with annual successive decreases for 2016 and 2017 years (99.87 and 99.79%). Period average shows a value above the reference one with 0.18% (100.18%).

In the case of table grapes, there is an increase of 3.52% of the surface in the year 2016, compared with the reference term, after which for 2017, a decrease of 21.36% occurs. Under these conditions period average exceeds the reporting base 1.16 times. Surfaces that are areas related to grapes for wine increased for 2016 year by 0.97% when are compared to the first term of dynamical series, then they

decrease for 2017 year (-0.70%), and in this time, the period average exceeds by 0.15% the previous term of dynamical series.

As regards the county structure of the regional wine patrimony, this is contained in Table 2.

Table 2. Region South-West Oltenia. Area of wine patrimony – County structure (average period 2015-2017)*

Specification	Total		Grafted Vineyards		Hybrid Vineyards		Table Grapes		Wine grapes	
	Effective (ha)	Str. (%)	Effective (ha)	Str. (%)	Effective (ha)	Str. (%)	Effective (ha)	Str. (%)	Effective (ha)	Str. (%)
Total region	32,866.00	100	10,680.00	100	22,186.00	100	485.33	100	32,380.67	100
Dolj County	12,881.00	39.19	4,376.00	40.97	8,505.00	38.33	124.67	25.69	12,756.33	39.39
Gorj County	3,399.33	10.34	-	-	3,399.33	15.32	-	-	3,399.33	10.50
Mehedinți County	5,842.00	17.78	1,824.33	17.08	4,017.67	18.11	173.66	35.78	5,668.34	17.51
Olt County	5,753.00	17.50	1,286.67	12.05	4,466.33	20.13	57.67	11.88	5,695.33	17.59
Vâlcea County	4,990.67	15.19	3,193.00	29.90	1,797.67	8.11	129.33	26.65	4,861.34	15.01

Source: *own calculation from http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table (26.02.2019).

It is noteworthy from the outset that Gorj County does not have areas occupied by grafted vineyards or areas of table grapes.

In the case of total patrimony, Dolj County is predominant with 12,881 ha (39.19%), followed by the counties of Mehedinţi and Olt (5,842 and 5,753 ha, respectively, and shares of 17.78 and 17.50%). Vâlcea County, contributes 4,990.67 ha to the formation of regional patrimony (15.19%), while Gorj County is characterized by a total area of 3,399.33 ha (10.34% - Fig. 1).

For the grafted vineyards, the structure was as follows: 12.05% Olt County (1,286.67 ha), 17.08% Mehedinţi County (1,824.33 ha), 29.90% Vâlcea County (3,193 ha) and 40.97% Dolj County (4,376 ha – Fig. 1).

Taking in consideration the data for hybrid vineyards, the weights are variable from 8.11% for Vâlcea County (1,797.67 ha) to 38.33% at Dolj county level (8,505 ha). The rest of the counties held weights, somewhat, close: 15.32% Gorj (3,399.33 ha), 18.11% Mehedinţi (4,017.67 ha) and 20.13% Olt (4,466.33 ha - Fig. 1).

Considering the surfaces occupied by table grapes, Mehedinţi County is predominantly 35.78% (173.66 ha), followed by Vâlcea County – 26.65% (129.33 ha), Dolj County – 25.69% (124.67 ha) and Olt County – 11.88% (57.67 ha - Fig. 1).

The regional area for the production of wine grapes presents the following structure: 10.50% Gorj County (3,399.33 ha), 15.01% Vâlcea County (4,861.34 ha), 17.51% Mehedinţi County (5,668.34 ha), 17.59% Olt County (5,695.33 ha) and 39.39% Dolj County (12,756.33 ha - Fig. 1).

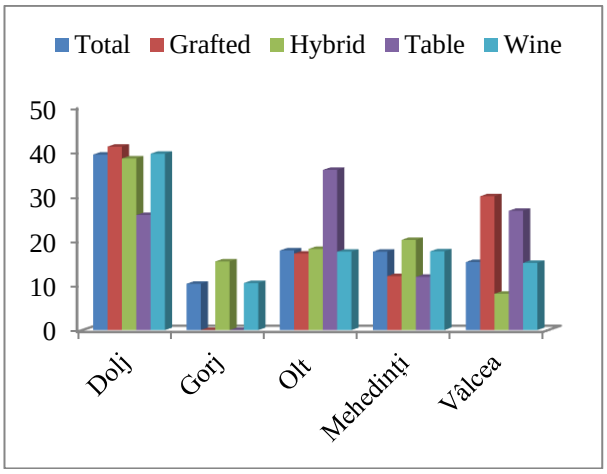

Fig. 1. County structure of regional viticulture patrimony, by types of vines and production directions – average period (%)

Source: Own design based on the own results.

Total grape production is presented in Table 3. For the year 2015, the weights of 32.72 and 62.79% are found for grafted and hybrid vineyards, which produced 38.044 and 64,190 t productions, so that the total wine production was 102,234 t. Of total production, table grapes held 1.71% (1,752 t) and wine grapes 98.29% (100,482 t).

At the level of 2016, there is a total production of 95,559 t, of which 37.17% grafted vineyards (35,518 t) and 62.83% hybrid vineyards (60,041 t), respectively 1.82% table grapes (1,737 t) and 98.18% wine grapes (93,822 t).

In the case of 2017, a total production of 184,684 t of grapes is found, of which 59,018

t from grafted vineyards (31.96%), 125,666 t from hybrid vineyards (68.04%). On production directions, the indicator reached 2,386 t – table grapes (1.29%) and 182,298 t – wine grapes (98.71%). The average of the period was 127,492.33 t, with the following weights: 34.66 and 65.34% grafted vineyards respectively hybrid (4,419.33 and 83,299 t); 1.54 and 98.46% of the table grapes respectively wine (1,958.33 and 125,534 t).
Total production decreased in the year 2016 by 6.53% compared to the previous year, increased by 93.27% in 2017 compared to the level in 2016, and the average of the period was less with 30.97% compared to the specific level of 2017.

Table 3. Region South-West Oltenia. Total grape Production

Specification	Year								Period average**			
	2015		2016			2017						
	Eff. (t) *	Str. (%)**	Eff. (t) *	Str. (%)**	2016/ 2015**	Eff. (t) *	Str. (%)**	2017/ 2016**	Eff. (t)	Str. (%)	average/ 2017	% beside the national level
Total	102,234	100	95,559	100	93.47	184,684	100	193.27	127,492.33	100	69.03	14.69
Grafted Vineyards	38,044	37.21	35,518	37.17	93.36	59,018	31.96	166.16	44,193.33	34.66	74.88	8.73
Hybrid Vineyards	64,190	62.79	60,041	62.83	93.54	125,666	68.04	209.30	83,299.00	65.34	66.29	23.05
Table grapes	1,752	1.71	1,737	1.82	99.14	2,386	1.29	137.36	1,958.33	1.54	82.08	4.57
Wine grapes	100,482	98.29	93,822	98.18	93.37	182,298	98.71	194.30	125,534.00	98.46	68.86	15.22

Sources:*http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table(26.02.2019), ** own calculation.

In the case of grafts, for the year 2016 there is a decrease of 6.64% when is compared to the first term of dynamical series, followed by an overrun of 1.66 in 2017 of the comparing bases. So, the period average is reduced by 25.12% compared to the situation specific for 2017 year. The production of hybrid calves is inferior in 2016, with 6.46% compared to the level in 2015, it increases substantially in 2017 (+109.30%) Compared to the situation in the case of year 2016, and the average period is reduced by 33.71% from the reporting base. The total production of table grapes decreased by 0.86% in for 2016 year beside the level that are recorded in 2015, it increases by 1.37 times for year 2017 compared to the reference term. The average period is lower than the reporting base by 17.92%. Wine grapes are characterized by fluctuating developments in total production. Thus, the indicator is reduced by 6.63% in 2016 compared to the characteristic situation of 2015, it is pushing 1.94 times the comparison period at the level of year 2017, while for the period average there is recorded a decrease of 31.14% compared to the previous term of Dynamic series. In Table 4, the county structure of regional grape production is presented, by types of vine and production directions.

Table 4. Region South-West Oltenia. Total grape production – County structure (average period 2015-2017)*

Specification	Total		Grafted Vineyards		Hybrid Vineyards		Table Grapes		Wine grapes	
	Eff. (t)	Str. (%)	Eff. (t)	Str. (%)	Eff. (t)	Str. (%)	Eff. (t)	Str. (%)	Eff. (t)	Str. (%)
Total region	127,492.33	100	44,193.33	100	83,299.00	100	1,958.33	100	125,534.00	100
Dolj County	49,031.34	38.46	18,490.67	41.84	30,540.67	36.66	554.00	28.29	48,477.33	38.62
Gorj County	13,509.33	10.60	-	-	13,509.33	16.22	-	-	13,509.33	10.76
Mehedinți County	19,856.33	15.57	6,086.33	13.77	13,770.00	16.53	400.33	20.44	19,456.00	15.50
Olt County	20,967.33	16.45	4,469.67	10.11	16,497.67	19.81	229.67	11.73	20,737.67	16.52
Vâlcea County	24,128.00	18.92	15,146.66	34.28	8,981.33	10.78	774.33	39.54	23,353.67	18.60

Source: *own calculation from http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table (26.02.2019).

It is noteworthy, from the outset, that Gorj County does not obtain productions from grafting calves or in the case of table grapes. In the case of total production, Dolj County is

predominant with 49,031.34 t (38.46%), followed by the counties of Vâlcea, Olt and Mehedinţi (24,128, 20,967.33 and 19,856.33 t, respectively, shares of 18.92, 16.45 and 15.57%). Gorj County is characterized by the realization of a total production of 13,509.33 t (10.60% - Fig. 2).

For the grafted vineyards, the structure was as follows: 10.11% Olt County (4,469.67 t), 13.67% Mehedinţi County (6,086.33 t), 34.28% Vâlcea County (15,146.66 t) and 41.84% Dolj County (18,490.67 t - Fig. 2).

If we refer to the situation of hybrid calves, there are variable weights from 10.78% in the case of Vâlcea County (8,981.33 t) to 36.66% at the Dolj county level (30,540.67 t). The rest of the counties held weights, somewhat, close: 16.22% Gorj (13,509.33 t), 16.53% Mehedinţi (13.770 t) and 19.81% Olt (16,497.67 t - Fig. 2). With regard to the grapes productions for table, Vâlcea County is predominantly 39.54% (774.33 t), followed by Dolj County – 28.29% (554 t), Mehedinţi County – 20.44% (400.33 t) and Olt County – 11.73% (229.67 t - Fig. 2). The total regional production of wine grapes presents the following structure: 10.76% Gorj County (13,509.33 t), 15.50% Mehedinţi County (19,456 t), 16.52% Olt County (20,737.67 t), 18.60% Vâlcea County (23,353.67 t) and 38.62% Dolj County (48,477.33 t - Fig. 2). The data related to the average production levels are presented in Table 5. At the level of 2015, an average production of 3,121 kg/ha is found, compared to which the grafting vines carried out 115.63% (3,609 kg/ha) and the hybrid vines 92.57% (2,889 kg/ha), respectively 109.87% of the table grapes (3,429 kg/ha) and 99.83% of wine grapes (3,116 kg/ha). In the case of 2016, an average production of 2,888 kg/ha is found, compared with which the grafted vines achieved 3,259 kg/ha (112.85%) and the hybrid vineyards 2,706 kg/ha (93.70%).

On production directions, the indicator levels were 3,284 kg/ha for table grapes (113.71%) and 2,881 kg/ha in wine grapes (99.76%). For the year 2017, positioning is found at 98.71 and 100.60% for grafts and hybrid vineyards, which produced average yields of 5,567 and 5,674 kg/ha, so that the average overall production was 5,640 kg/ha. Compared with the national indicator level, table grapes achieved 101.70% (5,736 kg/ha) and wine grapes 99.96% (5,638 kg/ha).

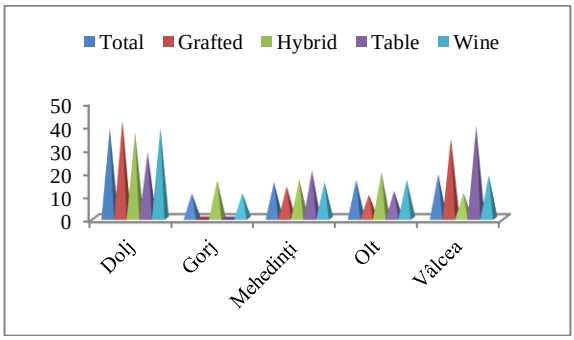

Fig. 2. County structure of total regional production, by types of vines and production directions – average period (%)
Source: Own design based on the own results.

The average of the period, recorded a level of 3,879 kg/ha, with different placements compared to it, by types of vines and production directions: 106.68 and 96.80% of the grafts and hybrids respectively (4.138 and 3,755 kg/ha); 104.02 and 99.95% of the table Grapes respectively wine (4,035 and 3,877 kg/ha).

Table 5. Region South-West Oltenia. Average grape production

Specification	Year								Period average**			
	2015		2016			2017						
	Eff. (kg/ha)*	% beside total**	Eff. (kg/ha)*	% beside total**	2016/ 2015**	Eff. (kg/ha)*	% beside total**	2017/ 2016**	Eff. (kg/ha)	% beside total	media/ 2017	% beside national level
Total	3,121	100	2,888	100	92.53	5,640	100	195.29	3,879	100	68.78	79.52
Grafted Vineyards	3,609	115.63	3,259	112.85	90.30	5,567	98.71	170.82	4,138	106.68	74.33	75.41
Hybrid Vineyards	2,889	92.57	2,706	93.70	93.67	5,674	100.60	209.68	3,755	96.80	66.18	88.94
Table grapes	3,429	109.87	3,284	113.71	95.77	5,736	101.70	174.67	4,035	104.02	70.35	64.59
Wine grapes	3,116	99.83	2,881	99.76	92.46	5,638	99.96	195.70	3,877	99.95	68.77	80.37

Sources: *http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table (26.02.2019), **own calculation.

Overall, average production decreased by 7.47% for 2016 year when is reported to the first term of dynamical series, in 2017 it has outrun 1.95 times previous level, as for the average of the period, that was less than 31.22% compared to the situation specific for 2017 year.

Taking in consideration the indicator evolution, at the level of grafted vineyards, are found the same trend as the one previously shown (-9.70% for 2016, +70.82% in 2017, -25.67% at period average).

In the case of hybrid calves, two subunit levels of dynamic indices (93.67 and 66.18% in 2016 and the average period respectively) and a super unit level in the case of 2017 (209.68%) are found. For table grapes, there is found an uneven evolution for the indicator, the decreases for 2016 year (-4.23%), being followed by increases in year 2017 (+74.67%) and then decreasing for the period average (-29.65%). Wine grapes present an uneven trend of average production, characterized by a decrease of 7.54% in 2016 year compared to the situation specific for 2015, an increase of 95.70% in 2017 compared to the previous term of the dynamic series, a decrease of 31.23 % for the average period compared to the reference term.

In Table 6, the position of counties in comparison with the regional situation is presented in the case of average.

In the case of the general situation, there are two counties that have outrun the regional level (Vâlcea and Gorj of 1.24 and 1.02 times – 4,835 and 3,974 kg/ha) and three counties placed under it (Dolj, Olt and Mehedinţi – 98.12, 93.97 respectively 87.63%, effective levels of 3,806 , 3,645 and 3,399 kg/ha - Fig. 3).

For the grafting vineyards, the positioning was as follows: 80.62% Mehedinţi County (3,336 kg/ha), 83.95% Olt County (3,474 kg/ha), 102.10% Dolj County (4,225 kg/ha) and 114.64% Vâlcea County (4,744 kg/ha - Fig. 3).

Table 6. Region South-West Oltenia. Average grape production – County positioning in regional context (average period 2015-2017)*

Specification	Total		Grafted Vineyards		Hybrid Vineyards		Table Grapes		Wine grapes	
	Eff. (kg/ha)	% compared to region	Eff. (kg/ha)	% compared to region	Eff. (kg/ha)	% compared to region	Eff. (kg/ha)	% compared to region	Eff. (kg/ha)	% compared to region
Total region	3,879	100	4,138	100	3,755	100	4,035	100	3,877	100
Dolj County	3,806	98.12	4,225	102.10	3,591	95.63	4,444	110.14	3,800	98.01
Gorj County	3,974	102.45	-	-	3,974	105.83	-	-	3,974	102.50
Mehedinți County	3,399	87,63	3,336	80.62	3,427	91.26	2,305	57.13	3,432	88.52
Olt County	3,645	93,97	3,474	83.95	3,694	98.38	3,982	98.69	3,641	93.91
Vâlcea County	4,835	124,65	4,744	114.64	4,996	133.05	5,987	148.38	4,804	123.91

Source: *own calculation http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table (26.02.2019).

If we refer to the situation of hybrid vineyards, there are variable placements from 91.26% for Mehedinţi County (3,427 kg/ha) to 133.05% at the Vâlcea county level (4.996 kg/ha). The rest of the counties were positioned as follows: 95.63% Dolj (3,591kg/ha), 98.38% Olt (3,694 kg/ha) and 105.83% Gorj (3,974 kg/ha - Fig. 3).

As regards the production of grapes for the table, the counties of Vâlcea and Dolj are devanting the regional level (1.48 and 1.10 or 5,987 and 4,444 kg/ha), and the counties of Olt and Mehedinţi are placed below it (98.69 and 57.13% respectively 3,982 and 2,305 kg/ha - Fig. 3).

Compared to the average regional production of wine grapes, the counties are positioned as follows: 88.52% Mehedinţi County (3,432 kg/ha), 93.91% Olt County (3,641 kg/ha), 98.01% Dolj County (3.800 kg/ha), 102.50% Gorj County (3,974 kg/ha) and 123.91% Vâlcea County (4,804 kg/ha - Fig. 3).

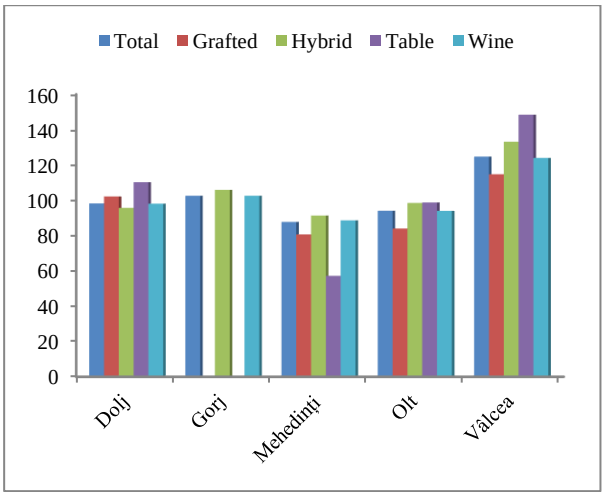

Fig. 3. Average production. Position of counties in relation to regional situation, by types of vines and production directions – average period (%)
Source: Own design based of the own results.

CONCLUSIONS

For the south-west region Oltenia, a share of 18.48% at national level, in terms of the surface, with weights that can be considered unsatisfactory, at least, for those grafting vines for table grapes (compared to the national situation). It is necessary to improve the weighting (32.50%) Grafting and table grapes (1.48%) In total operating areas. Dolj County is the main vine grower at regional level, excluding table grapes (Vâlcea County), and Gorj County has the smallest area, at its level lacking table varieties and vineyards grafting.

Total regional production, represents only 14.69% of national production, which is worrying (lower than existing at surface level), which highlights different shortcomings of producers in this region (possibly technical, technological, professional, etc.). At county level, the structure of total production is dominated by Dolj County (more for Table grapes-place I County Vâlcea), and in the last position is the county of Gorj to total and for wine grapes, Olt County in the case of grafted vineyards and Table Grapes, Vâlcea County for hybrid Vineyards.

Average production has evolved unevenly, almost similar to the evolution of total production. The performances achieved, on the productive unit, highlight the favorable situation of Vâlcea County (place I in all cases) and the less convenient situation of Mehedinţi County (last place in all cases).

It is noted the need to continue the process of reform of the wine sector, even if it has benefited – on the whole-in the period 2007-2013 adequate support measures through PNDR. This must manifest both in terms of funding (non-refundable funds, subsidies, attractive interest on the credits contracted by producers, attracting foreign investors, etc.), capitalization (modernization and development of Plantations, improvement of the range of mechanical means, construction of suitable storage and processing spaces, etc.), training of the workforce (consultancy, qualification courses, training, etc.).

REFERENCES

[1]Constantin, M., 2017, Marketing of Agri-Food Production, Romanian Science Academy Publishing house, Bucharest, Chapter 14, Vol. II, pp. 115-186.
[2]Certan, S., Certan I., 2015, The grapes and wine market in the Republic of Moldova: trends and insights, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 15(1):95-104.
[3]Delame, M., Prado, E., Blanc, S., Robert-Siegwald G., Schneider, C., Mestre P., Rustenholz, C., Merdinoglu, D., 2019, Introgression reshapes recombination distribution in grapevine interspecific hybrids, Theoretical and applied genetics, Volume: 132(4):1073-1087.
[4]Gaina, B., 2006, Something about wine, Mendeleev's tablet and policy. Rev. ”Pro Business”, No. 4, pp. 2-3.
[5]Iațisin, T., Colesnicova, T., 2015, Current situation and prospects of the labour organization in wine and grape industry in the Republic of Moldova, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 15(2):151-152 .
[6]Intrieri, C., Filippetti, I., Allegro, G., Valentini, G., Pastore, C., Colucci, E., 2011, The semi-minimal-pruned hedge: A novel mechanized grapevine training system. American Journal of Enology and Viticulture, 62, 312–318.
[7]Örmeci, K. Ç., Gül, M., Karadağ, G. A., 2018, Technical efficiency in grape production: A case study of Denizli, Turkey, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 18(4):211-217.
[8]Pânzaru, R. L., Medelete, M. D., Ștefan, G., 2009, Economia producției vegetale, Editura Universitaria,

(Economy of Vegetal Production, Universitaria Publishing House), Craiova, Chapter 4, pp. 189-209.
[9]Popescu, A., Pop, C., 2013, Considerations regarding the E.U. role in the world grape production, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 13(2):331-335.
[10]Tempo on line, National Institute of Statistics, http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table, Accessed on Feb. 26, 2019.
[11]Van Leeuwen, C., Seguin, G., 2006, The concept of terroir in viticulture, Journal of Wine Research, Vol. 17, pp:1–10.
[12]Weiler, C. S., Merkt, N., Hartung, J., Graeff-Hoenninger, S., 2019, Variability among Young Table Grape Cultivars in Response to Water Deficit and Water Use Efficiency, Agronomy-Basel, Vol. 9(3), Article No. 135.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

MODELLING PERCEPTION AND ECONOMIC PERFORMANCE OF TEAK (*TECTONA GRANDIS*) PRODUCTION IN RURAL PLANT NURSERIES OF BENIN REPUBLIC

Yann Emmanuel MIASSI[1], Fabrice Kossivi DOSSA[2], Patrice Ygué ADEGBOLA[3], Anselm Anibueze ENETE[2], Şinasi AKDEMIR[1]

[1]Çukurova University, Faculty of Agriculture, Department of Agricultural Economics, PO Box 01330 Bacali, Adana, Turkey, Email: yannmanu006@gmail.com, sinasi.akdemir@gmail.com
[2]University of Nigeria, Faculty of Agriculture, Department of Agricultural Economics, PO Box 041006, Nsukka, Nigeria, Emails: fabdossa@gmail.com, anselm.enete@unn.edu.ng
[3]National Institute of Agricultural Research of Benin, 01 BP 884 Cotonou, Benin, Email: patrice.adegbola@yahoo.fr

Corresponding author: yannmanu006@gmail.com

Abstract

In Benin Republic, teak sector is the most active among the wood markets with a strong national demand. It is therefore necessary to improve its efficiency. This study aimed at modelling the perception and economic performance of teak plant production in some rural nurseries. To this end, a survey was conducted among 140 teak nurseries in northern, central and southern regions of Benin using the "snowball" sampling method. Interviews organized with plant nurserymen served to gather data on their demographic and socio-economic characteristics, plant production techniques, production costs and output, and teak production perception. The perception of producers and the performance of teak plant production were modeled respectively from a logistic regression model and then from a linear regression model. The analysis of the results showed that the age of the nurseryman, unlike variables such as gender and seniority in production, negatively influences the economic performance of teak plant production. Household size also influences the economic performance of teak plant production and the perception of the nurseryman, but with a negative effect on the last variable. Nevertheless, the number of years of schooling and the nurseryman's assessment of the distance between the plant nursery and his home has a positive influence on his perception. Policies development aimed at improving the production of teak plants in Benin would therefore require particular attention to these different determinants.

Key words**:** *Benin, economic performance, modelling, perception, teak*

INTRODUCTION

Forest plantations are particularly important for economic and social development of rural areas in Benin. They also play a crucial role in maintaining environmental functions [13, 19,20]. Teak (*Tectona grandis Lf*) is a tropical tree species with a significant economic potential [29, 32]. Globally, teak occupies about 5.7 million hectares, of which about 250,000 are in Africa [6]. Native to Southeast Asia, its wood is prized for centuries and it is not uncommon to find old carved works, doors and vaults entire in Indian and Persian temples [24]. In West Africa, teak is the forest species most used [2, 31]. It was introduced there about a century in Nigeria (1889), Tanzania (1898), Ghana (1905), Cameroon and Togo (1907-1912) [43]. In Benin, a West African country, forest formations were valued at 4.311 million hectares [18] on a total of 19,000 hectares of forest plantations [5, 17]. According to [7], domanial plantations are teak alone covering about 15,000 ha. In Benin, the importance of teak in the economic area as well as environmentally is also highlighted [3]. Several studies have shown the importance of the revenue generated by the production of teak) [36]. These benefits also involve job creation, added value and revenue generated through downstream processing and distribution of the product [37].

However, forest cover decrease for about 50,000 ha per year, being 1.06% of the total forest cover per year [17]. This loss affecting

the overall Beninese forest cover could threaten teak wood production in general, affecting the economy of production particularly. Therefore, reforestation policies are conducted by the Beninese Government to encourage local authorities to invest in teak plantations (*Tectona grandis Lf*) [42]. Thus, in order to fill this deficit and meet the high demand for wood in the domestic market, it appears imperative to improve teak production. This study aimed at modelling perception and economic performance of the production of teak in the rural nurseries of Benin.

MATERIALS AND METHODS

Study Area

The study was conducted in the Republic of Benin, a tropical country in West Africa. It was carried out from the north to south of the country. To this end, nine (9) Research sites were identified, Tori-Bossito, Toffo and Agbomey Calavi in the South; Savè, Dassa and Glazoué in the Center; Parakou, Bembèrèkè and Malanville in northern Benin. These areas were selected because of the large number of plant nurseries existing in each of them, and the important contribution of these different areas of Benin teak production. According to [37], the southern area of Benin like the other two areas alone contributes to 69.2% of the domestic wood. By adding the contribution of the Center region, this estimate could be around 85% of total production. South and Center teak plantations benefits from a sub-equatorial type of climate in transition to tropical climates (Sudanian or Sudan Guinea) characterized by an average annual rainfall varying from 1,100 mm/year to 1,200 mm/year [30]. They are all characterized by four seasons: two rainy seasons alternating with two dry seasons. The average temperature ranges from 27°C to 28°C [30]. The North area meanwhile have a Sudanese type of climate that varies between 1,100 and 1,200 mm/year with alternating two (02) seasons: A (01) rainy season extends from May to October and a (01) dry season from November to April [16].

Sampling and database

The study population represents teak producers. Surveyed are nurserymen ensuring the management and control of production operations and maintenance of teak plants in nurseries. To this end, the sample is composed of both North, Center and South nurserymen. In total 140 nurseries spread over 9 research sites were investigated. The research sites are located in the municipalities of Tori-Bossito, Toffo and Agbomey Calavi in the South; Savè, Dassa and Glazoué in the Center; and Parakou, Bembèrèkè and Malanville in Northern Benin.

Table 1 shows the structure of the formed sample. The said sample was prepared from the snowball method (snowball sampling).

Table 1. Distribution of teak nurseries surveyed by area and municipalities

Areas	Municipalities	Number of nurseries surveyed	Percentage of the total sample (%)
South	Abomey	8	5.7
	Tori-Bossito	18	12.9
	Toffo	9	6.4
Center	Dassa	13	9.3
	Glazoué	14	10.0
	Savè	8	5.7
North	Bembèrèkè	20	14.3
	Parakou	35	25.0
	Malanville	15	10.7
Total		140	100.0

Source: Results of investigation (2018).

The data collected from the sampled nurserymen were related to demographics and socio-economic (gender, age, affiliation or not to a Peasant Organization, years of schooling, household size, access to extension service, seniority in the production of teak), expenses and production costs recorded by the nursery and their perception of the production of teak nursery plants. Note that all these data were collected during surveys (structured interviews) based on a questionnaire containing both open and closed questions. The veracity of this information was evaluated by triangulation through focus groups.

Constitution, processing and analysis of performance data

Analysis of economic performance

In this study, the economic performance of the production of teak plant nurseries was evaluated from several economic performance indicators on the basis of expenses and production costs recorded by the nursery. This study is inspired by the work of [8, 10, 16, 33, 37]. Some profitability indicators such as Product Gross Value (PBV), the Gross Income (RB) and Net Income (RN) have been calculated.

The Gross Product Value (PBV) is designated by the multiplication of the number (Q) of teak plants by the selling Price Unit (PU). Thus, the Gross Product Value (PBV) is given by:

PBV = Q * PU ..... (1)

The Gross Income (RB) in turn corresponds to the difference between the Gross Product Value and Variables charges (CV). The Variable Charges represent costs directly related to production inputs acquisition (teak seeds, polyethylene bags, fungicides, insecticides, fertilizers and casual labor work). The Gross Revenue is calculated by deducting from PBV all expenses directly related to production. Note that the Gross Income is the wealth created by the teak nursery. Its formula is given:

RB = PBV- CV .....(2)

It is expressed in FCFA/1,000 plants. If RB> 0, then it is concluded that the Gross Product Value arrives to cover the costs Variables. The production of teak plant in nurseries is economically profitable from the perspective of Revenue Gross operating the nursery.

Net Income (RN) of output is obtained by subtracting from the Gross Product Value (PBV), the total cost (CT) or by deducting from Gross Income (RB), fixed costs (CF). It is given by the following formula:

RN = PBV - CT = PBV - CV - CF = RB - CF .....(3)

It is expressed in FCFA/1,000 plants. If RN> 0, then it is concluded that the Gross Product Value manages to cover both Fixed and Variable Costs. The production of nursery teak plants is economically profitable. By cons, if RN <0, then the Gross Product Value cannot cover all the costs of production. In this case, the production is not economically profitable. Note that Fixed Costs (FC), correspond to expenses incurred by the operation but not related to the output level. These charges are related to depreciation of agricultural equipment, membership fees and finance charges. Charges related to depreciation are determined by applying a linear damping rate to the total value of acquisition of the equipment for the nursery for the execution of production activities. This rate corresponds to the inverse of the life of the equipment [44]. The life and cost vary from one tool to another. The tools used in the various sites are: hoe, rake, watering can, wheelbarrow, etc.

Identification and analysis of the determinants of economic performance

One of the objectives of this study is to analyze the determinants of economic performance in the production of teak nurseries. The research methodology was made based on the work of [4, 26, 41]. In order to analyze the determinants of economic performance, a multiple linear regression model was developed on the basis of 140 nurserymen. The equation of the regression model can be written as follows:

$$y = \alpha 0 + + \alpha 1 xi\ Ɛi \quad \text{.....(4)}$$

where: y is the dependent variable, the explanatory variables xi, α is a constant called "intercept" and Ɛi the error term of the model.

The explanatory variables included in the model are: age of the nurseryman, gender, household size, membership of a Peasant Organization, seniority in the activity, the ease of access to water, access to extension services. From the existing literature and observations in the field, various reasons to justify the inclusion of these variables in the regression model. Thus, age, a variable

expressed in years, is a parameter determining the economic performance of agricultural production. Indeed, the more the nurseryman is aged, the more he is gaining experience to improve the economic performance of his activities. Age could positively influence the economic performance of production. It is a dichotomous variable coded by the value 0 if the producer is a woman; and 1 if he is a man. Certain factors are likely to prevent women from devoting themselves full time to the maintenance of their plants. Household size is a source of labor power for any farm. Therefore, it could positively influence the net income of the teak nursery. Whether or not to belong to a cooperative of nursery farmers (OPA) could also have a positive effect on the economic performance of production. Indeed, nurseries belonging to a group receive training and various forms of support to help them improve the economic performance of their operations. It is a binary variable taking the values 1 if the nurseryman is a member of an OPA or 0 if not. In addition to these variables, the experience of the nurseryman positively influence the net income from operations. The more the nurseryman has experience in planting teak, the more he has strengths and knowledge that will enable him to improve his teak production; which production could be done without other essential factors among such water. Indeed, water is an indispensable factor in teak production. Although, all nurseries have access to water, some easier to that resource than others. This variable could have a positive or negative effect on the economic performance of nursery. So this is a dichotomous variable that takes the value 1 when the nurseryman has easy access to water and 0 if not. Some nurserymen benefit from the support of agricultural services and certain development projects in order to improve the performance of their production. Access by nurserymen to agricultural services is therefore an important variable; it is a binary variable taking the value 1 if the nurseryman has access to the various extension services or 0 otherwise. This variable could positively influence the economic performance of production. Tables 2 and 3 show a summary of all the variables included in the model with their expected sign.

Table 2. Summary of model variables and the expected signs for Net Income

Variables	Variable Types	Descriptions	
Variables explained			
Net Income (RN)	Quantitative	Dependent Variable: Net Income Value of operating the nursery	
Explanatory variables			Expected sign
Age	Quantitative	Age nurseryman	+
Sex	Qualitative	Gender nurseryman 0 = Female, 1 = Male	+
Household size	Quantitative	Number of people forming the household	+
Belonging to a OPA	Qualitative	Whether or not a takeover 0 = No, 1 = Yes.	+
Seniority	Quantitative	Years of experience in nursery	+
Ease of access to water	Qualitative	Ease of access to water 0 = No, 1 = Yes	±
Access to extension services	Qualitative	Access or not to extension services 0 = No, 1 = Yes.	+

Source: Results of investigation and documentary research (2018).

Table 3. Summary of model variables and the expected signs for nurseryman perception

Variables	Variable Types	Descriptions	
Variables explained			
Nurseryman perception	Quantitative	Dependent: Perception Nursery	
Explanatory variables			Expected sign
Household size	Quantitative	Number of people forming the household	+
Belonging to a OPA	Qualitative	Whether or not a takeover 0 = No, 1 = Yes.	+
Seniority	Quantitative	Years of experience in nursery	+
Years of schooling	Qquantitative	Number of years of schooling	+
Distance from home to nursery	Qualitative	Distance between home and the nursery nursery 0 = Close, 1 = Far.	+

Source: Results of investigation and documentary research (2018).

Constitution, processing and analysis of data on perception

Mobilized Data

The evaluation of the perception of teak production by nurserymen can be developed on several fronts. In this study, it was focused on their perception of technical and economic performance of the production of nursery teak plants. The technical performance measures the ability of the farm to get the maximum outputs from a combination of inputs and or its ability to achieve a given level of output from smaller quantities of inputs [23]. The production will be economically efficient when the nursery is making profit from his operations [27]. To this end, a series of questions was asked to each nurseryman forming the sample to set the variable "perception of technical and economic performance of the production." Chronologically, the questions were: 1) Do you think the production of teak plants is economically viable? 2) By combining all production inputs, do you think you achieve maximum profit? 3) From the combination of your resources, are you satisfied with your production of teak plants? 4) What do you consider the parameters that influence both economic performance and technical teak production in nursery.

Processing and data analysis

In this study, the approach used to analyze the technical and economic performance perception of nurserymen has been designed into a model. The model was based on demographic and socioeconomic characteristics of nurserymen. These are: household size of the nursery, membership of a cooperative, experience in production, the number of years of schooling, and the appreciation of the distance between home and the nursery (Table 3). Based on the literature review, two main types of models are commonly used to analyze the perception of producers. These are mainly logit regression model and Probit model. Here, as developed by [28] we adopt the logit model to specify the relationship between the probability of perceiving the technical and economic performance of the production and its determinants. Logit models have been introduced for decades by [12, 25, 35, 39] to explain the choice of a profession in its different perspectives [28]. This model is often used in the case studies of perception based on an econometric model for the convenience. In addition, the Logit model maintains the estimated probability between 0 and 1 [38].

[1] present the model by the following equation:

$$E(Y) = P(Y) = \frac{e^{\alpha+\beta Xi}}{1+e^{\alpha+\beta Xi}} \quad \text{.....(5)}$$

When the producer does not perceive the technical and economic performance of the production of teak plants, the probability becomes for this purpose:

$$P(\text{non-perceived}) = 1 - P(Y) = \frac{1}{1+e^{\alpha+\beta Xi}} \quad \text{.....(6)}$$

where:

P (Y): The probability of a nurseryman i to perceive the technical and economic performance of the production; P (Y) = 1 if the nurseryman perceives and 0 if not.

e: The exponential function

Yi: the dependent variable; perception of technical and economic performance of the production of teak,

β: The vector of parameters to be estimated whose sign allows the interpretation of results

α: Constant

Xi: i characteristic of the nurseryman; it represents the vector of variables

with

$$X = \beta 0 + + \beta 1 TailM\ \beta 2 AppOPA\ \beta 3 Exp + + + \beta 4 AnSco\ \beta 5 Dist \quad \text{.....(7)}$$

where: TAilM = Household size of nursery,

AppOPA = Belonging to a OPA,

Epx = Seniority in the production ANSCO = the number of years of schooling,

Dist = Evaluation of the distance between home and the nursery the nursery.

RESULTS AND DISCUSSIONS

Techniques of teak plant production

The information collected in the field and the comments made, provided a record of the technical route followed by nurseries for the production of teak plants in Benin. Four main phases have been identified. These are: the acquisition of teak seeds, triggering pre-germination, planting itself and for the maintenance of seedlings. These different plant production steps are similar to that identified by [37] in the Atlantic region in southern Benin. Two main sources of seed supply have been identified. The collection of teak seeds at the foot of mature trees in the dry season is the first form of acquisition and is used by nearly 65% of nurserymen who have been investigated. The second approach is supply by purchasing or support of the governmental structures. There is two different varieties of seeds. The local variety and the variety of Tanzania. However, the variety of Tanzania remains the most requested by producers.

Indeed, the latter compared to the local variety showed better growth performance [22]. It is a variety of seeds tested and introduced by the National Office of Wood in order to improve national level production. As was mentioned above, the seed is obtained after the outbreak of the pre-germination of the seed and sowing. Thereby, Seeds are exposed to sun and watered until the release of rootlets. This operation is conducted by all nurseries because of the physical dormancy of teak seeds [14]. It follows by the maintenance of seedlings. Nurserymen maintain seedlings through watering and regular weeding and by providing the necessary minerals.

Economic performance production plants

The costs and expenses indicated by nurserymen have been utilized to assess the economic performance of the production of teak plants in Benin. Indeed, nurserymen in the production plants are facing different forms of production costs. The analysis of the results allowed us to distinguish fixed costs and variable costs of production.

Table 4. Costs and revenue for 1,000 teak plants in CFA

Elements	Average	Standard Deviation
Seeds	323.67	65.32
Polyethylene bag	2,881.42	482.77
Soil	108.03	91.31
Fertilizers	269.69	40.12
Fongicides-Insecticides	441.32	50.56
Casual labor	8,617.85	2,540.92
Variable costs	12,642.01	2,584.39
Amortization	3,453.57	1,694.14
Various Charges	401.03	97.11
Fixed costs	3,854.60	1,698.46
Total costs	16,496.62	7,668.34
Revenue generation	74,464.28	32,755.34
RNE	**57,967.66**	**32,790.46**

Source: Results of estimates made with SPSS.

Table 4 presents costs and revenue for 1,000 teak plants in CFA.

These identified charges are identical to those highlighted by [15].

Thus, for a production of 1,000 teak plants, with higher variable costs as fixed, nurseries on average perform an expenditure of 16,496.62 CFA (± 7,668.34) and realize an average revenue of 7,668.34 CFA (± 32,755.34) (Table 4).

According to [9, 40], net income from operations of nurseries being positive, we can conclude that the production of teak plants is profitable in Benin. These results are consistent with those of [37] whose economic evaluation led to the conclusion that the production of teak production is profitable in Southern Benin.

Modeling the perception of producers and production performance

The perception of producers and the teak plants production performance were modeled respectively from a logistic regression model and a linear regression model (Table 5). Estimated models are generally significant at the 1% level (probability <0.01). Thus, unlike to the age of the nurseryman, variables such as gender and experience in production

negatively affect the economic performance of the production of teak plants. Household size influences both the perception of nurseries that economic performance teak production. But unlike the economic performance of the production, it has a negative effect on the perception of producers producing teak plants.

Table 5. Estimation results of the econometric models

	Performance Model			Perception model		
Variables	***Coefficient***	***t***	***prob***	***Coefficient***	***z***	***prob***
Constant	8,431.434	0.55	0.580	-0.487	-0.79	0.427
Age	-527.575 **	-2.06	0.041	-	-	-
Sex	11,814.270 *	1.96	0.052	-	-	-
Belonging to a takeover	3,988.615	0.89	0.372	0.536	1.24	0.212
Household size	1,770.793 **	3.11	0.002	-0.089 *	-1.76	0.079
Ease of access to water	6,644.879	0.69	0.494	-	-	-
Access to the extension service	17,955.180	1.89	0.61	-	-	-
Seniority	1,332.023 **	3.00	0.03	0.062	1.46	0,144
Number of years of schooling	-	-	-	0.100 **	2.18	0,029
Distance from home to nursery	-	-	-	1,830 ***	4.06	0.000
Abstract models	Number of observation = 140 F (7, 132) = 6.78 Prob> F = 0.0000 *** R-squared = 0.4268 Adj R-squared = 0.3964			Number of observation = 140 LR chi^2 (5) = 30.13 Prob> chi^2 = 0.0000 *** Log pseudolikelihood = -67.760437 Pseudo R^2 = 0.1819		

***: significant at the 1% (P _ 0.01); **: significant at 5% (0.01 <P _ 0.05); *: Significant at 10% (0.05 <p _ 0.10).
Source: Results of estimates made with STATA.

The age and sex

Age has a negative and significant effect at the 5% level on the economic performance of teak production. We therefore conclude that the more nurseryman is aged, the less he took advantage of his operation. Indeed, becoming older nurseryman is less involved in his operations. An old nurseryman is not really open to new technologies that are proposed to improve his production and indirectly the income of his operations. As age of the nurseryman, sex has a negative and significant effect at the 10% probability level on the economic performance of the production. From these results, it is concluded that male perform better than female producers. Male are heads of their households and have to deal with the different needs of their households which are food and health-care. To this end, they are involved as much as possible in their operation in order to get the most profit from their exploitation. Moreover, women in the study area, unlike men, by their mother nurturing function they play in their household [34] devote little time to their operations so as not to miss their obligation.

Seniority in production

The seniority of the nurseryman defines his years of experience in the production of teak plants. This variable has a positive and significant effect at the 5% level of economic performance production. Indeed, the nurseryman, gain experience from the previous challenges he used to face before. Thus, the more experienced he is, the more he has assets that will enable him to better

produce and maximize the output. This is what justifies the positive effect of the seniority of the nurseryman on the economic performance of the production.

The household size

Household size is a potential source of labor and allows producers to increase production. This variable has a positive and significant effect on the level of 1% of economic performance production. Thus, the bigger nurseryman household, the higher he gets to benefit from his operations. Indeed, the members forming the nursery household (spouse (s), child (ren) and relatives) represent a potential workforce source; a workforce that can be called "free" [21] because it does not require any payment. He performs by cons an indirect payment in the sense that he has to meet the needs of the household from income of the production. However, this payment qualified as indirect has a negative influence on the perception that the nurseryman have on the technical and economic performance of the production. Indeed, household size has a negative and significant effect at the 10% level on the perception of the nurseryman. According to him, the larger the household, the less he takes advantage of its operations.

The number of years of schooling

In a context of development, education has always been a key parameter. The number of years of schooling has a positive and significant effect at the 5% level on nurserymen perception. According to these, the more the nurseryman is educated, the better he benefits from its operation. The educated nurseryman is able to read, write and have a minimum master of basic operations management tools. According to [15], Education is a factor of crucial importance because it enables producers to understand and establish the account of his operations. To this end, the most educated nurserymen have the facility to apply the guidance received during the training and information sessions within groups. The combination of these assets allows teak producers to improve their production and income in turn.

The distance between home and the nursery

The distance between home and the nursery also influences the perception of nurserymen. This parameter has a positive and significant effect at the 5% level on the latter. According to nurserymen, when the nursery is close to their home, they easily go there and make the longest possible maintenance operations. Nurserymen whose nursery is near the farm, get to perform on average 7 to 8 hours of working time per day; unlike those whose nursery is far who have only 3 to 4 hours daily working time. The production of teak plants, like any other agricultural production requires important maintenance [11].

CONCLUSIONS

This study aimed to modelling perception and economic performance of the production of teak in rural plant nurseries of Benin. According to the analysis, teak production is economically profitable and technically efficient as perceived nurserymen. The analysis of the determinants of perception and economic performance of the production identified and highlight all of the parameters that will enhance the production of teak plants in Benin. Thus, Age of the nurseryman unlike variables such as gender and seniority in production negatively affect the economic performance of the production of teak. Household size affects both the perception and economic performance of teak production, but with a positive effect on the latter. Nevertheless, the number of years of schooling and the appreciation of the nursery of the distance between the operation and home positively influences the perception. Policy development for improving the production of teak production in Benin must therefore pay special attention to these determinants. This will not only boost the national economy in terms of wealth creation, but also participate in the fight against drought and climate changes that threaten local populations. The support of extension services, Non Governmental Organizations and relevant international institutions will also facilitate attending this goal.

ACKNOWLEDGEMENTS

We thank the data collection team and all contributors for the realization of this document. We are also thankful to teak nurserymen for their real implication in the work.

REFERENCES

[1]Adéoti, O., Tamò, R., Coulibaly, M., 2002, Facteurs affectant l'adoption des nouvelles technologies du niébé Vigna unguiculata en Afrique de l'Ouest, Bulletin de la Recherche Agronomique du Bénin, Vol.(1)36: 1–18.

[2]Afoudah, O.A.C.L., 2018, Circuit de commercialisation et rentabilité des plantations de teck de l'Office National du Bois (ONAB): Cas de la Lama, Sud Bénin, Thèse pour l'obtention du diplôme de Maître ès sciences, Université de Laval, Canada, 59.

[3]Akossou, A.Y.J., Houmenou, W., Zinsou, V., 2016, Caractérisation agromorphologique des graines de teck (*Tectona grandis* L. f.) au Bénin. Int. J. Biol. Chem. Sci. 10(2) : 559-572.

[4]Allagbe, C.M., Adegbola, P.Y., Ahoyo Adjovi, N.R., Komlan-Ahihou, C.M., Crinot, G.F.D.J.C.E., Hessavi, P.M., Djenontin, A.J.P., Mensah, G. A., 2014, Etude financée par le Projet Multinational d'Appui à la Filière Coton-Textile dans les quatre pays de l'Initiative Sectorielle sur le Coton (PAFICOT)-Bénin, Rapport technique d'exécution de l'INRAB, 45.

[5]Aoudji, A.K.N., Adégbidi, A., Ganglo, J.C., Lebailly, P., 2014. Teak (*Tectona grandis* L.f.) planting in smallholders' farming system in southern Benin. Bois For. Trop., 319, 7-17.

[6]Atindogbe, G., Fonton, N.H., Fandohan, B., Lejeune, P., 2012, Caractérisation des plantations privées de teck (*Tectona grandis* L.f.) du département de l'Atlantique au Sud-Bénin. Biotechnol. Agron. Soc. Environ. 16(4), 441-451.

[7]Atindogbe, G., Fonton, N.H., Lejeune, P., 2013, Evaluation de la ressource en teck, Tectona grandis L . f., des plantations privées du Sud-Benin. Bois et forêts des tropiques 316(2), 93–103, http://bft.cirad.fr/cd/BFT_316_93-103.pdf, Accessed on Oct.30, 2018.

[8]Ayena, M., Yabi, A.J., 2013, Effets du Conseil à l'Exploitation Familiale (CEF) sur les performances économiques des exploitations bénéficiaires à Banikoara au Nord-Benin, Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, Hammamet, Tunisia, September 22-25, 14.

[9]Batamoussi, H.M., Moumouni, I., Orou Tokore Mere, S.B.J., 2015, Contribution à l'amélioration des pratiques paysannes de production durable de coton (*Gossypium hirsutum*) au Bénin : cas de la commune de Banikoara. Int. J. Biol. Chem. Sci, 9(5): 2401-2413.

[10]Biaou, D., Yabi, J.A., Yegbemey, R.N., Biaou, G., 2016, Performances technique et économique des pratiques culturales de gestion et de conservation de la fertilité des sols en production maraîchère dans la commune de Malanville, Nord Bénin. International Journal of Innovation and Scientific Research, (21)1: 201-211.

[11]BIO L, 2002 Les Techniques de pépinières, Projet Forestier de Bassila, 15.

[12]Boskin, M., 1974, A conditional logit model of occupational choice. Journal of Political Economy 82:389–98.

[13]De Groot, R.S., van der Meer, P.J., 2010, Quantifying and valuing goods and services provided by plantation forests. In: Bauhus J., van der Meer P.J. & Kanninen M., eds. Ecosystem goods and services from plantation forests. London; Washington: Earthscan, 16-42.

[14]Demenois, J., Heurtaux, A., 2001, La filière teck en Inde du Sud (Karnataka, Kérala, Tamil Nadu). De la plantation à la commercialisation du teck : aspects sociaux, économiques et techniques. Mémoire de fin d'étude : ENGREF Montpellier (France).

[15]Dossa, F., Miassi, Y., Banzou, K., 2018, Onion (*Allium cepa*) Production in Urban and Peri-Urban Areas: Financial Performance and Importance of This Activity for Market Gardeners in Southern Benin. Curr Investig Agric Curr *Res* 3(2): 01-13.

[16]Dossa, F.K., Miassi, Y.E.S., 2018, Socio-Economic Influencing Factors Adoption of Organic Cotton in North-East Benin: Case of Kandi Commune. Int J Progress Sci Technol 6(2) : 577-584.

[17]FAO, 2010, Évaluation des ressources forestières mondiales 2010. Rome: FAO, http://www.fao.org/docrep/013/i1757f/i1757f.pdf, Accessed on Sept.30, 2014.

[18]FAO, 2015, Évaluation des ressources forestières mondiales 2015 : Répertoire de données de FRA 2015, http://www.fao.org/3/a-i4808f.pdf, Accessed on Sept.29, 2014.

[19]Ferraz, S.F.B., de Paula Lima, W., Rodrigues, C.B., 2013, Managing forest plantation landscapes for water conservation. For. Ecol. Manage, 301, 58-66.

[20]Jean, B.,2008, Agriculture et développement dans l'Est du Québec, Edité par la Presse de l'Université du Québec, p.431.

[21]Johnston, L.G., Sabin, K., 2010, Échantillonnage déterminé selon les répondants pour les populations difficiles à joindre. Methodol. Innovations Online, 5(2), 38-48.

[22]Kokutse, A.D., Adjonou, K., Kokou, K., Gbeassor, M., 2009, Problématique de la performance du teck de provenance tanzanienne par rapport au teck local en plantation au Togo. Bois For. Trop., 302, 43-52.

[23]Kwayep Dimou, L., 2007, Mesure de l'efficacité des banques commerciales de la CEMAC (Communauté Economique et monétaire de l'Afrique Centrale), Thèse pour l'obtention du diplôme d'ingénieur en statistique, Institut sous-régional de statistique et d'économie appliquée du Cameroun, Cameroun, p.66.

[24]Louppe, D., 2008, *Tectona grandis* (L.f) In: Louppe, D., Oteng-Amoako, A.A., Brink, M., eds. Ressources végétales de l'Afrique tropicale. Bois d'oeuvre 1. [Traduction de: Plant Resources of Tropical Africa. Timbers 1]. Wageningen, Pays-Bas : Fondation PROTA; Leiden, Pays-Bas: Backhuys Publishers; Wageningen, Pays-Bas: CTA, p785.
[25]McFadden, D., 1968, Econometric analysis of qualitative response models. In: Griliches, Z., Intrilligator, M. (eds.), Handbook of econometrics, Vol. 2. Amsterdam: Elsevier BV.
[26]Miassi, Y., Dossa, F., Banzou, K., 2018, Etude des marges dans les circuits de commercialisation de céréales au sud-bénin: cas du maïs (*Zea mays*), Global Scientific Journal, (6)7 : 1162-1174.
[27]Miassi, Y.E.S., Dossa, K.F., 2018, Influence of the Types of Fertilizers on the Economic Performance of the Market Garden Production in Parakou Town, Northern Benin. Agri Res & Tech: Open Access J, 15 (1): 1-6.
[28]Mounirou, I., 2015, Perception et adoption des innovations techniques agricoles dans le bassin cotonnier de Banikoara au Bénin. African Journal of Agricultural and Resource Economics, 10 (2): 87-102.
[29]Niskanen, A., 1998, Financial and economic profitability of reforestation in Thaïland. For. Ecol. Manage., 104, 57-68.
[30]ONAB, 2005, Aménagement Participatif des Plantations Forestières d'Agrimey, Djigbé, Koto, Massi et Toffo: Période 2004-2023, ONAB: Bénin.
[31]Palupi, E.R., Owens, J.N., Sadjad, S., Sudarsono, Solihin, D.D., 2010, The importance of fruit set, fruit abortion, and pollination success in fruit production of teak (Tectona grandis). Canadian Journal of Forest Research, 40: 2204-2214.
[32]Pandey, D., Brown, C., 2000, Teak: a global overview. International journal of forestry and forest industries,51(2),1-15, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.490.2916&rep=rep1&type=pdf, Accessed on May.15, 2019.
[33]Paraïso, A., Yabi, J.A., Sossou, A., Yegbemey, R., 2012, Rentabilité économique et financière de la production cotonnière à Ouaké au Nord-Est du Bénin. Annales des Sciences Agronomique, (16) 1 : 91-105.
[34]Pestana, G., 2004, Problématique du genre et dynamiques des systèmes ruraux en Afrique de l'ouest : l'exemple du Fouta-Djalon (République de Guinée) Article publié dans la revue Montagnes Méditerranéennes, n°19, « genre et territoire: regards croisés de la Méditerranée à l'Afrique », 97-102.
[35]Schmidt, P., Strauss, R.P., 1975, The prediction of occupation using multiple logit models. International Economic Review 16(2): 471–86.
[36]Siregar, U.J., 2007, Economic analysis of sengon (*Paraserianthes falcataria*) community forest plantation, a fast growing species in East Java, Indonesia. For. Policy Econ., 9, 822-829.
[37]Séhouéto, C.K.P., Aoudji, A.K.N., Avocèvou-Ayisso, C., Adégbidi, A., Ganglo, J.C., Lebailly, P., 2015, Évaluation technico-économique de la production de plants de teck (*Tectona grandis* L.f.) dans les pépinières villageoises au Sud-Bénin, Biotechnol. Agron. Soc. Environ, 19(1) : 32-41.
[38]Tene, G.L.M., Havard, M., Temple, L., 2013, Déterminants socio-économiques et institutionnels de l'adoption d'innovations techniques concernant la production de maïs à l'ouest du Cameroun. Tropicultura, (31) 2:137–142.
[39]Theil, H, 1969, A multinomial extension of the linear logit model. International Economic Review 10(3): 251–9.
[40]Tokoudagba, S.F., 2014, Economie de la production du maïs au nord-bénin : une analyse du compte de résultat des exploitations agricoles, Bulletin de la Recherche Agronomique du Bénin, numéro spécial 3: économie et sociologie rurales, 20-28.
[41]Tovignan, S., Hinvi, J., Glin, L.C., Sodjinou, E., Bonou-Zin, R., Koussahoué, S., Nicolay, G., 2014, Déterminants de la rentabilité de la production du coton biologique au Bénin, 3ième Conférence Ouest Africaine sur l'Agriculture Biologique du 27 au 29 Août 2014, Cotonou, Bénin.
[42]Toyi, M.S., Bastin, J.-F., André, M., De Cannière, C., Sinsin, B., Bogaert, J., 2013, Effets de lisière sur la productivité du teck (*Tectona grandis* L.f.) : étude de cas des teckeraies privées du Sud-Bénin, Tropicultura, 31, 1, 71-77.
[43]Willan, R.L., 1992, Guide de manipulation des semences forestières. Étude FAO Forêts 20/2, http://www.fao.org/docrep/006/ad232f/ad232f00.htm#TOC, Accessed on Apr.16, 2014.
[44]Yabi, A.J., 2010, Analyse des déterminants de la rentabilité économique des activités menées par les femmes rurales dans la commune de Gogounou au Nord-Bénin. Annales des Sciences Agronomiques, (14) 2: 221-239.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ASSESSMENT OF THE EFFICIENCY OF LITHUANIAN DAIRY FARMS OF DIFFERENT ECONOMIC SIZES

Deiva MIKELIONYTĖ, Ovidija EIČAITĖ

Lithuanian Institute of Agrarian Economics, LIAE, A. Vivulskio st. 4A-13, 03220 Vilnius, Lithuania, Phones: +37052614547, +37052622429, Emails: deiva.mikelionyte@laei.lt, ovidija.eicaite@laei.lt

Corresponding author: ovidija.eicaite@laei.lt

Abstract

This study aims at assessing the efficiency of Lithuanian dairy farms of different economic sizes, and at observing changes in this efficiency over a period of time. In order to achieve this aim, three groups of indicators, namely resource, input and result ones, were used for the analysis. On the basis of information available from the Farm Accountancy Data Network, these indicators were calculated for the years 2013, 2015 and 2017. The results of the analysis revealed that the least efficient dairy farms in terms of all three groups of indicators were the smallest ones (those of the economic size of EUR 2-<8 thousand of standard production). As the economic size of dairy farms increased, the efficiency of dairy farms also increased, and the most efficient dairy farms were the medium and larger ones (those of the economic size of EUR 25-<50 and 50-<100 thousand of standard production). However, the efficiency of the largest dairy farms (those of the economic size of EUR 100-<500 thousand of standard production) was already lower than that of the medium and larger ones and close to the efficiency of the smallest dairy farms.

Key words**:** *dairy farms, economic size, efficiency, resource indicators, input indicators, result indicators, Lithuania*

INTRODUCTION

Milk production is one of the most important sub-sectors within Lithuanian agriculture, and for many years, it has been ranked second, after cereals production. Nevertheless, the role of milk production in Lithuanian agriculture is declining: in 2013, the share of milk in the total agricultural production has comprised 19.2%, while in 2018, it has made up 16.2%. Milk production has decreased from 1,723.1 thousand tonnes in 2013 to 1,515.0 thousand tonnes in 2018, or by 12.1%, while over the same period, milk purchase for processing has slightly increased from 1,339.5 thousand tonnes to 1,363.0 thousand tonnes, or by 1.8% [9]. The vast majority of Lithuanian dairy farms are small-scale family dairy farms. Despite the fact, that the average herd size in Lithuania has increased from 4.8 cows per farm in 2013 to 6.6 cows per farm in 2017, it remains one of the smallest in the EU (only Romania has a smaller average herd size than Lithuania) [7]. In Lithuania, the largest share of freshly milked raw milk (about 80%) is sold for processing. The smaller dairy farms receive considerably lower prices for raw milk than the larger ones. Taking this into account, the smaller dairy farms either go out of business or become the larger ones. In many countries, the number of dairy farms has been decreasing, while the size of dairy farms has been increasing. The question arises whether only the larger dairy farms perform most efficiently. A number of studies have been carried out in different countries in order to analyse various aspects related to the situation and development of dairy farms of different economic sizes, such as efficiency [4; 6], competitiveness [10], value added [5], level of saved up surplus for investment self-financing [3], unit cost [8]. Such studies are lacking in Lithuania, therefore, in order to fill the gap, this study has been carried out. The present study has been aimed at assessing the efficiency of Lithuanian dairy farms of different economic sizes, and at observing changes in this efficiency over a period of time.

MATERIALS AND METHODS

First of all, in this study, the size structure of Lithuanian dairy farms over the period 2013–

2017 was examined. In order to achieve this, data from the State Enterprise Agricultural Information and Rural Business Centre was used [1].

Secondly, the efficiency of Lithuanian dairy farms of different economic sizes was assessed, using three groups of indicators, namely resource, input and result ones. All these indicators were calculated per livestock unit. Although the dominant source of income for dairy farms is milk production, the livestock unit rather than dairy cow was selected for the analysis since other cattle are also involved in the reproduction process. In order to maintain these cattle, resources are needed, and in addition, these cattle generate certain income on dairy farms.

Resource indicators helped to assess the degree of utilisation of resources needed to carry on and develop the activity on dairy farms of different economic sizes. These indicators included the following:

-Total utilised agricultural area.
-Total labour input.
-Total fixed assets.
-Renewal ratio of fixed assets.
-Total current assets and inventories.
-Balance subsidies and taxes on investments including on agricultural investments.
-Debt to assets ratio (although this indicator is commonly used to assess a farm activity risk, but it also shows the capacity of a farm to attract external capital for the development of this farm).

Input indicators helped to assess which categories of inputs were used most efficiently on dairy farms of different economic sizes and how these categories of inputs affected the total inputs. These indicators included the following:

-Total specific costs.
-Total farming overheads.
-Depreciation.
-Total external factors.
-Total inputs.

Result indicators included the following:

-Milk yield per dairy cow.
-Total output.
-Sum of balance current subsidies and taxes and total direct payments.
-Ratio of total output to total input.
-Ratio of sum of total output and balance current subsidies and taxes and total direct payments to total input.

All indicators were calculated for the years 2013, 2015 and 2017. In these years, the conditions for the development of dairy farming in Lithuania differed significantly. The year 2013 was exceptionally good for dairy farming due to a very high worldwide demand for dairy products which lead to higher milk purchase prices. In that year, milk purchase prices in Lithuania reached their all-time highest level. On the contrary, the year 2015 was unfavourable for the development of dairy farming. The collapse in worldwide demand for dairy products and increased raw milk supply had a negative impact on milk purchase prices. In 2015, as compared to 2013, the average purchase price for raw milk in Lithuania dropped by 32%. Finally, the 2017 year was average for the development of dairy farming, and the average purchase price for raw milk was higher by 37% than in 2015 but lower by 8% than in 2013 [9].

In order to assess the efficiency of Lithuanian dairy farms of different economic sizes, data from the European Union Farm Accountancy Data Network (FADN) was used [2]. For the year 2013, the FADN database provided data on dairy farms of four different economic sizes, while for the years 2015 and 2017, this database provided data on dairy farms of five different economic sizes.

RESULTS AND DISCUSSIONS

Size structure of Lithuanian dairy farms

Milk production in Lithuania is very fragmented: in 2017, there were 41,354 dairy farms which kept 272.1 thousand dairy cows. Between 2013 and 2017, the number of dairy farms and the number of dairy cows continuously decreased. Over this period, the number of dairy farms declined by more than one third (35.8%) and the number of dairy cows dropped by more than one tenth (12.3%) (Table 1).

Table 1. Dairy farms by number of dairy cows in 2013, 2015 and 2017 in Lithuania (at the end of the year)

Number of dairy cows per farm	Number of dairy farms				Number of dairy cows, thousand heads			
	2013	2015	2017	Change 2017, compared to 2013, %	2013	2015	2017	Change 2017, compared to 2013, %
1–2	45,014	35,558	26,416	–41.3	56.8	45.5	33.7	–40.7
3–9	14,250	13,183	10,298	–27.7	65.7	61.5	48.6	–26.0
10–19	2,642	2,443	2,216	–16.1	35.8	33.2	30.3	–15.4
20–29	1,003	1,017	949	–5.4	23.9	24.2	22.8	–4.6
30–49	781	764	719	–7.9	29.7	29.0	27.1	–8.8
50–99	457	509	487	6.6	31.0	34.9	33.0	6.5
>=100	244	256	269	10.2	67.5	72.3	76.6	13.5
Total	64,391	53,730	41,354	–35.8	310.4	300.6	272.1	–12.3
Average per farm, heads	–	–	–	–	**4.8**	**5.6**	**6.6**	**37.5**

Source: State Enterprise Agricultural Information and Rural Business Centre.

Table 2. Number of livestock units on Lithuanian dairy farms of different economic sizes in 2013, 2015 and 2017

Year	Economic size, thousand EUR of standard production				
	2-<8	**8-<25**	**25-<50**	**50-<100**	**100-<500**
2013	n. a.	9.4	27.7	55.4	130.6
2015	4.3	10.5	27.2	55.4	131.9
2017	4.1	10.5	27.7	52.3	134.1

Source: FADN data base.

In 2017, in Lithuania, the smallest dairy farms (those with less than 10 dairy cows) accounted for 88.8% of the total number of all dairy farms and dairy cows on these dairy farms represented 30.2% the total number of dairy cows. Between 2013 and 2017, the number of the smallest dairy farms and the number of dairy cows on these dairy farms fell the most. Over this period, only the number of dairy farms with 50 and more dairy cows rose and the number of dairy cows on these dairy farms showed an increase as well. In 2017, these dairy farms accounted for 1.8% of the total number of all dairy farms and dairy cows on these dairy farms represented 40.3% the total number of dairy cows. In Lithuania, the structural changes in dairy farming were strong with the number of dairy farms, especially the smallest ones, dropping significantly.

In order to compare the performance and activity of Lithuanian dairy farms of different economic sizes, the FADN, which provides data for specialised dairy farms from the EU countries, is useful. Table 2 presents the classification of dairy farms by economic size and the number of livestock units on Lithuanian dairy farms of different economic sizes in 2013, 2015 and 2017.

Efficiency of Lithuanian dairy farms of different economic sizes in terms of resource indicators

Table 3 presents the resource indicators per livestock unit on Lithuanian dairy farms of different economic sizes in 2013, 2015 and 2017.

The smallest dairy farms (those of the economic size of EUR 2-<8 thousand of standard production) needed to accumulate the most resources per livestock unit, therefore, these dairy farms were the least efficient in terms of resource utilisation. Compared to dairy farms which required the least resources per livestock unit, the smallest dairy farms needed around three times more labour input and ten times more total fixed assets. Differences in utilisation of other resources were smaller but also significant. However, with regard to renewal ratio of fixed assets, the smallest dairy farms showed having the potential: the renewal ratio of fixed assets for these dairy farms was the highest.

Table 3. Resource indicators per livestock unit on Lithuanian dairy farms of different economic sizes in 2013, 2015 and 2017

Resources	Unit	Economic size, thousand EUR of standard production				
		2-<8	8-<25	25-<50	50-<100	100-<500
2013						
Total utilised agricultural area	ha	n. a.	2.42	1.88	1.75	1.45
Total labour input	Number	n. a.	0.17	0.06	0.05	0.04
Total fixed assets	EUR	n. a.	4,386	3,055	3,162	3,527
Renewal ratio of fixed assets	–	n. a.	0.09	0.13	0.15	0.15
Total current assets and inventories	EUR	n. a.	1,615	1,209	1,245	1,274
Balance subsidies and taxes on investments including on agricultural investments	EUR	n. a.	56	94	37	34
Debt to assets ratio	%	n. a.	5.8	11.8	15.6	17.8
2015						
Total utilised agricultural area	ha	2.10	2.34	1.86	1.59	1.35
Total labour input	Number	0.30	0.16	0.06	0.04	0.03
Total fixed assets	EUR	6845	4,079	2,355	2,620	3,178
Renewal ratio of fixed assets	–	0.21	0.11	0.09	0,12	0.13
Total current assets and inventories	EUR	2,040	1,798	1,400	1,419	1,524
Balance subsidies and taxes on investments including on agricultural investments	EUR	760	280	61	109	150
Debt to assets ratio	%	4.5	10.1	9.8	20.2	18.4
2017						
Total utilised agricultural area	ha	2.99	2.36	1.84	1.54	1.40
Total labour input	Number	0.34	0.14	0.06	0.04	0.03
Total fixed assets	EUR	7,882	4,582	2,506	2,743	3,582
Renewal ratio of fixed assets	–	0.16	0.11	0.09	0.17	0.13
Total current assets and inventories	EUR	2,230	2,334	1,870	1,830	1,679
Balance subsidies and taxes on investments including on agricultural investments	EUR	837	925	170	158	196
Debt to assets ratio	%	2.3	8.9	13.5	15.2	19.3

Source: Own calculations.

The effect of economies of scale was most noticeable, when considering total labour input and total utilised agricultural area per livestock unit: these indicators were the highest on the largest dairy farms and the lowest on the smallest dairy farms. On the largest dairy farms (those of the economic size of EUR 100-<500 thousand of standard production), as compared to the smallest ones (those of the economic size of EUR 2-<8 thousand of standard production), the total labour input per livestock unit was lower from 9 times in 2015 to 10 times in 2017, while the utilised agricultural area per livestock unit was lower from 56% in 2015 to 2 times in 2017. It is to be noted, that in 2017, as compared to 2015, the disparities had increased. The larger the dairy farm, the more efficiently the labour input and utilised agricultural area per livestock unit were used.

The total fixed assets per livestock unit was used more efficiently on the medium dairy farms (those of the economic size of EUR 25-<50 thousand of standard production). These dairy farms had the least amount of total fixed assets per livestock unit. As the economic size of dairy farms increased or decreased, the needs for total fixed assets per livestock unit rose. The same situation was observed in 2013 and 2015 with regard to total current assets and inventories per livestock unit. However, this trend reversed in 2017, when the largest dairy farms (those of the economic size of EUR 100-<500 thousand of standard production) had the least amount of total current assets and inventories per livestock unit, and as the economic size of dairy farms

decreased, the needs for total current assets and inventories per livestock unit rose.

The renewal ratio of fixed assets helped to assess whether the technical condition of fixed assets was outdated and depreciated, and whether it served as an obstacle for dairy farms to develop their activity. The value of this indicator is to be assessed over a period of several years. In this study, the renewal ratio of fixed assets was calculated as averages of 2013, 2015 and 2017 values. The results showed that the smallest dairy farms (those of the economic size of EUR 2-<8 thousand of standard production) had the fastest renewal of fixed assets: the renewal ratio of fixed assets for these dairy farms was 0.19. The values of this indicator for dairy farms of other economic sizes were smaller: 0.10 for dairy farms of the economic size of EUR 8-<25 and 25-<50 thousand of standard production, 0.15 for dairy farms of the economic size of EUR 50-<100 thousand of standard production, and 0.14 for dairy farms of the economic size of EUR 100-<500 thousand of standard production. This could simply be explained by the fact that the smallest dairy farms received the highest investment support per livestock unit – an average of EUR 799 per the years 2015 and 2017, while the dairy farms of other economic sizes received lower investment support per livestock unit – an average of EUR 101–420 per the years 2013, 2015 and 2017. The larger and largest dairy farms (those of the economic size of EUR 50-<100 and 100-<500 thousand of standard production) were more capable to attract external capital. The values of debt to assets ratio for these dairy farms in all years were among the highest and reached 15–20%, while the values of debt to assets ratio for other dairy farms were 2–13%.

Efficiency of Lithuanian dairy farms of different economic sizes in terms of input indicators

Table 4 presents the input indicators per livestock unit on Lithuanian dairy farms of different economic sizes in 2013, 2015 and 2017.

In 2013 and 2015, the most efficient dairy farms in terms of total inputs per livestock unit were the medium ones (those of the economic size of EUR of 25-<50 thousand of standard production): the total inputs per livestock unit on these dairy farms were lower by 17.1% in 2013, and by 20.8% in 2015 than on dairy farms with the highest total inputs per livestock unit in the relevant year. In 2017, the situation slightly changed and the most efficient dairy farms in terms of total inputs per livestock unit became the larger ones (those of the economic size of EUR 50-<100 of standard production). The total inputs per livestock unit on these dairy farms were lower by 35.0% than on dairy farms with the highest total inputs in that year.

In 2015 and 2017, the least efficient dairy farms in terms of total inputs were the smallest ones (those of the economic size of EUR 2-<8 thousand of standard production). The total inputs per livestock unit on these dairy farms were higher by 26.2% in 2015, and by 53.9% in 2017 than on dairy farms with the lowest total inputs per livestock unit in the relevant year. The second least efficient dairy farms in terms of total inputs per livestock unit were the largest ones (those of the economic size of EUR 100-<500 thousand of standard production). The total inputs per livestock unit on these dairy farms were higher by 20.6% in 2013, by 23.4% in 2015, and by 29.6% in 2017 than on dairy farms with the lowest total inputs in the relevant year.

The specific costs accounted for the largest share of total inputs per livestock unit (on average 42–50%) but they did not influence the efficiency of dairy farms in terms of total inputs per livestock unit. These costs were the lowest on the smaller dairy farms (those of the economic size of EUR 8-<25 thousand of standard production) and the highest on the largest dairy farms (those of the economic size of EUR 100-<500 thousand of standard production). The most efficient dairy farms in terms of total inputs were those with the lowest depreciation, however, these costs did not influence the efficiency of dairy farms in terms of total inputs per livestock unit as well since the depreciation accounted only for 23–28% of total inputs. The most efficient dairy

farms in terms of total inputs per livestock unit had the low and average levels of all categories of inputs.

Table 4. Input indicators per livestock units on Lithuanian dairy farms in 2013, 2015 and 2017

Inputs	Unit	Economic size, thousand EUR of standard production				
		2-<8	8-<25	25-<50	50-<100	100-<500
2013						
Total specific costs	EUR	n. a.	663	692	717	857
Total farming overheads	EUR	n. a.	400	301	265	271
Depreciation	EUR	n. a.	367	315	324	346
Total external factors	EUR	n. a.	47	58	95	173
Total inputs	EUR	n. a.	1,477	1,366	1,401	1,647
2015						
Total specific costs	EUR	625	572	606	654	778
Total farming overheads	EUR	488	401	281	240	236
Depreciation	EUR	393	446	276	284	333
Total external factors	EUR	44	73	64	99	172
Total inputs	EUR	1,549	1,491	1,227	1,278	1,518
2017						
Total specific costs	EUR	680	589	698	680	878
Total farming overheads	EUR	586	417	309	237	323
Depreciation	EUR	750	622	323	314	355
Total external factors	EUR	63	78	87	120	195
Total inputs	EUR	2,079	1,706	1,417	1,351	1,751

Source: Own calculations.

Efficiency of Lithuanian dairy farms of different economic sizes in terms of result indicators

Table 5 presents the result indicators per livestock unit on Lithuanian dairy farms of different economic sizes in 2013, 2015 and 2017.

For the milk yield per dairy cow, the highest was observed on the largest dairy farms (those of the economic size of EUR 100-<500 thousand of standard production), while the lowest was observed on the smallest dairy farms (those of the economic size of EUR 2-<8 thousand of standard production). The difference in milk yield per cow between the largest and smallest dairy farms widened: in 2013, it stood at 28.9%, while in 2017, it reached 36.0%. The highest output per livestock unit was also observed on the largest dairy farms (those of the economic size of EUR 100-<500 thousand of standard production), while the lowest was observed on the smaller dairy farms (those of the economic size of EUR 8-<25 thousand of standard production). The smallest dairy farms (those of the economic size of EUR 2-<8 thousand of standard production) had a better output per livestock unit performance than the smaller ones (those of the economic size of EUR 8-<25 thousand of standard production). A possible explanation for this could be that the freshly milked raw milk at least in some of the smallest dairy farms was not sold for processing but processed on these dairy farms. Produced dairy products were sold directly to consumers and sales of these higher value added dairy products generated more income for the smallest dairy farms.

The ratio of total output to total input reflects the efficiency of dairy farms most accurately. This indicator was not the highest on the largest dairy farms having the best output per livestock unit performance. For the ratio of total output to total input, in 2013, the most efficient dairy farms (those having the lowest total input and the highest total output per livestock unit) were the medium ones (those of the economic size of EUR 25-<50 thousand of standard production), while in 2015 and 2017, the most efficient dairy farms were the larger ones (those of the economic size of EUR 50-<100 thousand of standard production). According to this indicator, the least efficient dairy farms were the smaller and smallest ones: those of the economic size of EUR 8-<25 thousand of standard

production in 2013 and 2015, and those of the economic size of EUR 2-<8 thousand of standard production in 2017. These dairy farms had the highest total input and the lowest total output per livestock unit and their activity without support was the least profitable in 2013 and had been loss making in 2015 and 2017.

Table 5. Result indicators per livestock unit on Lithuanian dairy farms in 2013, 2015 and 2017

Results	Unit	Economic size, thousand EUR of standard production				
		2-<8	8-<25	25-<50	50-<100	100-<500
2013						
Milk yield per dairy cow	kg/year	n. a.	4,785	5,390	5,393	6,170
Total output	EUR	n. a.	1,599	1,721	1,716	2,056
Total output/Total input	–	n. a.	1.08	1.26	1.22	1.25
Balance current subsidies and taxes + Total direct payments	EUR	n. a.	872	703	630	512
(Total output + Balance current subsidies and taxes + Total direct payments)/Total input	–	n. a.	1.67	1.77	1.67	1.56
2015						
Milk yield per dairy cow	kg/year	4,560	4,914	5,197	5,433	5,969
Total output	EUR	1,429	1,232	1,279	1,339	1,563
Total output/Total input	–	0.92	0.83	1.04	1.05	1.03
Balance current subsidies and taxes + Total direct payments	EUR	965	1,079	915	759	638
(Total output + Balance current subsidies and taxes + Total direct payments)/Total input	–	1.55	1.55	1.79	1.64	1.45
2017						
Milk yield per dairy cow	kg/year	4,613	5,300	5,412	5,604	6,272
Total output	EUR	1,530	1,410	1,570	1,698	1,965
Total output/Total input	–	0.74	0.83	1.11	1.26	1.12
Balance current subsidies and taxes + Total direct payments	EUR	1,252	1,166	936	755	632
(Total output + Balance current subsidies and taxes + Total direct payments)/Total input	–	1.34	1.51	1.77	1.81	1.48

Source: Own calculations.

Lithuanian dairy farms of different economic sizes received uneven levels of support for their activity. The support for the activity in this case was considered as the sum of balance current subsidies and taxes and direct payments as both these components affected income equally. The smaller dairy farms (those of the economic size of EUR 8-<25 thousand of standard production) received the highest support per livestock unit. As the economic size of dairy farms increased, the support per livestock unit decreased. The largest dairy farms (those of the economic size of EUR 100-<500 thousand of standard production) received the lowest support per livestock unit, and this support was by 41–50% smaller than support received by the smaller and smallest dairy farms. The higher support for the smaller and smallest dairy farms (those of the economic size of EUR 2-<8 and 8-<25 of standard production) made their activity from loss making to profitable. For the ratio of sum of total output and all the support to total input, the most efficient dairy farms were the medium and larger ones: those of the economic size of EUR 25-<50 thousand of standard production in 2013 and 2015, and those of the economic size of EUR 50-<100 thousand of standard production in 2017. According to this indicator, the largest dairy farms (those of the economic size of EUR 100-<500 thousand of standard production) were the least efficient in 2013 and 2015, while they were the second least efficient in 2017 (in that year, the least efficient dairy farms were the smallest ones (those of the

economic size of EUR 2-<8 thousand of standard production)). Nevertheless, the activity of Lithuanian dairy farms of all economic sizes with support was profitable.

CONCLUSIONS

In order to comprehensively assess the efficiency of Lithuanian dairy farms of different economic sizes, three groups of indicators, namely resource, input and result ones, were used for the analysis. On the basis of information available from the Farm Accountancy Data Network, these indicators were calculated for the years 2013, 2015 and 2017 to observe changes in the efficiency of Lithuanian dairy farms of different economic sizes over a period of time.

The most efficient dairy farms in terms of resource indicators were the larger and largest ones (those of the economic size of EUR 50-<100 and 100-<500 thousand of standard production). The needs for all resources on these dairy farms were among the lowest. The smallest dairy farms (those of the economic size of EUR 2-<8 thousand of standard production) receiving the highest investment support per livestock unit had the fastest renewal of fixed assets. The larger and largest dairy farms (those of the economic size of EUR 50-<100 and 100-<500 thousand of standard production) receiving much less investment support per livestock unit renewed fixed assets at only a slightly slower pace since they were more capable to attract external capital.

The best efficiency of dairy farms in terms of input indicators was related to the low and average levels of all categories of inputs. In 2013 and 2015, the medium dairy farms (those of the economic size of EUR 25-<50 thousand of standard production), and in 2017, the larger dairy farms (those of the economic size of EUR 50-<100 thousand of standard production) had such levels of all categories of inputs.

Assessing the result indicators, it could be noted that, as the economic size of dairy farms increased, the milk yield and total output increased as well. However, in order to achieve higher milk yield and total output, dairy farms of larger economic sizes needed higher input. For the ratio of total output to total input, the most efficient dairy farms were the medium and larger ones (those of the economic size of EUR 25-<50 and 50-<100 thousand of standard production), while the least efficient dairy farms were the smallest ones (those of the economic size of EUR 2-<8 thousand of standard production). Although as the economic size of dairy farms increased, the all support per livestock unit decreased, according to the ratio of sum of total output and all the support to total input, the most efficient dairy farms were the medium and larger ones (those of the economic size of EUR 25-<50 and 50-<100 thousand of standard production), while the least efficient dairy farms were the smallest and largest ones.

The least efficient dairy farms in terms of all three groups of indicators were the smallest ones (those of the economic size of EUR 2-<8 thousand of standard production). As the economic size of dairy farms increased, the efficiency of dairy farms also increased, and the most efficient dairy farms were the medium and larger ones (those of the economic size of EUR 25-<50 and 50-<100 thousand of standard production). However, the efficiency of the largest dairy farms (those of the economic size of EUR 100-<500 thousand of standard production) was already lower than that of the medium and larger ones and close to the efficiency of the smallest dairy farms. In 2013, the medium dairy farms (those of the economic size of EUR 25-<50 thousand standard production) were more efficient than the larger ones (those of the economic size of EUR 50-<100 thousand of standard production), while in 2017, slightly more indicators showed that the larger dairy farms were more efficient than the medium ones.

REFERENCES

[1]Agricultural Information and Rural Business Centre, https://www.vic.lt, Accessed on January 10, 2020.
[2]Farm Accountancy Data Network, Public Database, https://ec.europa.eu/agriculture/rica/database/database_en.cfm, Accessed on December 18, 2019.

[3]Kołoszycz, E., 2017, Volatility of milk prices and the formation of the surplus on the self-financing of investments in dairy farms, Problems of Agricultural Economics, 2(351), 77-93.
[4]Kovács, K., Szucs, I., 2016, Measuring of the Hungarian dairy farms efficiency, Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu, 18(5).
[5]Krieviņa, A., 2009, Effect of concentration and specialisation on value added in dairy sector, Economic Science for Rural Development.
[6]Krisztián, K., Ratnesh, P., 2017, Hungarian Dairy And Beef Production Sector Technical Efficiency Comparsion Using Dea, APSTRACT: Applied Studies in Agribusiness and Commerce, 11(1033-2018-2962), 131-140.
[7]Lietuvos žemės ir maisto ūkis 2017 = Agriculture and food sector in Lithuania 2017, Autorių kolektyvas: R. Melnikienė – vadovė … [et. al.], Vilnius, Lietuvos agrarinės ekonomikos institutas, 2018, 178 p., iliustr., lent., reziumė (angl.), (online), https://www.laei.lt/?mt=leidiniai&straipsnis=1333&metai=2018, Accessed on December 18, 2019.
[8]Sinisalo, A., 2015, Production costs of Finnish dairy farms in the 2000s, Economic Science for Rural Development, 26.
[9]Statistics Lithuania, https://www.stat.gov.lt/#, Accessed on January 8, 2020.
[10]Ziętara, W., Adamski, M., 2018, Competitiveness of the Polish dairy farms at the background of farms from selected European Union countries, Problems of Agricultural Economics, 1(354).

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

HARMONIZATION WITH THE COMMON AGRICULTURAL POLICY FOR A NEW MEMBER STATE: THE CASE OF CROATIA

Ornella MIKUS[1], Ramona FRANIC[1] Tajana RADIC[2], Tihana KOVACICEK[1]

[1]University of Zagreb, Faculty of Agriculture,Department of Agricultural Economics and Rural Development, 25 Svetošimunska Street, 10000 Zagreb, Croatia, Phone: 00385 1 239 3964; 00385 1 239 3757; 00385 239 4024; E-mails: omikus@agr.hr, ramonaf@agr.hr, tkovacicek@agr.hr
[2]Croatian Chamber of Agriculture, 78 Vukovarska Street, 10000 Zagreb Croatia, Phone: 003856109 260; E-mail: tajana.radic@komora.hr

Corresponding author: omikus@agr.hr

Abstract

The integration process of candidate and potential candidate countries for the EU causes confusion and scepticism among different stakeholders, which often leads to missing out on accession opportunities. Although NMS are able to achieve economic growth by joining the EU, membership success also depends on the initial agricultural structure, local and national policy, pre-accession and post-accession measures, education, vocational training, development of the non-farm rural economy and institutional environment. Croatia, as the newest EU member state, has been experiencing certain issues in the implementation of CAP measures. Using thematic references dealing with the issues of the CAP and harmonization of NMS and conducting interviews among stakeholders in Croatia through focus groups during the pre-accession and membership period, the goals of this paper were to determine: (1) the understanding of the CAP principles and adjustments of national agricultural policies (2) the effects of policy results on national agriculture and further expectations (3) the state of policy learning and dialogue. These results could serve agricultural policy scholars as contribution to the analysis of integration policies and decision makers to avoid misunderstandings when implementing new agricultural policy measures.

Key words**:** *CAP, Croatia, candidate countries, the EU, membership, NMS, stakeholders*

INTRODUCTION

For Croatian agriculture, which is a highly sensitive sector dependent on political decisions, the process of adjustment to the Common Agricultural Policy (CAP) was estimated as not enough successful. Previous research implied that reasons for political and economic failures could be found in a great disparity of goals at national and EU level [4]. Budgetary support was primarily sector-oriented and intended for production increase. This is quite different intention than that of the CAP, which wants to target the multifunctional character of agriculture: environmental impacts, biodiversity, sustainable rural development, food safety, animal welfare and other non-market related elements. Agricultural policy has mostly benefited large-scale farms, while mid-scale and small ones lost their role in balancing a healthy structure of agricultural and rural sector.

Furthermore, CAP decision makers find it more and more difficult to create policy measures and instruments that would be acceptable to both Western and Eastern members [5]. Priorities of Western members are often oriented to agri-environmental issues, animal welfare, renewable resources and climate change. Central and Eastern member states (CEE), including Croatia, which mostly have semi-substantial farms with low levels of factor capitalization, seek for higher direct support in order to reach the amount of subsidies per farm as it is for Western farmers, simplification of legislative framework and for measures which would focus on rural poverty.

The case of Croatian adaptation to new political and economic circumstances could serve as a valuable evidence which brings together causes and consequences of national

agricultural policy and results in new policy learning not just for Croatian policy makers, but also for other countries with similar start positions in the process of joining the EU community, whether they are candidate countries as Albania, Montenegro, North Macedonia, Serbia, Turkey or potential candidate countries which do not yet fulfil the requirements for EU membership (Bosnia and Herzegovina and Kosovo).

MATERIALS AND METHODS

Results and conclusions in this paper are driven using outcomes from research studies and interviews through focus groups conducted during pre-accession and membership period (2005-2019). Additionally, secondary resources dealing with issues of the CAP and harmonization of NMS were used to discuss the context of adaptation to new political and economic situation. The chosen period is divided into two phases: in the first phase, from October 2005 (the opening of negotiation with the EU) to the end of 2013, three focus groups were organized. It related to joint project of Food and Agriculture Organization of the United Nations (FAO) and Regional Rural Development Standing Working Group in South Eastern Europe (SWG), "Streamlining of agriculture and rural development policies of SEE countries for EU accession". The main stakeholders of the project were the representatives from the Ministries of Agriculture of the participating countries (Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia, and Kosovo), research institutions in the CEE region and representatives from civil society associations dealing with agriculture and rural development policy issues.

In the second phase, in the period from 2014 to 2019, discussions were organized in three focus groups, trying to reach deep insight into opinions and attitudes of domestic stakeholders (researchers, MA and producers) about agriculture and agricultural policy during the first years of Croatian membership in the EU. Thirty participants altogether (phase 1 and 2, five from each group) from the domain of public administration responsible for creating and applying policies, agricultural producers (family farmers, representatives of farming associations, cooperatives and other business entities) and academic society took part in the discussions.

Using the results of this two-phase research, the goal of this paper is to determine among stakeholders:

(1)the understanding of CAP principles and adjustments of national agricultural policies (2)the effects of policy results in national agriculture and further expectations (3) the state of policy learning and dialogue.

RESULTS AND DISCUSSIONS

Historical issues of the Common Agricultural Policy

In the first decades after establishment, the CAP put a strong emphasis on the market support, while structural support measures were of minor importance. Consequently, the CAP became its own victim and faced the problem of surpluses and budgetary burden, additionally weighed due to the implementation of export subsidies, production quotas, and storage of surpluses.

In 1990s society became increasingly concerned about the environmental sustainability of agriculture and food safety. Additional pressure was made in the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) which demanded from the CAP to be less market distortive, to put limits on farm payments and to exercise control over growing budget expenditures.

Through MacSharry reform in 1992 and Agenda 2000, intervention price levels were significantly reduced at international market prices, direct payments to farmers were established and a serious debate about the role of agriculture in the European society was initiated. Especially with Agenda 2000, the strategy was to gradually decouple supports away from production and to turn subsidy towards rural development. Market and price support became pillar 1 and rural development pillar 2 of the CAP.

Although the name 'Mid-term review' (MTR) hinders extent and substance of the reform package in 2003 (also known as Fischler reform) it has been assessed by many experts as the most radical reform of the CAP since its creation [12] and [10]. The key element of the 2003 reform was the introduction of the single farm payment scheme (SFP) which meant decoupling a large share of CAP support from production.

Health check in 2008 was a rather modest reform. This reform is marked as a missed opportunity mostly because member states (MS) differ greatly in their views of future CAP and unanimous agreement is hardly achievable. Conservative MS (France, Italy, Ireland, Belgium, Luxembourg, Spain, Portugal, Greece) seek a greater budget for agricultural production, have strong farmers' lobbies and want more benefits from EU institutions. On the other side, reform-oriented MS (Denmark, Netherland, Sweden, Estonia, Latvia, Czech Republic, Slovakia) are liberally oriented and strive more for efficient production. Other members have changing positions, depending on political power and person involved in the negotiation [8].

CAP post-2013 was announced as the major reform with further orientation towards more cost-efficient and less distorting forms of farm support for the current period between 2014-2020. Raising challenges of climate change, environmental damages provoked by intensive agriculture, disproportion in payment amounts between farms, diversity between Old Member States (OMS) and New Member States (NMS) agricultural goals and public criticism on the amount of budget were to be faced more seriously in upcoming years. The main intentions of the reform were to make tighter connection between direct payments and rural development when it comes to agricultural and environmental support.

Croatian agricultural policy: significance of joining the EU and stakeholders' perception

The CAP is never sufficiently reformed to respond to the needs of Eastern Europe, but the experience of NMS that entered the EU in 2004 and 2007 is overall positive [2]. Accession resulted in a higher value of agricultural output, higher prices, higher export and import quantities and higher farmers' incomes. Still there are great differences in performance among countries due to differing initial conditions, pre-accession and post-accession policies.

A long period of communism in Croatia, as well as in the majority of NMS, left behind an adverse agricultural structure (large state farms vs. small private farms, negative perception of cooperation, lack of entrepreneurial spirit, etc.) that, together with a central-planned economy, caused great difficulties in adjustment to the market-oriented economy. Additionally, consequences of the War for Independence at the beginning of 1990s were obvious in devastation of natural resources, but economy was additionally limited by complicated transition period and WTO membership rules (regarding market liberalization). In the first decade after gaining independence, Croatian agriculture was characterized by considerable decrease in agricultural production and employment, indebtedness, technological lagging behind, worsening of trade balance and insolvency. The War considerably influenced the delay of economic reform and integration, but the post-war period also failed in policy adjustments regarding farmers and rural areas. During the process of Croatian integration into EU, the CAP was at the crossroads. Also, Croatian agricultural policy system had to adapt to the upcoming rules of capping direct payments, prepare domestic stakeholders to decoupled payments and greening procedures. To the EU, Croatia was another ascending member state with the centrally-planned economy background, with high average payment per farm, mostly coupled, which doesn't improve poor agricultural structure where few very big farms prevail. Low level of realization of strategically planned activities and rather an ad-hoc approach in designing and implementing agri-policy measures didn't fit properly in the CAP system. Still, it was not expected that Croatia by itself would

significantly affect budget planning or cause a key turnover of the CAP. Indeed, the previous reforms of the CAP were responses to challenging enlargements and integration of the EU with its Eastern neighbours.

Although Croatia had a good legal background which begins to develop in the mid-1990s, the lack of expert and scientific research has caused slow adjustment to new budgetary schemes and to preparation and implementation of rural development programs. In the period prior to the EU accession process, there was obvious, considerable dissatisfaction with the state administration, the gap between policy desires and opportunities (challenges of the European market versus uncompetitive domestic agriculture) and neglecting of expert advice in designing the policies [4]. It seems that the problem existed not only in the agricultural sector. It has been also found out that there are no precise studies about the impact of business sector on policy decisions and, although different experts have been invited into advisory bodies, their role was symbolic and proposed recommendations were disregarded and not implemented [9]. In agricultural sector this could partly be justified by tight deadlines in which policy decisions were made; in completely incomparable socio-economic circumstances, they had to meet the goals of policy that constantly changed as well. However, some comments of the public officers during debates also reflect a kind of professional arrogance against the academic community. Thus, it could be heard that "there is nobody at the faculties who knows anything about the principles of state intervention in agriculture" or doubts about “whether anyone knows about CAP mechanisms at the faculties" or a comment on how "faculty professors in their offices are not familiar with the situation in the field", implying that the academic opinion is not important. The attitude that nobody but a public official is competent as „a policy maker“ was obvious. Therefore, the academic community had little or no influence on final political decisions, and the results of professional studies were often neglected because public officials did not have confidence in scientific methods used.

Such a disagreement has contributed to the number of erroneous interpretations of CAP standards, ranging from imprecise translations of professional terminology in the first official documents to the selection of agricultural policy measures which, according to economic principles, could not achieve the declared goals (such as market-price policies in achieving competitiveness). Also, the lack of involvement of academics, interest groups and wider society in the accession process is a little remarked and analysed problem. It causes “democratic deficit” in CEE governance which is trying to demonstrate faster progress towards policy implementation [7].

Judging by the results of focus groups made during the pre-accession period and the first years of EU membership, the prevailing viewpoints of Croatian stakeholders are in many respects similar to those in most of the NMS which entered the EU before Croatia:

- The main goal of agricultural policy is "to increase production and self-sufficiency" with little or no awareness of “greening” standards; common belief among agricultural producers, but often present in a rhetoric of farmers or key administrators ("why should we give funds for non-production?”), ignoring the fact that Croatian agriculture is only a minor segment of the European market that must survive under liberal trade conditions;
- Asking farmers about the responsibility and who should act to improve the situation in agriculture, answers generally started as “The government/the Ministry of agriculture should... by giving incentives for...”, indicating still weak “bottom-up” approach over farmers’ expectations of the government’s ‘strong hand;
- Achieving competitiveness is possible through market-price instruments such as price regulation, foreign trade limitations and production support. Unfortunately, although economically unjustified, the idea has been prevalent among farmers and produced a longstanding misunderstanding of the concept of income support under the CAP principles,

which confirms farmers' productivist attitudes [6]. Farmers from both new and established member states mostly perceive themselves as someone who produces food and believes that the survival and market performance of their farms depends on policy support. In addition, authors discuss convergence of NMS in the EU [2] and [3]. Countries which implemented policy measures in favour of competitiveness helped the agricultural sector to make better use of the opportunities created by accession. For example, Poland, with its low pre-accession level of subsidies and the Baltic countries with their liberal land policies, increased their gross agricultural output after accession. On the contrary, Hungary, Romania and partially Czech Republic with high and uneven price and market support experienced very little price increase. Overall, Poland and the Baltic countries could be treated as the winners of EU accession in agriculture, while Romania and Bulgaria proved to have used their potentials to the least. Focusing on high value added agri-food products (animal and processed production) proved to be a good strategy of reaching development. Countries focusing on the production of cereals and agri-food raw materials turned out to benefit the least.

- National budgetary support are the first source that farmers rely on, and not the European funds, justifying it by following reasons: "It is difficult to fill in the paper, too much to administer", "It is impossible to meet the tender requests". Of course, some of these comments are understandable due to the unresolved land ownership issues, severe financial prerequisites or lack of institutional support as explained in Hungarian case [1]. Land reform resulted in a highly fragmented ownership structure which hampered agricultural and rural development. Hungary was also faced with a late establishment of an institutional framework for agricultural and rural development, which contributed to delays in receiving EU support.

Furthermore, it is evident that the ways in which the countries used pre-accession programmes such as SAPARD, ISPA and PHARE was very important. Those who focused on competitiveness, production improvement and creating the required institutions were better in obtaining benefits after accession [2].

- There is a great lack of argumentation for success or failure in farm business and agriculture.

For the representatives of the Ministry of Agriculture, the results and policy effects are measured mainly by "spending public money", with no interest in further socio-economic effects for the sector or rural areas. The effect of economic institutions and social capital on the agricultural success of CEE countries has been studied in literature [11]. It appears that countries with more economic freedom and trust in institutions achieve better results in attracting foreign investments (Czech Republic) and improving agricultural performance in the EU.

There are some other considerations that can explain slight and slow adjustments to the CAP principles – resistance to new organizational forms by farmers and some academics (dissatisfaction with the need to organize producer organizations while cooperatives already exist) or almost irrational resistance to any changes as a part of folklore (over-emphasizing pride about traditional values). Adjustment to the common market is one of the most pressing demands of the post-accession situation [2]. On that track only Slovenia and Poland, prevailing small-scale farms notwithstanding, adjusted more effectively to the enlarged market, unlike the countries with complicated land reform and farm restructuring processes (e.g. Hungary).

Table 1 presents in more detail the prevailing opinions of examined stakeholders through focus groups during the period of pre-accession (nine years) and in the first six years of EU membership.

Table 1. The most frequent stakeholders' perception of agricultural policy

	Understanding of policy	Effects and expectations	Dialogue
PHASE 1-pre-accession			
Academia (researchers)	-the CAP is spreading measures from agricultural production to sustainable rural development and environment -bottom-up approach for local development -infrastructural adjustment of national farms -increasing income by diversification of farms -support to achieve self-sufficiency is not welcomed in the CAP -easily accessible national support blocks the use of pre-accession funds	-pre-accession national policy is not preparing producers for common market shock and decoupled payments -missing statistical data will cause lack of reliable impact assessment analysis -missing an opportunity to use and learn from pre-accession funds -chance for improvement is in grouping of farms and support from Pillar 2	-abortion of official dialogue between academia and the MA -research studies become more scientific and less acceptable by producers -official data used in negotiation process are hidden from researchers -field studies are organized to gain producers' perception of EU entrance
Ministry of Agriculture (MA)	-three years after negotiation started national agricultural and rural support increased to obtain higher value of production -administrative adjustment means change in legislation -rules of implementing pre-accession funds have to be very strict	-higher agricultural support, higher income -increasing trend of agricultural prices and demand could increase producers' quotas -small-size agricultural land per farm could cause problem in common market	-researchers do not understand the process of negotiation and the system of support -researchers are slow and expensive in their analysis -producers shouldn't be afraid of accession into the EU due to the probability of higher support
Producers	-policy should protect national production by input support, high customs, support of quantities and self-sufficiency	-delays in transaction of national support - unstable domestic market and uncontrollable import are current policy effects -common market will cause deterioration of many small farms -larger farms could expect fairer business relationships, clearer legislation, better positions in food chain, comparative advantage in high value of natural resources, specific local products and tourism potential -based on the previous experiences of NMS which entered in 2004, the revitalization of rural area is expected	-lack of trust in national political system of clear support goals and control -lack of trust in pre-accession funds because of complexity and unfamiliar system -smaller farms-unfamiliar with negotiation process -only few bigger agricultural holdings were learning business according to EU rules mostly through pre-accession programs
PHASE 2-post-accession			
Academia (researchers)	-support for Pillar 2 is used mainly for investment in big agricultural holdings which does not lead to socio-economic improvements in vulnerable rural areas, but helps overall employment -the CAP and OMS are turning to agri-environmental goals -low level of coherence of policies in rural areas (financial, regional, agricultural) -the most appropriate policy factor is Farm Advisory Service which should be enhanced by human and knowledge capacity	-crisis is expected in the following sectors: milk, pig, wheat, sunflower, oilseed and corn -raising support for organic producers, producers of autochthonous breeds -producer organizations could result in an increase in production -raising support for High Nature Value pastures leads to an increase in surface covered but also to the decrease of production -closing down of small farmers statistically leads to higher farmers' income	- the MA is balancing between lobby groups and CAP demands to create policy, minimal participation of experts -increasing communication with producers through public media, decreasing communication through direct contact -low level of cooperation between governmental institutions to harmonize goals for rural development -lack of data for goals which the CAP wants to achieve (local development, farmers' income, agri-environment)
Ministry administration	-rules within the frame of spending EU funds are negotiable with the EC -legislation on family farms helps to define and improve family business -national self-sufficiency is important	-our success is measured on how much EU funds we distribute	-low interest for education and information among producers -difficulties in implementation of bottom up approach -local policy often ignores new opportunities
Producers	-satisfaction with on-time payments, young farmers scheme, small farmers scheme -small farmers are affected by lack of input support -commodity chain system is not improved in favour of producers -national land policy, consolidation, heritage are far away from improvement -Pillar 2 is seen mainly as support to technology and mechanization	-raising support and incomes for organic producers, biomass producers -no clear vision of national priorities -coupled support should be increased -direct support per farm should be limited -new markets both in and outside the EU	-complete lack of communication with the MA

Source: Authors' elaboration based on the results of focus groups.

CONCLUSIONS

For the Eastern countries with specific historical background and centrally planned economy, joining the EU often causes great difficulties in adjustment to the open market rules and non-productivist orientation of the CAP. The example of Croatia, based on the focus groups research as well as pre-accession and post-accession literature dealing with NMS, shows an evolution in the understanding of CAP principles and effects, expectations and the process of policy learning and dialogue among stakeholders.

The main obstacle in harmonization is the gap between national and CAP goals: Croatia is trying to increase production and CAP is trying to respond to damage caused by intensive agricultural production. Further, Pillar 2 is mostly recognized by large agricultural companies as an opportunity to improve their infrastructure and increase competitiveness and it did not serve the purpose of rural development. Overall, national priorities in agricultural sector are barely clear, local administration rarely cooperates and accepts new opportunities through EU funds which complicates the process of decentralization. Still, the research of focus groups and studies shows that dissatisfaction with agricultural policy measures does not arise due to CAP rules but due to the national administrative institutions led by the Ministry of Agriculture, which are unwilling to establish regular dialogue with all relevant stakeholders (producer representatives, academics, NGOs, etc.)

REFERENCES

[1]Bauko, T., Gurzo, I., 2001, Dilemmas in Agricultural and Rural Development in Hungary: The EU Accession Partnership and the Sapard Programme, European and Urban Regional Studies, 8: 361-369.

[2]Csáki, C., Jámbor A., 2013, The impact of EU accession: lessons from the agriculture of the new member states. Post-Communist Economies, 25: 325-342.

[3]Csáki, C., Jámbor, A., 2019, Convergence or divergence – Transition in agriculture of Central and Eastern Europe and Commonwealth of Independent States revisited, Agricultural Economics – Czech, 65: 160–174.

[4]Franić, R., Mikuš, O., 2013, Transformations in Croatian Agriculture and Agricultural Policy: Challenges and Opportunities within the European Context. In: Ortiz-Miranda, D., Moragues-Faus Ana and E. Arnalte-Alegre, (eds): Agriculture in Mediterranean Europe: Between Old and New Paradigms, Emerald Group Publishing Limited, 233-261.

[5]Gorton, M.C., Hubbard, C., Hubbard, L., 2009, The Folly of European Union Policy Transfer: Why the Common Agricultural Policy (CAP) Does Not Fit Central and Eastern Europe. Regional Studies: 43: 1305-1317.

[6]Gorton, M., Douarinb, E., Davidova, S., Latruffe, L., 2008, Attitudes to agricultural policy and farming futures in the context of the 2003 CAP reform: A comparison of farmers in selected established and new Member States. Journal of Rural Studies, 24: 322-336.

[7]Grabbe, H., 2001, How does Europeanization affect CEE governance? Conditionality, Diffusion and Diversity. Journal of European Public Policy (8): 1013-1031.

[8]Lovec, M., Erjavec, E., 2012, The Common Agricultural Policy Health Check: time to check the health of the theory of the reform? Journal of International Relations and Development 16, 111–137.

[9]Petak, Z., 2019, Policy-Making Context and Challenges of Governance in Croatia. In: Petak, Z., Kotarski, K., (eds): Policy-Making at the European Periphery: The Case of Croatia. Palgrave Macmillan, Cham, 29-45.

[10]Roederer-Rynning, C., 2015, The Common Agricultural Policy: The Fortress Challenged. In Wallace, H., M. A. Pollack and A. R. Young (eds): Policy-Making in the European Union, Oxford University Press, 197-219.

[11]Slangen, L.H.G., Van Kooten, G.C., Suchánek, P., 2004, Institutions, social capital and agricultural change in central and eastern Europe, Journal of Rural Studies, 20: 245–256.

[12]Swinnen, J., 2010, The Political Economy of the Most Radical Reform of the Common Agricultural Policy. German Journal of Agricultural Economics: 59: 37-48.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

INTROSPECTION IN DYNAMICS OF AGRITOURISM IN ROMANIA DURING 2016-2018

Adriana MOREA, Roxana VIDICAN, Ioana CRIȘAN, Mirela CIREBEA

University of Agricultural Sciences and Veterinary Medicine from Cluj-Napoca, Faculty of Agriculture, 3-5 Manastur Str., 400372 Cluj-Napoca, Romania;
E-mails: adriana.morea@usamvcluj.ro, roxana.vidican@usamvcluj.ro, ioana.crisan@usamvcluj.ro

Corresponding author: adriana.morea@usamvcluj.ro

Abstract

In last few years agritourism sector in Romania showed a constant expansion and number of arrivals in agritourist accommodation units exceeded for the first time 1 million in 2018. Romanians still represent majority of customers accounting for more than 90% of tourists while foreigners accounted for only around 8%. Majority of foreign tourist were from EU countries by nationality were Hungarians, Germans, French, Polish and Italians. Data indicate that largest number of foreigners visited farms from macroregion I of development which corresponds to Transylvania and Crișana historical areas. Within this macroregion, Romanians preferred agritourist accommodations from county Brașov while foreign tourists showed preference for the ones from Harghita and Sibiu. Five counties display consistent positive trend between studied interval both for native and foreign tourists: Bihor, Cluj, Alba, Harghita and Covasna. Diversification of recreational and leisure possibilities provided on farms as well as outsourcing digital advertising could enhance the success of this enterprise.

***Key words*:** *holiday, traditional, foreigners, culture, advertising*

INTRODUCTION

In European Union, both tourism infrastructures in rural areas as well as other gainful activities of farmers are indicators of rural development [2]. This is because activity diversification improves long-term economic viability of rural communities which EU aims to sustain [8, 9]. Agritourism operates as commercial touristic enterprise on farms by offering accommodation, meals and a range of leisure activities [4]. At functional level, agritourism is a link between urban and rural environment [10] through which biodiversity and conservation incentives can meet the economic and social ones [1, 7, 8]. The entire experience on farm provided to tourists is designed as a complex one. Besides contact with nature, this type of tourism can be combined with cultural tourism which creates a meaningful context and gives authenticity to the whole experience [8]. Motivation of urban dwellers to engage in agritourism is multi-layered. People feel drawn to agritourism from desire to get in contact with nature and agriculture, perceived as a natural and healthy activity. In agritouristic activity guests can take part at usual activities in farm and community, traditional crafts, observe local customs, as well as enjoy local and regional authentic cuisine and food products [7, 10]. Due to cultural aspect, agritourism poses huge potential to expand towards attracting more and more people who don't have links with rural space. To achieve success entrepreneurs have first to know the dynamics of tourists and assess the market trends. Aim of this study was to gain insight into agritourism consumer dynamics in Romania, which could prove useful in optimising services offer. Emphasis is placed on macroregion I of development which corresponds to Transylvania and Crișana historical region, due to high potential agritourism has in these areas.

MATERIALS AND METHODS

Statistical data was retrieved from Romanian National Institute of Statistics [5], reports entitled: Frequency of tourist reception structures with accommodation functions for

2016, 2017 and 2018. Data used for this study were: number of arrivals for foreigners and Romanians checking-in agritouristic units from each macroregion of Romania, as well as for twelve counties from macroregion I; total number of tourists in agritourism accommodation structures at national level by country of origin for same time interval.

RESULTS AND DISCUSSIONS

By nationality, during 2016-2018 over 90% of tourists were Romanians, with a small fluctuation from one year to another. Foreigners accounted for 7.72% of tourists in 2016, of 8.38% in 2017 and of 7.35% in 2018 [5]. By examining the ratio Romanians to foreigners' arrivals for each of the four macroregions of development from Romania can be observed some interesting trends (Fig. 1).

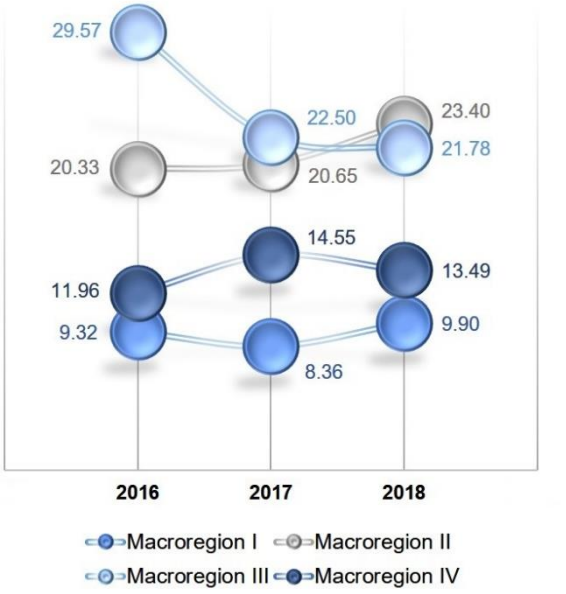

Fig. 1. Ratio Romanian/foreigner tourists arrivals in agrotouristic accommodation structures during 2016-2018.
Source: [5].

By nationality group, top ten most frequent tourists in Romania during 2016-2018 named in descending order were: Romanians, Hungarians, Germans, French, Polish, Italians, Israeli, British, Spanish and Americans (Fig. 2).

Important proportion of foreign tourists visited tourist establishments from macroregion I corresponding to Transylvania and Crișana historical regions with average arrivals ratio of roughly one foreign tourist for every 9 Romanian tourists. This one is followed by macroregion IV which corresponds to Banat and Oltenia historical regions for which was registered an average ratio of one foreign tourist to every 13 Romanian tourists.

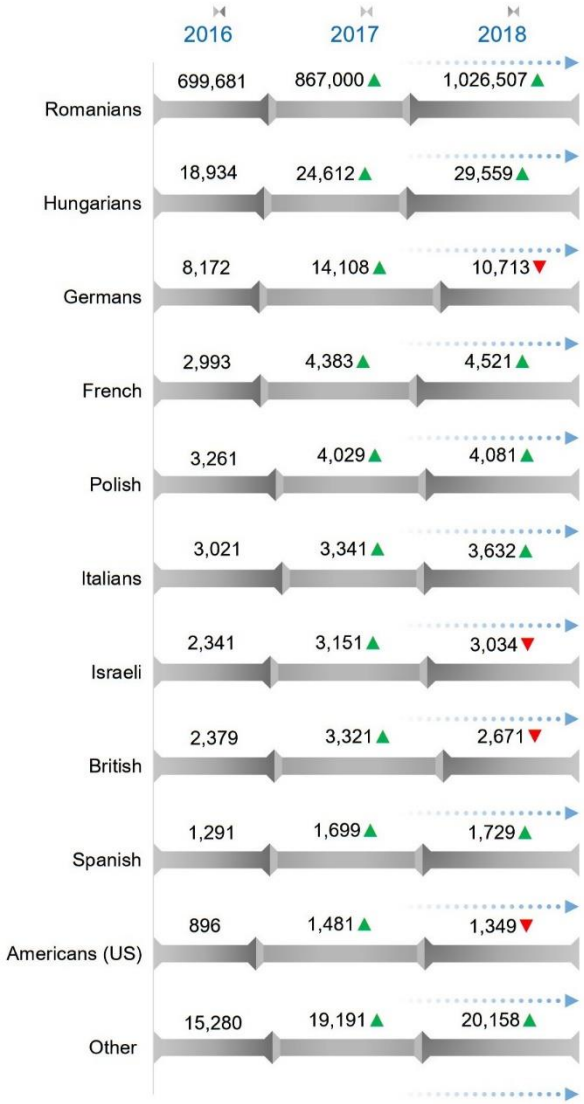

Fig. 2. Nationality profile of tourists in agrotouristic accommodation structures from Romania between 2016-2018.
Source: [5].

For the other two macroregions, average arrivals ratio for interval 2016-2018 was higher, of one foreign tourist to >20 Romanian tourists (Fig. 1). This suggests

foreigner's preference for agritouristic establishments from macroregions I and II.

In 2016-2017 interval, all of top ten nationality groups of tourists presented a positive trend, while between 2017-2018 four of them show a decreasing trend. Thus, in 2018 were less German, Israeli, British and American tourists in Romania compared to 2017. On the other hand, in 2018 the number of Romanian tourists exceeded 1 million at national level (Fig. 2). This could be due to introduction of holiday vouchers for public employees starting with 2018. Holiday vouchers are a new government measure introduced in 2018 to stimulate local tourism and because of this can be used only in Romania.

Average stay was 1.9 nights for Romanians and 2.0 – 2.2 for foreigners [5].

In macroregion I of development, the Romanian tourists versus foreign ones show different preference for county of choice (Fig. 2, 3).

	Bihor (RO111)	Bistrița-Năsăud (RO112)	Cluj (RO113)	Maramureș (RO114)	Satu-Mare (RO115)	Sălaj (RO116)	Alba (RO121)	Brașov (RO122)	Covasna (RO123)	Harghita (RO124)	Mureș (RO125)	Sibiu (RO126)
2016	42,628	3,557	38,503	26,266	5,891	4,484	30,022	119,947	7,179	21,045	29,222	45,878
2017	61,910	11,801	63,571	37,384	10,286	5,596	35,104	148,982	8,645	24,403	31,387	53,952
2018	85,580	16,681	69,461	45,680	10,949	5,550	41,031	166,879	12,329	28,123	34,078	48,829

Fig. 3. Dynamics for number of Romanian tourists in agrotouristic accommodation structures from 12 counties of Macroregion 1 of development, for the interval 2016-2018,
Source: [5].

	Bihor (RO111)	Bistrița-Năsăud (RO112)	Cluj (RO113)	Maramureș (RO114)	Satu-Mare (RO115)	Sălaj (RO116)	Alba (RO121)	Brașov (RO122)	Covasna (RO123)	Harghita (RO124)	Mureș (RO125)	Sibiu (RO126)
2016	1,435	34	3,700	2,753	254	377	4,261	5,986	2,010	9,765	3,741	5,884
2017	1,498	506	5,929	3,394	484	885	5,875	7,511	2,396	11,517	4,814	14,159
2018	2,674	441	7,095	3,227	138	846	6,437	6,609	2,951	12,264	4,556	9,845

Fig. 4. Dynamics for number of foreign tourists in agrotouristic accommodation structures from 12 counties of Macroregion 1 of development, for the interval 2016-2018,
Source: [5].

As observed in Fig. 3, between 2016-2018 the preferred county by Romanian tourists was Brașov. As for agritourism establishments from other counties, second most visited by Romanians were the ones from Sibiu in 2016, Cluj in 2017 and Bihor in 2018. Positive increase in number of arrivals followed by negative trend was observed for Sibiu county which showed 9.49% decrease of Romanian tourists check-ins in 2018 compared to 2017 and Sălaj county with 0.82% decrease in 2018 compared to 2017. All the other 10 counties showed positive trend of Romanian tourists arrivals between 2016-2018. Some noticeable increase was registered for counties Bistrița-Năsăud, Bihor, Maramureș and Covasna. The

most constant trend was found for number of arrivals in counties of Alba and Harghita (Fig. 3). Further analysis of trend between 2016-2018 across counties from macroregion I, revealed that foreign tourists preferred county of Harghita in 2016 and 2018 and Sibiu in 2017. Second most visited county by foreign tourists were Brașov and Sibiu in 2016, Harghita and Brașov in 2017 and Sibiu and Cluj in 2018. Increase of foreigner's arrivals in agritourism establishments in 2017 compared to 2016 followed by decrease in 2018 compared to 2017 was observed for none less than 7 counties. The steepest increase followed by steep decrease was registered for counties of Bistrița-Năsăud, Sibiu and Satu-Mare. Other counties which showed decrease in number of foreign tourists arrivals during 2018 compared to 2017 were Maramureș, Sălaj, Brașov and Mureș. Five counties maintain a positive growing trend between 2016-2018 for number of foreigners arriving in tourist accommodation units: Bihor, Cluj, Alba, Harghita and with most constant growth: Covasna.

Overall it was observed that regarding the number of arrivals, foreign tourists have a more fluctuating trend compared to Romanians. In addition, preference for a certain county can show slight variation from one year to another. By comparison, based on number of arrivals, the increase of Romanian tourists maintains a positive trend with few exceptions, and consist the bulk of agritourism consumers. Abundance of foreigners in certain counties can exercise influence over services portfolio offered in certain counties. Higher number of foreign tourists implies that staff must have communication skills in other languages in order to ensure optimum guest-host interaction. In order to overcome unstable market trends tourist accommodation providers could engage third parties for advertising offers abroad as well as for booking services. Some authors remarked that demand for experiencing the rural world through wine and food tours, tasting and cooking courses shows an increase [10]. Thus, autochthonous agritourism providers should be prepared to expand services range in order to secure constant flow of guests by offering such activities. In current context, success of agritourism enterprise relies heavily on the owners - consisting most often by a handful of family members who run the farm and the accommodation unit. But complex market structure and constant changes can pose considerable strain on this small-business model. Nowadays, the owner of an agritourism enterprise needs to be equipped with vision and flexibility. As mentioned in previous works, farmer has to be aware of trends and find means to adapt to new consumer preferences, to build a strategy in order to overcome pressure from competition and make sustained efforts to increase quality and diversify services, all this while managing farming activity as well [4]. In this light, the role of education provided by agronomic institutions, training centres and entrepreneurship programs, might prove pivotal in assisting future and current farmers to remain relevant on the market. Possibilities to increase training level of staff keep farmers informed and instruct them on possibilities for marketing on-farm leisure services would ensure a more sustainable rural development, well-connected to international context in which they operate. Because urban-rural linkages are foreseen to promote sustainable development within EU [3] the role agritourism could play is worth studying as well. Agritourism is an economic activity that contributes to regional development and to overall economic growth [6], but its success depends on a set of factors which remain to be more clearly defined. In Romania, geographical location as well as proximity to mass touristic attractions has influence over density of agritourism enterprises in given regions [4] suggesting the existence of suitability hot spots conditioned by consumer behavior.

CONCLUSIONS

Agritourism can serve as transition path from agrarian to service-based economy in rural space. It can also act as instrument for

achieving rural development and economic stability of small family farms which lack other options to increase their income.

In Romania, large majority of agritourism consumers are comprised by Romanians which in the case of macroregion I, display preference for county of Brașov. Most frequent foreign tourists are from Hungary and Germany and they exhibit preference for counties Harghita and Sibiu.

Agronomic education institutions could improve their curricula and provide future farmers with more ideas and options for diversification of activities including how to successfully manage an agritourism activity on their farms.

REFERENCES

[1]Arru, B., Furesi, R., Madau, A. F., Pulina, P., 2019, Recreational services provision and farm diversification: a technical efficiency analysis on Italian agritourism, Agriculture 9(42):42.

[2]European Commission - Agriculture and rural development, https://ec.europa.eu/agriculture/index_en, Accessed on Oct.10, 2019.

[3]European Commission - Urban-rural linkages, https://ec.europa.eu/regional_policy/, Accessed on Oct.10, 2019.

[4]Morea, A., Vidican, R., Crișan, I., 2019, Current national and regional trends for Romanian agritourism, 2019, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(3): 417-422.

[5]National Institute of Statistics – Romania, Frequency of tourist reception structures with accommodation functions, 2016, 2017, 2018.

[6]Nițescu, A., 2015, Development of rural tourism in the European context, Annals of "Constantin Brâncuși" University of Târgu Jiu Economy Series 1(2): 199-202.

[7]Sadowski, A., Wojcieszak, M. M., 2019, Geographic differentiation of agritourism activities in Poland vs. cultural and natural attractiveness of destinations at district level, PLoS ONE 14(9): e0222576.

[8]Sângeorzan, D.D., Morea A., Rotar, I., 2019, Grassland conservation in Romania: paths for tourism, Romanian Journal of Grassland and Forage Crops 19: 69-77.

[9]Sidali, K. L., Spitaler, A., Schamel, G., 2019, Agritourism: A hedonic approach of quality tourism indicators in South Tyrol, Sustainability 11:3747.

[10]Streifeneder, T., Gramm, V., Dellantonio, S., Omizzolo, A., Cattivelli, V., 2019, The diversity of urban-rural exchange. Is there still space for future developments? In: The regions of Europe among local identities, new communities and territorial disparities, Lattarulo, P., Omizzolo, A., Palermo, F., Provenzano, V., Streifeneder, T. (eds.), FrancoAngeli Milano, p. 242.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

PERCEPTIONS OF CONSUMER FOR PREPARATION AND CONSUMPTION OF TEA AND ANALYSIS OF BIOLOGICALLY ACTIVE COMPOUNDS OF BLACK TEA

Gjore NAKOV[1], Nastia IVANOVA[1], Marko JUKIĆ[2], Daliborka KOCEVA KOMLENIĆ[2], Davor DANILOSKI[3], Jasmina LUKINAC[2]

[1] "Angel Kanchev" University of Ruse, Razgrad Branch, Department of Chemistry, Food and Biotechnology, 47 Aprlosko vastanie Blvd., 7200 Razgrad, Bulgaria, Phone/Fax: +359882956044; Email: gnakov@uni-ruse.bg
[2] Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, Franje Kuhača 20, 31000 Osijek, Croatia, Phone/Fax: +38531224308; Email: mjukic@ptfos.hr
[3] "St. Kliment Ohridski" University of Bitola, Faculty of Technology and Practical Sciences, Dimitar Vlahov bb, 1400 Veles, Republic of North Macedonia, Phone/Fax: + 38977581240; Email: danilodavor@gmail.com

Corresponding author: mjukic@ptfos.com

Abstract

The aim of this study was to examine the opinion of tea drinkers about the type and the way the tea is prepared, as well as the knowledge of the biologically active substances contained in the black tea. Finally, the influence of the temperature and the method of preparation of black tea on its colour and content of biologically active compounds was determined. The survey found that black tea was the most consumed with 68.80% of the participants and has been also considered to be the healthiest type of tea (80.40%).Moreover, 39.50% of the respondents consumed tea once a month. Based on the results, tea has usually been prepared for a period of 5 min (74.10%) in boiling water at approximately 90^{0}C (47.50%). In addition, 56.70% of the respondents believe that the black tea contains a high amount of caffeine. As the number of macerations increased, the amount of biologically active substances decreased (total polyphenols 134.93±0.04 mg GAE/mL, tannins 19.98±0.19 %, flavonoids 232.84±0.07 mg QE/g, caffeine 37.33±0.12 mg/mL and antioxidant activity 551.94±0.41 µM Trolox/g in black tea infusions prepared in 90 ^{0}C (5 min) after first maceration and 7.53±0.01 mg GAE/mL, tannins 14.92±0.24 %, flavonoids 55.88±0.18 mg QE/g, caffeine 2.33±0.05 mg/mL and antioxidant activity 122.32±0.17 µM Trolox/g in black tea infusions prepared in 90^{0}C (5 min) after third maceration. The obtained correlation (p>0.01) showed that the total polyphenols were correlated with other biologically active substances tested (tannins, flavonoids, caffeine and antioxidant activity) and L, a* and b* colour parameters of black tea infusions.*

Key words**:** *antioxidant activity, caffeine, flavonoids, polyphenols, tannins*

INTRODUCTION

Tea (*Camellia sinensis*) is a popular plant originating in south-western China. Presently, tea is grown in different parts of the world [17]. Initially, the herb was used as a spice, and later as a drink with many useful benefits [9]. Depending on the level of fermentation (oxidation), the tea is divided into three groups: black tea (fully fermented), green tea (not fermented) and oolong tea (semi-fermented) [28]. The process of making black tea (*Camellia sinensis* (L.) O. Kuntze) involves several operations, such as harvesting, withering, rolling, fermentation and drying. During the process of fermentation, the enzymatic oxidation of the polyphenols found in the tea results in the formation of theaflavin and thearubigins, which provide the characteristic colour and taste of the black tea [23]. Infusions prepared from green and black tea (*Camellia sinensis* (L.) Kuntze) is a popular drink in many countries around the world [14].

The black tea accounts for more than 75% of the total world tea production [26]. It contains naturally occurring biologically active substances such as: polyphenols, alkaloids, pigments [27]. It can inhibit α-amylase and α-glycosidase activity due to the bioactivity of

oxidized catechins [16,20,22]. Numerous studies have shown the relation between the tea utilization and possible disease prevention due to the high content of polyphenols. Polyphenols are secondary metabolites that are classified as flavonoids, phenolic acids, lignans and stilbens. The most commonly used flavonoids are polyphenols and benzo-γ-pyrone derivatives containing a phenolic bond and pyrane bond. They are classified as: flavanols, flavones, flavonols, flavanones, isoflavones and anthocyanidins [26]. In addition, flavanols are made up of compounds such as quercetin, which are of great interest in research into prevention and treatment of important health conditions, such as cardiovascular disease and cancer. Caffeine (1,3,7-trimethylxanthine) is an alkaloid contained in different amounts in the tea. Median caffeine content is in the range of 1-4%, depending on the type of tea [19]. Caffeine, which is contained in large quantities in black tea, is a powerful stimulator of the central nervous system [24]. Tannins are shown with a high molecular weight and they are defined as polyphenolic biomolecules and are found in many plants. They react and precipitate proteins and other organic compounds such as amino acids and alkaloid [15]. Antioxidants are substances that can delay, prevent or remove oxidative damage to specific molecules. They are usually divided into enzyme antioxidants and non-enzyme oxidants in the human body [10]. There are very few studies today examining the impact of the black tea on the oxidative stress [18].

MATERIALS AND METHODS

Materials

The black tea used for the analysis was produced from a Bulgarian Tea Company and was bought from the local markets in Razgrad, Republic of Bulgaria. In regards of the examinations the following chemicals have been used: Folin-Ciocalteau, Gallic acid (3,4,5-Trihydroxybenzoic acid), DPPH (2,2-Di(4-tert-octylphenyl)-1-picrylhydrazyl), Trolox ((S)-6-Methoxy-2,5,7,8-tetramethylchromane-2-carboxylic acid) and Quercetin (Sigma-Aldrich, Germany); NaOH, $KMnO_4$, $NaCO_3$, $NaNO_2$, $AlCl_3$, $CHCl_3$, Chloroform (Chimtex Ltd.) and indigo carmine (Fluka Chemie GmbH).

Methods

Preparing of questionnaire

For the purpose of examining the method of preparation, the type of tea used and which biologically active substances the respondents knew, a questionnaire was made available online via the Google platform. A total of 215 people from the district of Razgrad, Republic of Bulgaria, participated in the process of examination. At the beginning, questions were asked in order to be determined the socio-demographic status of the respondents (gender, age and education).

Preparation of black tea infusions

The bag of black tea was placed into a 400 mL Beaker glassware and sprinkle with 300 mL of hot water. The water was boiled at the temperatures of 70°C and 90°C, and the maceration time was exactly 3 and 5 minutes at the appropriate temperatures. After the maceration time had been expired, the tea bag was taken out of the beaker cup, and the final presented the tea obtained after the first maceration at 70°C and 90°C and a maceration time of 3 and 5 minutes, respectively. The same packet of black tea was placed into another Baker at the same temperature for 3 and 5 minutes. The tea obtained was tea obtained after the second maceration. The procedure was repeated again under the same conditions and finally the tea was analyzed for the third maceration. The black tea samples obtained after the first, second and third maceration ware allowed to cool for 30 minutes and then used for analysis.

Biological active compounds in black tea infusions

Method used for the determination of caffeine ad flavonoids in black tea was presented by Zayadi, Rahim and Bakar, (2016) [29] and results were expressed as gram per litre (g/L) and mg of quercetin equivalents per gram (mg QE/g), respectively. Determination of content of tannins in black tea was measured

according to the method described by Atanassova and Christova-Bagdassarian, 2009 [3]. Total polyphenols content (TPC) was measured spectrophotometrically with *Folin-Ciocalteau*. Results was expressed as mg of gallic acid equivalents per millilitre (mg GAE/mL). Antioxidant activity was measured with DPPH radical, according to method as described by Wang and Ryu, 2013 [25], and results were expressed as micromole Trolox per gram (μMTrolox/g). All analyses were performed in quadruplicate.

Colour of black tea infusions

The colour was determined with the Konica Minolta Chroma Meter CR-400, in CIE L*a*b* system. L* is the luminance or lightness component, which ranges from black (L = 0) to white (L = 100), and parameters a* (from green to red) and b* (from blue to yellow). Each colour value was measured in triplicate.

Data Analysis

All results are presented as mean ± SD. Pearson's linear correlation analysis was performed with the software XLSTAT 2017.

RESULTS AND DISCUSSIONS

In Table 1 is presented the socio-demographics status of the correspondents with 73% females and 27 % males. As it can be obtained from the table, 31.20% of the correspondents were in the age group of 21 – 30 years and according to their education 67.44% of the correspondents were with higher education.

Table 1. Socio-demographics status of the correspondents

		Number	%
SEX	male	58	27.00
	female	157	73.00
Age	under 20	23	10.70
	21-30	67	31.20
	31-40	61	28.40
	41-50	43	20.00
	51-60	16	7.40
	over 60	5	2.30
Education	Primary	16	7.44
	Secondary	48	22.33
	Higher	145	67.44
	Ph.D	6	2.79

Source: Own calculation.

From the results demonstrated in the figure 1 it can be obtained that 68.8%, 27.40% and 1.90% of the correspondents drank a black tea, fruit tea and do not drink tea, respectively.

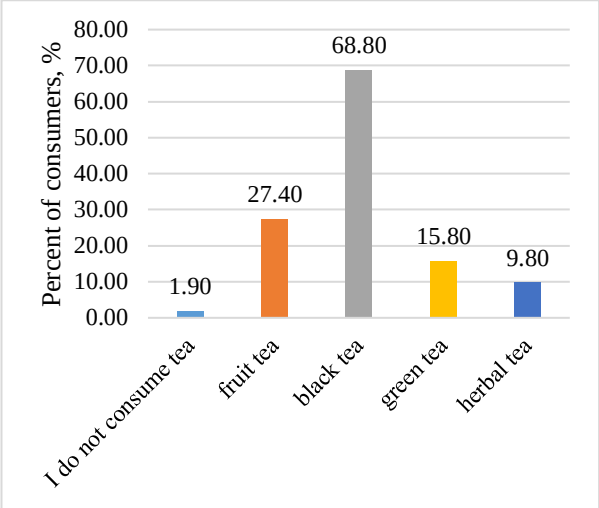

Fig. 1. Answers to the question "Which tea do you prefer for drinking?"
Source: Own results.

The given results in Fig. 2 showed that the respondents used water at a temperature of about 90°C (47.5%) during tea preparation. Additionally, 32.70% of the respondents answered that the water they used for tea was around 100°C. The smallest percentage (2.50%) of the respondents answered that the water used for tea used was around 50°C in the period of tea preparation.

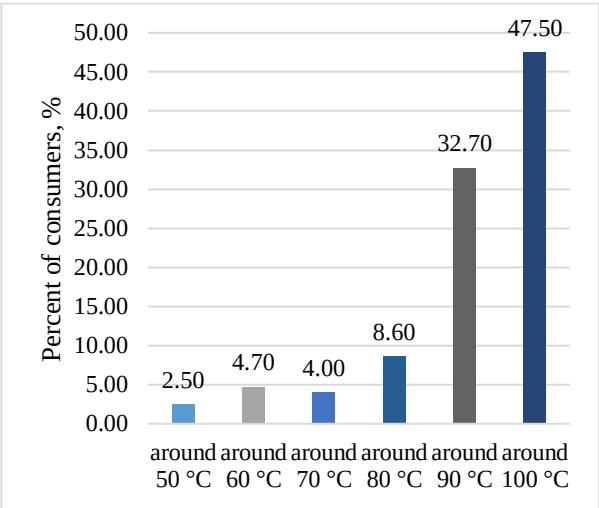

Fig. 2. Answers to the question "At which temperature do you heat the water for the tea preparation?"
Source: Own results.

When asked "When making tea bought from local stores, how many times you use the same tea bag", most of the respondents (68.90%) answered that they use only one bag (Fig. 3). The same tea bag has been used three or more times by 6.40% of the correspondents.

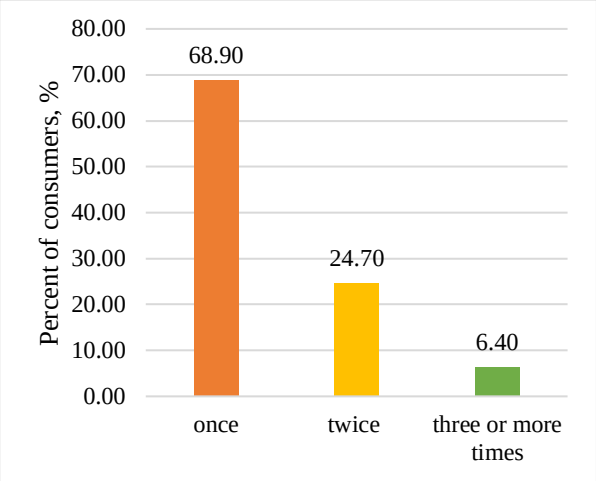

Fig. 3. Answers to the question "When preparing the tea bought from the local markets, how many times you use the same tea bag?"
Source: Own results.

The results presented in Fig. 4 showed that 74.10% of the respondents held the bag for about 5 minutes during the preparation of their tea, and 2.23% of the respondents held the bag for more than 10 minutes.

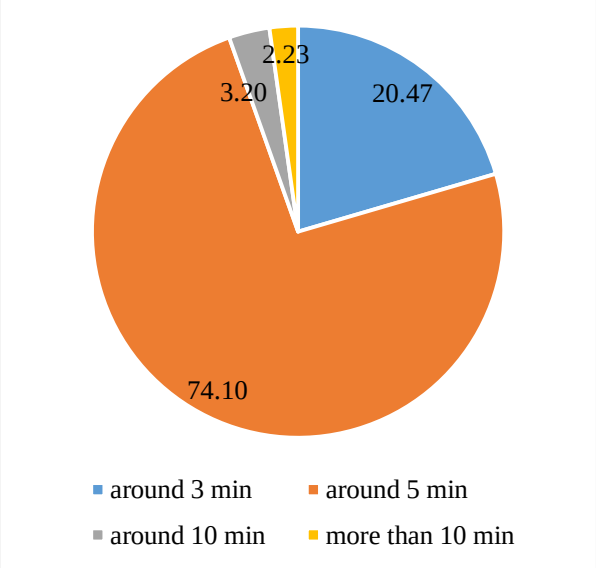

Fig. 4. Answers to the question "How long you keep your tea bag in the hot water for the tea preparation?"
Source: Own results.

It can been obtained from the results presented in Fig. 5 that 39.50% and 25.10% of the correspondents have been consuming tea once per month and once per day, respectively. Infusions prepared from green and black tea (*Camellia sinensis* (L.) Kuntze) is a popular drink in many countries around the world [14].

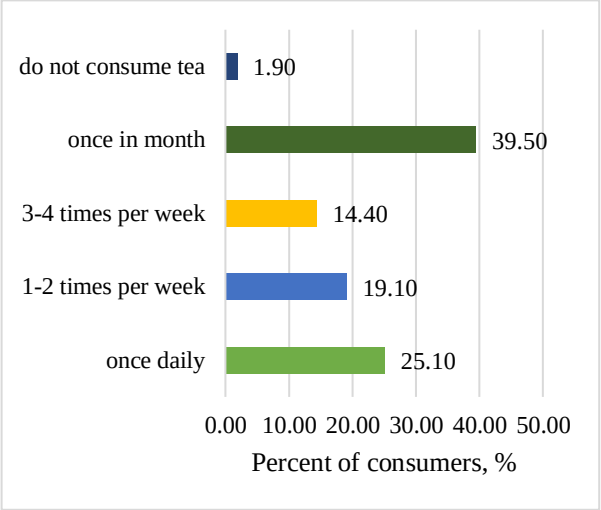

Fig. 5. Answers to the question "How often do you drink tea?"
Source: Own results.

In Fig. 6 there are illustrated the answers of the question "which tea is the healthiest for consuming". Most of the correspondents (80.40%) think that the black tea, and 12.60% believe that the healthiest tea is the green tea.

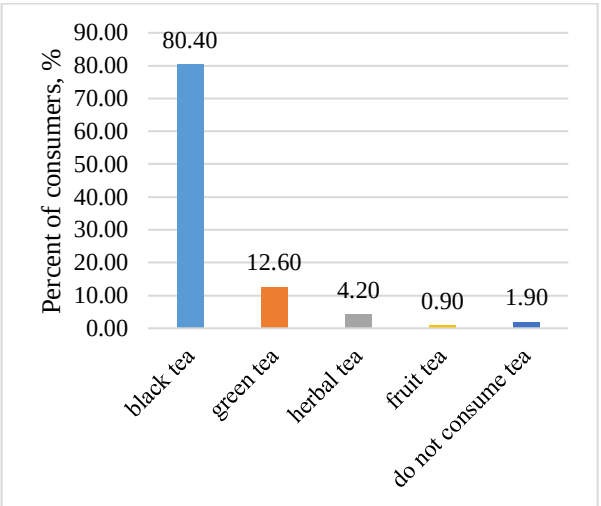

Fig. 6. Answers to the question "Which tea is the healthiest for drinking?"
Source: Own results.

The answers of the following question: Which biologically active components contain in the black tea, are shown in Fig. 7.

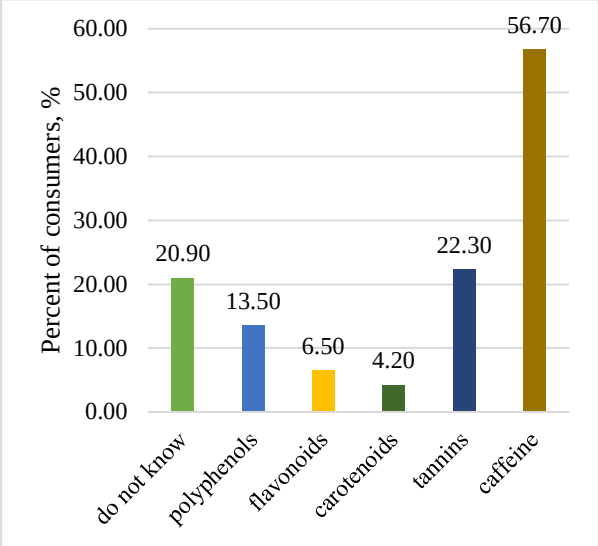

Fig. 7. Answers to the question "Which of the biologically active components you believe contain in the tea?" *One question can have more possible answers
Source: Own results.

On the other hand, the caffeine-containing products have been consumed for a long time because of their pleasant and stimulating effect [13]. High levels of caffeine can irritate the gastrointestinal tract and it is therefore advisable to keep the amount of caffeine in the tea leaves on a low level. Therefore, the determination of caffeine is a very important chemical analysis [19].

Figure 8 shows the amount of caffeine at different temperature (70°C and 90°C), different time (3 and 5 min) and different number (1 to 3) of maceration.

Figure 8 shows that as the number of macerations increased, the amount of caffeine in the black tea infusions decreased. A decrease in caffeine content was also observed when the black tea infusions were prepared at a lower temperature (70°C). After the third maceration at higher temperature (90°C) it was observed that the amount of caffeine was lower (2.33±0.05 mg/mL) compared to the third maceration for 5 minutes at lower temperature at 70°C (6.07±0.10 mg/mL).

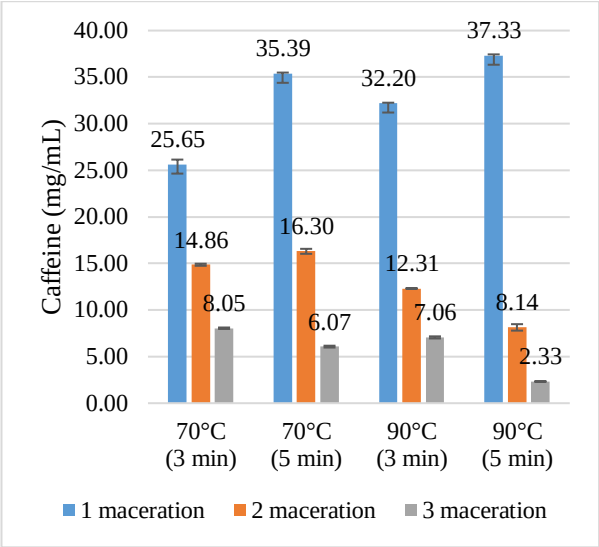

Fig. 8. Caffeine in black tea infusions
Source: Own results.

The results showed that the time of maceration is of great importance for the caffeine content of the tea. Zayadi, Rahim and Bakar, (2016) [29] also made a similar statement in their study. The amount of caffeine determined by Komes et al., (2009) [13] was 3.86%. One previous study by Athayde, Coelho and Schenkel, (2000) [4] have shown that caffeine content is related to the origin, genetics, environment, and the method of the plant preparation (teas), ranging from 24 to 40%.

The polyphenolic compounds have several benzene rings in their composition, each containing at least one hydroxyl group (-OH). These compounds act by inhibiting the activity of the radical that causes side changes [19].

Fig. 9 shows the values obtained for the black tea infusions at different temperatures (70°C and 90°C), at different maceration times (3 and 5 min) and different number of macerations (1 to 3).

The temperature had a great impact ($p>0.01$) on the amount of total polyphenols in black tea infusions (Fig.1). At a temperature of 70°C the amount of total phenols determined was 86.29±0.25 mg GAE/mL, in addition, at a temperature of 90°C it was 134.93±0.04 mg GAE/mL.

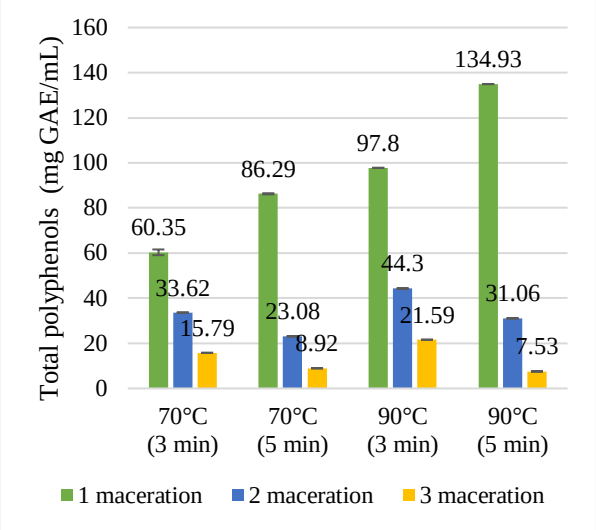

Fig. 9. Total polyphenols in black tea infusions
Source: Own results.

On the contrary, the total amount of polyphenols was also affected by the time for maceration (3 and 5 min), so the highest amount of TPC occurs when the maceration takes place within 5 min at 90°C (134.93±0.04 mg GAE/mL). It can also be seen from the fig. 9 that TPCs decrease with the increase in the number of macerations. Tea leaves are rich in polyphenols that have antioxidant properties. Tea polyphenols create the taste and aroma of beverages [21, 22]. Da Silva Pinto, (2013) [7] showed that the chemical composition of black tea greatly depended on the temperature at which the fermentation of black tea takes place. Choe et al., (2019) [6, 22] when determining total polyphenols in pure tea extracts, found that by increasing the extraction time the amount of TPC increased. Tannins are high molecular weight polyphenolic molecules and can be found in many plant species. Tannins bind and accumulate proteins and other organic compounds such as amino acids and alkaloids [13].

Fig. 10 shows the determined amount of tannins at different temperatures (70 and 90°C), different number of macerations (1 to 3) and different maceration time (3 and 5 min).

From the results presented in Figure 10, it can be observed that the amount of tannin was higher when using a higher maceration temperature (20.22±0.08% at 90°C). It can also be concluded that after the first maceration at both temperatures at 70°C and 90°C the tannin content is the highest (13.28±0.04% and 20.22±0.08%, respectively).

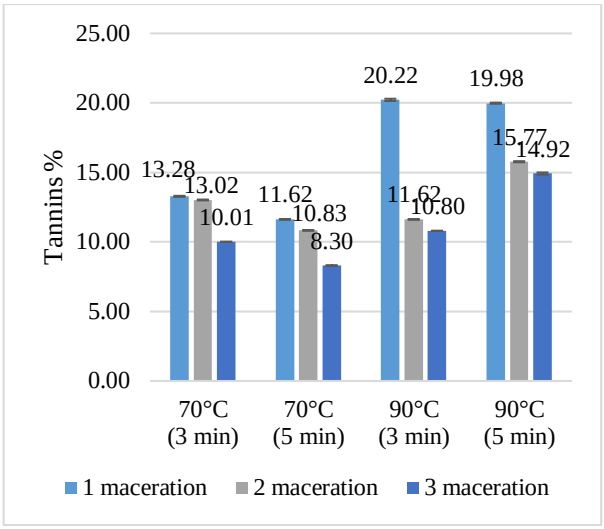

Fig. 10. Tannins in black tea infusions
Source: Own results.

As the number of macerations continues (from the first to the second and finally to the third maceration), the amount of tannin in black tea infusions decreased (form 20.22±0.08% after first maceration and 10.80±0.47% after third maceration). Khasnabis, Rai and Roy, (2015) [12] in their study of different types of tea found that black tea contained more tannins than green tea. The amount of tannins determined in their black tea ranged from 11.76% to 15.14%. Within these limits was the amount of tannins determined in our study when preparing black tea infusions at 70°C. In contrast, Atanassova and Christova-Bagdassarian, (2009) [3] established that green tea had a higher amount of tannin than black tea, 10.23% and 55.89%, respectively. The large differences in tannin content in different tea species may be due to different tea production processes (fermentation), leaf tea aging or differences in climate and soil composition of tea trees [12].

Flavonoids are considered to be the most common, most important, and most widely used singlet group of phenols present in plants. Flavonoids are proven antioxidants. They inhibit lipid oxidation and form complexes with metal ions [1].

Fig. 11 shows the amount of flavonoids determined in black tea, three different tea infusions (1, 2 and 3), different time (3 and 5 min) and different maceration temperature (70 and 90 °C).

It has been noted that the amount of flavonoids was the lowest after the third maceration at both temperatures of 70°C and 90°C (78.54±0.06 mg QE/g and 55.88±0.18 mg QE/g, respectively). The highest amount of flavonoids was determined in the black tea infusions prepared at 90°C after the first maceration (232.84±0.07 mg QE/g) (Fig. 11).

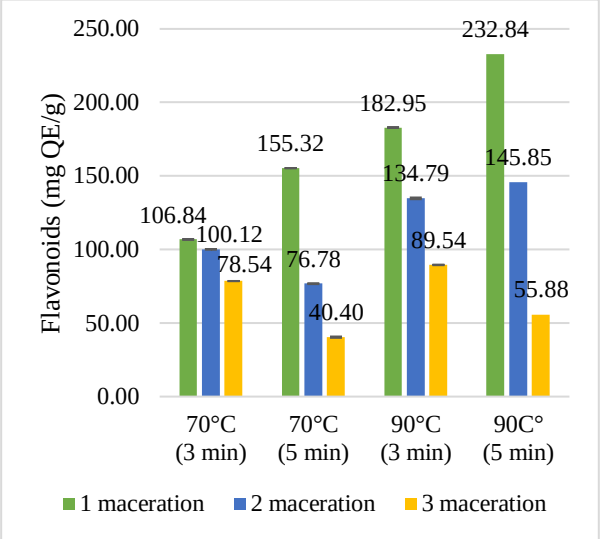

Fig. 11. Flavonoids in black tea infusions
Source: Own results.

Abdeltaif, Sirelkhatim, and Hassan, (2018) [1] in their study determined the amount of total flavonoids in black tea (49.57 mg QE/g). In addition, Mashkouri Najafi, Hamid and Afshin, (2003) [19] presented that black tea contained a higher amount of total flavonoids compared to oolong tea (8.8 mg QE/g total flavonoids in black tea). The different amounts of total flavonoids depend on the method of extraction and the temperature at which the extraction is performed [1].

Antioxidants are substances that can prevent or eliminate oxidative damage to molecules [8]. They are divided into enzymatic antioxidants and non-enzymatic. Exogenous antioxidants are usually non-enzymatic antioxidants. Tea is considered to be a drink with strong antioxidant properties due to its high content of polyphenols [18].

Fig. 12 depicts the antioxidant activity of black tea infusions at different time (3 and 5 min), number (1 to 3), and temperature (70°C and 90°C of maceration).

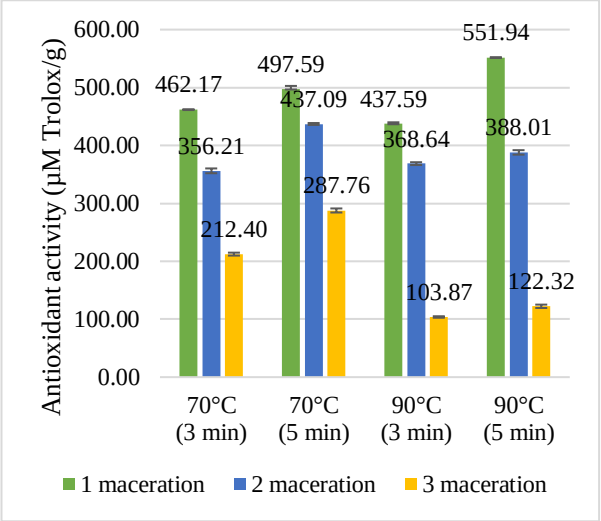

Fig. 12. Antioxidant activity in black tea infusions
Source: Own result

The highest antioxidant activity in the black tea infusions was determined at higher temperature (90°C) during extended maceration (5 min) (551.94±0.41 µM Trolox/g). From the results presented in Fig. 12 it can be seen that with the continuation of maceration the antioxidant activity decreased (form 551.94±0.41 µM Trolox/g after first maceration to 122.32±2.89 µM Trolox/g after third maceration in 90°C in 5 min). The reduction was even greater when the number of macerations was performed at higher temperatures. When comparing the antioxidant activity of green and black tea, previous studies have shown that green tea has a higher antioxidant activity. This is due to the fact that black tea is fermented while green tea is not [2]. Bhuyan et al., (2013) [5, 29] determined the antioxidant activity of black tea produced in different regions of North-East India and found that the antioxidant activity was in the range from 84.50% to 89.03% DPPH.

The colour change of black tea infusions at different temperatures (70°C and 90°C), time (3 and 5 min) and number of maceration (1 to 3) are presented in Table 2.

Table 2. The change of the colour of black tea infusions

Temperature	Time of maceration	Number of maceration	L*	a*	b*
70 °C	3 min	1	21.30±2.26	2.22±0.72	12.81±0.01
		2	24.73±0.04	1.24±0.05	16.43±2.20
		3	25.30±0.42	0.03±0.04	21.33±0.04
	5 min	1	19.81±0.01	2.24±0.06	12.81±0.01
		2	26.53±0.04	1.24±0.05	22.75±0.06
		3	28.25±0.35	-1.13±0.04	27.24±0.06
90 °C	3 min	1	20.91±0.01	2.53±0.04	16.06±0.11
		2	30.21±0.01	0.94±0.06	18.44±0.13
		3	32.08±0.11	-0.73±0.04	21.22±0.33
	5 min	1	18.91±0.01	3.32±0.02	15.63±0.04
		2	30.84±0.05	-1.24±0.05	17.13±0.04
		3	31.73±0.04	-3.92±0.04	28.63±0.04

Source: Own Calculation.

Lightness (L*) was in the range of 19.81±0.01 to 32.08±0.11. From Table 2 it can be observed that as the number of macerations L* increased, the colour of the tea became brighter. Jin et al., (2016) [11] in the study presented that the values for the L* parameter of herbal teas ranged from 46.38 to 99.98. The same authors in green tea for parameter L * set values in the range from 90.36 to 97.21. On the contrary, the b* parameter values in black tea infusions decreased with increasing number of macerations, i.e. the colour of the brewed black tea after the first maceration in all trials was yellow, and with the continuation of the macerations it reduced its intensity and in many of the samples it turns to blue (negative values for b*). The values for parameter a* range from 12.81±0.01 to 28.63±0.04. It has been found that the values for this parameter are higher when the maceration was performed at a higher temperature (90°C). Increasing the values for parameter a* by increasing the number of macerations means that the red colour of the black tea infusions became more intense. In Fig. 13 presents a visual comparison of the color of the black tea infusions at temperature 70°C for 3 and 5 minutes of maceration (a) and at temperature 90°C for 3 and 5 minutes of maceration (b).

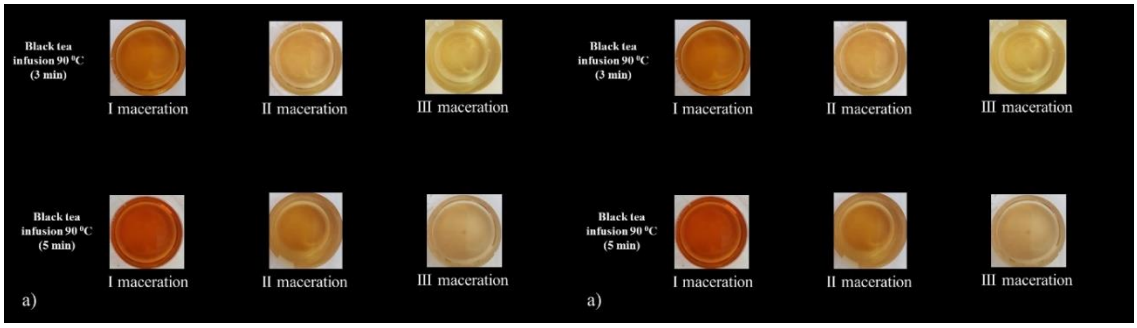

Fig. 13. Visual comparison of the color of the black tea infusions at temperature 70 °C for 3 and 5 minutes of maceration (a) and at temperature 90 °C for 3 and 5 minutes of maceration (b)
Source: Own results in the laboratory.

The correlation between the biologically active substances and the colour are illustrated in Table 3. The table shows that total polyphenols are correlated with all the investigated characteristics (positive correlation with Tannin, Flavonoids, Caffeine and Antioxidant activity and negative correlation with L*and b* parameter). Tannin is in a positive correlation with Caffeine. Flavonoids are in positive correlation with Antioxidant activity and the parameter a* and negative correlation with b* parameter. Caffeine is in positive correlation with antioxidant activity and a* parameter and negative correlation with L*and b* parameter. Antioxidant activity correlated positively with parameter a* and negative correlated with parameter L* and b*. L* value is in a positive correlation with b* value, and negative correlation with a* parameter. a* value correlated negative with b* value.

Table 3. Correlation between the investigated chemical characteristics and the color of black tea infusions

Variables	Total polyphenols	Tannin	Flavonoids	Caffeine	Antioxidant activity	L*	a*
Tannin	0.721*						
Flavonoids	0.928*	0.777*					
Caffeine	0.941*	0.556*	0.799*				
Antioxidant activity	0.766*	0.431	0.705*	0.836*			
L	-0.799*	-0.421	-0.586*	-0.907*	-0.691*		
a	0.653*	0.297	0.562*	0.744*	0.754*	-0.731*	
b	-0.744*	-0.380	-0.809*	-0.739*	-0.692*	0.535*	-0.549*

** $p<0.01$*

Source: Own calculation.

CONCLUSIONS

The survey found that black tea was the most consumed with 68.80% of the participants and has been also considered to be the healthiest type of tea (80.40%). Moreover, 39.50% of the respondents consumed tea once a month. Based on the results, tea has usually been prepared for a period of 5 min (74.10%) in boiling water at approximately 90°C (47.50%). In addition, 56.70% of the respondents believe that the black tea contains a high amount of caffeine. The results from this study have shown that the amount of polyphenols, flavonoids, tannins, caffeine, and antioxidant capacity of black tea infusions depended on the temperature of the maceration, the time and the number of macerations. At higher temperatures (90°C) the amount of biologically active substances was higher compared to the lower temperature (70°C). The number of macerations indicates that after the first maceration the amount of biologically active substances tested decreased significantly. The colour of black tea infusions also depends on the temperature of the maceration, the time and the number of macerations.

REFERENCES

[1]Abdeltaif, S. A., Sirelkhatim, K. A., Hassan, A. B., 2018, Estimation of phenolic and flavonoid compounds and antioxidant activity of spent coffee and black tea (Processing) waste for potential recovery and reuse in Sudan, Recycling, 2018, 3 (2).

[2]Anissi, J., El Hassouni M., Ouardaoui, A., Ouardaoui, K., 2014, A comparative study of the antioxidant scavenging activity of green tea, black tea and coffee extracts: A kinetic approach, Food Chemistry, 2014, 150: 438–447.

[3]Atanassova, M., Christova-Bagdassarian, V., 2009, Determination of tannins content by titrimetric method for comparison of different plant species, Journal of the University of Chemical Technology and Metallurgy, 2009, 44 (4): 413–416.

[4]Athayde, M. L., Coelho, G. C., Schenkel, E. P., 2000, Caffeine and theobromine in epicuticular wax of Ilex paraguariensis A. St.-Hil., Phytochemistry, 2000, 55 (7): 853–857.

[5]Bhuyan, L. P., Sabhapondit, S., Baruah, B. D., Bordoloi, C., Gogoi, R., Bhattacharyya, P., 2013, Polyphenolic compounds and antioxidant activity of CTC black tea of North-East India, Food Chemistry, 2013, 141: 3744–3751.

[6]Choe M. S., Jung C. H., Park, J. H., Yoon, W. K., Yoo, M., 2019, Polyphenol, Flavonoid and Tannin Variation in Puer Tea Extracts, Quantitative Bio-Science, 2019, 38 (1): 41–47.

[7]Da Silva Pinto, M., 2013, Tea: A new perspective on health benefits, Food Research International, 2013, 53 (2): 558–567.

[8]Franco, R., Navarro, G., Martínez-Pinilla, E., 2019, Antioxidant defense mechanisms in erythrocytes and in the central nervous system, Antioxidants, 2019, 8 (2): 1–10.

[9]Greathead, D. J., 1997, Tea, World Crop Pests, 387–392.

[10]Halliwell., S., 2007, Biochemistry of Oxidative Stress, Biochemical Society Transactions, 2007, 35 (5): 1147-50.

[11]Jin, L., Li, X.B., Tian D.Q., Fang X.P., Yu Y.M., Zhu, H.Q., Ge, Y.Y., Ma, G-Y., Wang, W.Y., Xiao, W.F., Li, M., 2016, Antioxidant properties and color parameters of herbal teas in China, Industrial Crops and Products, 2016, 87: 198–209.

[12]Khasnabis, J., Rai, C. Roy, A., 2015, Determination of tannin content by titrimetric method from different types of tea, Journal of Chemical and Pharmaceutical Research, 2015, 7 (6): 238–241.

[13]Komes, D., Horžlć, D., Belščak, A., Ganlč K. K., Baljak A., 2009, Determination of caffeine content in tea and maté tea by using different methods, Czech Journal of Food Sciences, 2009, 27: 213–216.

[14]Konieczynski, P., Viapiana, A. and Wesolowski, M., 2017, Comparison of Infusions from Black and Green Teas (Camellia sinensis L. Kuntze) and Erva-mate (Ilex paraguariensis A. St.-Hil.) Based on the Content of Essential Elements, Secondary Metabolites, and Antioxidant Activity, Food Analytical Methods, 2017, 10 (9): 3063–3070

[15]Laddha, A. P., Kulkarni, Y. A., 2019, Tannins and vascular complications of Diabetes: An update', Phytomedicine, 2019, 56: 229–245.

[16]Lee, W. K., Wong, L. L., Loo, Y, Y., Kasapis S., Huang D., 2010, Evaluation of different teas against starch digestibility by mammalian glycosidases, Journal of Agricultural and Food Chemistry, 2010, 58 (1): 148–154.

[17]Li, H., Yu, Y., Li, Z., Arkorful, E., Yang, Y., Liu, X., Li, X., Li R., 2018, Benzothiadiazole and B-aminobutyricacid induce resistance to ectropis obliqua in tea plants (Camellia Sinensis (L.) O. Kuntz), Molecules, 2018, 23(6): 1290.

[18]Liu, S., Huang, H., 2015, Assessments of antioxidant effect of black tea extract and its rationals by erythrocyte haemolysis assay, plasma oxidation assay and cellular antioxidant activity (CAA) assay, Journal of Functional Foods, 2015, 18: 1095–1105.

[19]Mashkouri Najafi, N., Hamid, A. S., Afshin, R. K., 2003, Determination of caffeine in black tea leaves by Fourier transform infrared spectrometry using multiple linear regression, Microchemical Journal, 2003, 75 (3): 151–158.

[20]Miao, M., Jiang, H., Jiang, B., Li, Y., Cui S.W., Jin, Z., 2013, Elucidation of structural difference in theaflavins for modulation of starch digestion, Journal of Functional Foods, 2013, 5 (4): 2024–2029.

[21]Ponmurugan, P., Kavitha, S., Suganya, M., Gnanamangai, B. M., 2019, Tea Polyphenols Chemistry for Pharmaceutical Applications in: Tea - Chemistry and Pharmacology (Editor: Justino, J.), IntechOpen, 1-15.

[22]Qu, F., Zeng, W., Tong, X., Feng, W., Chen, Y., Ni, D., 2020, The new insight into the influence of fermentation temperature on quality and bioactivities of black tea, LWT - Food Science and Technology, 2020, 117: 108646.

[23]Robertson, A., 1992, The chemistry and biochemistry of black tea production — the non-volatiles in: Tea (Editors: Willson K. C., Clifford, M. N.) Chapman & Hall, London, 555-601.

[24]Souza, M. C., Santos, M. P., Sumere, B.R., Silya, L. C., Cunha, D. T., Martínez, J., Barbero, G. F., Rostagno, M. A., 2020, Isolation of gallic acid, caffeine and flavonols from black tea by on-line coupling of pressurized liquid extraction with an adsorbent for the production of functional bakery products, LWT - Food Science and Technology, 2020, 117: 108661.

[25]Wang, Y. Y., Ryu, G. H., 2013, Physicochemical and antioxidant properties of extruded corn grits with corn fiber by CO_2 injection extrusion process, Journal of Cereal Science, 2013, 58 (1): 110–116.

[26]Wang, Y., Ho, C. T., 2010, Functional contribution of polyphenols in black tea in: Flavors in Noncarbonated Beverages (Editors: Da Costa, N., Cannon, R.) ACS Symposium Series, 45–59.

[27]Wu, T., Guo, Y., Liu, R., Wang, K., Zhang, M., 2016, Black tea polyphenols and polysaccharides improve body composition, increase fecal fatty acid, and regulate fat metabolism in high-fat diet-induced obese rats, Food and Function, 2016, 7 (5): 2469–2478.

[28]Yılmaz, C., Özdemir, F., Gökmen, V., 2020, Investigation of free amino acids, bioactive and neuroactive compounds in different types of tea and effect of black tea processing, LWT - Food Science and Technology, 2020, 117: 108655.

[29]Zayadi, R. A., Rahim, N. A. Bakar, F. A., 2016, Determination of Flavonoid and Caffeine Content in Black and Oolong Teas, Journal of Science and Technology, 2016, 8 (2): 18–24.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

RESEARCH REGARDING THE QUALITY AND PRESERVATION CAPACITY OF SOME PEAR CULTIVARS STORED IN DIFFERENT ENVIRONMENTS

Constantin NICOLAE, Adrian CHIRA, Lenuța CHIRA, Ligia ION

University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax: +40213182888, Mobile:+40733967955, Emails: nicolae.constantin1963@yahoo.ro lenutachira@yahoo.com, achira63@yahoo.com

Corresponding author: nicolae.constantin1963@yahoo.ro

Abstract

Modern quality standards require a series of steps meant to contribute to having a diet consisting of high-quality fresh fruit, regardless of season. Their preservation is an essential technological stage in the maintaining of qualitative and quantitative food attributes. Keeping this in mind, we conducted comparative research on different local and international pear cultivars with the aim to rank fruit in terms of quality, and testing two preservation methods in different environments. The distribution of experimental options are as follows: V_1*- Fruit storage in environmental conditions, at 29*^{0}*C and 75% relative humidity, under modified atmosphere, by using a plastic semipermeable pellicle;* V_2*-Fruit storage in refrigerated condition, at 4*^{0}*C and 90% relative humidity, under modified atmosphere, by using an plastic semipermeable pellicle. Observations and physical and chemical determinations regarding the evolution of the quantitative and qualitative changes during the preservation process were made every 30 and 60 days respectively. Following a fruit tasting process, the 'Red Williams', 'Abate Fetel' and 'Nashi' cultivars were deemed "extra" class, whereas 'Williams' and 'Carmen' were deemed class I. Preserving period of fruit varied depending on the cultivar and the experimental method used. The* V_1 *storage option showed greater weight loss and decreased biochemical components decreased more, with different values depending on the cultivar and the duration of storage. For* V_2*, the lowest amount of vitamin C loss was recorded for the 'Red Williams' cultivar. 'Carmen' proved to be the most resistant cultivar because it showed the lowest average weight loss and pulp consistency.*

Key words**:** *cultivar, quality, semipermeable pellicle, firmness, perishability*

INTRODUCTION

The dietary value of pears is represented by their chemical components and nutritional elements that are easily accessible for assimilation. Fruits are indispensable in rational human nutrition, and have multiple uses (fresh consumption, dehydrated fruits, compotes, marmalades, cider, distillates). Pear cider, known as perry, is appreciated and used in western European countries [3].

Because of their superior taste when compared to other fruits, pears are an excellent source of carbohydrates providing an optimal amount of sugars and fibres [2].

Pears are mainly consumed fresh and they reach their highest taste qualities at the optimum time of harvest [4]. The cultivar range is represented by varieties with different periods of ripening, ensuring fresh fruits for 10 months a year.

By keeping them in cooling rooms, the qualities of pears can be maintained until the next harvest [1]. Compositionally, the fruit consists mainly of pulp (97%), skin (2.5%), seeds (0.5%), and the yield in juice can reach 95% of the fruit weight.

Their sugar content is between 6.5 and 15. 2%, and they contain other substances such as: pectin substances (0.14-0.71%), tannin substances (0.06-0.27%), mineral substances (0.14 - 0.54%), and vitamin C (0.6-4.7 mg %). Total acidity is between 0.12 and 0.59%.

The perfecting of preservation techniques that are meant to maintain fruit in a state as close to the harvesting state as possible remains a highly important technological priority [10].

MATERIALS AND METHODS

The research was carried out using 5 international cultivars, namely 'Red Williams', 'Abate Fetel', 'Nashi', Williams' and 'Carmen' (Fig. 1). They were sampled from the fruit batches of a private producer from S.C. Transmim S.R.L., which is located around Slobozia, Ialomița County. They were analysed and kept under the conditions available at the laboratory of the Faculty of Horticulture in Bucharest.

Fig.1. General view of the analyzed pear cultivars
Source: Original.

Research was carried out in order to determine the weight, shape, size, firmness and colour of the fruits using an analytical scale, calibration rings, reference samples, plates, penetrometer, and colour code [6]. After harvesting, the fruits were analysed from an organoleptic point of view using the standard rating sheet, in order to be included in their respective quality classes [7]. In order to test their storage capacity and to determine the evolution of their main physical and biochemical characteristics, the experiment consisted of two trials:

V_1- Fruit storage in ambient conditions, at 29^0C and 75% relative humidity, under modified atmosphere, by using a plastic semipermeable pellicle;

V_2-Fruit storage in refrigerated condition, at 4^0C and 90% relative humidity, under modified atmosphere, by using an plastic semipermeable pellicle.

RESULTS AND DISCUSSIONS

Assessing fruit quality classes

An important element for the assessment of the quality of the fruits and their classification into quality categories was the organization of a session of organoleptic analysis, as well as the determination of quality indices, respectively the size and the average weight of the fruits [5]. The standard score sheet was used as a tool for the visual and organoleptic analysis of fruits and the results are shown in Table 1.

Table 1. The organoleptic fruit quality assessment sheet

Organoleptic quality analyzed	Grading	Cultivar				
		Abate Fetel	Carmen	Nashi	Williams	Red Williams
Size	3.....1	3	2	3	3	3
Typical shape	3.....1	3	3	3	3	3
Skin color	4.....1	3	3	4	2	4
Skin state	4.....1	4	2	3	2	4
Pulp color	3.....1	3	3	3	2	3
Pulp consistency	3.....1	3	3	3	1	3
Pulp juiciness	3.....1	3	2	3	3	3
Taste	7.....1	6	5	6	2	6
Aroma	4.....1	4	3	3	2	4
Total points	34....9	**32**	**26**	**31**	**20**	**33**
Quality class	**Extra 30-34**	X		X		X
	Quality I 20-29		X		X	
	Quality II 10-19					

Source: own determination.

By analysing the comparative data in the tasting sheet, it became apparent that 'Red Williams' (33 points), Abate Fetel (32 points), Nashi (31 points) had the highest qualities and were 'extra' class. They were followed by Carmen (26 points) and Williams (20 points), as class I fruit. The cultivars in the 'extra' class were preferred by consumers for the following reasons: -'Red Williams ranked first and showed remarkable qualities due to its balanced glucoses versus acidity ratio, coupled with very pleasant color, consistency and specific flavor;

- Abate Fetel' led the ranking in terms of fruit size, skin color, taste and its particular aroma.

It ranked second, while Nashi ranked 3rd place.

Qualitative and quantitative changes of fruit during storage. Storage period is a genetic capacity of fruit rendered by their resistance to alteration processes post-harvest without losing significant qualitative and quantitative traits [8]. Tables 2,3,4 and 5, show the evolution of these characteristics during storage:

Average fruit size

Table 2. The fruit average weight evolution during the storage period

Experiment	Cultivar	Average weight (g) / Storage period (days)				
		Harvest time (g)	30 days	Loss (%)	60 days	Loss (%)
V_1 (20°C, RH 75%)	Abate Fetel	341	260	23.7	170	50.1
	Carmen	148	102	31.0	74	50.0
	Nashi	235	198	15.7	116	50.6
	Williams	193	141	26.9	97	49.7
	Red Williams	169	129	23.6	98	42.0
V_2 (4°C, RH 90%)	Abate Fetel	341	305	10.5	277	18.7
	Carmen	148	125	15.5	115	22.2
	Nashi	235	213	9.3	202	14.0
	Williams	193	165	14.5	157	18.6
	Red Williams	169	148	12.4	135	20.1

Source: own determination.

For V_1, the largest quantitative loss during the same 30-day storage period was for 'Carmen' (31.0%). The lowest amount of weight loss was for 'Nashi' (15.7%). This was due to higher pulp humidity and a denser bloom. After 60 days in storage the weight loss increased to a larger extent, depending on the cultivar. The largest weight loss was registered for Abate Fetel (50.1%) due to the fruits having a larger skin surface and a lower amount of bloom. In the case of V_2, fruits showed less weight loss than for V_1, which was mainly due to the cooling room's temperature (4°C) as well as its relative humidity (90%).

Fruit firmness

During the storage period the fruit firmness change their values, depending of the variety, of the storage period and the storage condition [9].

Table 3. The fruit firmness evolution during the storage period

Experiment	Cultivar	Pulp firmness (kgf/cm^2) / Storage period (days)				
		Harvest time kgf/cm^2	30 days	Loss %	60 days	Loss %
V_1 (20°C, RH 75%)	Abate Fetel	9.1	8.5	6.6	7.1	21.9
	Carmen	8.7	8.0	8.0	7.3	16.0
	Nashi	10.6	9.5	10.3	8.6	25.2
	Williams	8.4	7.2	14.2	6.6	21.2
	Red Williams	9.6	8.8	8.3	7.2	25.0
V_2 (4°C, RH 90%)	Abate Fetel	9.1	8.9	2.2	8.6	5.5
	Carmen	8.7	8.4	3.4	8.1	6.9
	Nashi	10.6	10.2	3.7	9.8	7.5
	Williams	8.4	7.9	5.9	7.5	10.7
	Red Williams	9.6	9.4	2.1	9.0	6.2

Source: own determination.

The obtained results showed a direct correlation between the fruits firmness and the pulp mechanical strength.

It was noted that the ripening of the fruit decreased pulp firmness progressively. In the V_1 option, the fruits showed changes in the consistency of their pulp in terms of value, with slight variations from one cultivar to another. Thus, the biggest losses in the case of the V_2 option were demonstrated by the 'Williams' cultivar (14.2%) at 30 days, and at 60 days for the 'Nashi' varieties (25.2%), 'Red Williams' (25.0%), and 'Williams' (21.2%). In V_2, a lower perishability is noted and therefore an extension of the duration of storage of the fruits, compared to the first option, due to the storage conditions in the cooling room. 'Abate Fetel' proved to be the most resistant to preservation after 60 days, due to the high firmness of its pulp, but also because to its thicker bloom which prevented the water from evaporating from the fruit pulp.

Soluble dry matter

Research has shown that there were notable differences between the two experimental options. For V1, after 30 days of storage, the 'Nashi' cultivar showed the most important decrease of soluble dry matter (11.3%), while the other varieties showed intermediate values, compared to the 'Carmen' cultivar,

where the soluble dry matter content decreased the least (3.2%).

Table 4. The soluble dry matter evolution during the storage period

Experiment	Cultivar	Vitamin C (mg/100g fresh produce)				
		Harvest time (mg/100g pp)	30 days	Loss (%)	60 days	Loss (%)
V_1 (20°C, RH 75%)	Abate Fetel	4.6	4.1	9.7	1.9	47.3
	Carmen	7.9	7.0	11.2	3.5	49.2
	Nashi	5.7	5.1	9.7	2.3	59.4
	Williams	5.1	4.8	4.5	2.1	58.8
	Red Williams	4.9	4.0	18.6	2.2	55.0
V_2 (4°C, RH 90%)	Abate Fetel	4.6	4.3	5.4	3.4	26.0
	Carmen	7.9	7.4	6.3	5.9	25.0
	Nashi	5.7	5.3	6.2	4.3	24.6
	Williams	5.1	4.7	6.2	3.8	25.1
	Red Williams	4.9	4.6	7.6	3.7	25.7

Source: own determination.

After 60 days of storing the fruits under the same conditions, the reserves of soluble dry matter decreased the most in the 'Red Williams' cultivar (16.6%), and the least in the 'Carmen' cultivar (10.2%). Analyzing the losses in the case of V2, there were some gradual changes regarding the soluble dry matter content according to cultivar. Thus, the 'Nashi' cultivar showed the largest decrease of soluble dry matter, 8.9% at 30 days and after 60 days of storage under similar conditions, the 'Red Williams' cultivar showed a loss of 16.8%. Regardless of the experimental variant in the 'Carmen' cultivar, the smallest percentage decrease of the soluble dry matter content was found.

Vitamin C

As far as vitamin C is concerned, there were significant variations in fruit during various stages, from harvest to storing period. In the case of V_1, there was significant loss of vitamin C due to the storage conditions where the oxidative processes took place more intensely compared to V_2.

'Red Williams' showed the highest loss of vitamin C content in the case of V_1 – 18.6%, at 30 days, and 60 days for 'Nashi' at 59.4%. The environment conditions present in V_2 show a significant loss of vitamin C content of 4.6% at 30 days and 60 days for 'Abate Fetel' at 26.0%.

Table 5. The vitamin C evolution during the storage period

Experiment	Cultivar	Soluble dry matter (%) / Storage period (days)				
		Harvest time (%)	30 days	Loss (%)	60 days	Loss (%)
V_1 (20°C, RH 75%)	Abate Fetel	17.3	15.9	7.6	13.8	12.1
	Carmen	15.8	15.2	3.2	13.6	10.2
	Nashi	12.3	10.9	11.3	8.0	17.0
	Williams	15.0	13.7	8.2	12.0	11.3
	Red Williams	15.2	13.8	9.3	11.3	16.6
V_2 (4°C, RH 90%)	Abate Fetel	17.3	16.3	5.6	14.4	11.1
	Carmen	15.8	15.5	1.8	14.3	9.3
	Nashi	12.3	11.2	8.9	9.5	14.5
	Williams	15.0	14.1	5.8	12.6	15.6
	Red Williams	15.2	14.5	5.0	12.7	16.8

Source: own determination.

CONCLUSIONS

As a result of the organoleptic appreciation, the fruits of the 'Red Williams', 'Abate Fetel' and 'Nashi' varieties were deemed "Extra" class due to their exceptional size, shape and taste;

The size of the harvested fruits was variable from one cultivar to another, depending on the age of the tree, the culture technology and the climatic conditions of the harvest year;

'Abate Fetel' had the highest average fruit weight (341.0 g), being also a specific cultivar characteristic;

The low values of the average weight of the fruits in the 'Carmen' cultivar (148.0 g) were due to the high load of fruit on the tree, as a consequence of the quite high productive potential of the cultivar compared to the other cultivars, as well as the failure to perform the operation of balancing the fruit load on the tree.

The storage capacity of the fruits was variable according to the variety and the storage condition;

In the case of V_1, at the end of 60 storage days, the Red Williams variety registered the lower weight losses;

For the V_2 variant, there is a lower average weight loss of the fruits, compared to V_1, due to bouth the low temperature conditions (4°C), relative humidity (90%), and the protection of the fruits with semi-permeable plastic film;

During storage, the consistency of the fruits gradually decreased according to the variety, storage duration and condition;

For the V_1 variant, the value of soluble dry matter decreases more significant, according to the variety and the storage periods;

The storage method of the V_2 option showed the smallest loss of vitamin C after 60 for the 'Nashi' cultivar.

For the consistent supply of the market with fresh and high-quality fruit, V_2 is recommended as a storage method, under cold conditions, at a temperature of 4°C, relative humidity of 90%, as well as protected by a semi-permeable plastic pellicle.

REFERENCES

[1]Beceanu, D., Chira, A., 2003, Technology of horticutural products (Tehnologia produselor horticole, in Romanian), Economica Publishing House, Bucharest, 40 – 42.

[2]Blattny, C., 2003, Pears In: Caballero B, Trugo LC, Finglas PM (eds). Encyclopedia of Food Sciences and Nutrition, Academic Press, London, 4428-4433.

[3]Branişte, N., 1986, Pear tree culture (Cultura părului in Romanian), Ceres Publising House, Bucharest, 79 – 82.

[4]Branişte, N., Budan, S., Militaru, M., 2007, Cultivars of fruit trees, fruit bushes and strawberries created in Romania (Soiuri de pomi, arbuști fructiferi și căpșuni create în România, in Romanian), Paralela 45 Publishing House, Pitești, 119 – 122.

[5]Chira, A., 2014, Quality and safety management of agri-food products (Managementul calității și siguranței produselor agroalimentare, in Romanian), Ceres Publishing House, Bucharest, 14 -16.

[6]Chira, L., 2008, The control of fruit quality (Controlul calității fructelor,in Romanian), Ceres Publishing House, Bucharest, 138 – 141.

[7]Chira, L., Chira, A., 2017, Quality standards for unpolluted horticultural products (Norme de calitate pentru produsele horticole nepoluate, in Romanian) Ceres Publishing House, Bucharest,160 -167.

[8]Le Bohec, J., 1994, Poireau, la conservation, Fruits & Legumes, no. 122, Paris, 21 -25.

[9]Stănică, Fl., Branişte, N., 2011, Guide for fruit tree growers, Ceres Publishing House, Bucharest, (Ghid pentru pomicultori, in Romanian), 36 – 42.

[10]Tudor, T., Chira, A., Nicolae, D., 2002, Guidance for practical work in Horticulture Technology. Workshop for multiplying courses, USAMV-Bucharest, 81 - 87. (Îndrumător pentru lucrările practice la Tehnologia produselor horticole. Atelierul de multiplicat cursuri, USAMV- București, 81 – 87).

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ASSESSMENT OF INEQUALITY TO FOREST RESOURCES ACCESS IN THE CONTEXT OF SUSTAINABLE RURAL DEVELOPMENT

Ivan OPENKO, Oleksandr SHEVCHENKO, Ruslan TYKHENKO, Oleg TSVYAKH, Yuliia MOROZ

National University of Life and Environmental Sciences of Ukraine, 17 Vasylkivska Str., 03040, Kyiv, Ukraine, Phone:+380636792954, Emails: ivan_openko@ukr.net, shevchenko_ov90@ukr.net, rvtyhenko@ukr.net, 2231738@i.ua, moroz@nubip.edu.ua

***Corresponding author*:** ivan_openko@ukr.net

Abstract

The current trends in rural development, sustainable use of nature, provision of comfortable ecological, economic and social conditions for the life of the population determine the solution to the problem of inequality within the respective state and between the countries as a whole. According to the results of the study of equality of supply with natural resources, in particular, forest land we have found that the greatest imbalance in the generation of gross income from the use of forest land is determined in the Steppe natural and climatic zone (GINI = 0,53) and the Kyiv and Sumy regions, the northern part of which is located in the Polissya zone, and the southern part of the administrative unit is located in the Forest-steppe zone (GINI = 0,92). It should be noted that on all other indicators the calculated Gini index indicates a low inequality in the provision of natural resources to the population, in particular, forestry lands in the context of all natural and climatic zones of Ukraine, which is a favorable factor for rural development, the formation of environmentally-safe conditions people living and decentralization. With the help of Gini index (inequality), it is possible to formulate a conceptual direction of transformation of ecological and economic mechanisms of forest land use, the mainstream of which should approach absolute equality in providing the population with natural resources, in particular, forestry, distribution of economic income from the implementation of forestry production. safe environment and social living conditions of people in newly created UTC.

Key words: *inequality, forest resources, GINI – index, united territorial communities, decentralization, sustainable rural development*

INTRODUCTION

The current trends in rural development, sustainable use of nature, provision of comfortable ecological, economic and social conditions for the life of the population determine the solution to the problem of inequality within the respective state and between the countries as a whole.

The international community has made significant strides in ridding people of poverty. However, inequalities have not disappeared and persist, in particular the widening of the income gap (property inequality), the provision of food, natural resources (land, forest, water, etc.), the quality of health care and the provision of educational services, especially in rural areas of residence. most of the poor, as noted by the FAO World Organization [5].

The question of inequality in the availability of natural resources, including land for forestry purposes is of particular relevance in scientific studies of various scientists. In particular, M. L. Ross [18], which deals with the problem of the negative impact of the economic structure on economic growth, is surprised at how little is known about the definition of forest resources and inequality. The scientist says, that the study of the relationship among natural (forest) resources and property inequality is outlined only in a narrow circle of researchers.

Th. Gylfason and G. Zoega believe that there is a direct link between the level of property inequality and natural resources. Excess of natural resources can cause the outflow of employed workers from the manufacturing industry and services to the resource sector. At the same time, wage distribution in the manufacturing sector is fairly uniform (since

human capital is more or less equally distributed among the population), whereas in the sector related to the use of natural resources, income is unevenly attributed to the dependence of production on natural conditions and uneven distribution of natural resources. population [10].

Scientist F. van der Pluh emphasizes that high levels of property inequality are inherent in countries with a high share of natural resource exports in GDP, especially in cases of high levels of corruption [7].

Thus, the heterogeneity of the economic space affects the inequality of development of socio-economic urban systems, which in turn leads to the need to develop mechanisms to transform the socio-economic and environmental direction of the country's development and to carry out appropriate institutional transformations [8, 9].

Scientific studies directly addressing the issues of rational use and protection of forest land, uniform distribution between communities of forest land uses with the use of GINI index are outlined in the publications Anuja Raj Sharma [1], Sareth Nhem, Young Jin Lee, Sopheap Phin [13], Oliver T. Coomes, Yoshito Takasaki та Jeanine M. Rhemtulla [3], Tsegaye Tagesse Gatisoa, Tesfamicheal Wossen [6], Ouedraogo Boukary, Ferrari Sylvie [16], Bir Bahadur Khanal Chhetri, Patrick Asante, Atsushi Yoshimoto [2] and others [11, 12, 14, 15].

However, the direct analysis of problems of the organization structure of the land based on Gini Coefficient (GC), engaged Xinqi Zheng, Tian Xia, Xin Yang, Tao Yuan, Yecui Hu in China [21]. During the study, scientists were asked to use Gini Coefficient not only in its classical interpretation (in quantifying differences in income) but also in assessing the rational land use structure, the so-called Land Gini Coefficient (LGC). Using this coefficient, scientists were able to find out that over the 13 years (1996 - 2008), agricultural land and unused land were evenly distributed across China. However, the land under construction was relatively or completely unequally located, which contributed to the rapid development of urbanization processes in China.

Whereas, L. Erickson and D. Vollrath, in their scholarly work, emphasize the need to study the equitable distribution of land use among rural communities, as one of the main factors of economic and social development [4].

In addition, Sareth Nhem, Young Jin Lee, Sopheap Phin investigated and identified the distribution of forest land revenue and other variable income sources in rural communities in the Kingdom of Cambodia (Southeast Asia). participation in reducing income inequality and increasing rural poverty by using GI indicate that 'forest income' is an important part of the livelihoods in united territorial community (UTC) [13].

The purpose of our research was to definition the inequality of forest resources within the natural and climatic regions of Ukraine on the basis of the GINI index.

MATERIALS AND METHODS

The problem of inequality of socio-economic development of regions and increasing of environmental burden on the environment requires conceptual directions of transformation of ecological and economic mechanisms of forest land use [8, 9].

Thus, the next stage of our study was to study the dynamics of inequality of regions in our country on the basis of environmental indicators – "... a summary (generalizing) indicator of the quality of socio-economic development of the territories, reflecting in general the level and degree of anthropogenic impact on the environment" [8, 19], in the conditions of decentralization of power, using the most common indicator – the Gini index.

The idea of the study is based on the definition of the Gini index between the indicators that characterize the socio-economic development of the state and its regions, in particular:

I – indicator – gross income from forestry production, thousand UAH/area of forest land, thousand hectares - establishment of inequality between income from forestry production and area of forest land in terms of

regions and natural and climatic zones will allow to form an idea about the efficiency of forest resources use;

II – indicator – gross income from forestry production, thousand UAH. / united territorial communities population, individuals - determination of the Gini index between these indicators allows to calculate the even distribution of forestry production among the population in the united territorial communities in the conditions of decentralization of power;

III – indicator – area of forest land, thousand hectares / united territorial communities, units - calculation of the Gini index between outlined indicators, in our view, will allow in the future to reorient the economic direction of production in the respective communities in terms of decentralization of power, to form preconditions for the intensification of effective use of land forestry purposes;

IV – indicator – area of forest land, thousand hectares / population, persons - this ratio will allow to determine the degree of concentration of forest land among the population, which is a very important environmental and economic factor for the population;

V – indicator – area of forest land, thousand hectares/population of UTC, persons - this indicator will allow to measure the level of forest concentration in the UTC power. In this case, the Gini Index will be the main criterion for developing conceptual solutions in providing an environmentally friendly environment for rural livelihoods.

Gini Coefficient (GC) – a statistical indicator of the degree of stratification of society in a given country or region in relation to any studied trait. Used to estimate economic inequality ("economic inequality is the difference in economic well-being between individuals within a group, between population groups, or between countries") [17]. In absolute terms, this coefficient varies from 0 to 1. The greater its value deviates from 0 and approaches one, the greater the income is concentrated in the hands of individual populations. Sometimes this percentage coefficient is used - the Gini index (GI) [20].

The Gini coefficient is calculated by the formulas 1, 2 [21].

$$G = \frac{1}{n}(n + 1 - 2\left(\frac{\sum_{i=1}^{n}(n+1-i)y_i}{\sum_{i=1}^{n} y_i}\right) \quad (1)$$

or

$$G = \frac{2\sum_{i=1}^{n}(i)y_i}{n\sum_{i=1}^{n} y_i} - \frac{n+1}{n} \quad (2)$$

where: y_i = quantities for some general set of elements i = 1 to n.

RESULTS AND DISCUSSIONS

The calculation of the Gini index between the outlined indicators in Ukraine was carried out by the array of data by region x_i and y_i, pre-ranked in ascending order y_i / x_i. A positive aspect of the application of this coefficient is its applied nature and flexibility in interpretation, which allows us to assess interregional inequalities in the use of forest land [7].

Found in the Forest-steppe (GINI = 0.28), Polissya climatic zone and the Carpathians (GINI = 0.24) gross income from forestry production is evenly generated from the area of forest land, unlike in the Steppe zone (GINI = 0.53) where forest land use is inefficient.

The largest inequality by II indicator is similarly observed in the Steppe (GINI = 0.42) natural and climatic zone, which indicates the uneven distribution of income from forestry production among the population of the united territorial communities under decentralization.

The inequality in III – indicator in all natural and climatic zones of Ukraine is moderate, that is, the lands of forestry destination are evenly concentrated between UTC.

According to IV – indicator in all natural and climatic zones of Ukraine, low level of inequality between the population in the provision of forest lands is caused.

Similar is the differentiation of forest lands between the UTC population under decentralization, as evidenced by the low Gini

index by V – indicator in all natural and climatic zones of Ukraine.

According to the results of the study of equality of supply with natural resources, in particular, forest land we have found that the greatest imbalance in the generation of gross income from the use of forest land is determined in the Steppe natural and climatic zone (GINI = 0.53) and the Kyiv and Sumy regions, the northern part of which is located in the Polissya zone, and the southern part of the administrative unit is located in the Forest-steppe zone (GINI = 0.92) (Table 1).

Table 1. Generalized values of the Gini index by specific indicators in terms of natural and climatic zones of Ukraine

Name of the climate zone	Indicators				
	I	II	III	IV	V
	Gross income from forestry production, thousand UAH/Area of forest land, thousand ha	Gross income from forestry production, thousand UAH. / Population of UTC, persons	Area of forest land, thousand hectares / Amount of UTC, units.	Area of forest land, thousand hectares / Population, persons	Area of forest land, thousand hectares / population of UTC, persons
	GINI index				
Polissya and Carpathians	0.24	0.29	0.14	0.10	0.18
North part of Polissya, South part of Forest-steppe (Kyiv, Sumy region)	0.92	0.87	0.13	0.20	0.13
Forest-steppe	0.28	0.26	0.12	0.18	0.15
Steppe	0.53	0.42	0.17	0.21	0.17

Source: own calculations.

Similar is the situation in the inequality in the distribution of gross forestry production among the population of the UTC in the conditions of decentralization of power - in the Steppe natural and climatic zone (GINI = 0.42) and the Kyiv and Sumy regions, the northern part of which is in the Polissya zone, and the southern part of the administrative unit is located in the Forest-steppe zone (GINI = 0.87).

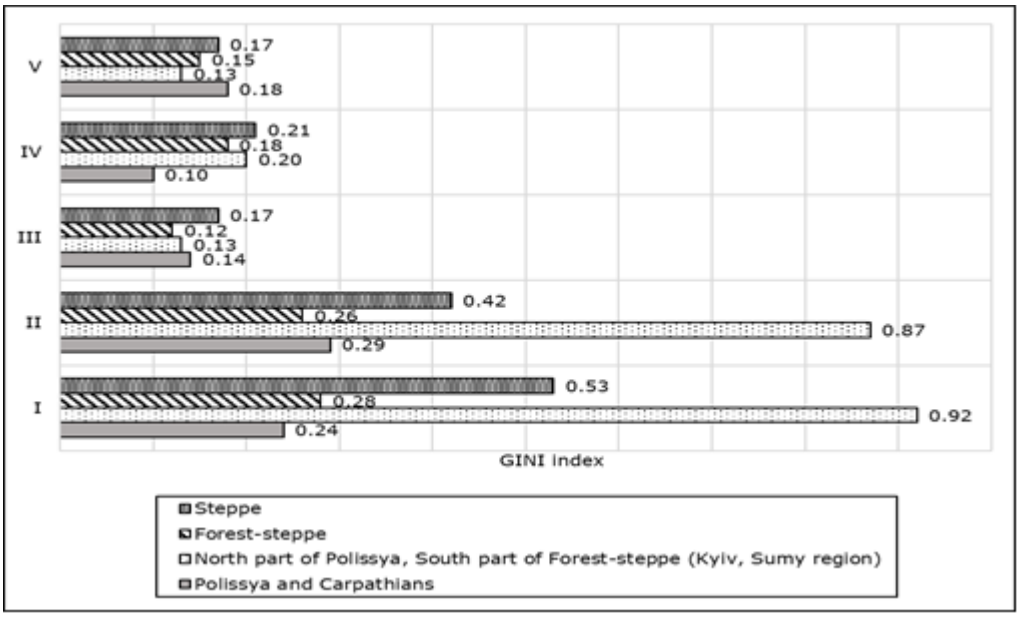

Fig. 1. Gini index chart by specific indicators in terms of natural and climatic zones of Ukraine
Source: author's calculations.

In the areas of Polissya, Carpathian, and Forest-steppe moderate equality is observed (Fig. 1).

CONCLUSIONS

It should be noted that on all other indicators the calculated Gini index indicates a low inequality in the provision of natural resources to the population, in particular, forestry lands in the context of all natural and climatic zones of Ukraine, which is a favorable factor for rural development, the formation of environmentally-safe conditions people living and decentralization.

With the help of Gini index (inequality), it is possible to formulate a conceptual direction of transformation of ecological and economic mechanisms of forest land use, the mainstream of which should approach absolute equality in providing the population with natural resources, in particular, forestry, distribution of economic income from the implementation of forestry production. safe environment and social living conditions of people in newly created UTC.

ACKNOWLEDGMENTS

This paper was supported by the project "The Newest Concept of Creating a Digital Atlas of Land Value in Ukraine – An Instrument for Regulation of Market Land Relations and Spatial Development" funded from the Ministry of Education and Science of Ukraine 2018 – 2020, State registration code and number 00493706 No. 0118U000291.

REFERENCES

[1]Anuja, R. S., 2010, Using GINI coefficient for analysing distribution of community forests in Nepal by development and ecological regions. International Journal of Social Forestry (IJSF), Vol. 3(1): 17 – 27.

[2]Chhetri, K. B. B., Asante, P., Yoshimoto, A., 2016, Forest Dependence and Inequality: An Empirical Study from Community Forests in Kaski, Nepal. FORMATH, Vol. 15, pp. 33 – 43.

[3]Coomes, O. T., Takasaki, Y., Rhemtulla, J. M., 2016, Forests as landscapes of social inequality: tropical forest cover and land distribution among shifting cultivators. Ecology and Society, Vol. 21(3): 20.

[4]Erickson, L., Vollrath, D., 2004, Dimensions of Land Inequality and Economic Development. International Monetary Fund, p. 23. https://www.imf.org/external/pubs/ft/wp/2004/wp04158.pdf, Accessed 23.01.2020.

[5]FAO, 2015, Sustainable Development Goals. Reduce inequality within and among countries. http://www.fao.org/sustainable-development-goals/goals/goal-10/en/, Accessed 20.11.2019.

[6]Gatiso, T. T., Wossen, T., 2015, Forest dependence and income inequality in rural Ethiopia: evidence from Chilimo-Gaji community forest users. International Journal of Sustainable Development & World Ecology, Vol. 22(1):14 – 24.

[7]Gonotskaya, Zh. A., 2013, Property inequality and the resource curse: points of view and empirical evidence. Moscow: Vysshey shkoly ekonomiki, 32 p. (in Russian).

[8]Gorsky, A. M., 2013, Research of inequalities of sustainable development of regions of Ukraine in the discourse of ecological safety. Efektyvna ekonomika (electronic journal), Vol. 11. http://www.economy.nayka.com.ua/?op=1&z=2511, Accessed on 20.11.2019).

[9]Granberga, A. G., 2000, Regional development: the experience of Russia and the European Union. Moscow: Ekonomika. (in Russian).

[10]Gylfason, Th., Zoega, G., 2002, Inequality and Economic Growth: Do Natural Resources Matter? https://www.semanticscholar.org/paper/Inequality-and-Economic-Growth%3A-Do-Natural-Matter-Gylfason-Zoega/bbf5aedef39dd25da5222f7173581f9f55618a0a#paper-header, Accessed on 20.11.2019).

[11]Ievsiukov, T., Openko, I., 2014, An Inventory Database, Evaluation and Monitoring of Especially Valuable Lands at Regional Level in Ukraine. Abstracts. 3rd International Geography Symposium, Geomed 2013. Vol: 120, 513-523.

[12]Martyn, A., Openko, I., Ievsiukov, T., Shevchenko, O., Ripenko, A., 2019, Accuracy of geodetic surveys in cadastral registration of real estate: value of land as determining factor. 18th International Scientific Conference. Engineering for Rural Development, 22-24.05.2019 Jelgava, Latvia. pp. 1818 – 1825

[13]Nhem, S., Lee, Y. Jin, Phin, S., 2018, Forest income and inequality in Kampong Thom province, Cambodia: Gini decomposition analysis, Forest Science and Technology, Vol. 14(4):192 – 203.

[14]Openko, I., Shevchenko, O., Zhuk, O., Kryvoviaz, Ye., Tykhenko, R., 2017, Geoinformation modelling of forest shelterbelts effect on pecuniary valuation of adjacent farmlands. International Journal of Green Economics, Vol. 11(2):139 – 153.

[15]Openko, I., Shevchenko, O., Tykhenko, R., Tsvyakh, O., Stepchuk, Ya., 2019, Economic analysis of deforestation impact on the yield of agricultural cultures in Ukraine. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development. Vol. 19(4):233 – 237.

[16]Ouedraogo, B., Ferrari, S., 2012, Incidence of forest income in reducing poverty and inequalities: Evidence from forest dependant households in managed forest' areas in Burkina Faso, Cahiers du GREThA, Vol. 2012-28. http://ideas.repec.org/p/grt/wpegrt/2012-28.html, Accessed on 20.11.2019.
[17]Piketty, T., Goldhammer, A., 1971, Capital in the twenty-first century. Cambridge Massachusetts, VIII, 685 p., http://www.worldcat.org/title/capital-in-the-twenty-first-century/oclc/858914389, Accessed on 20.11.2019.
[18]Ross, M. L., 2007, How Mineral Rich States Can Reduce Inequality. Escaping the Resource Curse. N.Y.: Columbia University Press, 237 – 255.
[19]Sadykova, E. Ts., 2009, Otsenka prirodoyemkosti kak indikatora kachestva sotsial'no-ekonomicheskogo razvitiya regiona (Assessment of nature intensity as an indicator of the quality of the socio-economic development of the region). Ekonomika prirodopol'zovaniya, Vol. 2, 11 – 22. (in Russian).
[20]Toma, E., Vlad, I. M., 2018, Land concentration changes in Romania during 2002-2016 period. University of Agronomic Sciences and Veterinary Medicine of Bucharest. Agrolife Scientific Journal, Vol. 7(1):137 – 142.
[21]Zheng, X., Xia, T., Yang, X., Yuan, T., Hu, Y., 2013, The land Gini coefficient and its application for land use structure analysis in China. PLoS ONE. 8(10):e76165. DOI:10.1371/journal.pone.0076165.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

SOME CONSIDERATIONS REGARDING THE FOREIGN TRADE OF ROMANIA WITH OIL SEEDS (2014-2016)

Radu Lucian PÂNZARU, Dragoș Mihai MEDELETE, Marius VLADU, Gheorghe MATEI

University of Craiova, Faculty of Agronomy, 19 Liberty, 200421, Craiova, Romania, Phone: +40741 180 976, Fax: + 40 251 418 475, Emails: rlp1967craiova@yahoo.com, medelete@yahoo.com, mariusvaldu@yahoo.fr, matei.gheorghe@gmail.com

Corresponding author: medelete@yahoo.com

Abstract

Through the information presented, the study aims to highlight the trends of imports and exports of Romania, in the case of oilseeds (sunflower, rapeseed, oilseed, mustard, soybean and other oilseeds) for the period 2014-2016. As a result, it is based on the use of statistical information provided by international databases, recognized worldwide as FAO. The total national value of exports (average period) was 1062432 thousand $, of which each product contributed with: 1,195.66 thousand dollars flax for oil; 4,002.67 thousand $ mustard; 4852 thousand other oily seeds; 40,311 thousand soybeans; 463,659.67 thousand $ rapeseed; 548,411 thousand $ sunflower. The import, reached a value of 269,456.33 thousand $ (average 2014-2016), which is based on variable contributions of: 751.67 thousand $ flax for oil; 2,400.66 thousand $ mustard; 26,885 thousand other oily seeds; 34,877 thousand $ rapeseed; 62,289.67 thousand soybeans; 142,222.33 thousand $ sunflower. At the average level of the period, an excess trade balance is found (+ 792,975.67 thousand $).

Key words**:** *export, import, trade balance, sunflower, rapeseed, oil, soybean, mustard*

INTRODUCTION

For Romania, oily plants are constituted in an important group of cultures, due to the generally favorable conditions, as a result of the annual areas and productions recorded. The main plant components of this group (oily plants) are represented by sunflower, rapeseed, soy, flax for oil, mustard.

Sunflower, is a widely used plant worldwide, for the production of seeds and oil [4]. At the global level, Sunflower occupies the 5th place of the 13 major crop plants, under the Food security report [10]. Sunflower culture, presents a major dependence on pollinating insects [8].

In Europe, rapeseed is mainly grown as a source for biofuel, but also for edible oil [9]. The importance of rape culture is variable across European countries, as an example, for Germany, rapeseed is the most important oily culture [2]. By its potential, rapeseed generates, on the productive Unit (HA), at least a double amount of oil beside the soybean crop [6].

Soy is a cheap source of protein compared to animal protein [1]. Under the report of trade in soybeans, Romania is constituted in a certain importer. Significant quantities are brought from South America, where Brazil has, for example, doubled exports in the period 2002-2012 [5]. In this context, it is underlined that the price for soybeans in Romania is lower than that on the European market – Rotterdam [7].

The mustard is an oily culture with multiple uses, so we can also discuss the existence of secondary products of type: mustard buds, shell (which can be processed in the form of briquettes) [11].

MATERIALS AND METHODS

The indicators used for drafting the paper were extracted from the specific database [3]. Therefore, export and import (expressed in thousand $ value units) were used, on the basis of which the trade balance (thousand $) was determined.

The documentation was followed by data processing, dynamic series consisting of four

terms (years 2014, 2015, 2016 and the average of the period. Structural indices were determined for the value of exports, the value of imports, as well as dynamic indices (with a mobile base), so that the comparison was used in time.

RESULTS AND DISCUSSIONS

Table 1 presents the level and evolution of Romanian exports of oily seeds.

The year 2014 is characterized by a total value of exports of 1,094,360 thousand $, which is based on sequential, punctual contributions as follows: 1,122 thousand $ flax for oil (0.10%), 6,539 thousand $ mustard (0.60%), 7.286 thousand $ Other oily seeds (0.67%), 28.451 thousand $ soy (2.60%), 449,597 rapeseed thousand $ (41.08%), 601,365 thousand $ sunflower (54.95%).

In the case of 2015, a total value of the national exports of 889,392 thousand $ is found, the structure of which is based on percentage contributions of 56.42% Sunflower – 501,758 thousand $, 37.52% rapeseed – 333,798 thousand $, 5.04% soy – 44,806 thousand $, 0.47% other seeds oily – 4,141 thousand $, 0.42% mustard – 3,715 thousand $, 0.13% flax for oil – 1,174 thousand $.

Table 1. Export of oily seeds

Specification	Year								Period average **		
	2014		2015			2016					
	Th. $*	Str. %**	Th. $*	Str. %**	2015/ 2014**	Th. $*	Str. %**	2016/ 2015**	Th. $*	Str. %	Average/ 2016
Sunflower	601,365	54.95	501,758	56.42	83.44	542,110	45.04	108.04	548,411.00	51.62	101.16
Flax for oil	1,122	0.10	1,174	0.13	104.63	1,291	0.11	109.97	1,195.66	0.11	92.62
Mustard	6,539	0.60	3,715	0.42	56.81	1,754	0.15	47.21	4,002.67	0.38	228.20
Rapeseed	449,597	41.08	333,798	37.52	74.24	607,584	50.48	182.02	463,659.67	43.64	76.31
Soya	28,451	2.60	44,806	5.04	157.48	47,676	3.96	106.41	40,311.00	3.79	84.55
Other oily seeds	7,286	0.67	4,141	0.47	56.84	3,129	0.26	75.56	4,852.00	0.46	155.07
Total	1,094,360	100	889,392	100	81.27	1,203,544	100	135.32	1,062,432.00	100	88.28

Sources: * http://www.fao.org/faostat/fr/#data/TP (05.12.2018), ** own calculation.

If analysis of the situation of the year 2016, it can be noted that at the level of each product, different indicator values were recorded, from 1,291 thousand $ flax for oil (0.11%) up to 607,584 thousand $ in case of rapeseed (50.48%). For the other products, have known the indicator levels of 1,754 thousand $ mustard (0.15%), 3,129 thousand $ other oily seeds (0.26%), 47,676 thousand $ soy (3.96%) and 542,110 thousand $ sunflower (45.04%). The total export value was 1,203,544 thousand $.

Romanian export value was 1,062,432 thousand $ (for period average), of which, for each product, effective, variable contributions are found (Fig. 1): 1,195.66 thousand $ flax for oil (0.11%); 4,002.67 thousand $ mustard (0.38%); 4,852 thousand $ other oily seeds (0.46%); 40,311 thousand $ soy (3.79%); 463,659.67 thousand $ rapeseed (43.64%); 548,411 thousand $ sunflower (51.62%).

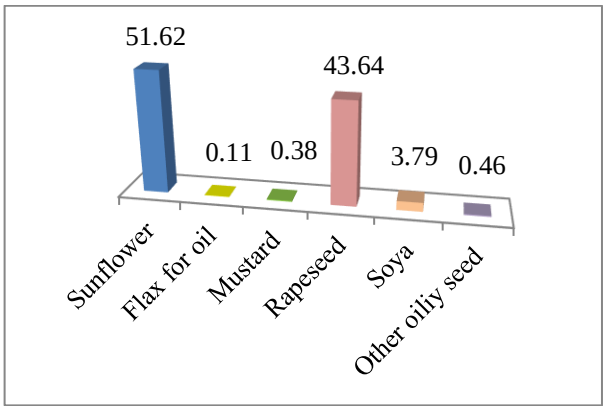

Fig. 1. Structure of exports (% of the period average)
Source: Own design and results.

The levels of exports (Fig. 2), for the period analyzed, some aspects are taking in consideration:

- at the level of sunflower seeds, the indicator has an uneven progression, decreases from the reference term, being 16.56% in case of 2015. For the average and 2016 year, exceeded was recorded, 1.08 and 1.01 times respectively compared to the reference term;
- for oil flax, the indicator evolved ascending (1.04 and 1.09 times) for 2015 and 2016 years. Average being smaller compared to 2016 year – 92.62%;
- for mustard, the indicator's dynamics are a downward one, the decreases in 2015 (-43.19%), followed by other decreases (-52.79%) in the situation of 2016. The average period, shall be 2.28 times the reference term; - the rapeseed has a oscillating indicator evolution, which is highlighted by the existence of two subunit levels of indices (2015 and average) and one super unitary (2016 year);
- at the level of soy seed, the indicator presents in dynamics, super unitary values - 157.48 and 106.41% for 2015 and 2016, respectively, and subunit values – 84.55% for the average of the period;
- for other oily seeds, value exports decreased in the year 2015 (-43.16%), decreases that were maintained in 2016 (-24.44%), after which the average of the period experienced a recovery (+55.07%);
- overall, the uneven evolution of exports is found, the decreases were: 18.73% in 2015 and 11.72% at the average of the period. The year 2016 was superior to the base of cooperation with 35.32%.

The level of imports of oily seeds is presented in table 2, both under the report of its structure and in terms of evolution-over time.

In the case of 2014, the indicator level ranged from 649 thousand $ to the oil flax, up to 131,759 thousand $ in the case of sunflower seeds, and the overall indicator level reached 259,254 thousand $. As a result, variable continental weights are found, in total, as follows: 0.25% flax for oil, 1.18% Mustard – 3,047 thousand $, 11.05% other oily seeds – 28,643 thousand $, 15.23% rapeseed – 39,492 thousand $, 21.47% Soy – 55,664 thousand $ and 50.82% sunflower.

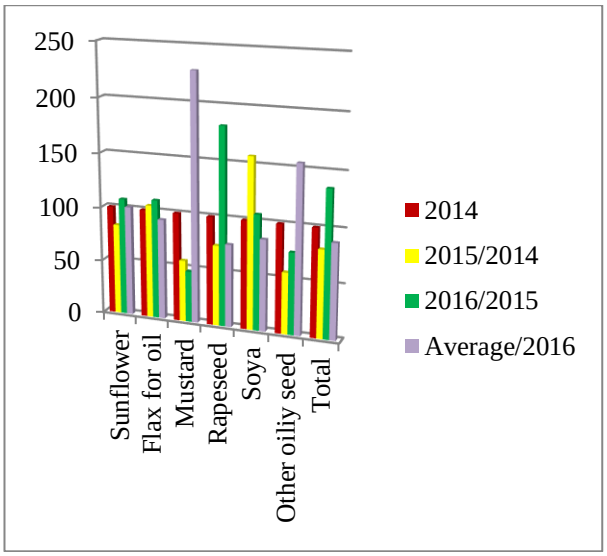

Fig. 2. Export dynamics (%)
Source: Own design and results.

If we look at the situation specific to the year 2015, it can be noted that the national level of the indicator was 274,009 thousand $, to which the specific products made contributions of: 141,686 thousand $ sunflower – 51.71%, 73,095 thousand $ soy – 26.68%, 29,467 thousand $ rapeseed – 10.75%, 26,851 thousand other oily seeds – 9.80%, 2,129 thousand $ mustard – 0.78%, 781 thousand $ flax for oil – 0.28%.

For the year 2016, the variation of the indicator level can be observed, from 825 thousand $ to flax for oil (0.30%), up to 153,222 thousand $ for sunflower (55.71%). The other products recorded 2,026 thousand $ mustard (0.74%), 25,161 thousand $ other oily seeds (9.15%), 35,672 thousand $ rapeseed (12.97%), 58,110 thousand $ soy (21.13%). These values, have made total imports record a value of 275,016 thousand $.

Taking in consideration the average, it is noted that the indicator at national level has reached a value of 269,456.33 thousand $, which is based on percentage-sequential contributions – variables (Fig. 3): 0.28% flax for oil (751.67 thousand $); 0.89% mustard (2,400.66 thousand $); 9.98% other oily seeds (26,885 thousand $); 12.95% rapeseed (34,877 thousand $); 23.12% soy (62,289.67 thousand $); 52.78% sunflower (142,222.33 thousand $).

Table 2. Import of oily seeds

Specification	Year								Period average **		
	2014		2015			2016					
	Th. $*	Str. %**	Th. $*	Str. %**	2015/ 2014**	Th. $*	Str. %**	2016/ 2015**	Th. $*	Str. %	Media/ 2016
Sunflower	131,759	50.82	141,686	51.71	107.53	153,222	55.71	108.14	142,222.33	52.78	92.82
Flax for oil	649	0.25	781	0.28	120.33	825	0.30	105.63	751.67	0.28	91.11
Mustard	3,047	1.18	2,129	0.78	69.87	2,026	0.74	95.16	2,400.66	0.89	118.49
Rapeseed	39,492	15.23	29,467	10.75	74.61	35,672	12.97	121.05	34,877.00	12.95	97.77
Soya	55,664	21.47	73,095	26.68	131.31	58,110	21.13	79.49	62,289.67	23.12	107.19
Other oily seeds	28,643	11.05	26,851	9.80	93.74	25,161	9.15	93.70	26,885.00	9.98	106.85
Total	259,254	100	274,009	100	105.69	275,016	100	100.40	269,456.33	100	97.98

Sources: * http://www.fao.org/faostat/fr/#data/TP (05.12.2018), ** own calculation.

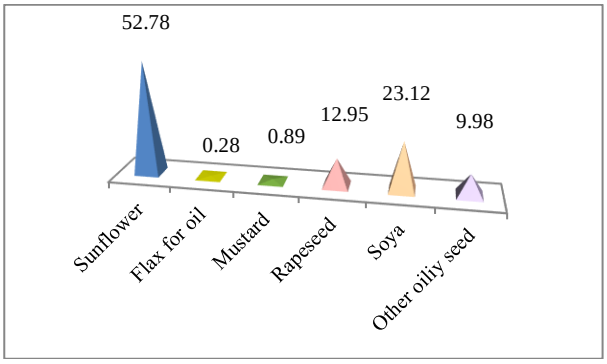

Fig. 3. Structure of imports (% of the period average)
Source: Own design and results.

The indicator dynamics shows (Fig. 4):
- for sunflower, the upward trend is found, the decreases of 7.12% are specific only to the average of the period. In the years 2015 and 2016, the comparison bases are 1.07 and 1.08 times exceeded;
- at the flax for oil level, an upward progression is observed, with differences from the comparison period being 20.33% in 2015 and 5.63% for 2016. The period average was 8.89% below the reference base;
- for mustard, the trend are decreasing for indicator in the years 2015 and 2016 (-30.13 and -4.84%). Increases appear for the period average (+18.49%);
- the evolution was uneven for rapeseed, decreasing in the year 2015 and for the average of the period (-25.39 and -2.23%), and for the year 2016 increases – compared to reference period-by 21.05%;
- in the case of soy seeds the indicator has evolved fluctuating. Thus, super unit values of indices are manifested in 2015 and for the average (131.31 and 107.19%), and smaller values for the year 2016 (79.49%);
- other oily seeds, have a downward evolution of the indicator. Thus, decreases in export levels occur in the year 2015 versus 2014 by 6.26%, after which, for the year 2016, all decreases by 6.30%. Period average increases in dynamics (+6.85%);
- the total imports increase. Thus, the indices are over unitary in the years 2015 and 2016 respectively (105.69 and 100.40%), and sub unitary indices are manifested for the period average (97.98%).

Trade balances are shown in Table 3.
The trade balance of national exchanges with oily seeds was excessing in the year 2014 (+835.106 thousand $), this state of things, being determined by the surpluses recorded for sunflower, rapeseed, mustard and flax for oil (+469,606, +410,105, +3,492 and +473 thousand $ respectively), which were not affected, decisively, by specific deficits for soybeans and other oily seeds: -27,213 and -21,357 thousand $ respectively.

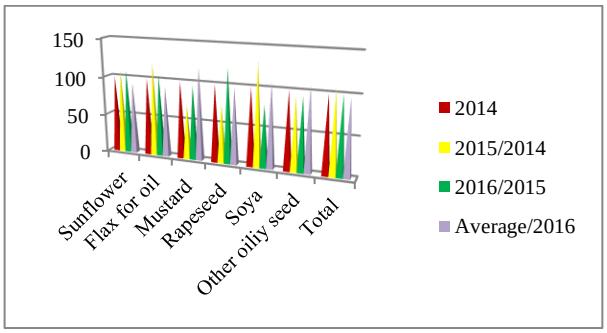

Fig. 4. Import dynamics (%)
Source: Own design and results.

Table 3. Trade balance - thousands $

Specification	Year			Period average
	2014	2015	2016	
Sunflower	+469,606	+360,072	+388,888	+406,188.67
Flax for oil	+473	+393	+466	+443.99
Mustard	+3,492	+1,586	-272	+1,602.01
Rapeseed	+410,105	+304,331	+517,912	+428,782.67
Soya	-27,213	-28,289	-10,434	-21,978.67
Other oily seeds	-21,357	-22,710	-22,032	-22,033.00
Total	+835,106	+615,383	+928,528	+792,975.67

Source:*own calculation based on the data from http://www.fao.org/faostat/fr/#data/TP (05.12.2018).

In the case of 2015, the trade balance maintains its surplus character (+615,383 thousand $), which is determined as in the previous year by the surplus from flax for oil, mustard, rapeseed and sunflower (+393, +1,586, +304,331 and +360,072 thousand $ respectively), Which have not suffered due to the deficits of the other products:-22,710 and -28,289 thousand $ - specific values for other oily and soybean seeds, respectively.

If we are referring to the situation in the year 2016, it can be noted that three products with poor trade balance – mustard, soybeans and other oily seeds (-272, -10,433 and -22,032 thousand $ respectively) appear, while the surplus character is specific to the flax For oil, sunflower and rape (+466, +88,888 and +517,912 thousand $ respectively). As in previous years, we can discuss a surplus world trade balance (+928,528 thousand $).

For period average, there is an excess trade balance (+792,975.67 thousand $), which is based on sequential levels of: +428,782.67 thousand $ rapeseed; +406,188.67 thousand $ sunflower; +1,602.01 thousand $ mustard; +443.99 thousand $ flax for oil; -21,978.67 thousand soybeans; -22,033.00 thousand other oily seeds.

CONCLUSIONS

As regards national exports and their structure, it is noted: exports were dominated by sunflower (51.62%), followed by rapeseed (43.64%), weights for the remainder of the products being less than 5%; the value of indicator dynamics is fluctuating, this trend being determined by sunflower and rapeseed. Exception make soy and mustard – upward and downward evolutions.

If the situation of imports is analyzed, the following conclusions may be drawn:

- the main product is sunflower (52.78%), followed at a considerable distance of soy and rapeseed – 23.12 and 12.95% respectively;
- for other oily seeds, the weight tends to 10% (9.98%), and in the case of oil mustard and flax the weights are less than 1%;
- the indicator's dynamics are an upward one at national level, except for the mustard and other oily seeds (decreasing trend), respectively rapeseed and soybeans (fluctuating trends).

As regards the situation of the trade balance of national trade in oily seeds, the following situations may be observed:

- the balance is strictly exceeding at national level, which is determined by the influence exerted by sunflower, rapeseed;
- for oil and mustard (strictly surplus balances with the exception of the mustard with a weak situation in the case of 2016);
- soybeans and other oily seeds, present a strictly weak balance;
- we can state that the situation is favorable, our country exploiting the favorable conjunctures especially for sunflower and rape.

REFERENCES

[1]Bye, S., U., Mu'Azu L., Y., Danladi B., B., 2018, Economic analysis of soybeans marketing in Billiri local government area of Gombe state, Nigeria, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 18(4):59-64.

[2]Drastig, K., Quinones, T., Zare, M., Damer, K.H., Prochnow, A., 2019, Rainfall interception by winter rapeseed in Brandenburg (Germany) under various nitrogen fertilization treatments, Agricultural and Forest Meteorology, Vol.: 268, pp. 308-317.

[3]FAO, http://www.fao.org/, Accessed on Dec. 5, 2018.

[4]Gholami-Yangije, A., Pirmohammadi, R., Khalilvandi-Behroozyar, H., 2019, The potential of sunflower (*Helianthus annuus*) residues silage as a forage source in Mohabadi dairy goats, Veterinary Research Forum, Vol. 10(1): 59-65.

[5]Fliehr, O., Zimmer, Y., Smith, L., 2019, Impacts of Transportation and logistics on Brazilian soybean

prices and exports, Transportation Journal, Vol.58(1): 65-77.
[6]Huang, J., Zhou, L., Zhang, F., Hu, Z., Li, Y., 2017, Regional climate-yield relationship for winter oilseed rape in Jiangsu Province, Southeast China, International Journal of Plant Production, Vol. 13(2): 93-102.
[7]Ionel, I., 2017, Romania's soybean market and coupled subsidies, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 17(1):249-252.
[8]Mallinger, R., Prasifka, J., 2017, Benefits of Insect Pollination to Confection Sunflowers Differ Across Plant Genotypes, Crop Science, Vol. 57(6): 3264-3272.
[9]Pullens, J. W. M., Sharif B., Trnka, M., Balek, J., Semenov M., A., Olesen J., E., 2019, Risk factors for European winter oilseed rape production under climate change, Agricultural and Forest Meteorology, Vol. 272, pp: 30-39.
[10]Seiler, G. J., Qi, L. L., Marek, L., 2017, Utilization of sunflower crop wild relatives for cultivated sunflower improvement, Crop Science, Vol. 57(3):1083-1101.
[11]Shehrawat, P. S., Sindhu, N., Devi, P., 2015, Agricultural waste awareness and utilization for healthy environment and sustainable livelihood, Scientific Papers Series "Management, Economic Engineering in Agriculture and Rural Development", Vol. 15(2):371-376.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ROMANIAN CONSACRATED RECIPES IN THE MILLING AND BAKERY INDUSTRY

Ciprian Nicolae POPA[1], Radiana Maria TAMBA BEREHOIU[2], Luminiţa VIŞAN[2], Vasilica SIMION[2], Claudia MUREŞAN[3], Sergiu Erich PALCU[3]

[1]Milling Bakery Research & Consulting, 8B Diamantului Av., 1th block, 1th floor, Ap. 2, Zip code 077025, Bragadiru, Romania, Phone: +40727277840, Email: cipnpopa@yaoo.com
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Zip code 011464, Bucharest, Romania, Phone: +40724143631, Emails: radianatamba@yahoo.com; l_visan@yahoo.com
[3]Aurel Vlaicu University of Arad, Faculty of Food Engineering, Tourism and Environmental Protection, 3 Elena Dragoi Av., Micalaca, Arad, Romania,310330, Phone/Fax:40257219331/ +40257219242; Emails: muresanclaudette@yahoo.com; palcusergiu@yahoo.com

Corresponding author: radianatamba@yahoo.com

Abstract

Romania has implemented a legislation whose purpose is to recover the recipes of some food products, in their original form, functional before 1984. The original recipes are known as "Romanian consecrated recipes". The purpose of the present study was to evaluate how the producers in the milling and bakery industry complied with this legislation, 5 years after its appearance. Our results show that the number of foods certified as being obtained with "Romanian consecrated recipes" is quite low, only 9 products, of which only 7 can be considered as completely belonging to the bakery industry. Also, the number of producers who hold consecrated recipes certificates is very small (21 producers compared to several thousand who work on the bakery market) and are distributed on less than half of the national territory. The vast majority of applications for consecrated recipes certification are concentrated on bakery products that contain potato derivatives. Only slightly over 18% of the old recipes and technologies are represented in the range of products certified according to the legislation in force. No milling industry product is certified as having consecrated recipes, although there is no equivalent in the products currently available on the market. The products obtained according to "consecrated recipes" have the quality to contribute to the diversified use of the available food resources and to the superior use of some by-products from the industry. However, these types of products are not necessarily correlated with the modern trends in the industry, in terms of energy efficiency or consumer expectations, being not "clean label".

Key words**:** *consecrated Romanian recipes, food products, milling and bakery*

INTRODUCTION

The consecrated recipes for certain categories of food products are described in the Romanian legislation by a series of normative acts issued by the Ministry of Agriculture. This is the joint Order of the Minister of Agriculture and Rural Development, the Minister of Health and the President of the National Authority for Consumer Protection no. 394/290/89 of 2014. This order regulates the conditions that must be met by the operators in the food sector, in order to register in the National Register of Consecrated Recipes certain categories of products, manufactured according to Romanian consecrated recipes. The legislation defines the Romanian consecrated recipe as being the food product manufactured in compliance with the composition used more than 30 years, before the date of entry into force of Order 394/290/89/2013 (before 1984). In order to be certified, the manufacturers must produce a technical documentation that includes: product name, description of raw materials and ingredients used, consecrated recipe, technological scheme, description of the technological process, sensorial, physical-chemical and microbiological quality indicators, respectively related elements for packaging, labelling, storage and transport.

The documentation must also describe the control procedures and methods [12]. In exchange for this documentation, the producers receive a certificate issued by the Ministry of Agriculture and Rural Development and the right to use a specific logo, on the label of the respective food products (Fig. 1).

Fig. 1. Official logo for the Romanian consecrated recipes
Source: [7].

The purpose of the present study is to evaluate the number of consecrated recipes on the market for milling and bakery products, 5 years after the appearance of this type of certification. We also set out to discuss a number of technological issues related to their implementation in the industry. At the same time, we intend to evaluate the future potential of approaching consecrated recipes also for other milling and bakery products.

MATERIALS AND METHODS

Our study is based on the critical evaluation of the data available in the public domain about the consecrated recipes, technologies, the level and the consumption behavior regarding the milling and bakery products. For this purpose, data available on the website of the Ministry of Agriculture and Rural Development, Eurostat, from the Romanian press and from the specialized literature of the milling and bakery field, have been processed. At the same time, we accessed the collections of standards, which regulated the recipes of milling and bakery products in the centralized type economy since 1989.
The paper has a critical approach of the published literature in the field and applied synthesis methods for setting up this paper.

RESULTS AND DISCUSSIONS

At the base of the economic agents interest for the consecrated recipes lies the tendency of the consumers to look for authentic foods, made according to old recipes and technologies. For example, the “Taste Tomorrow” study (2019) conducted at European level by the company Ipsos for the Puratos group, highlighted the interest of consumers for bakery products that provide less calories, fat and salt and more fibers, whole grains, seeds and protein.
Bread with leaven is considered by most consumers to be the bread of the future, based on three criteria: freshness, nutritional input and taste. The main consumers criterion for the bread choosing was identified as being the freshness [13]. Freshness is a bread characteristic which is described by a multitude of criteria, the most representative being the "starch retrogradation rate". This rate depends on: the quality of the raw material, the recipe, the applied technology, the packaging method, respectively the storage temperatures.
Old technologies, characterized by high durations of dough fermentation, are based on increasing the diversity of microbial species involved and implicitly on increasing the complexity of the enzymatic system that acts in dough. All this leads to the increase of the dough components hydrophilic properties and to the more uniform gelatinization of the starch granules.
Active compounds are formed in the process of dough stabilization, which act on proteins (organic acids). Lipid hydrolysis compounds contribute to the stabilization of gas bubbles, participating in the formation of micellar structures on their surface [1]. The diversity and quantity of active compounds in the Maillard reactions also increase, resulting in an improved flavor and taste profile. The so-called Chorleywood process (direct, single-phase method) is the basis of the modern bread-making technology. It originates from a series of researches conducted between 1950 and 1962 by the British Baking Industries Research Association, in order to streamline

the technological process of obtaining bread under the use of flours with a lower protein content. The average dough fermentation time of the United Kingdom bakeries was at that time of 2-3 hours. The obtained results allowed the adoption of a technology that has spread throughout the world and which is characterized by: the formation and development of the dough in a single short-term technological operation (max. 5-7 minutes), the use of intensive kneading, the use of an oxidizing agent (initially potassium bromate, currently ascorbic acid), the use of a high melting point emulsifier or fat, additional water amount to control the dough consistency and the addition of at least yeast double amount [3]. From an economic point of view, these modifications allow a significant shortening of the production times (increasing the degree of the production line use) and obtaining a better yield in bread (increasing the amount of dough on account of the additional water). In Romania, the direct method was introduced to the industry in the 1970s, being applied to obtain loaf type bread or bakery products with various additions, which offset the not too good taste generated by the short fermentation times [8].
The duration of a technological cycle, necessary for the preparation of the dough ready to be baked, for a product made after an consecrate recipe, can reach almost 10 hours, while in the case of modern methods, the product can be obtained in one hour (Table 1). Modern bakery technologies are characterized by complex recipes that contain substances that reduce dough resistance (a series of enzymes such as amylases, proteases, xylanases or L-cysteine-reducing agents) or on the contrary, contain substances that enhance the viscous-elastic properties of weak flours (ascorbic acid, enzymes in the category of oxidase-reductases, emulsifiers, lipases etc.) [11]. The kneading technologies are based on cycles of intensive kneading (at high speeds of action of the kneading arms) and working equipment geometries, which allow the mechanical work to be applied to the dough with minimum energy losses. Moreover, it utilize selected microorganisms capable of rapid activation (ie, to rapidly produce the enzymatic equipment necessary for starch degradation and the formation of fermentation gases that will contribute to the increase of bakery products volume). The result is the attainment of optimum properties during the shortest time [10].
Table 1 shows the time required to obtain the dark bread dough, depending on the type of technology used (the baking time was neglected because it depends on the weight of the products and the assortment and does not induce significant differences between technologies) (according to Leonte M., 2008) [6].

Table 1. Time required (min.) for obtaining the black bread dough according to different technologies

Technological procedure	**Romanian consecrated recipes**			**Current recipes**
	Two-phase method with leaven	Two-phase method with fluid leaven	Three-phase method with leaven	Direct method
Sponge kneading	0	0	5-6	0
Sponge fermentation	0	0	300	0
Sourdough kneading	6 - 10	8 -10	7 -10	0
Sourdough fermentation	90 - 135	300 – 360	90 - 200	0
Dough kneading	8 - 12	12 - 14	8 - 12	8 - 12
Dough fermentation (primary or bulk fermentation)	0 -30	25 -30	0 - 20	5 - 12
Dough Rekneading	3 - 8	3 - 8	3 - 8	0 - 3
Proofing	30 - 40	30 - 40	30 - 40	40 - 60
Total time (min)	130 -	378 - 462	443-596	53 - 87

Source: [6].

The technologies on which the Romanian consecrated recipes are based come from a centralized economic system and were not conceived under the pressure of factors that prevail in the current economy, like: factors related to energy efficiency, maximization of capital recovery rates, environmental impact etc. They are attractive from the perspective of the value added to the products from modern technologies and can withstand the market as long as the interest of the consumers for them remains constant, and

they are willing to offer more to buy this kind of products. The Romanian market for bakery products is characterized by one of the highest consumption per capita (70-90 kg/year, depending on various assessments and sources), but also by the lowest prices in relation to the European Union average (Fig. 2) [9].

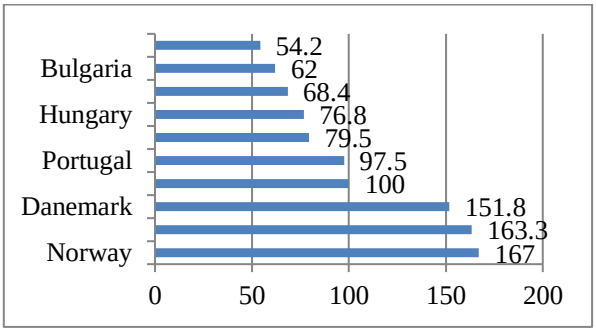

Fig. 2. The deviation of the prices of bakery products in European countries, compared to EU average 28
Source: [9].

A study conducted by GFk Romania in 2018 revealed that 82% of Romanians consume daily 7% less bread than in 2009, when this category of frequent consumers of bread was 89% (Gallup study). Over three quarters of Romanians were buying fresh bread, represented by traditional loaf [2]. At the end of 2019, a number of 33 Romanian consecrated recipes were registered. About 33% of them referred to milk products, 27% to meat products, 27% to bakery products, 9% to fruits and vegetables and the rest to other food products. No milling product is among them, probably due to the fact that milling technologies have not evolved significantly since 1984.

Table 2 presents the names of the certified bakery products, as well as the companies on the market, who have requested consecrated recipes certification.

From the Table 2, it is observed that the commercial companies that have requested the attestation for the consecrated recipes come from less than half of the country counties.

One of these companies, which holds the largest number of certificates, belongs to the Romanian Patronage in the Milling and the Bakery domain (ROMPAN).

The main interest for obtaining the certification was represented by the bakery products with the addition of potatoes, namely: white bread with potatoes (9 certified producers), half-white bread with potatoes and dark bread with potatoes (with 4 certified producers).

Table 2. The names of the Romanian bakery products for which the consecrated recipe certification was requested

Product name	Companies	Geographic area	Year of certification
White bread with potatoes	ROMPAN PROIECT SERVICE S.A.	Bucuresti	2014
	SIMPA S.A	Sibiu	2016
	PÎINEA DE CASĂ S.R.L.	Mureș	2016
	ANA PANIROM GRUP S.R.L.	Arges	2016
	PRODPAN S.R.L.	Tulcea	2016
	TOTH PEK S.RL.	Mures	2017
	TEROCO GEA CONSULT S.R.L.	Prahova	2017
	ALEXPAN S.R.L.	Bihor	2017
	GENICA S.R.L.	Brasov	2018
Half-white bread with potatoes	ROMPAN PROIECT SERVICE S.A.	Bucuresti	2014
	VALYSTON S.R.L	Bacău	2016
	BUNEXIM S.R.L.	Bihor	2017
	ALEXPAN S.R.L.	Bihor	2017
Dark bread with potatoes	ROMPAN PROIECT SERVICE S.A.	Bucuresti	2014
	PRODPAN S.R.L.	Tulcea	2016
	HARMOPAN S.A.	Harghita	2016
	ERPEK S.A.	Covasna	2019
Rye bread	ROMPAN PROIECT SERVICE S.A.	Bucuresti	2014
	TOTH PEK S.RL.	Mures	2017
	R&B COM S.R.L.	Maramures	2019
	LIDAS S.R.L.	Tulcea	2019
Overlaped knitting (Împletiți suprapuși)	ROMPAN PROIECT SERVICE S.A.	Bucuresti	2014
	TRADITIONAL COM S.R.L.	Buzău	2016
	DELICII SIBIENE S.R.L.	Sibiu	2017
București loaf	ROMPAN PROIECT SERVICE S.A.	Bucuresti	2014
	TED INTERNAȚIONAL 2000 S.R.L.	Hunedoara	2015
	ANA PANIROM GRUP S.R.L.	Arges	2016
	EVERY DAY PROD-COM S.R.L.	Suceava	2019
Savarineta	LORENZ FOOD IND S.R.L	Calarasi	2019
Wholemeal bread	LIDO GÎRBEA S.R.L.	Prahova	2019
Wafers - waffles with filling	no data	no data	no data

Source: Own conception.

Two of the products, although they have flour as a raw material, do not belong to the technologies of bread production, respectively the waffles with filling and savarineta

(product obtained by baking a fermented dough obtained from white flour, yeast, standardized liquid or powdered milk, sugar, eggs, oil, salt and water; the savarineta represent the baked dough of the product "savarina"). Also, two of the products that have consecrated recipes belong to the same technological type, namely the loaf products ("Bucureşti loaf" and "Overlaped knitting").

If we understand by technological cluster, a group of products with similar recipes and technologies that can be treated together, from the point of view of process management and compliance verification with a certain standard, the study of standards collections for the milling and bakery industry before 1988, allows the identification of 22 technological clusters, as seen in Table 3.

We note that not all of these products necessarily meet current consumer expectations, for food products without additives and healthy foods. Consecrated recipes do not exclude food additives (lactic, ascorbic, citric, acetic acids, diamalt) or substitutes for certain food products (artificial honey). In addition, certain products no longer meet current legislative requirements, for example: the product "graham bread with honey" refers in its own name to a food ingredient that does not actually contain, respectively natural honey.

Also, in the case of certain products, the names no longer reflect the ingredients corresponding to the current standards and may create confusion for the consumer. For example, the consecrated wholemeal bread recipe provides for the use of an whole flour whose definition in the standards of the time is not clear. Wholemeal bread is consumed since the interwar period and there was at least one official document (a discussion in a meeting of the Council of Ministers of 1942) in which it is mentioned that flour was used to obtain this type of bread with an extraction of at least 85% [4]. At this point, the whole wheat flour involves keeping in its content all the components of the wheat grain (germs, endosperm, outer shells).

Table 3. Technological clusters for old Romanian bakery products

	Cluster	Comments on recipes
1	Graham bread with honey	graham bread, compressed yeast, artificial honey and lactic acid
2	Wheat bread with potatoes	bread made from dark, white, whole wheat flour, with the addition of potato paste, potato flour, rice flour, yeast, water salt and enhancers such as: lactic acid, ascorbic acid, acetic acid, citric or diamalt
3	Hypoglycemic bread for diabetics	obtained from wet gluten with white and half-white wheat flour, wheat bran, yeast, salt, butter and cumin
4	Dietary bread	obtained from wheat flour type 1750, salt, yeast, whey and water
5	Baking products (with or without additions: rolls, buns, braids, sticks, bars, loafs, breads of different shapes and sizes)	Included in this category were a lot of products obtained from white flour, graham flour, type 800 flour, yeast, salt and various additions: sugar, glucose, diamalt, oil, fat, margarine, butter, milk, whey, buttermilk, lecithin, eggs, artificial honey, flavors, poppy, aniseed seeds, ascorbic acid, acetic acid, calcium gluconate, calcium citrate or calcium lactate
6	Wholemeal bread	obtained from whole wheat flour, yeast, salt and water
7	Rye bread	obtained entirely from rye flour type 1200, either from a mixture of rye flour type 1200 and wheat flour type 900, yeast, salt, diamalt and whey
8	Dâmbovița bread	obtained from wheat flour type 800, yeast, salt, water, to which diamalt and enhancers could be added, such as: lactic, ascorbic, citric, acetic acids or lecithin
9	Rye specialty	obtained from dark wheat flour, rye flour, yeast, salt, wheat bran and water
10	Graham specialty	obtained from dark wheat flour, graham flour, yeast, salt, cumin and water
11	Fibropan	obtained from wheat bran, white flour, yeast, salt, pasteurized powdered milk, water and baked in the tray
12	Low-calorie bread	obtained from wheat flour type 1250, protein flour type B from non-degreased corn germs, yeast, salt and water
13	Pandur specialty	obtained from type 900 durum wheat flour, yeast, salt, glucose or diamalt, whey or buttermilk, and water
14	Acloride bread	whole wheat flour, type 800 wheat flour, white flour, yeast, water and ascorbic acid, lactic acid, acetic acid, diamalt and lecithin
15	White bread	the product we currently buy under the generic title of white bread, obtained from white flour type 650, compressed yeast, salt and water; depending on the technological conditions, could be used as enhancers, different organic acids like ascorbic acid, diamond and lecithin
16	Sucevean specialty	obtained from white flour, yeast, salt, sugar, eggs, fats and milk
17	Little loaf dessert with apples	white wheat flour, yeast, salt, sugar, oil, lemon oil and grated apples
18	Vrancean specialty	white wheat flour, B type degreased soybean flour, maize cremogen, yeast, salt, sugar, oil
19	Bread with pre leaven (Galați bread, Danube bread)	white wheat flour, yeast, salt, type B degreased soybean flour, maize cremogen, diamalt, artificial honey, oil, lecithin and lactic bacterial extract
20	Protein bread	obtained from wet gluten, half-white wheat flour, yeast, wheat bran, salt and butter
21	Snagov specialty	white wheat flour type 680, yeast, salt, glucose, vegetable or animal fats, whey or buttermilk, corn cremogen and water
22	Bakery specialties with the addition of bran, wheat germs and wheat pearl barley (Mozaic, Herastrau, Germipan, Wheat)	obtained by baking a fermented dough prepared from white wheat flour, wheat bran, wheat pearl barley, wheat germs, milk, whey or buttermilk, oil, glucose or malt extract, or artificial honey and water

Source: Own conception based on [5].

Accepted losses are of maximum 1-2% as a result of a superficial peeling of the grain, to eliminate microbial or chemical contaminants remaining on the wheat kernel (microorganisms, mycotoxins, heavy metals, pesticides). An extraction of 85% can correspond to modern technologies of a classic flour of type 650-700, at most half-white flour.

However, the old Romanian recipes manage to combine, in a way that is missing from today's recipes, flours or technological products coming from various cereals or leguminous sources: corn flour, soybean flour, germs, rye flour, pearl barley, potato flour, graham flour, bran etc. In the current bakery all these ingredients come from premixes and are not directly managed by the bakers. Therefore, the old recipes have the advantage of the diversity of starch and fiber sources, as well as the use of protein sources that have disappeared in the usual recipes, such as whey and buttermilk.

If we combine the information from Tables 2 and 3 we can see that the products for which certificates have been obtained belong only to 4 of the 22 technological clusters (potato bread, rye bread, wholemeal bread and loaf bakery products).

Basically, only a little over 18% of the old Romanian recipes are currently represented in the range of products made after the consecrated recipes, offered by the Romanian producers. At the basis of this situation are probably both economic and social considerations, from which we list:

-technologies inadequate to the current requirements regarding energy efficiency and capital recovery (longer technological times, higher consumption of labor force, needs for monitoring and control of the technological parameters that involve specialized human resources);

-the lack of interest for the higher capitalization of the milling by-products (germs, bran, corn flower etc.), when the millers are used to deliver these products for animal feed and the bakers to buy them in the form of premixes, generally from the external markets. In the centralized economy, of the planned type, the by-products were scheduled to be part of certain food recipes for human consumption and the quantities that processors had to deliver to the food industry were established in advance;

-a distinction has to be made between nostalgia for food products available sometime and which we associate with certain flavors and tastes and the current expectations of consumers, interested in clean label foods.

No milling product can be found on the list of Romanian consecrated recipes. This is due to the fact that milling products are not the result of recipes, but of processing technologies that have not changed significantly in the last 40 years. The only significant change compared to how milling products were obtained 40 years ago concerns the correction of their milling quality. Basically, current milling products may contain certain amounts of substances with the effect of improving the technological potential, such as: ascorbic acid, cysteine, enzymes, vital gluten and so on.

Before 1984, additives were added exclusively in the bakeries, i.e. their use was conditioned by the destination of the flour in a certain bakery product. Basically, all milling products in which there are no enhancers additions can be considered as cosecrated recipe, in accordance with the legislation promoted by the Ministry of Agriculture.

Table 4. Milling products with potential for recovery in Romanian consecrated recipes

No.	Product name	Description
1	Biovit – flour from wheat germs	obtained by grinding wheat germs previously cleaned and heat treated at 130 140^0 C
2	Corn flour	resulting as a by-product in obtaining cornmeal, it can be used as an additive in various bakery products
3	Calciu gris (calcium semolina)	wheat semolina (99%) and 1% tricalcium phosphate or calcium gluconate
4	Cremogen of wheat or corn	fine white powder with shades of gray, respectively golden yellow, obtained by the expansion of wheat semolina or extra wheatmeal, followed by grinding and sieving; it can be used in the recipes of bakery products, sugary products, instant creams or mayonnaise

Source: Own conception.

However, there are a number of products from the milling industry since then, that can be re-evaluated as consecrated recipes, in the sense that they are characteristic of that era and are

not widely manufactured today. These would contribute to increase of the offers diversity on the market with minimal efforts from industry operators and would allow access to an important source of nutrients for consumers (Table 4).

We consider that, from the information presented here, the use of old recipes and technologies in modern food products can be a significant gain for the consumer. The disintegration of the centralized economic system and implicitly the dissolution of the institutions involved in standardizing the recipes and the norms of manufacturing the Romanian food products, led to the disappearance of the food products on the markets that could contribute to the diversification of the existing offers. Some of the old products of the Romanian milling and bakery industry are now imported or are part of the composition of complex inputs used in the industry, but coming from import.

The benefit of the legislation on food products based on consecrated recipes should not necessarily be a psychological one (the return of the consumer to the flavors and tastes he was once familiar with), because some of these recipes are in contradiction with the modern evolution of consumer behavior, being not “clean label” and containing ingredients that are currently controversial.

CONCLUSIONS

Romania has created a specific legislation whose purpose is to recover old recipes and technologies for the manufacture of certain bakery products. These products are identified as being obtained according to "Romanian consecrated recipes".

5 years after the implementation of the legislation, the number of certified bakery products is quite small, 9 products, of which only 7 can be considered as completely belonging to the bakery industry. Also, the number of producers who hold certificates is very small (21 producers compared to several thousand who operate on the bakery market) placed in less than half of the national territory.

The vast majority of applications for certification are concentrated on bakery products containing additions of potato-derived products.

Only slightly over 18% of the old recipes and technologies are represented in the range of products certified according to the legislation in force.

No milling product is certified, although there are old milling products for which there is no equivalent in products available on the market obtained from current recipes.

The products obtained from consecrated recipes have the quality to contribute to the diversification of the available food resources and to the superior use of some by-products from the industry, but they are not necessarily correlated with the modern trends of the industry in terms of energy efficiency, capital valorization or consumer expectations (no clean label).

REFERENCES

[1]Bordei D., 2005, Moodern bakery technology (Tehnologia modernă a panificației), Agir Publishing House, București, pp. 233-234.

[2]Bread market between tradition and innovation, 2019, White art (Piața pâinii între traditie și inovatie, 2019, Arta albă, https://artaalba.ro/piata-painii-intre-traditie-si-inovatie/, Accessed on Jan.5th, 2020.

[3]Cauvain, S.P., Young, L.S., 2006, The Chorleywood Bread Process, Woodhead Publishing Limited and CRC Press LLC, pp. 17-18.

[4]Ciucă, M.D., 2000, National Archives of Romania - Stenograms of the meetings of the Council of Ministers - Government Ion Antonescu, Vol. VI (Feb. - May 1942) Mica Valahie Publishing House, Bucharest (Arhivele Naționale ale României - Stenogramele sedintelor Consiliului de ministri - Guvernarea Ion Antonescu, Vol. VI (Feb. – Mai 1942) Ed. Mica Valahie, Bucuresti, pp. 267).

[5]Collection of standards for the milling and baking industry, volume II, Ministry of Food Industry, Industrial Milling and Breading Plant, Organization and Calculation Center Bucharest, 1989 (Colectie de standarde pentru industria de morarit si panificatie, vol II, Ministerul Industriei Alimentare, Centrala Industriala de Morarit si Panificatie, Centrul de Organizare și Calcul Bucuresti, 1989).

[6]Leonte, M., 2008, Technologies, machines and quality control in the bakery, pastry, confectionery, biscuits and pasta industry (Tehnologii, utilaje si controlul calitatii in industria de panificatie, patiserie, cofetarie, biscuiti si paste fainoase), Vol. 1, Ecozone Publishing House, Iasi, pg. 8 – 22.

[7]Ministry of Health, Order No.290 of 13 March 2014 regarding the attestation of the food products obtained according to the established Romanian recipes (Ministerul Sanatatii, Ordinul Nr.290 din 13.03.2014 privind atestarea produselor alimentare obţinute conform reţetelor consacrate româneşti), http://www.legex.ro/Ordin-290-2014-133017.aspx, Accessed on Jan.5, 2020.
[8]Moldoveanu, Gh., Niculescu, N. I., Mărgărit, N., 1973, The Book of the Baker (Cartea Brutarului), Tehnica Publishing House, Bucharest, pp. 82.
[9]Panaete, M., 2019, Romania has the lowest prices for bakery products in Europe, but it is the highest European consumer of bread (România are cele mai mici preţuri la produsele de panificaţie din Europa, dar este cel mai mare consumator european de pâine), Eurostat, quoted by Ziarul Financiar, https://www.zf.ro/companii/retail-agrobusiness/romania-are-cele-mai-mici-preturi-la-produsele-de-panificatie-din-europa-dar-este-cel-mai-mare-consumator-european-de-paine-18401440, Accessed on Jan.5th, 2020.
[10]Popa, N. C., 2007, The influence of some plant and microbial breeders on the quality parameters of wheat flour. Doctoral thesis, Faculty of Horticulture, University of Agronomic Sciences and Veterinary Medicine, Bucharest (Influenţa unor amelioratori de origine vegetală şi microbiană asupra parametrilor de calitate ale făinurilor din grâu. Teză de doctorat, Facultatea de Horticultură, Universitatea de Ştiinţe Agronomice şi Medicină Veterinară, București).
[11]Tamba-Berehoiu, R., Popa, C. N., Popescu, S., 2013, Assessment of the E 920 additive (l-cysteine) in relation to some problems of modern food industry. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 13(1), 413-418.
[12] The joint order of the Minister of Agriculture and Rural Development, the Minister of Health and the President of the National Authority for Consumer Protection no. 394/290/89 of 2014 (Ordinul comun al Ministrului Agriculturii si Devoltarii Rurale, Ministrului Sanatatii si a Presedintelui Autoritatii Nationale pentru Protectia consumatorilor nr. 394/290/89 din 2014).
[13]Vaschi, M., 2019, For European consumers, healthy eating means "less" and "more" at the same time, Piaţa Magazine (Pentru consumatorii europeni, mâncarea sănătoasă înseamnă “mai puțin” și “mai mult” în același timp, Revista Piața), https://www.revista-piata.ro/lazi/la-zi/item/14918-studiu-puratos-pentru-consumatorii-europeni-mancarea-sanatoasa-implica-mai-mult-si-mai-putin-in-acelasi-timp, Accessed on Jan.5th, 2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

TRENDS AND CHANGES IN TOURIST FLOW IN ROMANIA IN THE PERIOD 2009-2018

Agatha POPESCU[1], Adelaida Cristina HONTUS[1], Mirela CARATUS-STANCIU[2]

[1]University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest Romania, Phone: +40213182564, Fax: +40213182888, Email: agatha_popescu@yahoo.com, adelaidahontus@yahoo.com
[2]"Lucian Blaga" University of Sibiu, Faculty of Agricultural Sciences, Food Industry and Environmental Protection, 5-7 Ion Ratiu Street, 550003, Sibiu, Romania, Phone: +40269211338, Fax:+40213182888, Mobile:+40744472790, Email: mirela_stanciu2008@yahoo.com

Corresponding author: agatha_popescu@yahoo.com

Abstract

The paper analyzed the tourist flow in Romania in order to identify the main trends and changes during the period 2009-2018 using the official empirical data and the specific indicators: tourist arrivals, overnight stays, average length of stay, monthly concentration rate, tourism intensity and residents' travels abroad. Romania has become year by year a more attractive tourist destination as the total arrivals reached 12.9 million in 2018, a double level than in 2009. The market is dominated by the Romanian visitors who accounted for 78% of arrivals. Hotels absorbed 9 million tourists, meaning 70 % of arrivals. More than 86 % foreigners prefer hotels. The overnight stays increased by 60% reaching 23.3 million in 2018, but the general trend is a decreasing one. Of the total overnight stays, 82 % belong to the Romanian tourists and 90 % are recorded in hotels. The length of stay is in general short about 2 days and with a tendency of decline. The most numerous arrivals are concentrated in August and July when the concentration rate is about 14-15 %. The occupancy rate increased, but it reached 22.18 % in 2018, the lowest level among the EU countries. In hotels, the occupancy rate reached 30 %. With 66 tourist/100 inhabitants and 54.13 per km^2, Romania's tourism intensity is among the lowest in the EU. In 2018, the residents registered 21 million travels abroad, by 80 % more than in 2009 and with a tendency to grow. As a final conclusion, Romania's potential in tourism should be much better exploited, the demand/offer ratio should be balanced, tourist destinations should be more intensively promoted and service quality should be improved in order to grow the attractiveness of the country and tourist flow.

Key words**:** *tourist flow, changes, trends, arrivals, overnight stays, length of stay, concentration rate, tourism intensity*

INTRODUCTION

During the last decades, tourism has become one of the fastest growing economic branches in the world economy with a deep impact on the socio-economic progress [45].

Tourism flows have recorded a fast increase as never before due to people's interest to travel and meet other cultures and civilizations. This was due to the longer free time and vacations, the higher income, and the increased need of the people to explore the culture, history, landscapes and traditions of other countries. Therefore, all these aspects led to a higher tourism demand which obliged offer to adapt to the new requirements and challenges. In consequence, tourism was facing a sustainable growth of tourism flows and receipts [24, 25, 36].

In 2017, international tourists' arrivals accounted for 1,323 million and generated USD 1,340 billion receipts. Tourism has an important impact on the global economy contributing by 10 % to the GDP and 1/10 jobs, by USD 1.6 trillion to exports [47].

Europe is the top tourist destination in the world, attracting million of tourists every year, accounting for 51.3% of the world international flow [30, 31].

Besides the top visited countries in the EU-28: France, Spain, Italy, United Kingdom, Germany, Austria, Greece, Portugal, Netherlands, Belgium, the Central and Eastern countries of Europe are more and more visited by tourists. Poland, Czechia, Croatia,

Slovenia, Hungary, Slovakia, Romania, Bulgaria have a large variety of interesting attractions and among them it is a high competition in improving service quality and promoting tourist destinations for getting more visitors year by year [33, 35].

Romania is one of the Central Eastern European countries of a high attractiveness grace to its beautiful landscapes, the unique travel experiences that it offers to visitors in the Danube Delta, in the Carpathians Mountains, on the seashore of the Black Sea, the valuable historical and cultural heritage represented by castles, palaces, museums, art galleries, specific architectural treasures, monasteries and churches, medieval cities and fortresses, folk traditions and customs, gastronomy, hospitality and kindness of the people.

The rich and unique treasures such as: the old and beautiful Orthodox churches of North part of Romania (Voronet, Moldovita, Gura Humorului, Sucevita, Moldovita, Arbore etc), the Dacian fortresses in the Orastie Mountains, the medieval city of Sighisoara, the Danube Delta, the Horezu Monastery in Wallachia, the villages with fortified churches of Transilvania, the wooden churches of Maramures etc. are included in the UNESCO world heritage and are tourist destinations for the visitors who desire to meet the civilization and culture in this part of the Central-Eastern Europe.

The Danube Delta, the seashore resorts at the Black Sea, the skiing resorts in the Romanian Carpathians, the rural tourism in the traditions and customs in the villages of Bucovina, Maramures and Banat, the spa and health resorts based on mineral and thermal waters, the caves, the Transfagarasan and Transalpina roads, the glacial lakes, the George Enescu festival in Bucharest, the International Theater Festival in Sibiu, the Transilvania International Movie Festival in Cluj-Napoca, the Golden Deer Festival in Brasov, the Dracula legend, the food and wine festivals are among the most important tourist attractions [1, 8, 16, 44].

On the map of tourist destinations in the Eastern part of Europe, Romania has become more and more important, year by year being visited by more foreign visitors, and also the residents who dominate the internal market have become more and more interested to travel through the country and to discover its large mosaic of treasures.

In this context, the objective of this research was to analyze tourist flows in Romania in order to evaluate the main trends and changes based on the empirical official data and a large number of specific indicators which could offer a comprehensive image of the tourism in the period 2009-2018.

MATERIALS AND METHODS

Data collection

The research is based on the data were collected from the National Institute of Statistics Tempo Online Database for the period 2009-2018.

The following indicators were studied:

(i)Number of tourists visiting Romania, of which Romanians and foreigners,

(ii)Annual change in the number of tourists;

(iii)Trend line in the number of tourists;

(iv)Number of tourists accommodated in hotels,

(v)Number of overnight stays, of which belonging to Romanians and foreign tourists;

(vi) Annual change in the number of overnight stays;

(vii) Trend line in the number of overnight stays; (viii)Number of overnight stays in hotels,

(ix)Average length of stay,

(x)Trend line in average length of stay,

(xi) Tourist arrivals along the year 2018 by month,

(xii)Monthly tourist concentration rate,

(xiii)Occupancy rate of the places in establishments with function for tourist accommodation,

(xiii)Romanians' travels abroad.

Methodological aspects used in this study

Dynamics analysis was analyzed involving:

- Index with fixed basis, $I_{FB(\%)}$, using the formula: $I_{FB(\%)} = (X_n/X_1)100$, where: X_n is the variable level in the year n and X_1, the variable level in the year 1.

- Index with variable basis, $I_{VB(\%)}$, using the formula: $I_{VB(\%)} = (X_n/X_{n-1})100$, where: X_{n-1} is the variable level in the previous year.

Trend line of the variable was established using the Excel facilities.

Average length of stay, ALS, was calculated with the formula: ALS = OS/NT, where: OS = overnight stays and NT = number of tourists.

Monthly concentration rate, $MCC_{(\%)}$, was determined with the formula: $MCC_{(\%)}= (NT_m/NT)100$, where: NT_m = number of tourists per month, NT = number of tourists.

Occupancy rate, $OR_{(\%)}$, was calculated with the formula: $OR_{(\%)} = [OS/(NP*D)]100$, where: OS = overnight stays, NP= number of places (beds), D = 365 days (the supply days).

Tourism intensity, TI, was determined in two variants: (a) in relation to the population, according to the formula: $TI_{(P)}$= NT/100 inhabitants, where: NT = number of tourists and (b)in relation to the surface, using the formula: $TI_{(S)}$= NT/S, where: S= surface of Romania, i. e. 238,397 km^2.

Comparison method was used to analyze the level of the studied indicators in various years. The results were graphically illustrated and also tabled and finally commented.

RESULTS AND DISCUSSIONS

Number of tourists visiting Romania has doubled its figure in 2018 compared to 2009, accounting for 12,905,131 visitors, of which 78.3% Romanians and 21.7% foreigners.

The number of the Romanian tourists increased by 107.7% from 4,865,545 in 2009 to 9,383,266 in 2018. This was due to the need of active relaxation, leisure, desire to know the beautiful landscapes in the mountains and at the Black Sea, the cultural and historical heritage in terms of castles, palaces, medieval fortresses, memorial houses, monasteries and churches, monuments, museum and art galleries, folk traditions and gastronomy.

Romania looks to become a more and more attractive destination for foreign tourists as well, because in the analyzed period their number increased by 119.2 % from 1,275,590 in 2009 to 2,796,622 in 2018 (Fig. 1).

The main countries of origin of the foreign visitors are: Germany, Italy, France, United Kingdom, Hungary, Spain, Poland, Austria, but also Israel, USA, and China [41].

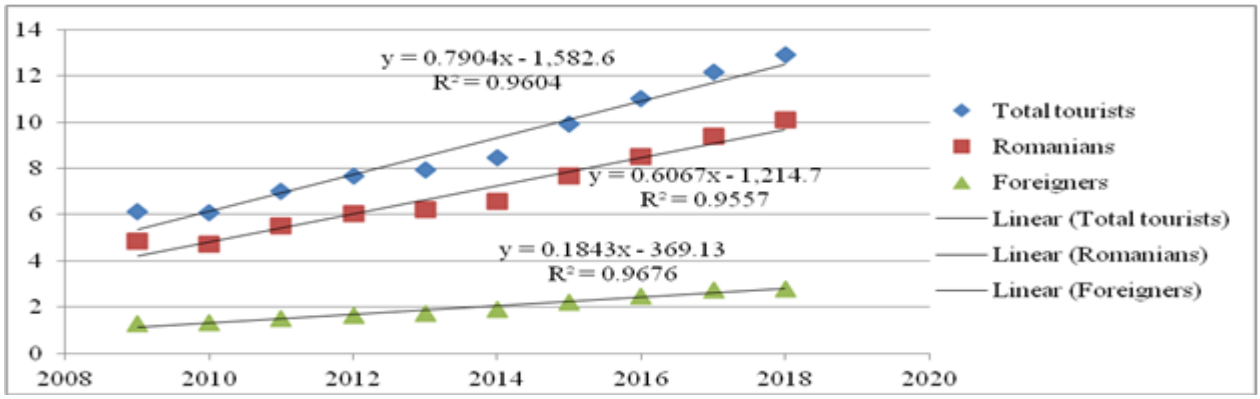

Fig. 1. Dynamics and trend line of the number of tourists visiting Romania, 2009-2018 (Million)
Source: Own design based on [17].

Annual change in tourists' number reflected the different growth rates from a year to another. At the country level, the highest growth rates were registered in 211 versus 2010, +15.78%, and in 2015 versus 2014, + 17.19%. In case of the Romanian tourists, the highest growth rates were recorded also in 2011 versus 2010, +16.68%, and in 2015 versus 2014, +17.25%. In case of the foreign tourists, the highest growth rate accounted for +12.65% in 2011 versus 2010 and for +16.99 in 2015 versus 2014 (Table 1).

The higher and higher tourist arrivals in Romania brings the country on 34th position among the tourists destinations [3].

This has determined the growth of the spending on tourism activities and of the receipts in tourism, these two indicators being closely related [4, 43].

Despite its high touristic potential, its natural, human, and cultural and historical resources are not enough and efficiently used in comparison with the top 10 most visited countries in the EU-28 and even with Slovenia, Bulgaria, Hungary and Poland and for this reason the number of arrivals is lower. But, Romania has more visitors than Slovakia, Serbia, Bosni Hertzegovina, Belarus and Rep. of Moldova [15, 33].

Table 1. Annual change in tourists' demand, Romania, 2009-2018 (%)

	Annual change in:		
	Total tourists	Romanian tourists	Foreign tourists
2009	100.00	100.00	100.00
2010	98.88	97.14	105.54
2011	115.78	116.68	112.65
2012	109.31	109.34	109.21
2013	103.33	103.24	103.67
2014	106.58	105.22	111.48
2015	117.19	117.25	116.99
2016	110.89	110.93	110.75
2017	110.36	110.11	111.25
2018	106.27	107.72	101.32

Source: Own calculation based on [16].

The territorial distribution of tourists arrivals is not equal among the regions of development and counties.

The most numerous visitors were noticed in the Central part of Romania, Bucharest- Ilfov area and South Eastern part and Western part of the country [9, 10, 27, 28].

The most agreable and interesting attractions for visitors are considered to be: Transilvania, especially Maramures, Cluj Napoca, Sibiu, Brasov, Mures, Sighisoara, Hunedoara, Alba Iulia [6, 19, 20, 21, 34, 37, 38, 46], Bucharest-Ilfov due to the capital which the most visited city in Romania [14, 32], Bucovina [2, 22] and the Romanian resorts at the Black Sea [18, 39].

The higher flow of tourists in specific areas of Romania has determined the alignment of the offer of tourist services in terms of accommodation capacity (establishments and places) so that the ratio demand/offer to be balanced and the economic efficiency in the travel and tourism sector to be higher. This means a better management and strategic planning in tourism offer using innovation and creativeness in assuring infrastructure in close relationship with tourism demand [5, 7, 11, 12, 13, 26, 29, 42].

Number of tourists accommodated in hotels

Hotels are the main establishments preferred by tourists to accommodate during their stay or travels through Romania and this is available both for Romanians and foreigners.

In 2018, the hotels registered 9,004,486 tourist arrivals, by 98.34% more than in 2009. The Romanian tourists accommodated in hotels accounted for 6,606,653 persons in 2018, being by 94.17% more than in 2009.

The highest growth rate, more exactly +110.82%, was registered by the foreign tourists who preferred to be accommodated in hotels, whose arrivals reached 2,397,833 in 2018 compared to 1,137,357 in 2009.

Therefore, in 2009, 73.92% of the total number of tourists were accommodated in hotels, and taking into account their origin, 86.16% of nonresidents tourists and 69.93 % of residents tourists preferred the hotels.

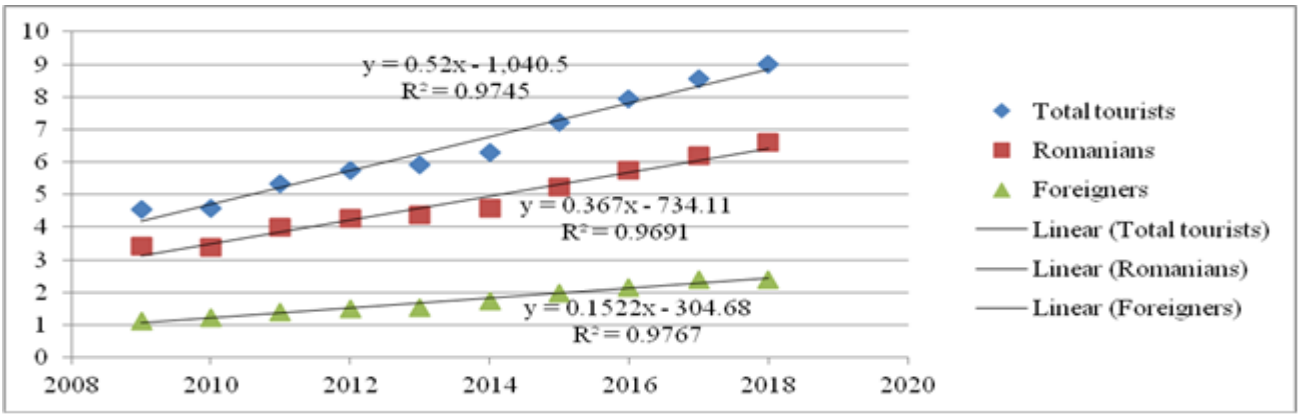

Fig.2. Dynamics and trend line of the number of tourists accommodated in hotels, Romania, 2009-2018 (Million)
Source: Own design based on [17].

The high percentage of hotels among the tourists' preferences for accommodation is justified by the high degree of satisfaction for facilities and service quality compared to other types of establishments [40].

In the analyzed period it was noticed a decline in the preferences for hotel accommodation, so that in 2018 the proportion of tourists accommodated in hotels was as follows: 69.77% of the total number of tourists, 65.35% of the Romanian tourists and 85.74% of the foreign visitors.

However, the foreigners prefer especially hotels probably thinking that the facilities and service quality related to price/room and night could satisfy much better their needs and expectations than other types of establishments with function for visitors' accommodation (Fig.2).

Number of overnight stays registered by the tourists visiting Romania has also increased in the analyzed interval. In 2018, the total number of overnight stays accounted for 28,644,742, being by +65.33% higher than in 2009.

The overnight stays belonging to the residents accounted for 23,315,138 in 2018 being by 59.06% higher than in 2009.

The highest growth rate was recorded by non residents, their overnight stays reached 5,329,604 in 2018 compared to 2,667,666 in 2009 (Fig.3).

The share of the overnight stays belonging to the Romanian tourists in the total overnight stays was 81.39% in the year 2018 and the remaining belonged to the foreign visitors.

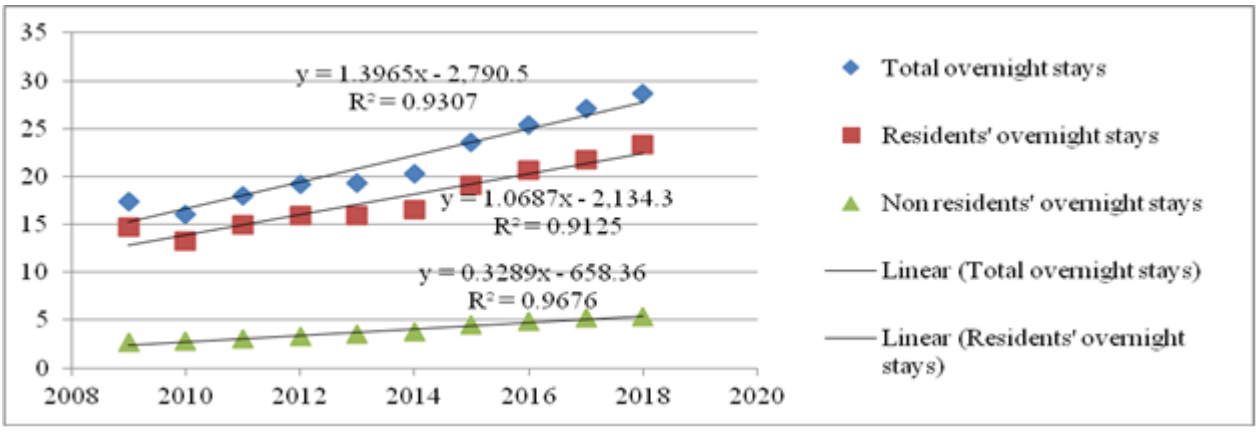

Fig.3. Dynamics and trend line of the overnight stays in establishments with function for tourists' accommodation, Romania, 2009-2018 (Million)
Source: Own design based on [17].

The number of overnights stays per inhabitant in Romania is about 1, the lowest level in EU-28 countries [23].

Annual change in the number of overnight stays varied from a year to another depending on the number of arrivals.

The highest growth rates were registered in the same years like in case of the number of tourists, respectively in 2011 and 2015 compared to the previous years (Table 2).

Number of overnight stays in hotels raised by 53.65% in 2018 accounting from 20,935,932 compared to 13,625,294 in 2009 (Fig.4).

Table 2. Annual change in the number of overnight stays in establishments with function for tourists' accommodation Romania, 2009-2018 (%)

	Annual change in:		
	Total overnight stays	Romanians' overnight stays	Foreigners' overnight stays
2009	100.0	100.0	100.0
2010	92.6	90.6	103.7
2011	112.0	112.2	110.8
2012	106.6	106.4	107.5
2013	101.0	100.1	105.5
2014	104.7	103.9	108.3
2015	115.9	115.3	118.6
2016	108.2	108.2	108.1
2017	106.4	105.7	109.5
2018	195.7	106.9	100.7

Source: Own calculation based on [17].

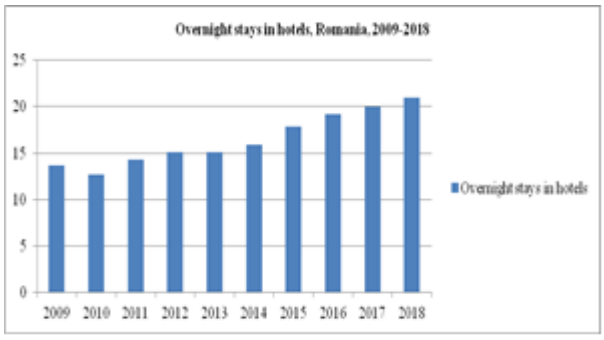

Fig.4. Dynamics and trend line of the overnight stays in hotels, Romania, 2009-2018 (Million)
Source: Own design based on [17].

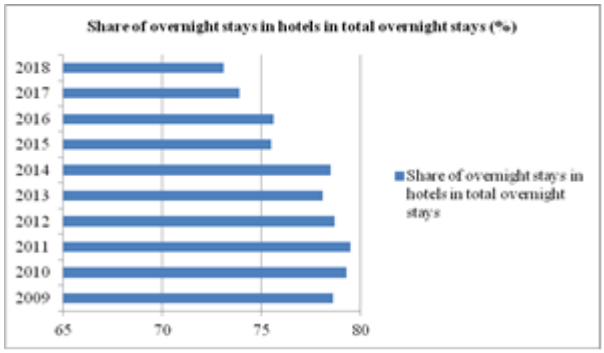

Fig. 5. Share of overnight stays in hotels in the total overnight stays, Romania, 2009-2018 (%)
Source: Own design based on [17].

The share of the overnight stays in hotels in the total overnight stays declined from 78.64 % in 2009 to 73.08% in 2018, reflecting the change in tourists' preferences for accommodation during their stay (Fig.5).

Average length of stay registered a decreasing trend in the analyzed period. In 2009, the level of this indicator was 2.82 days, while in 2018, it was 2.22 days, reflecting a decline by -21.28%.

In case of the Romanian tourists, the average length of stay declined by -23.26% from 3.01 days in 2009 to 2.31 days in 2018. In case of the foreign tourists, the duration of stay decreased by only 8.7% from 2.09 days in 2009 to 1.91 days in 2018.

The figures proved that the foreigners registered a lower length of stay compared to the Romanians, but the decline of the average length of stay is smaller (Fig. 6).

Tourist arrivals along the year 2018 reflects the seasonality of tourism. In general, in February, the number of tourists is at the lowest level compared to other months.

The most preferred months for visiting Romania, taking into account the total number of visitors in 2018, were, in the decreasing order: August, July, September, June, October and May. In August 2018, Romania was visited by 1,848,953 tourists whose number is 2.61 times higher than in February.

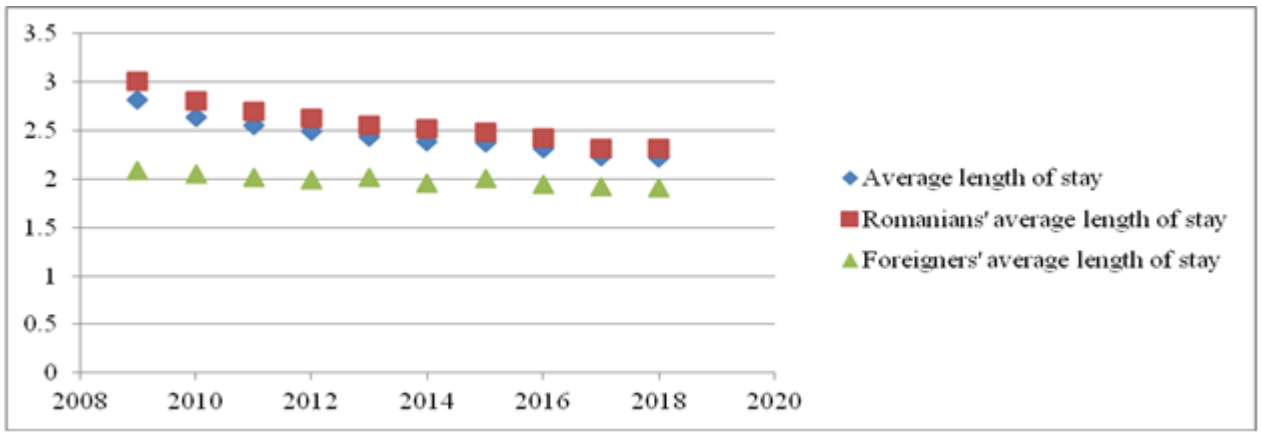

Fig. 6. Dynamics of the average length of stay, Romania, 2009-2018 (days)
Source: Own design based on [17].

In case of the Romanian tourists, also in August was recorded the highest number of arrivals, accounting for 1,520,457, meaning 82.23% of the total arrivals in this month. The foreigners' arrivals accounted for 328,496 in August, the highest level in their case. The non residents prefer the same months to visit Romania like Romanians but the peak of their arrivals are in the following months in the decreasing order: August, July, June, September, May and October (Fig. 7).

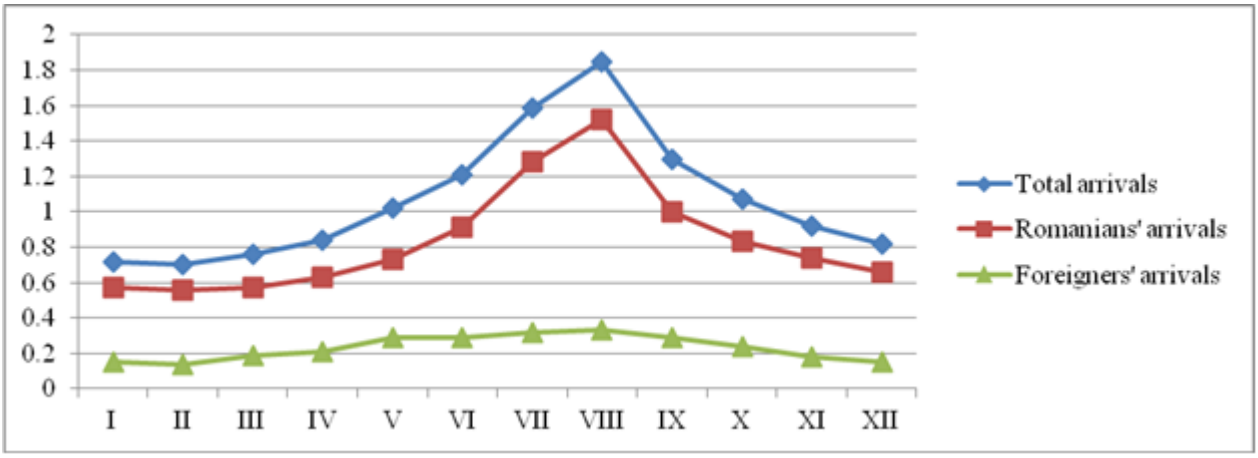

Fig. 7. Dynamics of the tourists' arrivals by month in 2018, Romania, 2009-2018 (Million)
Source: Own design based on [17].

Monthly tourist concentration rate is another indicator reflecting the distribution of tourist arrivals along the year.

Taking into consideration the total arrivals in the year 2018, the concentration rate had the following levels in the months with the highest number of tourists: August 14.3%, July 12.3 %, September 10.1%, June 9.4%, October 8.2% and May 6.5%. The lowest concentration rate was noticed in February, 5.5%.

In case of the Romanian tourists, the highest concentration rate was registered as follows: 15.1 % in August, 12.7 % in July, 10.1 % in September, 9.1 % in June, 8.3 % in October and 7.3 % in May, and the lowest level in February, 5.6%.

In case of the foreign tourists, the highest concentration rate was: 11.8% in August, 11.35 in July, 10.6% in June, 10.5% in September, 10.3 % in May and 8.8% in October (Fig.8).

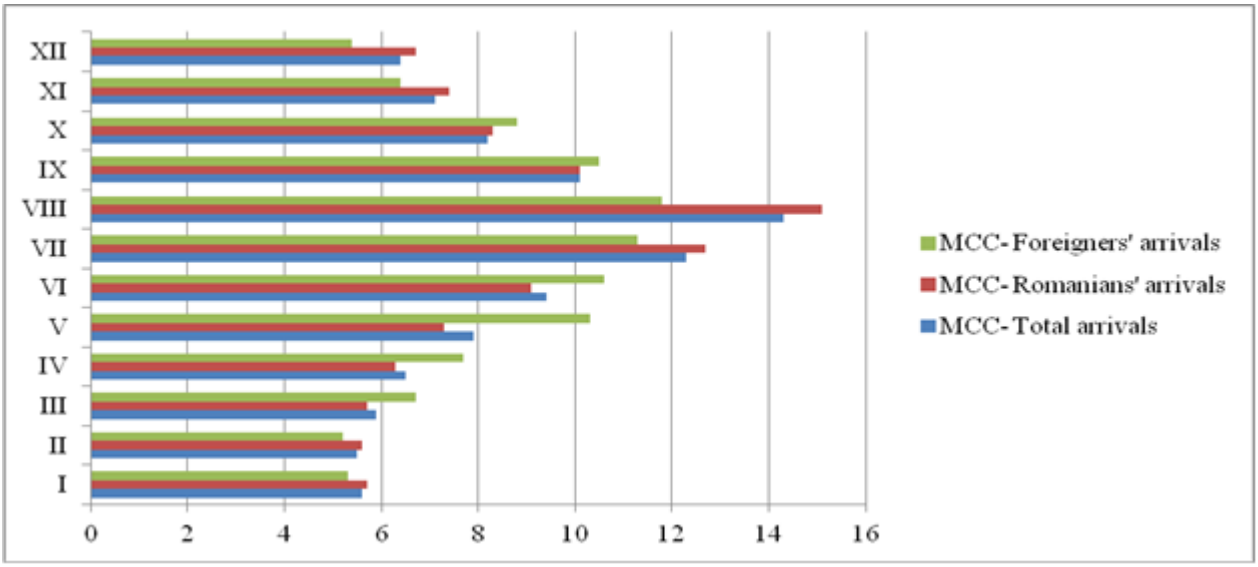

Fig. 8. The monthly concentration rate (MCC) of tourist arrivals in 2018, Romania, 2009-2018 (%)
Source: Own design based on [17].

Occupancy rate in Romania's establishments with function for tourist accommodation is in general low and varies along the year, the peak rates are registered in summers season.

Taking into consideration the whole number of units with function for tourist accommodation, the occupancy rate increased from 15.64 % in 2009 to 22.18% in 2018.

In hotels, the occupancy rate is higher than at the country level and also registered an ascending trend from 20.83% in 2009 to 29.34% in 2018 (Fig.9).

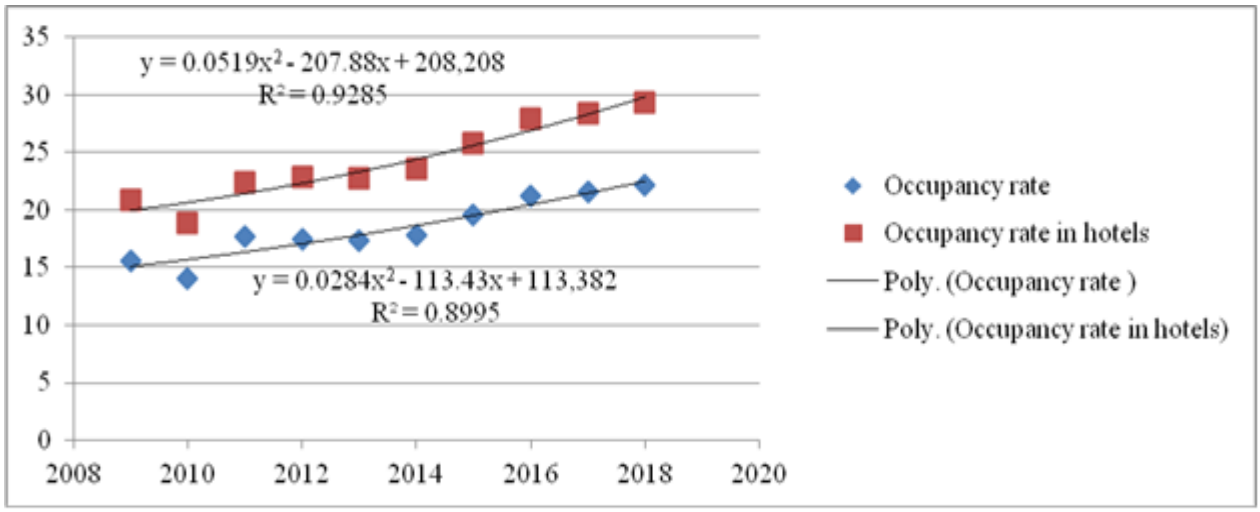

Fig. 9. The occupancy rate in the establishments with function for tourist accommodation, Romania, 2009-2018 (%)
Source: Own design based on [16].

Tourism intensity in Romania increased from 30 tourists per 100 inhabitants in 2009 to 66 tourists in 2018, and per square kilometer, it was also noticed an increase from 25.76 tourists in 2009 to 54.13 tourists in 2018 (Table 3).

Table 3. Tourism intensity (TI), Romania, 2009-2018

	TI/100 inhabitants	TI/km²
2009	30	25.76
2010	30	25.47
2011	35	29.49
2012	38	32.24
2013	40	33.32
2014	42	35.51
2015	50	41.61
2016	56	46.15
2017	62	50.94
2018	66	54.13

Source: Own calculation based on [17].

Romanians' travels abroad registered a variation from a year to another but the general trend is an increasing one. In 2009, 11,723 thousand persons travelled abroad for tourist purposes, while in 2018 their number reached 21,039 thousand persons, being by 79.4% higher than at the beginning of the studied period.

This justify the desire to extend the knowledge horizon meeting other cultures and civilizations and also an increase of income destined to be spent for tourism abroad (Fig.10).

The most preferred countries by Romanians are Greece, Bulgaria, Turkey, Spain, Italy, France, Hungary.

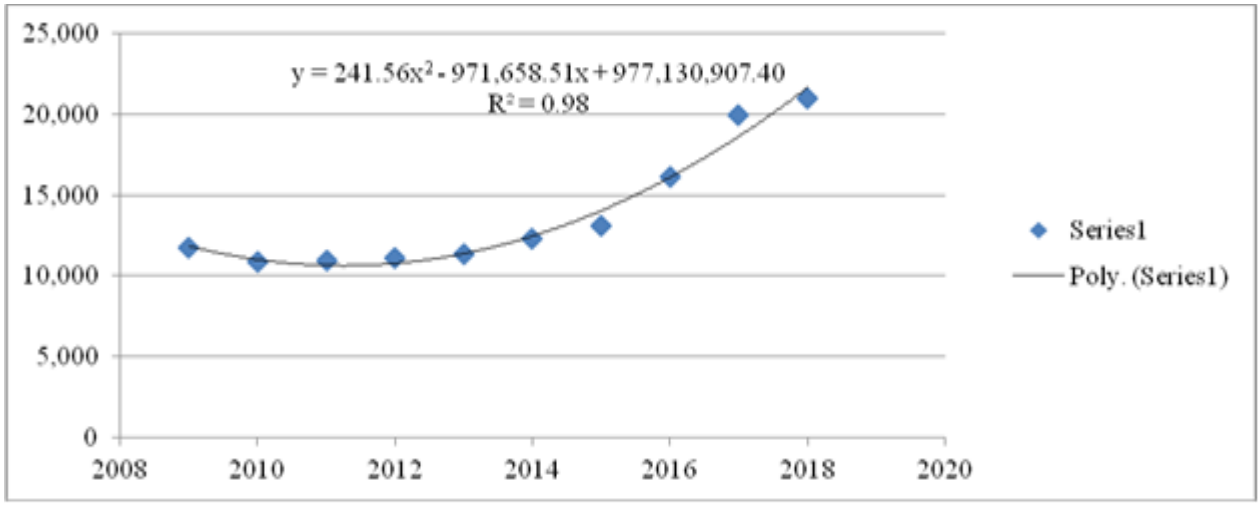

Fig. 10. Dynamics and trend line of the Romanians' travels abroad, 2009-2018 (Thousand)
Source: Own design based on [17].

CONCLUSIONS

The analysis of tourist flow in Romania during the period 2009-2018 has proved that Romania becomes more and more attractive as a tourist destination both for the residents and non-residents.

In 2018, the number of arrivals reached 12.9 million, a double level than in 2009. The Romanian tourists dominate the market with 78.3% and the highest annual change rate was registered in 2011 and 2015. The most visited areas of Romania are Transilvania, Bucharest-Ilfov, Bucovina, The Danube Delta and West part.

In 2018, 9 million tourists, that is 70 % of total arrivals, were accommodated in hotels. About 86% of the foreign tourists preferred hotels as well.

The overnight stays reached 23.3 million in 2018, being by 60 % higher than in 2019. But, while the arrivals trend is an increasing one, in case of overnight stays, it was noticed a declining tendency. Of the total overnight stays, 82 % belong to the Romanian tourists and 90 % are recorded in hotels.

The average length of stay is very short in Romania compared to other countries, and has a decreasing trend.

Tourism is a seasonal activity, as long as the highest concentration rate of arrivals, 14-15 % is in the summer months, mainly in August and July.

The occupancy rate is very small in Romania, 22.18% in 2018, compared to the most visited countries. However, it has the tendency to grow which is a positive aspect. In hotels, the occupancy rate reached 30 %.

Tourism intensity has also a low level, just 66 tourist/100 inhabitants and 54.13 per km^2 compared to other countries.

Romanians are not among the top travellers, but the number of their voyages abroad reached 21 million in 2018 being by 80 % more numerous than in 2009.

Therefore, the analysis led to the conclusion that tourism has been continuing to develop in Romania a fact confirmed by the higher and higher number of resident and non-resident visitors.

But, it was also highlighted that the tourism potential of Romania is not enough valorized, there are still discrepancies between demand and offer, the promotion of tourism need to be intensified, service quality has to be improved in all the types of establishments with function for tourist accommodation to increase the attractiveness of the country and the tourist flow.

REFERENCES

[1]Angheluta, V.A., 2016, Romania - a country branding and tourist destination (Romania- branding de tara si destinatie turistica), https://books.google.ro/books?id=7NeECwAAQBAJ&pg=PA83&lpg=PA83&dq=analysis+romania;s+tourism&source=bl&ots=qb5IarUz2O&sig=ACfU3U2k1rmkXKIjjHTotR2IwHhYOMPFHw&hl=ro&sa=X&ved=2ahUKEwjhpPzw78TmAhXQ-yoKHc-XBNA4RhDoATAHegQIChAB#v=onepage&q=analysis%20romania%3Bs%20tourism&f=false, Accessed on Dec.20, 2019.

[2]Bähre, H., Fergen, U., Chasovschi, C., 2013, Bucovina as a tourist destination and the impact of the recent international financial crisis. Recommendations for a modern destination management approach in international destination marketing, Journal of tourism-studies and researches in tourism, No.16, North America, http://www.revistadeturism.ro/rdt/article/view/172, Accessed on Dec.21, 2019.

[3]Bujdoso, Z., Pénzes, J., Madaras, S., David, L., 2015, Analysis of the spatial trends of Romanian tourism between 2000-2012, Geographia Technica, Vol. 10(2):9-19.

[4]Cioban, G.L., 2015, The black swan of the Romanian tourism, Ecoforum, Vol.4(1)(6), pp.88-93

[5]Coroş, M.M, Negruşa, A.L., 2014, Analysis of Romania's and Transilvania's tourist supply development and performance, Amfiteatru Economic, Vol. XVI • Special No. 8 • November 2014, 1312-1326.

[6]Cosma, S., Negrusa, A., 2008, The place of cultural tourism for Cluj-Napoca, Romania as a tourist destination, WSEAS Transactions on Business and Economics, Vol.5(7):403-413.

[7]Grigoras, M.A., Popescu, A., Holeab, C., Chedea, V., Merce, E., 2007, Bridging the innovation gap and the management of interdisciplinary project for sustainable development, XXXVII Annual Meeting of European Society for New Methods in Agricultural Research, ESNA, Sept.10-14, 2007.

[8]Honţuş, A. C., 2009, Tourist and agrotouristic geography of Romania - 2nd revised edition, Ceres Publishing House, Bucharest, pp.85.

[9]Honţuş, A. C., 2012, Tourist traffic analysis for the Maramureş better area tourist facilities, Scientific

Papers Series Management, Economic Engineering in Agriculture and Rural Development, Faculty of Management, Economic Engineering in Agriculture and Rural Development, Vol.12(3):75-78.
[10]Honţuş, A. C., 2013, Study on tourist traffic analysis for tourism area planning in the town of Moreni, Dâmboviţa county, Bulletin of UASVM-CN, Horticulture, 70(2):331-338.
[11]Honţuş, A., 2014, Analysis of tourist traffic - one of the essential elements for planning travel to an area, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 14(1):147-152.
[12]Honţuş, A. C., 2015, Land Planning for tourism and agrotouristic - the Second edition revised and enlarged, Ceres Publishing House, Bucharest, pp.25.
[13]Honţuş, A. C., 2015, Analysis of tourist traffic in Slanic Prahova to develop tourism in the area,
Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 15(3):159-165.
[14]Honţuş, A. C., Tindeche, C., 2019, dynamics of tourist circulation in Ilfov County for the tourist area planning, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Faculty of Management, Economic Engineering in Agriculture and Rural Development, Vol.19(4):101-108.
[15]Kadir, K., Sibel, S., 2014, Determinants of tourist inflows to Romania: Evidence from augmented panel gravity model, Annals of Oradea University, Economic Sciences, 347-358.
[16]Mazilu, M., Dumitrescu, D., Marinescu, R., Baltălungă, A., 2019, New Trends in Romanian Tourism in 2018, J Tourism Hospit 7(4): 372. https://www.longdom.org/open-access/new-trends-in-romanian-tourism-in-2018-2167-0269-1000372.pdf, Accessed on Dec.20, 2019.
[17]NIS Tempo Online Database, 2019, Accessed on Dec.20, 2019.
[18]Plesoianu, D.M., Eftei, I., 2016, Mangalia spas potential, a potential tourism resource of the Romanian seaside, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(3):249-253.
[19]Plesoianu, D.-M., Sandu, C., Popescu, A., 2017, Aspects of cultural tourism in Brasov County with a special look at the period 2015-2016, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.17(3):287-293.
[20]Plesoianu, D.-M., Moise, A., Popescu, A., 2017, Aspects regarding tourism potential of Mures County, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.17(3): 295-300.
[21]Plesoianu, D.-M., Grecu, E., Popescu, A., 2018, The heritage of traditions and tourism facilities in Transilvania, Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.18(1):325-336.
[22]Plesoianu, D.-M., Caraus, D., Popescu, A., 2018, Valorisation of the tourism and traditions potential of Bucovina, Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.18(1):349-356.
[23]Popescu, A., 2013, Considerations on the main trends in the tourists, receipts and expenditures flows in the EU-27 Tourism, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.13(1):283-292.
[24]Popescu, A., 2014, Considerations on the trends of international tourist flows, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(4):179-192.
[25]Popescu, A., 2014, Considerations on the trends of international tourism receipts, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(4):201-210.
[26]Popescu, A., 2016, Research on the economic efficiency in Romania's tourism, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(1):411-416.
[27]Popescu, A., 2016, Research on the concentration of tourist arrivals in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(1):425-430.
[28]Popescu, A., 2016, Research on the dynamics and territorial dispersion of the occupied population in Romania's tourism in the period 2007-2015, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.16(4):279-288
[29]Popescu, A., 2016, Correlation between tourism accommodation capacity and tourist flow by micro region of development in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.16(4):289-298.
[30]Popescu, A., 2016, The correlation between international tourist arrivals and tourism receipts - a key factor of tourism efficiency, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.16(4):299-306.
[31]Popescu, A., 2017, Trends in tourism demand in the top visited European countries, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(4):243-254.
[32]Popescu, A., 2017, Analysis of tourism offer and demand synergy in Bucharest-Ilfov, Romania, in the period 2008-2015, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(4):.255-266.
[33]Popescu, A., 2018, Analysis of Tourism Trends in the New EU Member States, Proceedings of the 32nd IBIMA International Conference on Vision 2020: Education Excellence and Management of Innovations through Sustainable Economic Competitive Advantage, Sevilla Spain, Nov. 15-16, 2018.

[34]Popescu, A., 2018, Tourist arrivals concentration- A case study in Romania's Central area, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.18(3):331-338.
[35]Popescu, A., 2019, Tourism and Travel Competitiveness in the European Union new member states, Proceedings of the 33rd IBIMA International Conference on Vision 2020: Education Excellence and Management of Innovations through Sustainable Economic Competitive Advantage, Granada, Spain, April 10-11, 2019.
[36]Popescu, A., Plesoianu, D., 2017, Analysis of accommodation demand/offer in Romania's tourism, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(3)2017, p.339-346.
[37]Popescu, A., Plesoianu, D., 2017, Trends of tourist arrivals and overnight stays in the Maramures County, Romania, 2007-2016 and forecast for 2017-2021, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(4): 281-292.
[38]Popescu, A., Plesoianu, D.-M., Grigoras, M., A., 2018, The city of Cluj-Napoca and the Cluj County, important tourist attractions in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.18(1): 401-416.
[39]Popescu, A., Plesoianu, D.-M., 2019, Discrepancies between the demand and offer on the seaside tourism of Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.19(1): 409-420.
[40]Popescu, A., Tindeche, C., Hontus, A.C., Marcuta, A., 2019, Tourists' satisfaction degree for service quality in hotel industry. A case study in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.19(3): 463-474.
[41]Popescu, I., Chirileasa, A., 2015, Over 1.9 million tourists visit Romania, where do they come from, https://www.romania-insider.com/over-1-9-million-tourists-visit-romania-where-do-they-come-from, Accessed on Dec.19, 2019.
[42]Simionescu Bratu, M., 2017, The relationship between tourist arrivals and accommodation in Romanian regions. A panel data approach, Journal of Tourism- studies and research in Tourism, North America, No.23, http://www.revistadeturism.ro/rdt/article/view/357, Accessed on Dec.20, 2019.
[43]Simoni, S., 2013, Analyzing the main indicators of the Romanian tourism flows in evolution and structure during the first decade of the 21st century, Scientific Papers, Series I, Vol. XV(4):191-196.
[44]Stanculescu, M.S., Marin, M., 2012, Tourism Demand in Romania, Romanian Statistical Review, 3rd Quarter/2012- Supplement, 41-61.
[45]Travel &Tourism- A force for Good in the World, https://www.icao.int/Meetings/iwaf2018/Documents/Travel%20and%20Tourism.pdf, Accessed on December 20, 2019.
[46]Tudorache, D.M., Musteata-Pavel, M., Simon, T., Radulescu, A., 2016, Tourism market development trends of Brasov County, Knowledge Horizons - Economics Vol. 8(3):27–32.
[47]UNWTO, Tourism highlights Edition 2018, https://www.unwto.org/publication/unwto-tourism-highlights-2018, Accessed on December 20, 2019.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

TURNOVER'S IMPACT ON PROFITABILITY IN THE COMERCIAL COMPANIES DEALING WITH DAIRY FARMING

Agatha POPESCU, Toma Adrian DINU, Elena STOIAN, Valentin SERBAN

University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest Romania, Phone: +40213182564, Fax: +40213182888,
Emails: agatha_popescu@yahoo.com, tomadinu@yahoo.fr, stoian_ie@yahoo.com, srbn.valentin@yahoo.com

Corresponding author: agatha_popescu@yahoo.com

Abstract

The paper analyzed turnover indicators in terms of working capital (WCT), total assets (TAT) and fixed assets (FAT) on the profitableness in term of return on assets (ROA) and equity (ROE) of six companies, codified F1-F6, dealing with dairy farming in the surroundings of Bucharest, the capital of Romania in the period 2009-2018. Descriptive statistics, correlation and determination coefficients, as well as polynomial regression models were used to process the data in order to prove in what measure the increase of turnover could have a beneficial effect on effectiveness of the business. Despite that the firms are in the top for their financial results, it was noticed a large variation regarding the dynamics of sales and profit, but the general trend was an increasing one. Based on the indicators taken into account, the resulting hierarchy of the companies was F5, F2, F1, F3, F4 and F6. A weak relationship was found between WCT, TAT and FAT and ROA and ROE, with a few exceptions as follows: in F4, r =0.540 between WCT and ROA, r=0.703 between TAT and ROA, r = 0.806 between FAT and ROA and r=0.565 between WCT and ROE, in F5, r=0.565between WCT and ROE, and in F6 r = 0.601 between TAT and ROA and r = 0.525 between FAT and ROA. Another conclusion was that in F4, the variation of WCT and TAT could influence the variation of ROA, and the variation of FAT could influence the variation of ROE in a higher measure. The polynomial regression models showed that in F4, one more unit of TAT could determine an increased ROA by 0.2609, and one more unit of FAT could led to a higher ROA by 0.333 and of ROE by 0.970. In F5, one more unit of WCT could grow ROE by 3.895, and one more unit TAT will determine a higher ROE by 0.282. As a final conclusion, in financial management of the dairy companies turnover must be carefully managed in order to get a higher effectiveness and profitability of the business.

Key words**:** *turnover, profitability, dairy farms, Romania*

INTRODUCTION

Financial management implies a large variety of principles, methods, techniques, tools which are used for running the financial operations of a firm in order to increase its profitability, its financial autonomy and raise its economic power and competitiveness in the market.

Financial analysis aims to assess the firm performance at the end of a financial year emphasizing the strengths and weaknesses of the financial management.

The financial decisions could have either a positive impact on the profitability of a company or a negative effect leading to bankruptcy [6, 7, 8, 9, 10, 20].

Dairy farming is one of the most important and also difficult sector of agriculture as milk chain is facing with high problems related to production costs closely linked to the higher and higher price for farm inputs, milk quality, collection and a low milk price at the farm gate [1, 18, 25, 26, 37, 38].

Milk market in Romania is passing through a critical situation as the dairy cattle livestock is decreasing, milk yield per cow has a low level compared to the EU average and records in the top milk producing countries, milk production is going down, which affects consumption which has to be covered by imports [31, 32, 33, 34, 36, 37].

Financial analysis in dairy farming pointed out how important is to increase income, to manage the working capital and fixed assets, to keep production costs under a permanent control and mainly the operational expenses, to assure the a balanced ratio among the

capital and debts, between receivables and cash flow, to assure a higher turnover and profit, a high return on fixed assets and equity [11, 12, 13,14, 19, 21, 22, 23].

To increase incomes coming from dairy farming supposes to improve investments in modern technologies, milk yield per dairy cow, milk quality, to deliver more milk in the market and get a good price at the farm gate to cover production costs and assure profit [15, 17, 24, 28, 29, 34, 35]. There are many differences from a farm to another regarding production and financial management with a deep impact on profitableness of the business in dairy farming [27, 30]. The capital, the largest municipality in the county absorbs a large amount of milk from the companies operating in the surrounding counties [16]. For this reason, the purpose of this paper was to analyze turnover and evaluate its impact on the sales return on assets and equity, in a word on the profitability of the companies dealing with dairy farming in the proximity of Bucharest, taking into account firms which are on the top among the dairy cattle growing and milk producers. This topic of high interest in financial management, as the firm managers have to be aware in what measure to increase turnover is an objective which deserves to be included among the development strategy of the business in dairy farming [2, 4, 39, 40].

The objectives of the paper were:

(i)to analyze the evolution of turnover and profit, and also of the independent variables: WCT, TAT and FAT, and also of the dependent variables: ROA and ROE,

(ii) to quantify the relationship between various pairs of these indicators by means of the correlation coefficients,

(iii) to estimate the variation of the dependent variables cased by the variation of the independent variable by means of the determination coefficients,

(iv)to set up the regression models using polynomial equations for each pair of indicators in order to assess the effect of the turnover independent variables on the effectiveness of the business in terms of return on assets and shareholders' equity.

MATERIALS AND METHODS

Data collection

The research is based on the data collected from the Balance Sheets of six commercial societies dealing with dairy farming in the surroundings of Bucharest, the capital of Romania [3]. The firm seats are in Bucharest, and Ilfov, Girugiu, Calarasi, and Prahova Counties. The companies are codified in this study as F1, F2, F3, F4, F5 and F6.

The data refer to the period 2009-2018.

The following indicators were studied: (i)Turnover (T), (ii)Net Profit (NP), (iii)Working capital turnover (WCT), Total Assets Turnover (TAT), Fixed Assets Turnover (FAT), Return on Assets (ROA), and Return of Equity (ROE).

The independent variables were considered to be: T, NP, WCT, TAT and FAT, and the dependent variables were ROA and ROE.

Methodological aspects used in this study

Dynamics analysis was studied using the Fixed basis Index, $I_{FB(\%)}$, according to the formula: $I_{FB(\%)} = (Z_n/Z_1)100$, where: Z_n is the value of the variable in the year n and Z_1, the value of the variable in the year 1.

Descriptive statistics was determined for Turnover and Net Profit, in terms of Mean, Standard deviation, Coefficient of variation, Minimum and Maximum values, and for WCT, TAT and FAT was determined only the average, as basis for establishing the firms classification. The independent variables were calculated using the following formulas:

Working capital turnover (WCT): WCT=T/WC, where: T= turnover and WC is Working capital.

Total Assets Turnover (TAT):TAT = T/TA, where: TA = Total Assets.

Fixed Assets Turnover (FAT): FAT = T/FA, where: FA= Fixed Assets.

The dependent variables were determined using the formulas:

Return on Assets (ROA): ROA= NP/TA, where: NP= Net profit, and TA= Total Assets.

Return on Equity (ROE): ROE = NP/E, where: NP= Net profit, and E= Average Shareholders' Equity.

Trend line of the pairs of variables was based on the polynomial regression equation, having the formula: $Y = a + bx + cx^2$, established by means of the Excel facilities. In the formula, Y represent the dependent variable and X is the independent variable. There were established the regression equations for pairs of indicators: between ROA, depending on WCT, TAT and FAT, and for ROE, also depending on WCT, TAT and FAT.

The correlation coefficient, r, was also calculated for the pairs of variables mentioned above. The interpretation of the values of the correlations coefficients was made in accordance with [5].

The determination coefficient, R^2, was also used in order to quantify how much of the variation of the dependent variable is caused by the variation of the independent value. For testing the significance of the coefficient of correlation it was applied ***t Test (Student), Two-Tails*** for the significance threshold $\alpha = 0.05$. The interpretation of the r significance was made as follows: (i) If $t_{calc} > t_{tab}$ (critical value), then H_o (null hypothesis) is rejected in favor of the alternative hypothesis, H_1; (ii) If $t_{calc} < t_{tab,}$ then H_o is accepted and H_1 is rejected. The values of t_{tab} for $\alpha = 0.05$ and the degrees of freedom, df= N-2, that is 10-2= 8, is 2.306.

Comparison method was utilized to enable the author to comparatively examine the correlation coefficients and the regression models and to draw the conclusions in what measure the independent indicators of the turnover have influenced the effectiveness of assets and equity among the firms dealing with dairy farming. The results were partially graphically illustrated and mainly tabled. At the end of the paper, there were drawn the corresponding conclusions and also a few recommendations.

RESULTS AND DISCUSSIONS

Turnover dynamics

Turnover varied from a farm to another and from a year to another in the analyzed period. However, the data showed a general increasing trend since 2009 to 2018. In case of F1, the turnover increased 2.91 times from Lei 2.80 Million in 2009 to Lei 8.17 Million in 2018. In case of F2, the turnover increased 1.86 times from Lei 4.36 Million to Lei 8.11 Million. In case of F3, the turnover increased 3.76 times from Lei 4.03 Million to Lei 15.18 Million. In case of F4, the growth of turnover was 1.82 times from Lei 5.52 Million to Lei 10.05 Million. In case of F5, the turnover increased 1.97 times from Lei 1.11 Million to Lei 2.19 Million and in case of F6, the level of turnover raised 2.22
times from Lei 4.29 Million to Lei 9.52 Million (Fig. 1).

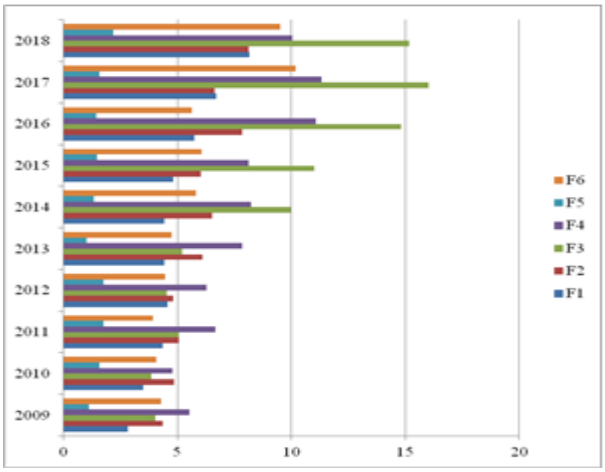

Fig. 1. Dynamics of Turnover of the analyzed dairy farms, 2009-2018 (Lei Million)
Source: Own design based on the Balance Sheets of the farms [3].

Net Profit dynamics

Net profit also varied among farms and from a year to another, but in general had an ascending trend with a few exceptions.

In case of F1, the net profit increased 8.25 times from Lei 0.12 Million in 2009 to Lei 0.99 Million in 2018. In case of F2, the net profit raised 1.5 times from Lei 0.4 Million to Lei 0.6 Million. F3 registered net profit in the years 2009, 2011, 2014-2017, while in the other years 2010, 2012-2013 and 2018 it recorded losses. In case of F4, the net profit increased 2.7 times from Lei 0.4 Million to Lei 1.08 Million. In case of F5, the net profit increased 1.66 times from Lei 0.39 Million to Lei 0.65 Million, with only one exception in 2016 when it registered losses. In case of F6, the net profit raised 1.89 times from Lei 0.56 Million to Lei 1.06 Million (Fig.2).

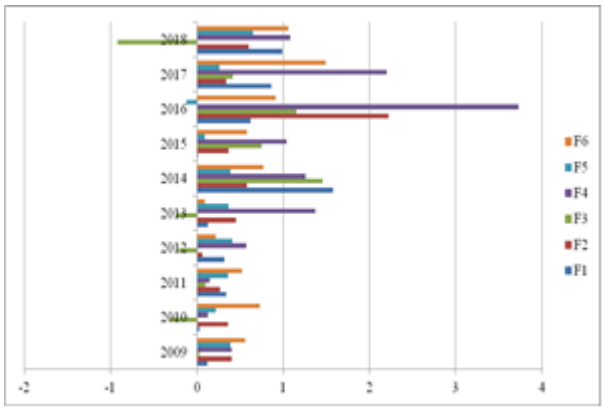

Fig. 2. Dynamics of Net Profit of the analyzed dairy farms, 2009-2018 (Lei Million)
Source: Own design based on the Balance Sheets of the farms [3].

Descriptive statistics for Turnover and Net Profit by dairy farm.

The variation coefficients in case of turnover have in general low values, below 10 % in case of F1, F2, F4 and F5, reflecting that the turnover was homogenous from a year to another. In case of F3 and F6, the coefficient of variation varied between 10% and 20 % showing a relatively homogenous level around the mean.

Regarding the coefficient of variation for net profit, it was noticed that in case of F5 and F6, the data were relatively homogenous (10%<CV<20%). In case of F4, the net profit was relatively heterogeneous ((20%<CV<30%), in case of F1, F2 and F3, the coefficient of variation registered values over 30%, reflecting a heterogeneous distribution of the data (Table 1).

Table 1.Descriptive statistics for Turnover and Net Profit by dairy farm

	F1	F2	F3	F4	F5	F6
	Turnover					
Mean	4.94	6.02	8.96	7.98	1.51	5.86
St. Dev.	0.49	0.41	1.58	0.71	0.11	0.71
Coeff. of var. (%)	9.91	6.81	17.63	8.89	7.28	12.11
Min.	2.08	4.36	3.83	4.78	1.01	3.93
Max.	8.17	8.11	16.03	11.33	2.19	10.11
	Net Profit					
Mean	0.50	0.56	0.22	1.19	0.30	0.69
St. Dev.	0.16	0.19	0.22	0.34	0.06	0.12
Coeff. of var. (%)	32.00	33.92	100.00	28.57	20.00	17.39
Min.	0.01	0.06	-0.92	0.13	-0.12	0.09
Max.	1.58	2.22	1.46	3.73	0.65	1.49

Source: Own calculations based on the Balance Sheets of the farms [3].

Dairy farms' ranking based on the average values of the independent and dependent variables is presented in Table 2. The results show that F5 came on the 1st position four times, F2 came on the 1nd position also four times, F1 came on the 3rd position four times, F3 came on the four position two times and on the 5th position one time, F4 came on the 5th position three times, and F6 came on the 6th position three times. Therefore, this is the classification of the dairy farms based on their performance for these five specific indicators: Working capital turnover WCT, Total assets turnover TAT, Fixed assets turnover FAT, Return on total assets ROA and Return on equity ROE.

The correlation coefficients by pair of indicators for each firm are presented in Table 3.

In case of the relationship between WCT and ROA, the values of the correlation coefficients varied between r = 0.146 for F5, the minimum value, and r = 0.540 for F4, the maximum value. The values of r reflects that there is not any relationship between WCT and ROA in case of F5, and in case of F1, F2, F3, and F6, there is a weak relationship. In case of F4, r value reflects a moderate relationship between the two indicators. All the coefficients of

correlation are not statistically significant, as $t_{calc} < t_{tab}$ for $\alpha = 0.05$.

Table 2. The ranks of the dairy farms depending on the average value of the independent and dependent studied variables

	F1	F2	F3	F4	F5	F6
The mean values of the independent variables: WCT, TAT and FAT						
WCT	2.16	2.14	1.87	1.25	2.22	1.24
Rank for WCT	2	3	4	5	1	6
TAT	0.62	0.65	0.51	0.46	1.91	0.43
Rank for TAT	3	2	4	5	1	6
FAT	0.89	0.95	0.73	0.77	4.67	0.80
Rank for FAT	3	2	6	5	1	4
The mean values of the dependent variables: ROA and ROE						
ROA	0.0603	0.05673	0.00609	0.11332	0.28274	0.05293
Rank for ROA	3	4	6	2	1	5
ROE	0.083	0.087	0.0259	0.12558	0.0424	0.010918
Rank for ROE	3	2	5	1	4	6

Source: Own calculations.

In case of the relationship between TAT and ROA, the value of the correlation coefficients ranged between r = 264 for F1, the minimum value and r =0.703 for F4, the maximum value. In case of F1, F2 and F5, r value reflects a weak relationship, in case of F3, F4 and F6, r value signifies a moderate relationship.

Almost all the coefficients of correlation are not statistically significant, as $t_{calc} < t_{tab}$ for $\alpha = 0.05$, except r = 0.703 whose $t_{calc} = 2.800 > t_{tab} = 2.306$ for $\alpha = 0.05$, reflecting that r value is statistically significant.

In case of the relationship between FAT and ROA, the value of the correlation coefficients varied between r = 0.231, the minimum value in case of F1, and r = 0.806, the maximum value, for F4. The values of r reflected the inexistence of a relationship between the two indicators in case of F1, a weak connection in case of F2, F3, F5, and F6, and a strong link in case of F4.

Almost all the coefficients of correlation are not statistically significant for $\alpha = 0.05$, except r = 0.806 in case of F4, whose $t_{calc} = 3.856 > t_{tab} = 2.306$ for $\alpha = 0.05$, and also higher than $t_{tab} = 2.998$ for $\alpha = 0.02$ and higher than $t_{tab} = 3.499$ for $\alpha = 0.01$ reflecting that r value is statistically very significant.

In case of the relationship between WCT and ROE, the values of the correlation coefficients ranged between r = 0.251, the minimum value for F3, and r = 0.657, the maximum value for F5. In general, the values of the correlation coefficients showed the non existence of any link between these two indicators in case of F3, a weak relationship in case of F1, F2, and F6, a moderate link in case of F4 and F5. Despite that almost all the values of the coefficients are not statistically significant for $\alpha = 0.05$, in case of F5, the r value is significant as $t_{calc} = 2.469 > t_{tab} = 2.306$.

In case of the relationship between TAT and ROE, the values of the correlation coefficients varied between r = 0.212 in case of F2 and r = 0.579 in case of F5. The value of r in case of F2 showed a lack of link between the two indicators, in case of F1 and F3, r value reflected a weak relationship and in case of F4, F5 and F6 r value confirmed a moderate connection. Almost all the correlation coefficients are not statistically significant, except the case of F5 where r = 0.679 for which $t_{calc} = 2.611 > t_{tab} = 2.306$ for $\alpha = 0.05$.

In case of the relationship between FAT and ROE, the values of the correlation coefficients ranged between r = 0.249, the minimum value registered by F1, and r = 0.669 in case of F4. For F1, F2, F3, F6, the r values reflected a weak relationship between these indicators, while in case of F3 and F4, it was noticed a moderate connection. Almost all the correlation coefficients are not statistically significant, except r = 0.669, whose $t_{calc} = 2.553 > t_{tab} = 2.306$ for $\alpha = 0.05$.

Table 3. The coefficients of correlation, the coefficients of determination and the polynomial regression equations

	r	R^2	Polynomial regression equations
The impact of WCT on ROA			
F1	0.309	0.0957	$Y= -0.04454 X^2 + 0.2243 X - 0.2104$
F2	0.396	0.1573	$Y= 0.0871 X^2 - 0.2882 X+ 0.2698$
F3	0.319	0.1019	$Y = -0.0907 X^2 + 0.4122 X - 0.4695$
F4	0.540	0.2920	$Y= - 0.4599 X^2 + 1.1287 X - 0.6082$
F5	0.146	0.0213	$Y = -0.0214 X^2 + 0.075X + 0.2441$
F6	0.323	0.1046	$Y = 0.0357 X^2 - 0.0995 X + 0.1134$
The impact of TAT on ROA			
F1	0.268	0.0720	$Y =0.2233 X^2 - 0.1342 X + 0.054$
F2	0.264	0.0700	$Y = - 1.0252 X^2 +1.37 X - 0.3912$
F3	0.533	0.2850	$Y = -4.0679 X^2 + 4.8524 X - 1.4286$
F4	0.703*	0.4944	$Y = -1.3951 X^2 + 1.6756 X - 0.3953$
F5	0.319	0.1019	$Y = -0.0732 X^2 + 0.3257 X - 0.0118$
F6	0.601	0.3611	$Y = 0.2784 X^2 - 0.0757 X + 0.0302$
The impact of FAT on ROA			
F1	0.231	0.0532	$Y = 0.1615 X^2 - 0.2381 X + 0.1399$
F2	0.421	0.1770	$Y = -0.7609 X^2 + 1.3610 X -0.5195$
F3	0.522	0.2729	$Y = -2.1271 X^2 + 3.5746 X -1.4771$
F4	0.806***	0.6505	$Y = -0.2725 X^2 + 0.6055 X - 0.2170$
F5	0.361	0.1300	$Y = - 0.00 X^2 - 0.00 X + 0.3100$
F6	0.525	0.2761	$Y = 0.0196 X^2 - 0.0073 X + 0.0419$
The impact of WCT on ROE			
F1	0.317	0.1004	$Y = -0.0181 X^2 + 0.1289 X- 0.1083$
F2	0.496	0.2460	$Y = 0.2173 X^2 - 0.7776 X + 0.7447$
F3	0.251	0.0632	$Y = -0.1353 X^2 + 0.4929 X - 0.3994$
F4	0.565	0.3188	$Y = -0.8848 X^2 + 2.2276 X - 1.2349$
F5	0.657*	0.4323	$Y = 0.1552 X^2 - 0.6117 X + 0.8546$
F6	0.314	0.0987	$Y = 0.0679 X^2 - 0.1926 X + 0.2321$
The impact of TAT on ROE			
F1	0.298	0.0886	$Y = 0.3191 X^2 - 0.2111 X + 0.8660$
F2	0.212	0.0449	$Y = -1.9098 X^2 + 2.4290 X - 0.6676$
F3	0.264	0.0700	$Y = -3.594 X^2 + 3.9674 X - 1.0473$
F4	0.625	0.3905	$Y = - 0.2379 X^2 + 2.4491 X - 0.5435$
F5	0.679*	0.4608	$Y = 0.0713 X^2 - 0.1155 X + 0.3262$
F6	0.568	0.3230	$Y = 0.1958 X^2 + 0.1722 X - 0.0030$
The impact of FAT on ROE			
F1	0.249	0.0619	$Y = 0.1409 X^2 - 0.1752 X = 0.1237$
F2	0.447	0.2003	$Y = 1.2300 X^2 + 2.1575 X - 0.8030$
F3	0.469	0.2203	$Y = -2.5905 X^2 + 4.0245 - 1.4939$
F4	0.669	0.4482	$Y = - 0.3741 X^2 + 0.8297 - 0.2586$
F5	0.574	0.3300	$Y = 00 X^2 + 0.00 X +0.36$
F6	0.488	0.2382	$Y = - 0.0151 X^2 + 0.0905 + 0.0487$

*Statistically significant for $\alpha = 0.05$.
*** Statistically significant for $\alpha = 0.05$, $\alpha = 0.02$ and $\alpha = 0.01$.
Source: Own calculation.

The coefficients of determination are also shown in Table 3. Their values reflect in general a small percentage of the variation of the dependent value caused by the independent value.

But, there are a few exceptions which have to be mentioned as follows:

-The variation of ROA is determined in a low proportion by the variation of WCT in all the firms.

- The change of ROA is caused in a small proportion by the change of TAT in case of F1, F2, F3, F5 and F6, but is case on F5 it is 49.44 % influenced by TAT.

-The variation of ROA is determined in a very small proportion by the variation of FAT in

almost all the firms, except F4, where it is influenced 65.05 % by FAT variation.

-The variation of ROE is caused in a weak proportion by WCT variation in almost all the firms, except F5, where 43.23 % of its variation is determined by the change of WCT.

-The change of ROE is caused in a small proportion by the change of TAT in almost all the companies, except F5 where 46.08 % of its variation is determined by the change of TAT.

-The change of ROE is caused in a low proportion by the change of FAT, in almost all the companies, except F4 where its variation is caused 44.82 % by the FAT variation (Table 3).

The polynomial regression equations reflecting the impact of the independent variables belonging to turnover on the effectiveness in terms of ROA and ROE are shown in Table 3. They could serve for quantifying in what measure an increase by one unit of the independent variable could led to a change of the dependent variable.

In case of the firms where the r and R^2 values are small, reflecting either the inexistence of relationship or a weak connection between the studied variables, it is clear that an increase by one unit of the value of X will have no impact on the Y value.

But, in case of the companies where the r and R^2 values are statistically significant, an increase of the independent variable will have an important impact of the dependent value.

For example, in case of F4, if TAT will increase by 1 unit, ROA will be 0.2609. Also, in the same company, if FAT will increase by 1 unit, ROA will increase by 0.333. If FAT will grow by 1 unit, ROE will go up by 0.970.

In F5, if WCT will raise by 1 unit, then ROE will increase by 3.895. Also, in F5, if TAT will increase by 1 unit, ROE will grow by 0.282.

CONCLUSIONS

The paper proved that turnover is important to be included among the objectives of the development strategy of the financial management in the companies dealing with dairy farming, but it is not the only indicator which could led to the growth of the effectiveness and profitableness.

Despite that the six analyzed companies dealing with dairy farming are in the top for their financial results, it was noticed a large difference among them regarding the dynamics of sales and profit, the share of profit in the turnover and the impact of turnover on return on assets and equity.

Taking into account the obtained results for working capital turnover, total assets turnover, fixed assets turnover, and return of assets and equity, the companies occupied the following positions, in the decreasing order: F5, F2, F1, F3, F4 and F6.

The correlation coefficients proved in almost all the cases, with a few exceptions, that it is a weak relationship between the analyzed pairs of turnover indicators: working capital turnover (WCT), total assets turnover (TAT) and fixed assets turnover (FAT) and the return on assets and equity (ROA and ROE). Therefore, WCT, TAT and FAT have a low importance in determining the effectiveness and profitableness of a dairy farming company.

However, there were found a few exceptions. It is about the company F4, where the correlation coefficient between WCT and ROA was r =0.540, between TAT and ROA r=0.703, between FAT and ROA r = 0.806 and WCT and ROE, r=0.565 showed that the independent variables WCT, TAT and FAT could be taken into consideration among the factors sustaining the growth of ROA and ROE. Also, in F5, WCT could positively influence ROE, as r= 0.657, in F6, TAT could have a positive impact on ROA as r = 0.601 and FAT on ROA as r = 0.525.

The determination coefficients reflected that in the company F4 the variation of WCT and TAT could influence the variation of ROA, as well as the variation of FAT could influence in a higher proportion the variation of ROE. In F5, the variation of WCT and also the variation of TAT have a positive impact in a higher measure on ROE than in the other companies.

The polynomial regression models showed that only in F4 and F5 the increase of the independent variables could led to the growth of the effectiveness. In F4, one more unit of TAT could determine an increased ROA by 0.2609, and one more unit of FAT could determine a higher ROA by 0.333 and of ROE by 0.970. In F5, one more unit of WCT could increase ROE by 3.895, and one more unit TAT will determine a higher ROE by 0.282.
Therefore, in financial management of the dairy companies, the managers must be aware that the increase of turnover has not always a benefic effect on the profitability of the firm. Turnover must be an indicator which has to be carefully managed in order to get a higher effectiveness and profitability of the business in dairy farming.

ACKNOWLEDGEMENTS

The author thanks the managers of the six companies for their interest in the running of this research work and for supporting with the needed data from the Balance Sheets.

REFERENCES

[1]Angel, E., Popescu, A., 2009, Milk Quality Management at Flav O'Rich Dairy, USA, Scientific Papers Management, Economic engineering in agriculture and rural development, Vol.9(1), p.11-14.
[2]Arnis, N. I., Kolias, G. D., Filios, V. F., 2008, The profitability of the Greek retail firms and the relations among the determinants (in Greek). Review of Economic Sciences, 14, 161-180.
[3]Balance Sheets of F1, F2, F3, F4, F5, F6 concluded at the end of the years 2009-2018.
[4]Caruntu, R.C., 2011, Theoretical aspects regarding the turnover analysis, Annals of "Constantin Brâncuși" University, Târgu Jiu, Series Economics, No. 3, 177-183.
[5]Colton, T., 1974, Statistics in Medicine, Little Brown and Company, Boston, Mass.02106, XII, 372 pp.
[6]Dragotă, V., Dragotă, M., Obreja, L., Ciobanu, D., 2003, Financial Management, Vol. I & II, Economica Publishing House, Bucharset, pp.142-149.
[7]Dumbrava, M., 2010, Model of analysis of firm performance, Theoretical and applied economics, Vol. XVII, No. 8(549), 105-119.
[8]Ghic, G., Grigorescu, C. J., 2009, Economic and financial analysis, Universitaria Publishing House, Bucharest, 130-135.
[9]Isfanescu, A., Robu, V., Hristea, A. M., Vasilescu, C., 2002, Economic and financial analysis, ASE Publishing House, Bucharest, 75-80.
[10]McLaughlin, E., 2019, Case study: Financial analysis, https://www.sophia.org/tutorials/case-study-financial-analysis--2, Accessed on Dec.20, 2019.
[11]Pirvutoiu, I, Popescu, A., Grigoras, M.A., 2010, Profitability Analysis – a Study Case Agroindustriala Pantelimon Joint Venture Dairy Farming Company, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.10(2)/2010, 161-164.
[12]Popescu, A., 2003, Financial Analysis in Dairy Farming, The 2nd International Symposium on "Prospects for the 3rd Millenium Agriculture", USAMV Cluj-Napoca, 9-11 Oct. 2003, Bulletin of UASVM Cluj-Napoca, Zootehnie si Biotehnologii (Animal Science and Biotechnologies), Vol.59, 11-14.
[13]Popescu, A., 2004, Prospects for dairy farm management under milk quota. The International symposium on"Prospects for the 3rd Millenium Agriculture", USAMV Cluj-Napoca, 20-23 Oct.2003, Bulletin of UASVM Cluj-Napoca, Zootehnie si Biotehnologii (Animal Science and Biotechnologies), Vol.60, 14 - 20.
[14]Popescu, A., 2004, Financial Statement - a tool in decision making in dairy farming. The International symposium on"Prospects for the 3rd Millenium Agriculture", USAMV Cluj-napoca, 20-23 Oct.2003, Bulletin of USAMV Cluj-Napoca, Zootehnie si Biotehnologii (Animal Science and Biotechnologies), Vol.60, 384 - 389.
[15]Popescu, A., Muresan, G., 2004, Analysis in dairy farming in Arad County achievements and prospects under the background of Romania's entry into the E.U. The International symposium on "Prospects for the 3rd Millennium Agriculture", USAMV Cluj-Napoca, 20-23 Oct.2003, Bulletin of UASMV Cluj-Napoca, Zootehnie si Biotehnologii, (Animal Science and Biotechnologies), Vol.60, p.385.
[16]Popescu, A., 2005, Research concerning dairy cows, farm structure and milk performances in the proximity of the capital, The 4th International Symposium "Prospects of the 3rd Millennium Agriculture, 6-7 Oct.2005, Bulletin UASVM Cluj-Napoca, Romania, Series Zootehnie si Biotehnologii si Medicina Veterinara (Series Animal Science and Biotechnologies and Veterinary Medicine), Vol.61, 399-403.
[17]Popescu, A., 2006, Research concerning the economic impact of investments in dairy farms of various size, International Symposium "Prospects of Agriculture in the 3rd Millennium", UASVM Cluj-Napoca, 5-6 October 2006, Bulletin of USAMV Cluj-Napoca, Romania, Seria Zootehnie si Biotehnologii si Medicina Veterinara (Series Animal Science and Biotechnologies and Veterinary Medicine), No.62, 8-12.
[18]Popescu, A., 2006, Study upon milk market in the EU countries, Bulletin of the University of Agricultural Sciences and Veterinary Medicine, Animal Husbandry

and Biotechnologies, Vol. 62, 214, Symposium on Prospects for the 3rd Millenium Agriculture, Oct.5-6, 2006, Cluj-Napoca
[19]Popescu, A., 2006, Managementul financiar in fermele de vaci, Ed. Dominor Bucuresti, (Financial management in dairy farms, Dominor Publishing House, Bucharest), 69 p.
[20]Popescu, A., 2007, Analiza financiara, Ed.Dominor, Bucuresti (Financial Analysis, Dominor Publishing House, Bucharest), 188-194.
[21]Popescu, A., 2009, Considerations upon Net Working Capital Management, Scientific Papers Series Management, Economic engineering in agriculture and rural development, Vol.9(2):125-128.
[22]Popescu, A., 2010, Net Sales Analysis in a Dairy Farming Company, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.10(2):179-184.
[23]Popescu, A., 2010, Research concerning Gross Margin Forecast based on Milk Yield using the Least Square Method of Regression Analysis, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.10(2):173-178.
[24]Popescu, A., 2012, Economia productiei in ferma de vaci, Ed.Eikon, Cluj Napoca, coeditare cu Ed.RawexComs, Bucuresti, (Production economics in dairy farms, Eikon Publishing House, Cluj Napoca, coediting with RawexComs Publishing House, Bucharest), 45-52.
[25]Popescu, A., 2014, Research on milk cost, return and profitability in dairy farming, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(2):219-222.
[26]Popescu, A., 2014, Research on profit variation depending on marketed milk and production cost in dairy farming, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(2):223-230.
[27]Popescu, A., Condei, R., 2014, Considerations regarding the criteria of efficiency for the classification of dairy farms, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(3):256-265.
[28]Popescu, A., Condei, R., 2014, Study on the average marketed milk as a measure of profitableness threshold in dairy farms, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(4):219-222.
[29]Popescu, A., David, L., 2014, Research on regression modeling of profit related to milk yield in dairy farming, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(4):211-218.
[30]Popescu, A., 2015, Research on the top Romanian trademarks in the milk and dairy products market, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1): 367-376.
[31]Popescu, A., 2015, Research on the trends in milking livestock and milk production in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1):377-386.
[32]Popescu, A., 2015, Research on the trends in milk production and consumption in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1):387-392
[33]Popescu, A., 2015, Research on the trends in Romania's milk and dairy products foreign trade, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1):391-398.
[34]Popescu, A., 2015, Regression modeling in prediction milk production depending on the dairy bovine livestock, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(4): 225-230.
[35]Popescu, A., 2015, Multiple correlation and regression in predicting milk price, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(4):231-238.
[36]Popescu, A., 2016, The milk market concentration and competition thresholds in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(2):247-253.
[37]Popescu, A., 2017, Trends in milk market and milk crisis impact in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.17(2):281-290.
[38]Popescu, A., Angel, E., 2019, Cow raw milk quality and its factors of influence in relationship with milk price, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.19(1): 421-440.
[39]Robu, V., Georgescu, N., Analiza economico-financiara, ASE, (Economical and financial analysis, ASE) Digital Library, http://www.biblioteca-digitala.ase.ro/biblioteca/carte2.asp?id=113&idb=6, Accessed on Dec.20, 2019.
[40]Warrad, L., Al Omari, R., 2015, The Impact of Turnover Ratios on Jordanian Services Sectors' Performance, Journal of Modern Accounting and Auditing, February 2015, Vol. 11(2):77-85, http://www.davidpublisher.com/Public/uploads/Contribute/551d04d6b02d9.pdf, Accessed on Dec.20, 2019

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

PROFIT AND PROFITABILITY OF THE COMMERCIAL COMPANIES DEALING WITH DAIRY FARMING

Agatha POPESCU, Alina MARCUTA, Cristina TINDECHE, Carmen ANGELESCU, Liviu MARCUTA

University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest Romania, Phone: +40213182564, Fax: +40213182888, Email: agatha_popescu@yahoo.com, alinamarcuta@yahoo.com, tindeche_cristina@yahoo.com, angelescucarmen@yahoo.com, liviumarcuta@yahoo.com

Corresponding author: agatha_popescu@yahoo.com

Abstract

The paper analyzed net profit and profitability of a panel of six commercial companies (C1-C6) raising dairy cows and supplying milk on the capital market in the period 2009-2018, based on the data from Balance Sheets which were processed using fixed index, descriptive statistics, points method, regression modeling, correlations and determination coefficients. All the companies registered an increased net profit in the analyzed period except C3 which registered losses in 2010, 2012, 2013 and 2018 and C5 with losses in 2016. The highest annual profit average was achieved by C4 (Lei 1.19 Million) and the lowest one by C5 (Lei 0.3 Million). Net profit margin varied between 23 %, the highest level in C5, and 1.1 %, the lowest level in C3. The highest average net profit obtained per one million used assets was Lei 370 thousand in C5 and the lowest level was Lei 6 thousand in C3.For one million equity, the return of net profit accounted for Lei 0.42 million in C5 and Lei 30 thousand in C3. The total costs of the firms increased influencing the net profit. For Lei one million expenses, the average net profit varied between Lei 310 thousand in C5 and 20 thousand in C3. The total number of points received for each analyzed indicator led to the following classification of the companies, in the decreasing order of profitability: C5, C4,C2, C6,C1 and C3. The F test confirmed that the linear regression models attested that costs have an influence on net profit. However, only in case of C5 and C2, the variation of net profit was caused by total costs in a higher proportion than 50%, and in case of C4 and C1 with about 31 %. The correlation coefficients reflected a high positive connection between net profit and costs in C2 (r = 0.994) and C6 (r = 0.711). The profitability analysis in these companies emphasized that even though they are in top agribusiness in dairy farming, they could get losses in a few years as net profit is influenced by costs. As a final conclusion, to increase net profit and profitability, the decision makers have to set up a development strategy of the business based on a deep financial analysis and prospecting the opportunities which could assure economic growth in the future.

Key words**:** *net profit, net profit margin, return on assets, return on equity, return on costs, dairy farms, Romania*

INTRODUCTION

The business analysis in dairy farming is focused in various directions: dairy herd, crops. labor, and financial aspects. Financial performance of a company dealing with dairy farming is "the mirror" of the whole activity run along the year evaluated at the end of the year and which enable the farm manager to understand in what direction his business is going, how to plane the future strategy and evaluate the farm position among the competitors. The Balance Sheet, Profit and Loss Account, and Cash Flow Statement are the information sources for assessing the financial situation of the farmer's business. Besides the analysis of the assets, liabilities, income and expenses statement, cash flow statement, it is compulsory to analyze the financial ratios regarding liquidity, solvency, profitability, repayment capacity, efficiency which allow to evaluate the strengths, weaknesses, and opportunities of the business [4].

Business management is the science and art to use the known resources in an unknown context of the future. For this reason, decision makers should pay attention to the current farm performance analysis, technological, financial and economic factors, and to adopt a "probabilistic ways of thinking" and create scenarios and breakeven budgets based on key

elements of decision which could guess the future events and outcomes [12].

Profitability is the aim of a company to survival and growth is the guarantee for obtaining profit for a long run. Profit in terms of net profit is the first goal of a business because it represents the money which remain at the firm disposal after the deduction of all the expenses related to production and product selling. Income statement and also the relationship between income and expenses are crucial in determining profit. Profitability must be analyzed using the specific ratios. Growth opportunities are essential for business development and producing more profit and for this reason marketed products, number of employees, turnover and market share have to be items where managers have to be focused on [18].

Financial analysis is a decision tool for the future development of business in dairy farming. Financial statement has to be analyzed in order to identify the opportunities for improving efficiency and profitability [9, 10, 14, 17, 19, 22, 23, 24, 29, 30, 31, 32, 33, 49].

Dairy farmers must be more focused on farm finances because of the tendency of low profit margins visible nowadays. Farm production and financial records have to be carefully analyzed by managers. In order to maintain the viability of the business, farmers' objectives have to be: to assure profitability, a low risk, a high liquidity and income. Based on the information provided by the balance sheet, net farm income and cash-flow statements, farm managers could analyze "profitability, solvency, financial efficiency, and repayment capacity of the farm business" [52].

Various factors influence efficiency and profitability in dairy farming and they have been studied by many authors.

Studying the profitability, Arnis et all (2009) mentioned the key indicators which could be used for such an analysis [2].

Using Cobb-Douglas production function and multiple regression models to assess milk productivity and gross margin in small dairy farms of Bangladesh, Datta et al (2019) found that the larger farms with a higher milk production have better results because it is a positive and statistically significant relationship between farm size, milk productivity and gross margin. Also, crossbred cows produce more milk and a higher gross margin than the indigenous breeds [5].

Delgado (2015) analyzed various factors influencing profitability of an animal in dairy farms along the time using an information visualization methodology and recommended to farm managers to use "the Cumulative lifetime profitability and its variant Adjusted for regressed opportunity cost of the postponed replacement" for making the decisions regarding the future strategy regarding profitability of the herd. He pointed out that profitability varies among dairy farms due to the different types of housing and milking systems, expenses till the age of the first calving and for solving the health problems [6].

Analyzing returns on costs (variable and total) and their correlations with milk price, variable cost, total cost, and year and also "the relationships between revenue, production, and cost factors among groups of high-, medium-, and low-profit dairy operations" in dairy farming of Kansas Farm Management Association for period of 22 years (1989 - 2010), Dhuyvetter (2011) concluded that high profit dairy farmers achieved the highest milk yield per cow, lower costs per cow, have slightly larger operations, get slightly higher milk price at delivery compared to low-profit producers. Therefore, milk yield, cost per cow and milk price are the key factors which assure the highest profit [7].

Dolewikou et al (2016) studied income and profitability of dairy farming found that the business was more profitable in the group of farms which applied for loans with low interest rate [8].

FAO, 2019, pointed out that farm size is the cause of the large variability economic efficiency and profitability in dairy farming. Farm size determines an asymmetric access to farm inputs, information, subsidies, and

environmental practices. The farms with a high efficiency will be more profitable [11].

An analysis of the gross and net profit of culture, cross and native-breed dairy cattle farms in Turkey, concluded that gross profit is higher in case of culture-breed farms because feeding cost is lower compared to other farms, a reason to recommend them for milk production in Turkey [13].

An analysis on gross profit margin in milk producing EU countries using regressions models led to the conclusion that the most influencing factors on profitability in dairy farming are herd size, forage area, milk yield, milk price, energy and labor cost [15].

Haloho at al (2013) studied the influence of the production factors (cost of forage, cost of concentrate, cost of labor, capital and farm experience) on the profit of the dairy farming using the profit function Output Unit Price Cobb-Douglas Multiple linear regression and found that farm inputs, forage and concentrate cost, partially the capital affected the revenue and profit [16].

Assessing profitability in improved dairy farmers compared to the local farmers using gross margin and cost benefit analyses, and also the economic efficiency based on a stochastic profit frontier model, Nyekanyeka (2011), found that the profit efficiency is higher in improved dairy farmers due to their higher education, longer experience and access to credit [20].

Pirvutoiu and Popescu (2010) proved that profitability analysis is fundamental for setting up the future strategy of the business in dairy farming [21, 25]. Also, the sane author affirmed that the larger the herd size and the higher the milk yield per cow, the higher milk production, income and profit in dairy farming [26].

For assuring a higher performance and efficiency in dairy farming, investments are required to keep pace with modern technologies [27].

Using Cobb-Douglas function in the analysis of profitability in dairy farms, Popescu (2014) affirmed that input cost (materials, labor), milk cost, marketed milk and milk price are the key factors efficiency and influencing profitability in dairy farms [35, 36, 37, 38, 39, 45].

Milk market has also by carefully studied to bring information to farm managers regarding milk price, demand/offer ratio, milk and dairy products consumption, external market, milk and dairy products trade [28, 40, 41, 42, 43, 44, 46, 47].

Milk quality has a deep impact on milk price offered by milk processors and of course on income coming from marketed milk [1, 48].

The economic viability and efficiency of dairy cattle farms in Bulgaria is deeply influenced by herd size, and milk yield as found Stankov (2015). He also mentioned that largest farms of 100 dairy cows obtain a higher milk production, income and income per cow, profit and profit per cow, gross profit margin, a high cost-effectiveness and the highest profitability rate [50]. Also, Stankov et al (2015) using regression and correlation analysis identified that labor efficiency, farm size, and milk yield are the key factors with a deep impact on profit per milk kilogram and that the best results are obtained in the largest dairy farms [51].

Analyzing costs of milk production, gross production value, gross margin, absolute and relative profit of dairy cattle farms in Turkey, Yilmaz et al (2016) concluded that herd size and feeding cost have a deep influence of profitability [53].

In this context, the aim of this paper was to analyze profit and profitability by means of all the indicators where profit is a component and also its relationship with costs in six commercial companies confirmed as top milk producers in the counties from the South Romania surrounding the capital in the period 2009-2018, that is in the last decade.

The objectives of the paper were:

(i)to analyze the evolution of net profit, net profit margin, return on assets, return on equity, and return on costs,

(ii)to determine the average level of all these indicators mentioned above in order to set up the classification of the companies,

(iii)to analyze the relationship between the total costs of the each company and net profit

using a regression model, determination coefficient and correlation coefficients.

MATERIALS AND METHODS

Data collection

The paper was set up using the financial data provided by the Balance Sheets belonging to six commercial companies profiled on cattle growing for milk production. The firms are important raw milk suppliers for the capital of Romania being situated in its proximity. One company is located in Bucharest, two companies are situated in Ilfov Country, one company has its seat in Calarasi, one company is from Giurgiu County and the last one is from Prahova county. The data refer to the last decade for which the balance sheets were concluded 2009-2018 [3].

All the companies are in top agribusiness for dairy farming and in this paper they are codified C1, C2, C3, C4, C5 and C6.

The following indicators were taken into consideration: (i)Net Profit (NP), (ii)Net Profit Margin (NPM), (iii)Return on Assets (ROA), (iv)Return of Equity (ROE), (v)Total costs (TC) and (vi) Return on costs (RC).

Methodology applied

Fixed base Index, $I_{FB(\%)}$, according to the formula: $I_{FB(\%)} = (V_n/V_0)$ x100, where: V_n is the value of the variable in the year n and V_0, the value of the variable in the year 0 was used for the temporal comparison among the studied farms based on the time series data.

Descriptive statistics was used for estimating Mean, Standard Deviation, Coefficient of variation, Minimum and Maximum values for all the indicators specified above.

The profit effect on profitability of the firms was analyzed using the following formulas:

Net Profit Margin (MPM): NPM= NP/T, where: NP = Net Profit and T = Turnover or Sales.

Return on Assets (ROA): ROA= NP/TA, where: TA= Total Assets.

Return on Equity (ROE): ROE = NP/E, where: E= Shareholders' Equity.

Return on Costs (RC): RC = NP/TC, where: TC= Total costs.

Points Method was used for establishing the rank of each company for each indicator and the final rank among companies based on the cumulated points.

ANOVA, the analysis of variance, Regression model based on the formula: Y = a + bx, was used for quantifying the impact of Total Costs, considered the independent variable X, on Net Profit, considered the dependent variable Y. For this purpose there were used the Excel facilities which also allowed to calculate: ***the determination coefficient, R^2***, which reflect the influence of the variation of the independent variable on the variation of the dependent variable, and ***the correlation coefficient, r.***

Comparisons were made between the six companies based on the average value, correlation coefficients, determination coefficients and regression equations for the studied indicators.

The results were represented in suggestive graphics and tables.

RESULTS AND DISCUSSIONS

Net Profit evolution

Net Profit increased in all the companies in the analyzed interval, but it varied from a firm to another.

In the company C1, net profit grew up from Lei 0.12 Million in 2009 to Lei 0.5 Million in 2018, meaning by 315.66% more than in the first year of the study. For C2, net profit increased by 42 %, from Lei 0.4 Million to Lei 0.6 Million. For C3, during the analyzed period, the financial result was positive only in the years 2009, 2011, 2014, 2015, 2016 and 2017, but in 2010, 2012, 2013 and 2018, the company registered losses. As a consequence, net profit value declined from Lei 0.03 Million in 2009 to the loss of Lei - 0.91 Million in 2018. For C4, net profit increased from Lei 0.4 Million to Lei 1.19 Million, meaning 2.97 times. The company C5 recorded profit in almost all the analyzed years, except 2016, when it registered Lei 0.12 Million losses. In 2018, C5 registered Lei 0.3 Million net profit by 23.1 % less than in 2009, when this accounted for Lei 0.39

Million. For C6, net profit raised by 23.21 % from Lei 0.56 Million in 2009 to Lei 0.69 million in 2018. Therefore, in general, all the six companies had a good financial situation, except a few companies which registered losses in a few years (Fig.1).

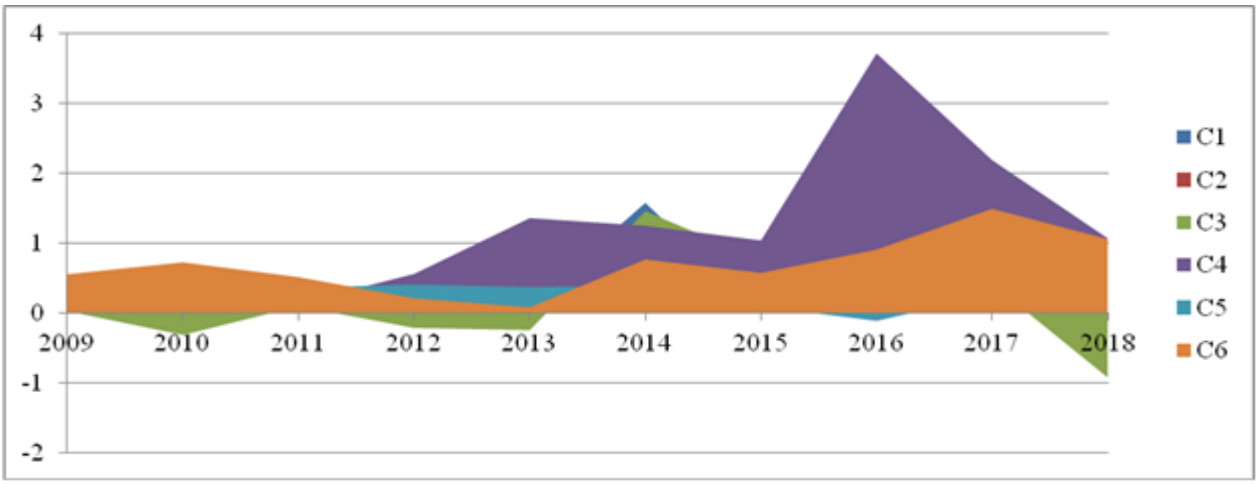

Fig.1.The evolution of net profit by company in the period 2009-2018 (Lei Million)
Source: Own design based on the data of the Balance Sheets of the six companies [3].

Fig.1. reflects very well that the highest net profit was achieved by C4 followed by C6 , and mainly in the last years of the analysis, while C3 registered losses in a few years.

Net Profit Margin was considered an important indicator for making comparisons between the analyzed firms as it reflects the share of the net profit in sales, in other words, how much turnover is represented by net profit, that is after taxation, in Romania, profit tax being 16 % on gross profit.

Net Profit Margin registered different levels from a firm to another depending on its sales, and also on the income and expenses levels.

For C1, the net profit margin accounted for 12.11 % in 2018 compared to 4.38% in 2009, which is a positive aspect, and it varied between 0.88%, the lowest level registered in 2010 and 35.71%, the highest level, recorded in 2014.

For C2, net profit margin was 9.28% in 2009, but 7.37% in 2018. Its level ranged between 1.37%, the minimum value in 2012 and 28.45%, the maximum value in 2016.

The company C3 has a special situation, because of the losses registered in the years 2010, 2012, 2013 and 2018. In this case, if in 2009, C3 registered 0.7% net profit margin, in 2018, it was recorded a negative margin accounting for -6.07%. The highest net profit margin accounted for 14.62 % in 2014 and the lowest one was - 8.20% in 2010.

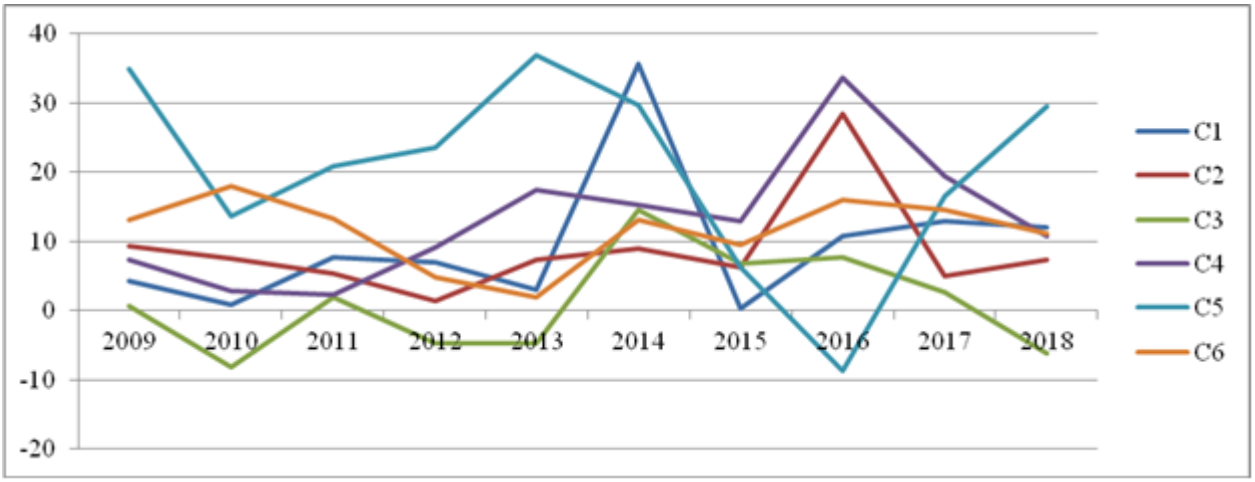

Fig. 2. Dynamics of Net Profit Margin in the analyzed companies, 2009-2018 (%)
Source: Own design based on the Balance Sheets of the firms [3].

For C4, net profit margin increased by 47.5% in the analyzed interval from 7.3% in 2009 to 10.77% in 2018. The highest net profit margin was 33.72% recorded in 2016, and the lowest one was 2.32% in 2011.

For C5, net profit margin declined from 34.89% in 2009 to 29.61 % in 2018, but the highest level was achieved in the year 2013 and accounted for 36.935 and the minimum level was -8.69% in 2016.

For C6, net profit margin was 13.16% in 2009 and 11.12 % in 2018, the peak of this indicator being 18.04% in 2010 and the lowest level was 1.995 in 2013 (Fig.2).

Return on assets (ROA) was used in order to establish how much of net profit was produced using the total assets (fixed and working capital) of the companies.

For C1, in 2009, the utilization of Lei 1 assets produced Lei 2.02 net profit, while in 2018, the company obtained Lei 9.67 net profit, meaning 4.78 times more than in the first year of the interval. The highest ROA level was Lei 19.55 recorded in 2014, and the lowest value was 0.46 lei in 2010.

For C2, in 2009, it was achieved Lei 4.32 net profit per Lei one assets, while in 2018, the company got Lei 4.23 net profit. Therefore, in 2018, the net profit per asset was by 2.1 % smaller than in 2009. The highest net profit per Lei one asset was Lei 19.71 in the year 2016 and the lowest level accounted for Lei 0.97 in 2012.

For C3, the years when the company carried out net profit using its assets were 2009, 2011, 2014, 2015, 2016 and 2017, when per Lei one asset it was obtained Lei 7.74 net profit, the highest value in 2014, and Lei 0.34 net profit, the lowest level in 2009. In the other years, the company achieved losses per Lei one asset varying between Lei - 4.22, the highest loss in 2010, and Lei -1.8, the lowest loss registered in 2013.

For C4, per Lei one asset, the company produced Lei 5.68 net profit in 2009 and Lei 5 in 2018. The ROA of this company ranged between Lei 16.7 in 2016, the maximum level, and Lei 0.82, the minimum level registered in 2010.

In case of C5, per Lei one utilized asset, the firm obtained Lei 45.92 net profit in 2009 and Lei 77.97 in 2018, that is by 70.91% more than in the first year of the studied period. The highest net profit per Lei one asset was Lei 77.97 achieved in 2018, and the lowest level was Lei 8.48 in 2015. But, this company achieved losses of Lei -17.12 per Lei one asset in the year 2016.

In case of C6, the net profit per Lei one asset declined by 2.8% from Lei 5.8 in 2009 to Lei 5.64 in 2018. The top net profit was noticed in 2017 and accounted for Lei 8.71m and the minimum net profit was Lei 0.74 registered in 2013 (Fig.3).

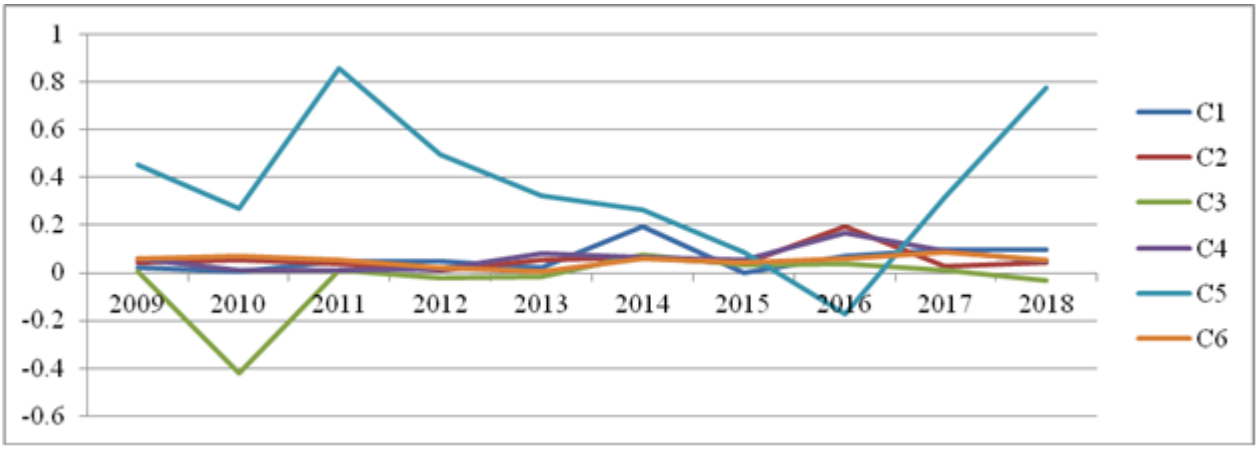

Fig.3.The evolution of Return on Assets (ROA) by company, 2009-2018
Source: Own calculation and design based on the data from the Balance Sheets

Return on Equity (ROE) was also an important indicator reflecting profitability taking into account how much profit resulted using the shareholders' equity.

For C1, per Lei one equity, it was achieved Lei 0.04 net profit in 2009 and Lei 0.13 in 2018, that is 3.25 times more. The value of net profit ranged between the maximum level Lei 0.13 registered in 2018 and the minimum level Lei 0.01 achieved in 2011.
For C2, per Lei one of equity, the company produced Lei 0.07 net profit in 2009 and Lei 0.09 in 2018, that is by 28.57 % more than in the first year of the interval. The net profit per Lei one equity varied between the maximum level Lei 0.29 in 2016 and the minimum level Lei 0.01 in 2012.
For C3, the net profit per Lei one equity ranged between Lei 0.007 in 2009, the lowest level and Lei 0.29 in 2014, the highest level. But, in the years 2010, 2012, 2013 and 2018, this company achieved losses. The highest loss was Lei 0.09 per Lei one equity in 2018, and the lowest loss was Lei 0.06 in 2012.
For C4, the net profit per Lei one equity declined by 41.7% from Lei 0.12 in 2009 to Lei 0.07 in 2018. However, C4 registered the highest net profit per Lei one equity Lei 0.27 in 2016, and the lowest level Lei 0.03 in 2011.
For C5, ROE accounted for 0.57 in 2009 and by 56.14% more in 2018, that is 0.89. The highest net profit per Lei one equity was Lei 1 in the year 2011, and the lowest level was Lei 0.08 in 2015. In 2016, the company registered Lei -0.16 loss per Lei one equity.
For C6, the net profit per Lei one equity decreased by 8.4% from Lei 0.12 in 2009 to Lei 0.11 in 2018. The highest net profit was Lei 0.18 in 2017 and the lowest one was Lei 0.05 in 2012 (Fig. 4).

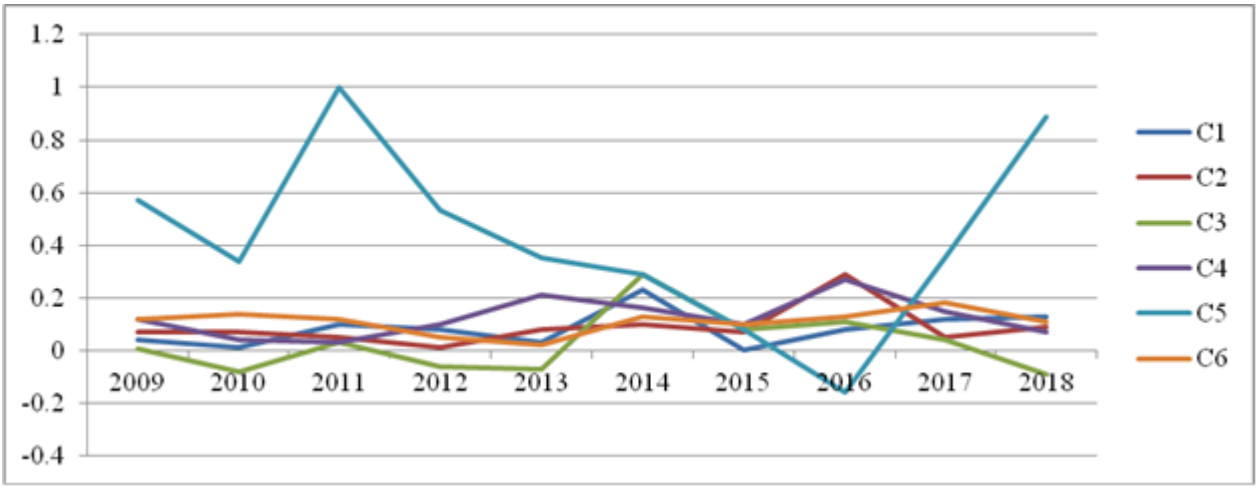

Fig.4.The evolution of Return on Equity (ROE) by company, 2009-2018
Source: Own calculation and design based on the data from the Balance Sheets

Return on Costs (RC) was also studied because this indicator reflects how much profit was carried out by the company per Lei one expenses.
First of all, the dynamics of the total costs in the period 2009-2018 reflected a continuous growth in all the companies.
For C1, the total costs increased 2.29 times from Lei 4.33 Million in 2009 to Lei 9.94 Million in 2018, the average accounting for Lei 6.82 Million.
For C2, the total costs raised by 66.29% from Lei 5.4 Million in 2009 to Lei 8.98 Million in 2018, meaning Lei 6.89 Million in average.
For C3, the costs raised 3.14 times in 2018, reaching Lei 17.45 Million compared to Lei 5.54 Million in 2009. The average total cost accounted for Lei 9.93 Million in the studied period.
For C4, the total expenses raised 2.59 times from Lei 3.9 Million in 2009 to Lei 10.10 Million in 2018.
For C5, the total costs accounted for lei 0.66 Million in 2009 and for Lei 1.52 Million in 2018, that is 2.3 times more.
For C6, the total spending increased 2.73 times from Lei 5.36 Million in 2009 to Lei 14.64 Million in 2018, the average costs in the whole period accounting for Lei 8.99 Million (Fig.5).

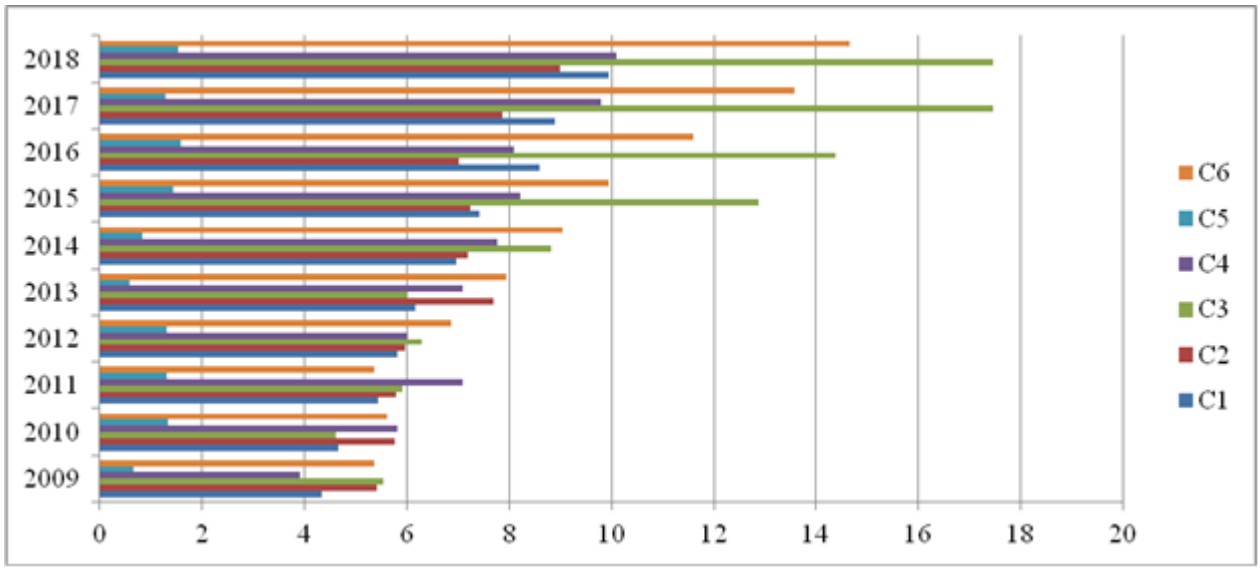

Fig.5.The evolution of Total costs (TC) by company, 2009-2018 (Lei Million)
Source: Own calculation and design based on the data from the Balance Sheets

As a consequence of the evolution of the net profit and of the total costs, the Return on Costs (RC) registered different levels by company.

For C1, RC increased 4.5 times from Lei 0.02 net profit per Lei 1 costs in 2009 to Lei 0.09 in 2018. The RC value ranges between the maximum level Lei 0.23 per Lei 1 costs in 2014 and the minimum level Lei 0.002 registered in 2015.

For C2, RC remained at the same level in 2018 like in 2009, respectively Lei 0.07 net profit per Lei 1 costs. But, during the analyzed period, it was registered the highest net profit per Lei 1 cost, Lei 0.32 in the year 2016 and the minimum level Lei 0.01 in 2012.

Fir C3, per Lei 1 costs, the company achieved Lei 0.16 net profit, the highest level in 2014, and Lei 0.001, the lowest level in 2009. In the years with losses, the highest loss per Lei1 spent was Lei 0.07 in 2010 and the lowest loss was Lei 0.03 noticed in 2012.

For C4, the net profit per Lei 1 costs increased from Lei 0.10 in 2009 to Lei 0.11 in 2018, that is by 10 % more. For C4, RC ranged between Lei 0.46 in 2016, the maximum level, and Lei 0.02 in 2010 and 2011, the minimum level.

For C5, per Lei 1 costs, the company carried out Lei 0.58 net profit in 2009 and Lei 0.43 in 2018, meaning by 26% less. However, the highest net profit was Lei 0.66 in 2013 and the lowest level was Lei 0.06 in 2015. In 2016, this company registered Lei 0.08 loss per Lei 1 costs.

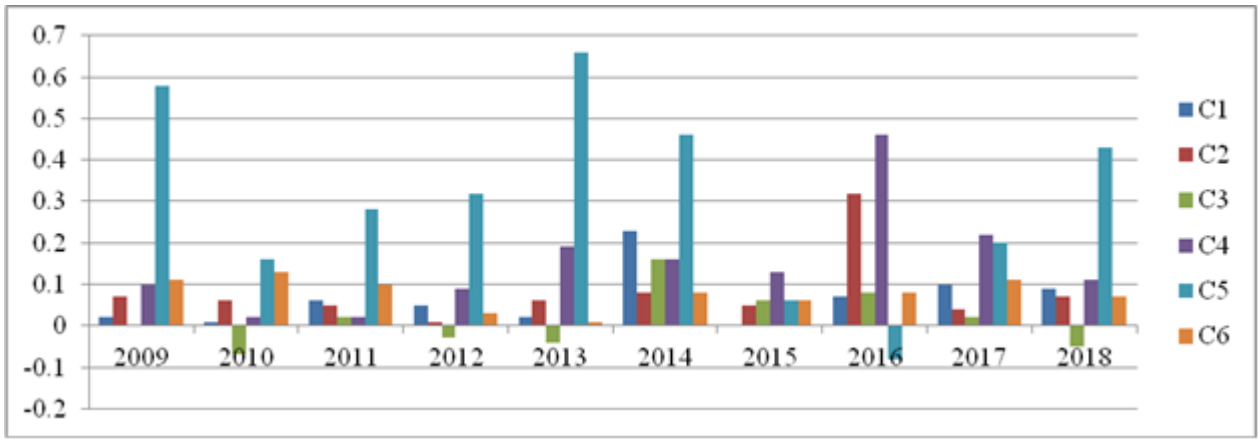

Fig.6.The evolution of Return on Costs (RC) by company, 2009-2018
Source: Own calculation and design based on the data from the Balance Sheets

For C6, the net profit per Lei 1 costs declined by 36.4 % in the analyzed period from Lei 0.11 in 2009 to Lei 0.07 in 2018. The minim net profit per Lei 1 spent was Lei 0.01 recorded in 2013 and the highest net profit was Lei 0.13 registered in 2010 (Fig. 6).

Ranking of the companies based on the results obtained for profit and the studied indicators characterizing profitability is presented in Table 1.

On the 1st position is C1 which came on the top position for NPM, ROA, ROE, TC and RC, but on the 5th position for NP.

On the 2nd position is situated C4, which occupied the 2nd position for NOM, ROA, ROE and RC, on the 1st position for NP and on the 4th position for TC.

On the 3rd position was placed C6, which was ranked the 2nd for NP, the 3rd for NPM, ROE AND RC, and the 4th for ROA and the 5th for TC.

Also, on the 3rd position is situated C2, which summed the same number of pints like C6. But, it got the following positions: the 2nd for TC, the 3rd for NP and RC, the 4th for ROE and the 5th for NPM.

On the 4th position came C1, which was situated on the 2n place for ROA, on the 3rd for TC, on the 4th for NP, NPM and RC and on the 5th for ROE.

Finally, on the 5th position was situated C3. It came on the 5th position for ROA and RC, on the 6th position for NP, NPM, ROE and TC (Table 1).

Table 1. The ranking of the companies based on the average value of the studied indicators

	Specification	NP	NPM	ROA	ROE	TC	RC	Total points	Rank
C1	Value	0.50	0.095	0.06	0.08	6.82	0.07	-	-
	Rank	4	4	2	5	3	4	22	4
C2	Value	0.57	0.087	0.057	0.09	6.89	0.08	-	-
	Rank	3	5	3	4	2	3	20	3
C3	Value	0.22	0.011	0.006	0.03	9.93	0.02	-	-
	Rank	6	6	5	6	6	5	34	5
C4	Value	1.19	0.13	0.06	0.13	7.38	0.15	-	-
	Rank	1	2	2	2	4	2	13	2
C5	Value	0.30	0.23	0.37	0.42	1.18	0.31	-	-
	Rank	5	1	1	1	1	1	10	1
C6	Value	0.69	0.12	0.051	0.11	8.99	0.08	-	-
	Rank	2	3	4	3	5	3	20	3

Source: Own calculation.

Analysis of the relationship between Net Profit and Costs based on regression model, determination coefficient and correlation coefficient

The considered hypothesis has been:

H0: There is no significant influence of total costs on net profit

H1**:** It is a significant impact of costs on net profit.

To test the hypothesis it was used the linear regression model.

The interpretation of the F Stat supposes to compare the Sign. F, the critical calculated value of the test, with F tab, that is α, usually for p=0.05. If Sign F < α the hypothesis of lack of significance of the independent variables H0 is rejected in favor of the hypothesis H1, that is the two variables are statistically significant and the regression model is confirmed as significant as well.

Considering that the degrees of freedom, df, are 1 for regression and 8 for residuals, it was found Ftab= α = 5.32.

The results regarding ANOVA, regression model and the determination coefficient are presented in Table 2.

Table 2 shows that for all the studied companies, Sign F was < α, therefore the H0 hypothesis was rejected and the H1 hypothesis was accepted, meaning that costs have an influence on net profit and the regression models are confirmed.

The determination coefficient registered different values from a company to another, and it showed that the variation of the net profit is caused by the variation of the total

costs in a lower proportion that is: 2 % for C3, 26.2 % for C4, 31.8% for C5, 32.6 % for C1, and in a higher proportion: 98.9 % for C2, and 50.6% for C6.

Table 2. ANOVA, regression model and the determination coefficient for Net profit, Y and Costs X by company

Company		df	Sum of squares	Mean square	F	Sign F
C1	Regression	1	0.763345	0.763346	3.870572	0.084687
	Residual	8	1.577744	0.197218		
	Total	9	2.34109			
	R^2	0.326	Regression equation: Y= 0.1549659 X -0.557867			
C2	Regression	1	3.254132	3.254132	741.3065	3.5709
	Residual	8	0.035118	0.00439		
	Total	9	3.28925			
	R^2	0.989	Regression equation: Y= 6.974884 X +3.433848			
C3	Regression	1	0.097919	0.097919	0.167976	0.692672
	Residual	8	4.663520	0.58294		
	Total	9	4.76144			
	R^2	0.020	Regression equation: Y = 0.020388 X + 0.021507			
C4	Regression	1	2.824444	2.824444	2.849449	0.129883
	Residual	8	7.929796	0.991225		
	Total	9	10.75424			
	R^2	0.262	Regression equation: Y = 0.3008529 X - 1.028400			
C5	Regression	1	0.039344	0.039344	0.903388	0.369702
	Residual	8	0.348416	0.043552		
	Total	9	0.38776			
	R^2	0.318	Regression equation: Y = - 0.1850626 X + 0.520373			
C6	Regression	1	0.745272	0.745272	8.204026	0.021013
	Residual	8	0.726738	0.90842		
	Total	9	1..47201			
	R^2	0.506	Regression equation: Y = 0.084671 X - 0.06828			

Source: Own calculations.

The coefficients of correlation between Net profit and Total costs reflected a very weak relationship, r = 0.143 in case of C1, a weak relationship in case of C5 (r = 0.318), a moderate connection in case of C4 and C2 (r = 0.512 and, respectively, r = 0.571) and a high relationship in case of C6 and C2 (r = 0.711 and, respectively, r = 0.994) (Table 3).

Table 3. The correlation coefficient between Net profit and Costs by company

C1	C2	C3	C4	C5	C6
0.571	0.994***	0.143	0.512	0.318	0.711*

*Statistically significant for α = 0.05. *** Statistically significant for α = 0.05, α = 0.02 and α = 0.01.
Source: Own calculations.

CONCLUSIONS

In the period 2009-2018 in the analyzed companies net profit increased in general with a few exceptions.

The analysis of profit and profitability in the six top agribusiness commercial companies dealing with dairy cows growing proved that even thou they carried out the best performances in the field, the financial year could be not always ended with profit like in case of C3, which had losses in 2010, 2012, 2013 and 2018 and C5 with losses in 2016.

The highest performance was carried out by the companies C4 and C5 where the annual average net profit in the whole period accounted for Lei 1.19 Million and, respectively, for Lei 0.3 Million.

The highest net profit margin was achieved by C5, 23 %, and the lowest one by C3, 1.1 %..

Return on assets registered the highest annual average level in C5 and the lowest annual average level in C3, respectively for Lei one

million used assets it was obtained Lei 370 thousand net profit and Lei 6 thousand.
Return on equity reflected that for Lei one million equity, it was produced
for Lei 0.42 million net profit in F5, the highest level and Lei 30 thousand in C3, the lowest one. In the analyzed interval, the total expenses of the companies increased having a deep influence on the net profit. For Lei one million expenses, the average net profit varied between Lei 310 thousand in C5, the highest value and 20 thousand in C3, the minimum value. Based on the total number of points cumulated for all the analyzed indicators, the ranking of the companies in the descending order of profitability was: C5, C4,C2, C6,C1 and C3. Total costs have a deep influence on net profit, as we know very well that expenses and incomes are the main determinant factors of profit. The linear regression models confirmed the relationship between net profit and total costs. The determination coefficients reflected that only in case of C5 and C2, the variation of profit was caused by the variation of total costs in a higher proportion than 50%. In case of C4 and C1 the found determination degree was about 31 %. In case of the other companies, C3 and C6, net profit is much more influenced by other factors than costs.
Between net profit and costs it is a positive relationship, but its intensity differs from a company to another. The highest correlation coefficients reflecting a high positive connection between net profit and costs were r = 0.994 in C2 and r =0.711 in C6.
As a final conclusion, to increase net profit and profitability, the company managers have to make a careful financial analysis and indentify the risk factors and unutilized resources, and to set up a development strategy which has to valorise the opportunities assuring the future economic growth.

ACKNOWLEDGEMENTS

All the support given by the managers of the commercial companies selected in the panel of this study is entirely acknowledge.

REFERENCES

[1]Angel, E., Popescu, A., 2009, Milk Quality Management at Flav O'Rich Dairy, USA, Scientific Papers Management, Economic engineering in agriculture and rural development, Vol.9(1), p.11-14.
[2]Arnis, N. I., Kolias, G. D., Filios, V. F., 2008, The profitability of the Greek retail firms and the relations among the determinants (in Greek). Review of Economic Sciences, 14, 161-180.
[3]Balance Sheets of F1, F2, F3, F4, F5, F6 concluded at the end of the years 2009-2018.
[4]Betz, R., Nott, S., Schwab, S., Knuth, J., Staton, M., 2012, Spartan Dairy Farm Business Analysis Workbook, Financial Section, https://msu.edu/~steind/Dairy%20Farm%20Business%20Analysis%20Handbook.pdf, Accessed on Jan. 2, 2020.
[5]Datta, A.K., Haider, M.Z., Ghosh, S.K., 2019, Economic analysis of dairy farming in Bangladesh, Trop Anim Health Prod. 51(1):55-64, https://www.ncbi.nlm.nih.gov/pubmed/30003526, Accessed on Jan. 2, 2020.
[6]Delgado, H.A., 2015, Profitability analysis of Quebec Dairy Cattle suing health and management data via visualisation tools, Thesis for Dr. in Philosophy, McGill University.
[7]Dhuyvetter, K., 2011, Factors Impacting Dairy Profitability: An Analysis of Kansas Farm Management Association Dairy Enterprise Data, Kansas State University, https://www.agmanager.info/node/7139, Accessed on Jan. 2, 2020.
[8]Dolewikou, R.L., Sumekar, W., Setiadi, A., 2016, The profitability analysis of dairy cattle business on the group of dairy farmers in West Ungaran District Semarang Regency https://www.researchgate.net/publication/314194006_The_profitability_analysis_of_dairy_cattle_business_on_the_group_of_dairy_farmers_in_West_Ungaran_District_Semarang_Regency, Accessed on Jan. 2, 2020.
[9]Dragotă, V., Dragotă, M., Obreja, L., Ciobanu, D., 2003, Financial Management, Vol. I & II, Economica Publishing House, Bucharest, pp.142-149.
[10]Dumbrava, M., 2010, Model of analysis of firm performance, Theoretical and applied economics, Vol. XVII, No. 8(549), 105-119.
[11]FAO, 2019, Profitability and Efficiency of Indian Dairy Farms, http://www.fao.org/3/x6170e36.htm, Accessed on Jan. 2, 2020.
[12]Ferris, A, Malcolm, B., 1999, Sense and Nonsense in Dairy Farm Management Economic Analysis, University of Melbourne, https://pdfs.semanticscholar.org/91c6/27ef11df029c269de6f9fa6ebe3e093bc721.pdf , Accessed on Jan. 2, 2020.
[13]Gencdal, F., Yildirim, I., 2018, Gross and net profit of dairy cattle farms- A case study in Eastern Anatolia Region of Turkey, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 18(4):121-127.

[14]Ghic, G., Grigorescu, C. J., 2009, Economic and financial analysis, Universitaria Publishing House, Bucharest, 130-135.
[15]Gołaś, Z., 2017, Determinants of milk production profitability of dairy farms in the EU member states, Problems of Agricultural Economics, 3(352):19-40.
[16]Haloho, R.D., Santoso, S. I., Marzuki, S., Roessali, W., Setiadi, A., 2013, Profit function analysis of dairy cattle farming in getasan and west ungaran districts, semarang regency https://www.researchgate.net/publication/297728341_Profit_function_analysis_of_dairy_cattle_farming_in_getasan_and_west_ungaran_districts_semarang_regency, Accessed on Jan. 2, 2020.
[17]Isfanescu, A., Robu, V., Hristea, A. M., Vasilescu, C., 2002, Economic and financial analysis, ASE Publishing House, Bucharest, 75-80.
[18]Maverick, J.B., 2019, Is Profitability or Growth More Important for a Business?, https://www.investopedia.com/ask/answers/020415/what-more-important-business-profitability-or-growth.asp, Accessed on Jan. 2, 2020.
[19]McLaughlin, E., 2019, Case study: Financial analysis, https://www.sophia.org/tutorials/case-study-financial-analysis--2, Accessed on Dec.20, 2019.
[20]Nyekanyeka, T., 2011, Analysis of profitability and efficiency of imporved and local smallholder dairy production: A case of Lilongwe Milk Shed Area, M. Sc. Thesis, University of Malawi, Bunda College.
[21]Pirvutoiu, I, Popescu, A., Grigoras, M.A., 2010, Profitability Analysis – a Study Case Agroindustriala Pantelimon Joint Venture Dairy Farming Company, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.10(2)/2010, 161-164.
[22]Popescu, A., 2003, Financial Analysis in Dairy Farming, The 2nd International Symposium on "Prospects for the 3rd Millenium Agriculture", USAMV Cluj-Napoca, 9-11 Oct. 2003, Bulletin of UASVM Cluj-Napoca, Zootehnie si Biotehnologii (Animal Science and Biotechnologies), Vol.59, 11-14.
[23]Popescu, A., 2004, Prospects for dairy farm management under milk quota. The International symposium on"Prospects for the 3rd Millenium Agriculture", USAMV Cluj-Napoca, 20-23 Oct.2003, Bulletin of UASVM Cluj-Napoca, Zootehnie si Biotehnologii (Animal Science and Biotechnologies), Vol.60, 14 - 20.
[24]Popescu, A., 2004, Financial Statement - a tool in decision making in dairy farming. The International symposium on"Prospects for the 3rd Millenium Agriculture", USAMV Cluj-napoca, 20-23 Oct.2003, Bulletin of USAMV Cluj-Napoca, Zootehnie si Biotehnologii (Animal Science and Biotechnologies), Vol.60, 384 - 389.
[25]Popescu, A., Muresan, G., 2004, Analysis in dairy farming in Arad County achievements and prospects under the background of Romania's entry into the E.U. The International symposium on "Prospects for the 3rd Millennium Agriculture", USAMV Cluj-Napoca, 20-23 Oct.2003, Bulletin of UASMV Cluj-Napoca, Zootehnie si Biotehnologii, (Animal Science and Biotechnologies), Vol.60, p.385.
[26]Popescu, A., 2005, Research concerning dairy cows, farm structure and milk performances in the proximity of the capital, The 4th International Symposium "Prospects of the 3rd Millennium Agriculture, 6-7 Oct.2005, Bulletin UASVM Cluj-Napoca, Romania, Series Zootehnie si Biotehnologii si Medicina Veterinara (Series Animal Science and Biotechnologies and Veterinary Medicine), Vol.61, 399-403.
[27]Popescu, A., 2006, Research concerning the economic impact of investments in dairy farms of various size, International Symposium "Prospects of Agriculture in the 3rd Millennium", UASVM Cluj-Napoca, 5-6 October 2006, Bulletin of USAMV Cluj-Napoca, Romania, Seria Zootehnie si Biotehnologii si Medicina Veterinara (Series Animal Science and Biotechnologies and Veterinary Medicine), No.62, 8-12.
[28]Popescu, A., 2006, Study upon milk market in the EU countries, Bulletin of the University of Agricultural Sciences and Veterinary Medicine, Animal Husbandry and Biotechnologies, Vol. 62, 214, Symposium on Prospects for the 3rd Millenium Agriculture, Oct.5-6, 2006, Cluj-Napoca
[29]Popescu, A., 2006, Managementul financiar in fermele de vaci, Ed. Dominor Bucuresti, (Financial management in dairy farms, Dominor Publishing House, Bucharest), 69 p.
[30]Popescu, A., 2007, Analiza financiara, Ed.Dominor, Bucuresti (Financial Analysis, Dominor Publishing House, Bucharest), 188-194.
[31]Popescu, A., 2009, Considerations upon Net Working Capital Management, Scientific Papers Series Management, Economic engineering in agriculture and rural development, Vol.9(2):125-128.
[32]Popescu, A., 2010, Net Sales Analysis in a Dairy Farming Company, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.10(2):179-184.
[33]Popescu, A., 2010, Research concerning Gross Margin Forecast based on Milk Yield using the Least Square Method of Regression Analysis, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.10(2):173-178.
[34]Popescu, A., 2012, Economia productiei in ferma de vaci, Ed.Eikon, Cluj Napoca, coeditare cu Ed.RawexComs, Bucuresti, (Production economics in dairy farms, Eikon Publishing House, Cluj Napoca, coediting with RawexComs Publishing House, Bucharest), 45-52.
[35]Popescu, A., 2014, Research on milk cost, return and profitability in dairy farming, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(2):219-222.
[36]Popescu, A., 2014, Research on profit variation depending on marketed milk and production cost in dairy farming, Scientific Papers Series Management,

Economic Engineering in Agriculture and Rural Development, Vol.14(2):223-230.
[37]Popescu, A., Condei, R., 2014, Considerations regarding the criteria of efficiency for the classification of dairy farms, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(3):256-265.
[38]Popescu, A., Condei, R., 2014, Study on the average marketed milk as a measure of profitableness threshold in dairy farms, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(4):219-222.
[39]Popescu, A., David, L., 2014, Research on regression modeling of profit related to milk yield in dairy farming, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(4):211-218.
[40]Popescu, A., 2015, Research on the top Romanian trademarks in the milk and dairy products market, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1): 367-376.
[41]Popescu, A., 2015, Research on the trends in milking livestock and milk production in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1):377-386.
[42]Popescu, A., 2015, Research on the trends in milk production and consumption in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1):387-392
[43]Popescu, A., 2015, Research on the trends in Romania's milk and dairy products foreign trade, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1):391-398.
[44]Popescu, A., 2015, Regression modeling in prediction milk production depending on the dairy bovine livestock, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(4): 225-230.
[45]Popescu, A., 2015, Multiple correlation and regression in predicting milk price, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(4):231-238.
[46]Popescu, A., 2016, The milk market concentration and competition thresholds in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(2):247-253.
[47]Popescu, A., 2017, Trends in milk market and milk crisis impact in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.17(2):281-290.
[48]Popescu, A., Angel, E., 2019, Cow raw milk quality and its factors of influence in relationship with milk price, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.19(1): 421-440.
[49]Robu, V., Georgescu, N., Analiza economico-financiara, ASE, (Economical and financial analysis, ASE) Digital Library, http://www.biblioteca-digitala.ase.ro/biblioteca/carte2.asp?id=113&idb=6, Accessed on Dec.20, 2019.
[50]Stankov, K., 2015, Economic efficiency analysis of dairy cattle farms in Bulgaria, Trakia Journal of Sciences, Vol. 13, Suppl. 1, pp 226-232,
[51]Stankov, K., Stoyanova, S., Petrov, D., 2015, Regression analysis of profit per 1 kg milk produced in selected dairy cattle farms, Int. J. Curr. Microbiol. App. Sci (2015) 4(2): 713-719.
[52]Tranel, L.F., Frank, G., 2002, Managing Dairy Farm Finances, Iowa State University, Cooperative Extension, https://www.extension.iastate.edu/dairyteam/files/page/files/ManagingDairyFinance2.pdf, Accessed on Jan. 2, 2020.
[53]Yilmaz, H., Gül, M., Akkoyun, S., Parlakay, O., Bilgili, M.E., Vurarak, Y.,Hizli, H., Kilicalp, N., 2016, Economic analysis of dairy cattle farms in east Mediterranean region of Turkey, Revista Brasileira de Zootecnia, 45(7):409-416.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

PORK MARKET CRISIS IN ROMANIA: PIG LIVESTOCK, PORK PRODUCTION, CONSUMPTION, IMPORT, EXPORT, TRADE BALANCE AND PRICE

Agatha POPESCU[1,2,3]

[1]University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest Romania, Phone: +40213182564, Fax: +40213182888, Email: agatha_popescu@yahoo.com
[2]Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu-Șișești", 61 Marasti Boulevard, District 1, 011464, Bucharest Romania, Phone: +40213184450, +40213184451, Fax: +40-21-310.49.23, Email: agatha_popescu@yahoo.com
[3]Academy of the Romanian Scientists, 3 Ilfov Str., District 5, Phone: +40213147491, Email: agatha_popescu@yahoo.com

Corresponding author: agatha_popescu@yahoo.com

Abstract

The paper analyzed Romania's pork market crisis by means of pig livestock, pork production, consumption, import, export, trade balance, pork price based on the empirical data provided by NIS Tempo Online for the period 2014-2018 emphasizing the effects of the African Swine Fever (ASF). Dynamic analysis, trend analysis, descriptive statistics, regression modeling, and comparison have been the main methodological tools used in this study. Despite that pig number declined by 27.7%, in 2018 accounting for3.92 million heads compared to 2010, and in 2019 there were lost other 486, 000 heads due to the ASF, pork production remained relatively stable at 426,100 Tons in 2018, being by only 3.3% higher than in 2014. Its level is justified by the increased live weight at slaughter and by the imports of pigs and pork carcasses. Pork consumption is 38.3kg/capita, by 15% higher than in 2010, but a little lower than 41 kg/capita, theEU-28 average. Romania's pork trade is dominated by imports, which led to a negative trade balance in 2018 of -327,010 Tons, being by 87.3 % higher than in 2014. In 2018, import represented 85% of pork production, 48.3 % of pork consumption, import dependency being 48%, and self sufficiency rate 56.5%. Export/import ratio registered 9% in terms of quantity and 5.7% in terms of value, the both figures reflecting the lowest level recorded by Romania, reflecting its status of net importing country and the inefficient trade. The ASF impact is seen in the growth of farm inputs price, production cost, and farm gate price, which since April 2019 increased from Lei 5.61 to Lei 8 per kg live weight in the month of December, that is by 42.6%, and the massive imports of pigs and carcasses practiced by the processors affecting the local breeders. To recover the pork market in Romania, both the breeders and processors have to respect the strategy and measures imposed by the authorities regarding pig growing, transportation, slaughtering, to sustain the development of pork production, its quality, and export and to increase efficiency and competitiveness of pork sector.

Key words*: *pig number, pork production, import, export, trade balance, import dependency, self sufficiency rate

INTRODUCTION

For sustaining its vital functions, the human body needs a balanced diet including all the nutrients, among which meat occupies an important position, because it is the main source of high value proteins (in average about 22%), amino acids, fats, fatty acids, vitamins (A, B group and folic acid), minerals (zinc, iron, potassium, magnesium, selenium, sodium), about 70% water and also a high digestibility (0.92). The chemical composition differ from a meat sort to another [1].

Pork lean meat has a high importance for maintaining health, a reason to be included in high protein diets for reducing the risks of cardiovascular disease, diabetes, for regulating blood pressure, decreasing body weight and increasing satiety [16].

Pork has been for a long period of time the most consumed meat in the world. Even at present it is consumed by hundreds of millions people from all the continents and in almost all the countries. Only the Jewish and Muslim people do not consume pork due to their religion which does not allow this.

At present, pork is ranked the second after poultry meat, as during the last decades poultry industry has developed much faster advantaging the producers and also offering a meat rich in high quality protein, and with less cholesterol.

The world pork production increased and in 2019 it accounted for 106.1 Million tons (Carcass Weight Equivalent), the main producing countries being China, EU, USA, Brazil, Russia, Vietnam, Canada, Philippines, Mexico [15, 21].

The EU-28 is the second large producer and the main exporter of pork at the global level, Spain, Germany, France, Poland, Denmark, Netherlands, Italy, Belgium, Unites Kingdom, Austria and Portugal being the main producing countries [8].

Pork represents the top meat consumed in the EU, the average annual consumption being 41 kg/capita, 3.28 times higher than the global average which accounts for 12.5 kg/capita. In six EU countries: Spain, Poland, Austria, Germany, Czech Republic, and Portugal, the EU mean is exceeded [13, 26, 36].

Romania is a country with a high potential in pork production, able to cover its domestic market and to assure important amounts of pork for export as proved along the time. Pig farming and pork production are especially concentrated in the South part of Romania, but also in the Eastern and Western regions, but pigs are raised in the whole country in many households [37]. The Romanians consume in average about 38.5 kg pork per year, keeping pork on the top position among the other meat sorts: poultry meat, beef and sheep and goat meat. Pork is a traditional meat in Romania, and could be prepared in a large range of specific and tasty meals [35].

During the last 13 years, new challenges have appeared in Romania's pork sector mainly after the country access into the EU. Romania came on the top position in the EU for its huge number of pigs. Also, it has a high number of pig farms, dominated by the small sized farms, in fact households where pigs assures in general the family needs. The industrialized units are not so numerous, but their slaughtering capacity is high, so that they have the highest share in pork production at present.

Most of farmers are facing many problems among which the key ones are: high farm inputs price, high production costs, and also the lack of subsidies which were offered just for a short period of time.

The profitability in pig fattening depends on many factors which vary from a farm to another: breeds and lines grown in the farm, number of series per year, number of sows, artificial insemination or natural mating, number of piglets per sow at birth and weaning, feeding system, daily gain, live weight at delivery, production cost, and price at the farm gate [33, 34].

The live weight at slaughter, the carcass weight and its share in the animal live weight, the quality of the carcass and of the cuts have a deep influence on meat price on the shelves of the supermarkets [30, 31, 32].

In the last years, the pork sector was deeply affected by the low number of sows to assure reproduction, the lack of piglets and their higher and higher price, resulting a higher and higher production cost, and a high price per kg live weight at the farm gate.

For this reason, meat processors proceeded to import pigs and carcasses at a low price, a fact which affected the local producers.

More than that, the outbreaks of the African Swine Fever in the Asian countries, mainly in China, and also in Europe in Romania, Poland, and other countries had and still has a deep on pork market. The EU key producing countries have intensified production and export mainly to China where pork price has exploded. In such a situation, on the EU market, it is a lack of piglets and carcasses and their price has rapidly increased.

Under this condition, Romania is facing the crisis of pork market, because the farmers have not enough biological material to develop their business, the farm input price has a high level as never before, the production cost is also high and the pig price at the farm gate is also high. The processors have not enough raw material, its acquisition from the internal is costing, and the opportunities to import carcasses are reduced

or if they exist, they are very expensive due to the boom of pork price on the EU market [27].

In this context, the paper purpose was to analyze the situation of pig livestock, pork production, consumption, import, export, trade balance, price to identify the main trends in the period 2014-2018, the last years which characterized the crisis of pork market in Romania and to look for solutions to recover of the pork sector in the coming years.

MATERIALS AND METHODS

Data collection

The paper is based on the data provided by the National Institute of Statistics, Tempo Online data base for different periods of time, mainly from 2010-2018 but also from the Food Balances 2014-2018. Also, there were used data from Faostat, and from Statista.

The studied indicators were: (i)pig livestock, (ii)pork production, (iii) pork consumption, (iv) pork trade: import, export, trade balance, (v) specific percentage ratios involving import such as: Import/Production, Import/Consumption, Import/Trade balance, Export/Import, Import dependency and Self sufficiency rate, (vi) average annual and monthly pork price at the farm gate, (vii) pork carcass price in a few member states.

Methodological aspects used in this study

The empirical data were illustrated in graphics to show the evolution of each indicator mentioned above and also was calculated the fixed basis index to reflect the percentage change in the final year compared to the first year of the chronological series.

In a few cases it was illustrated the trend line and the corresponding regression model, either a linear or a polynomial model, associated with the determination coefficient as measure of the variation in time of the studied indicator.

Other results were presented in tables whose data were also interpreted and discussed in details.

The study ends with the conclusions which emphasize the main aspects regarding the analysis of pork production in Romania in close relationship with the decline of the pig number, the increased imports of pigs and pork, the low export, the negative trade balance, the increased consumption, the increase of average price at the farm gate and in the European market.

RESULTS AND DISCUSSIONS

Pig number decline

The number of pigs in Romania was facing a continuous decline during the last decade from 5,428 thousand heads in 2010 to 3,925 thousand heads in 2018, meaning a reduction by 27.7% in the analyzed interval. This general decreasing trend is similar with the one noticed in the EU (Fig.1).

But compared to other EU countries, a few member states like Romania, Poland, Hungary, Lithuania, Belgium, Latvia, Bulgaria, Slovakia, Slovenia, Latvia, Italy, Estonia were affected by the African Swine Fever (ASF) [6].

In Romania the ASF appeared at the end of 2017 due to the wild boars which came from Ukraine and the outbreaks were mainly in the South Eastern part, South Muntenia, and Bucharest-Ilfov. In the other micro regions of development such as: West, Center, North East and North West, the number of pigs has slightly increased.

On May 1st 2019, the pig population in Romania accounted for 3,726 thousand heads, by 403 thousand heads less than at the same date in 2018, that is a 10% loss. More than this, the sows number declined by 29 thousand heads, and reached 251 thousand heads on May 1st 2019.

Taking into account the whole period since the 1st outbreak till present, the statistics shows that Romania lost 440,000 pigs and 46,000 sows due to the ASF [10, 24].

Romania is among the EU pig growing countries, being situated on the 9th position for the number of pigs, after Spain, Germany, France, Denmark, Netherlands, Poland, Italy, Belgium, and being followed by United Kingdom. The pig population grown in Romania represents 2.64 % of the EU-28 livestock existing at the end of the year 2018

(148,191.61 thousands).Taking into account the world pig population of 781 million heads, this means that in Romania in 2018 there was raised 0.05 % of the global swine livestock [9, 41]. The pig number decline started after Romania's access into the EU. A higher and higher number of pigs was slaughtered and could be compensated by the replacing rate which was very low, due to the non corresponding number of sows. In this way, Romania was and still is facing "the crisis of piglets" on the domestic market which led to the continuous increase of the acquisition price.

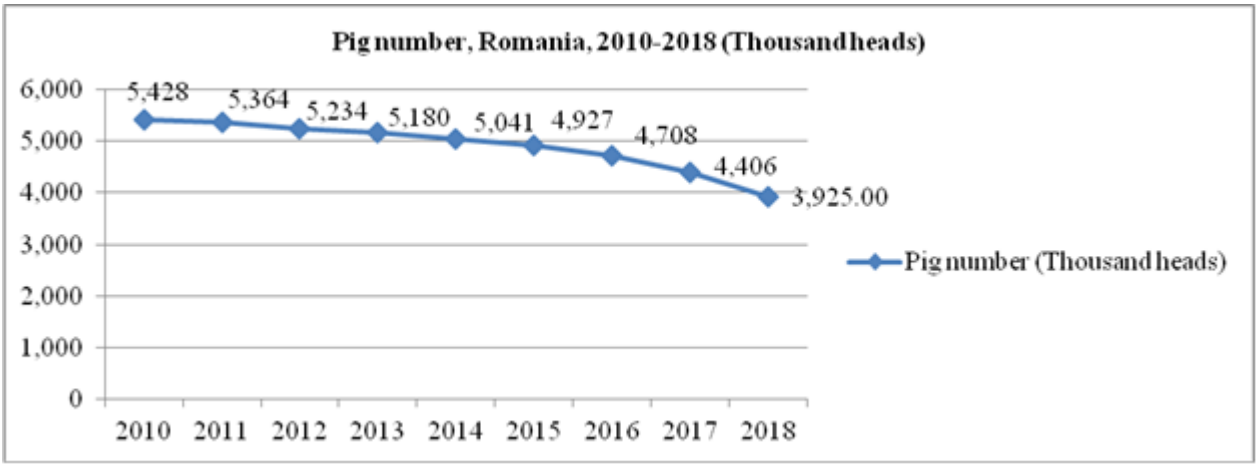

Fig.1. Pig number, Romania, 2010-2018 (Thousand heads)
Source: Own design based on data from [25].

Therefore, the pig breeders had to pay more for the farm inputs, production cost increased, while the price at the farm gate increased as well.

In addition, the fact that many Asian countries especially China, Vietnam, South Korea etc registered high losses of pigs due to the ASF, the pork demand increased and the pork price on the Asian market exploded. Under this condition, the main producing countries intensified their production and exports on the Asian market [27].

In the main EU pork producing countries like Spain, Germany and France, the sow number was maintained and the number of piglets as well for increasing the number of fattened pigs destined to the slaughter, and of course to intensify the export to China [7].

The Romanian pig farmers had no the possibility to buy piglets from other countries, the ones produced in the country were not enough to sustain pig fattening and, as a consequence, pork production decreased as well.

Therefore, the low reproduction in pig farming in Romania has led to a lack of piglets and to the increase of their price, to a lower and lower number of pigs for slaughter, but a higher and higher price per kg live weight. More than this, the pork carcass price raised due to the high demand on the Asian market [13, 42].

Pork production

Pork production was facing important changes after Romania's access into the EU. New breeds and breeding technologies have been implemented in pig farming and led to important changes in pig farms structure and productivity level.

In 2007, the small private households played the most important role in pork production, while the industrialized specialized units were just at the beginning of their activity. The fact that most of the pigs destined to slaughter were grown in the households, the increased price of the farms inputs especially for piglets, led to a high production cost and also to a high pig acquisition price per kg live weight.

In 2007, Romania had 1.6 million pig farms, representing 57% of the EU farms. Most of the small farms in Romania raised 1-2 pigs in a traditional growing system, with a cheap housing and feed and destined to assure only the family needs. In fact pig farms structure in Romania is represented mainly by the smallest farms raising 1-10 pigs, representing

about 64% of the total number of farms, the medium farms representing 3% raising 10-400 pigs and the largest farms with a share of about 33 % growing more than 400 pigs [11, 12].

Since 2009, the subsidies for pig growing were stopped, and due to this an important number of farms failed.

Due to the high acquisition price from the pigs delivered by the households, the processors changed their tactics and passed to cheap imports to assure the raw material and in this way, the importance of the households in the pork sector was diminished. As a result, in 2012, the industrialized and specialized units slaughtered 64.7% of the number of slaughtered pigs and produced 63.6% of pork production.

Since 2014, pig sector was affected by the trading embargo imposed to Russia by the EU, which led to a high amount of pork imports at low prices, which affected the local producers.

Pork production increased having a positive impact on the domestic market, but also encouraging the exporters to sell on external markets. However, the restraints imposed due to the appearance of the classical Swine Fever (SF) in the Romanian farms in the period 2007-2016 affected exports. After 2016, Romania was free of SF and the pork exports recovered [2, 14].

The dynamics of pork production was determined by the situation of the number of slaughtered pigs, average their live weight at slaughter, and the carcass weight. Pork production accounted for 426,100 Tons (equivalent fresh pork carcass) in the year 2018, being by 3.35 % higher than in 2014, when it was 412,272 Tons (Fig.2).

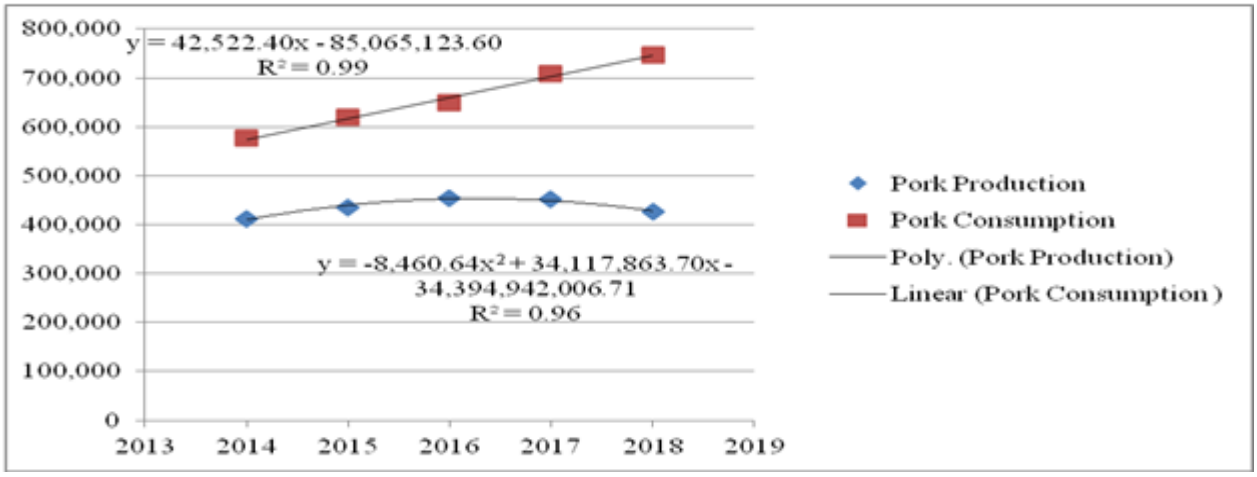

Fig.2. Pork production and pork consumption trend, Romania, 2014-2018
Source: Own design based on the data from [25].

In 2018, the highest number of pigs and the best pork production were carried out in industrialized and specialized units as presented in Table 1.

Table 1. Pork production achieved in industrialized and specialized units in the period 2011-2018

	No. of slaughtered pigs (Thousand)	Pig live weight at slaughter (Thousand Tons)	Average pig live weight at slaughter (kg/head)	Pork carcass weight (Thousand Tons)	Carcass share in live weight (%)
2011*	3,256.8	344.6	105.7	263.3	76.4
2012*	3,481.5	368.0	105.7	282.2	76.7
2013**	3,757.0	400.2	106.5	308.4	77.0
2014**	3,980.4	421.3	105.8	324.9	77.1
2015***	4,037.8	428.2	106.1	330.4	77.2
2016****	4,033.5	436.0	108.1	337.0	77.3
2017*****	3,882.0	423.4	109.1	328.0	77.5
2018******	4,265.4	470.1	110.4	365.1	77.5

Source: [18, 19, 20, 21, 22, 23].

Romania's contribution to the EU pork production is very small and accounted for 1.52% in 2018. At the world level, the contribution of Romania is much lower representing just 0.97% of the global pork output of 43,505.23 Thousand tons in 2018.

Pork consumption

Pork is a traditional and popular meat in Romania, which is reflected in the top position occupied by pork among other sorts of meat. The evolution of pork consumption compared to pork production may be observed in Fig.2, where it is clear that while pork consumption is increasing, pork production is declining. This means that the increased consumption is based not only on the domestic production but also on imports to cover the internal market needs. Consumption reached 38.3 kg/capita in 2018, being by 15% higher than in 2010. However, during the last decade, it varied, decreasing from the year 2010 to 29 kg/capita in 2014, the lowest level, but after this year it restarted to grow continuously till present [38]. (Fig.3)

On the following positions in the consumers' preferences decreasing order there are: poultry meat with 26.9 kg/capita, beef and veal with 5.2 kg/capita and sheep and goat with 2.2 kg/capita in the year 2018. An increased competition could be noticed among pork and poultry meat during the last decade when the population has become more conscious of the importance of a healthy diet. For this reason, poultry meat comes on the second position being more and more agreed by the ones who prefer to consume a lean meat, with a high value protein and low cholesterol content (Fig.3).

Therefore, pork represents more than a half, more exactly 51.8% of the total annual meat consumption per capita in Romania, which accounted for 73.8 kg/capita in 2018. Since 2016, pork consumption in Romania exceeded the average pork consumption in the EU [14].

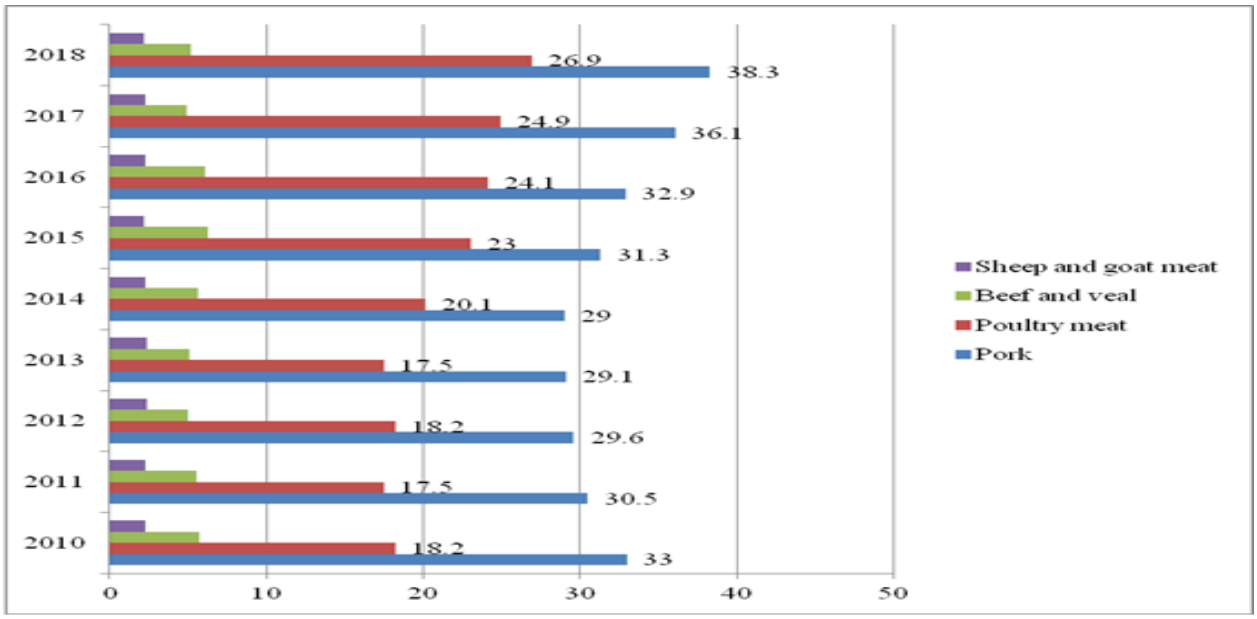

Fig.3. Pork consumption compared to other meat sorts, Romania, 2010-2018 (kg/capita)
Source: Own design based on the data from [17].

The evolution of pork consumption compared to meat consumption in Romania is presented in Table 2.

Table 2. Pork consumption compared to meat consumption in Romania, 2010-2018 (kg/capita)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2018/2010 %
Pork	33.3	30.5	29.6	29.1	29.0	31.3	32.9	36.1	38.3	115.01
Meat	59.9	56.0	55.3	54.4	57.8	63.4	65.5	68.4	73.8	123.20
Share of pork (%)	55.6	54.5	53.5	53.5	50.2	49.4	50.2	52.8	51.9	93.34

Source: Own calculation based on the data from [17].

The data reflect that despite that pork consumption increased in the period 2010-2018, its share in total meat consumption is still the highest, but it registered a slight decreasing trend from 55.6% in 2010 to 51.9% in 2018.

Compared to the EU-28 average pork consumption, Romania came on the 9th position in the year 2016, after Spain, Poland, Austria, Germany, Czechia, Portugal, Italy and Netherlands (Fig. 4).

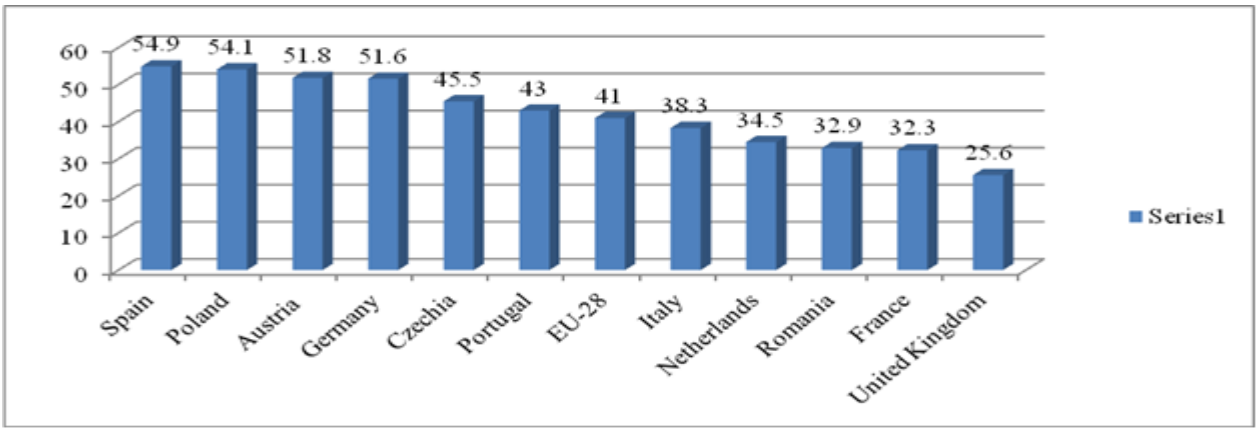

Fig.4.Pork consumption in Romania compared to the EU-28 average and the average consumption in the top European countries (kg/capita)
Source: Own design based on the data from [4].

Pork trade

Pork trade has been continuously developing in Romania because of the variation in the internal demand/offer ratio, the pork production being nonsufficient to cover the market requirements which explains why Romania, a country with a high pork production potential, has become a net importing country. Also, pork export is justified by the high demand and the higher and higher pork price in the international market, a good opportunity for exporting companied to increase their profit.

After the access into the EU, Romania has become more and more dependent on imports, at the beginning of live pigs and then of pork carcasses and meat at low prices.

Therefore, the quantities of imported pork increased year by year, in 2018 reaching 361,154 Tons by 73.28% more than in 2014. At the same time, the pork export was represented by small quantities which increased from 33,894 Tons in 2014 to 34,144 Tons in 2018, that is by +0.73%, the highest exported amount, 39,349 Tons being noticed in the year 2016 (Fig.5).

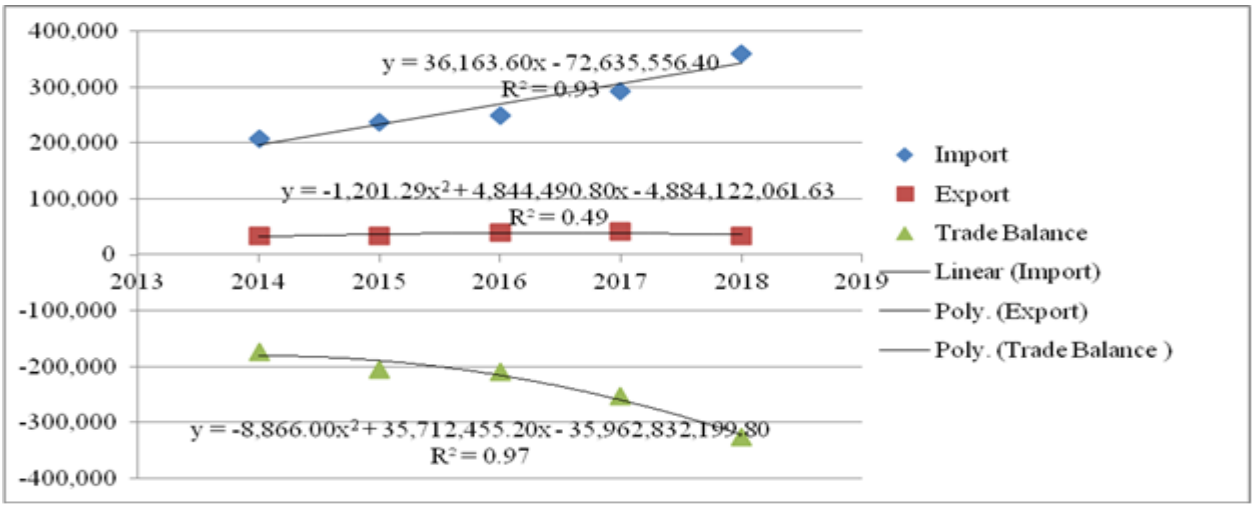

Fig.5. Pork import, export and trade balance, 2014-2018 (Equivalent fresh meat in carcass, Tons)
Source: Own design based on the data from [17].

The imports of pigs and pork were determined by processors who did not agree to assure the raw material from the internal market of pigs fattened in the small farms, due to the high production cost and high price at the farm gate.

The embargo imposed to Russia since 2014 by the EU has brought additional damages to the local producers, because of the invasion of pork at a low price coming from the other EU member states such as Netherlands, Hungary, Germany and Spain on the Romanian market [11]. Also, in the period 2007-2016, pork exports of Romania were very small because of the Swine Fever, the recovery of export was noticed only after the official recognition that Romania is a free-SF country [2, 3, 14].

As a result, the pork trade balance was negative after 2007 increasing year by year, due to the high growth rate of imports and low growth rate of exports. In 2018, Romania had a pork trade balance accounting for -327,010 Tons, by 87.3 % higher than in 2014 (Fig. 5).The value of pork import, export and trade balance is presented in Table 3.

The data from this table show that the import value of pork is double in 2018 versus 2014 and accounted for Euro 518 Million.

The export value declined by 24.16 % from Euro 38.5 Million in 2014 to Euro 29.2 Million in 2018. As a consequence, the trade balance is negative in all the analyzed years, increasing 2.22 times in 2018 compared to the level of 2014.

Table 3. Dynamics of the value pork import, export and trade balance, Romania, 2014-2018 (Million Euros)

	2012	2013	2014	2015	2016	2017	2018	2018/2012 %
Import value	257.9	269.3	284.7	295.5	343.6	479.7	518.0	200.85
Export value	38.5	42.3	51.8	38.7	54.3	55.1	29.2	75.84
Trade balance	-219.4	-227.0	-232.9	-256.8	-289.3	-424.6	-488.8	222.78

Source: Own calculation based on the data from [39, 40].

Descriptive statistics for pork production, consumption, import, export, and trade balance is presented in Table 4.

Table 4. Descriptive statistics for pork production, consumption, import, export, and trade balance

	Mean	St. Dev	Min.	Max.	Coeff. of variation (%)
Pork production	435,795.2	17,777	412,272	454,589	4.07
Pork import	270,261.2	59,391.3	208,417	361,154	21.97
Pork export	36,316.6	3,798.4	32,814	41,382	10.45
Pork trade balance	-233,845	58,985.5	-327,010	-174,523	25.21
Pork consumption	660,034.8	67,553.61	577,922	746,467	10.23

Source: Own calculation.

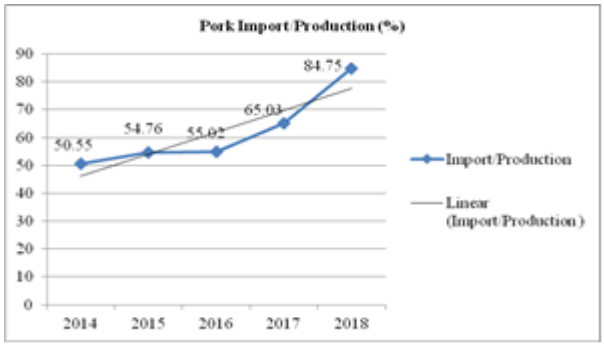

Fig.6. The dynamics of pork Import/Production ratio, Romania, 2014-2018 (%)
Source: Own design and calculation.

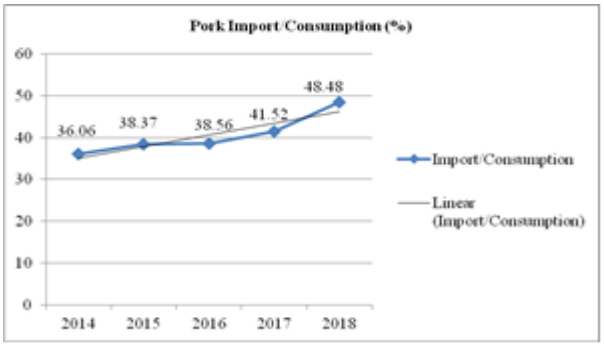

Fig.7.The dynamics of pork Import/Consumption ratio, Romania, 2014-2018 (%)
Source: Own design and calculation.

Important ratios reflecting the economic impact of the increased import

(i)Import/Production reflects in what measure import accounts in production. In case of pork, this ratio has continuously increased from 50.55% in 2014 to 84.75% in 2018 (Fig.6).

(ii)Import/Consumption shows what percentage of the consumed amount of pork comes from import. This ratio has also a continuous increasing trend from 36.06% in 2014 to 48.38% in 2018 (Fig.7).

(iii)Import/Trade balance reflects the influence of import on the negative trade balance as shown in Fig.8.

(iv)Export/Import ratio reflects the efficiency of Romania's pork trade. Unfortunately, the level of this ratio is very small, because imported quantities are much higher than the exported ones. If in 2014, the level of this ratio was 16%, in 2018 it reached the lowest figure, 9 % (Fig.9).

(v)Import dependency shows in what measures import covers the available pork amount existing on the domestic market after adding production with import and subtracting export. The level of this indicator increased from 35.51% in 2014 to 47.95% in 2018 (Fig.10).

(vi)Self sufficiency rate (SSR) shows that pork production carried out in Romania is not enough to cover consumers' needs and claims to satisfy the demand by additional amounts by import. The level of Self sufficiency rate declined from 70.25% in 2014 to 56.57% in 2018 (Fig.11).

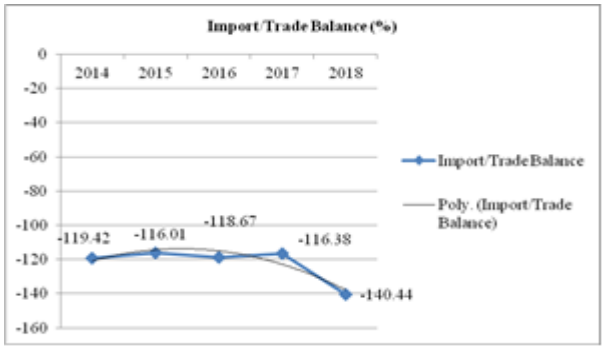

Fig.8.The dynamics of pork Import/Trade balance, Romania, 2014-2018 (%)
Source: Own design and calculation.

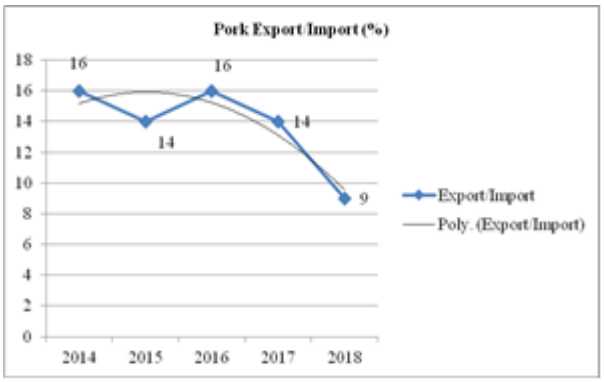

Fig.9.The dynamics of pork Export/Import ratio, Romania, 2014-2018 (%)
Source: Own design and calculation.

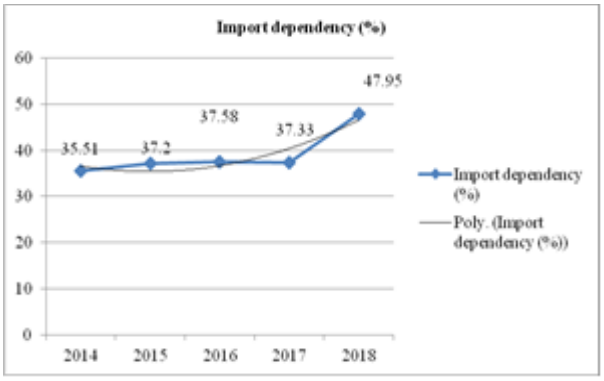

Fig.10.The dynamics of pork Import dependency, Romania, 2014-2018 (%)
Source: Own design and calculation.

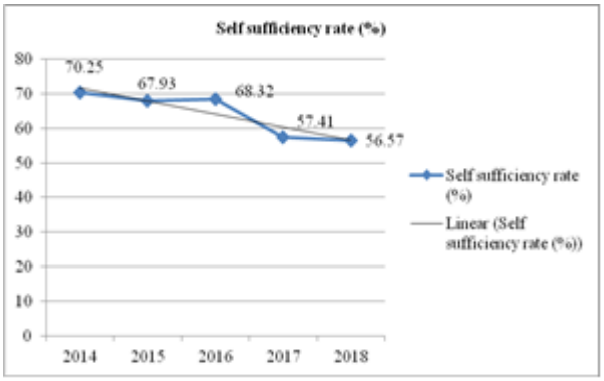

Fig.11.The dynamics of pork self-sufficiency rate, Romania, 2014-2018 (%)
Source: Own design and calculation.

In 2016, pork self sufficiency rate in Romania was 68.32%, much lower than the EU-28 average SSR, 114%.

However, in that year, Romania came on the 9th position in the EU-28 from this point of view, after Netherlands, Ireland, Spain, Germany, Austria, France, Poland, and Portugal (Fig.12).

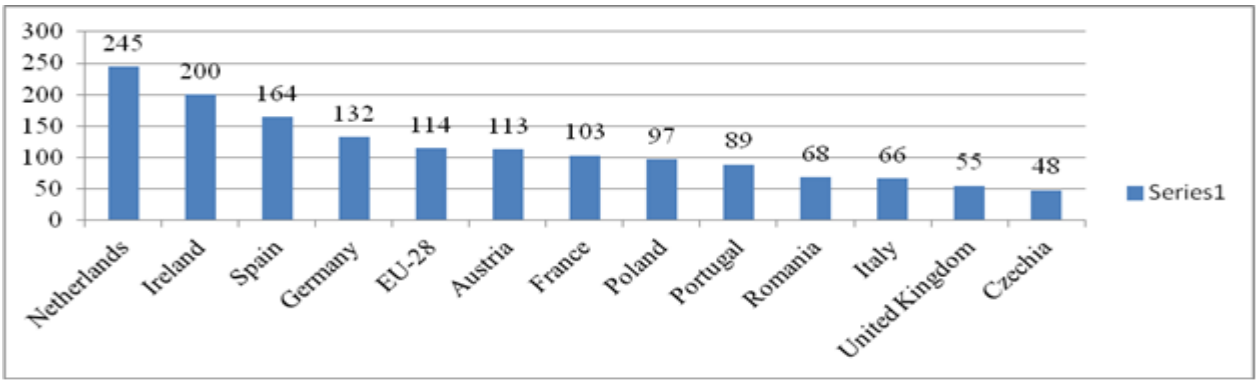

Fig.12.The dynamics of pork self-sufficiency rate in Romania compared with the EU-28 average and the SSR in the top consuming countries, 2014-2018 (%)
Source: Own design based on the data from [5].

Average acquisition price per kg live weight at the farm gate

In the period 2010-2019, the average annual acquisition price per kg live weight at the farm gate increased by 25.76 %, from Lei 4.93 in 2010 to Lei 6.2 in 2019 (Fig.13). The effects of the African Swine Fever, which diminished the pig livestock by about 440,000 pigs and 46,000 sows, increased the production cost, could be also seen in the increase of the price at the farm gate per pig at the acquisition. In the year 2019, mainly starting from the month of April.

The average month price started to grow from Lei 5.61 per kg live weight and continued month by month till the maximum level in December, when it accounted for Lei 8 per kg live weight (Fig. 14).

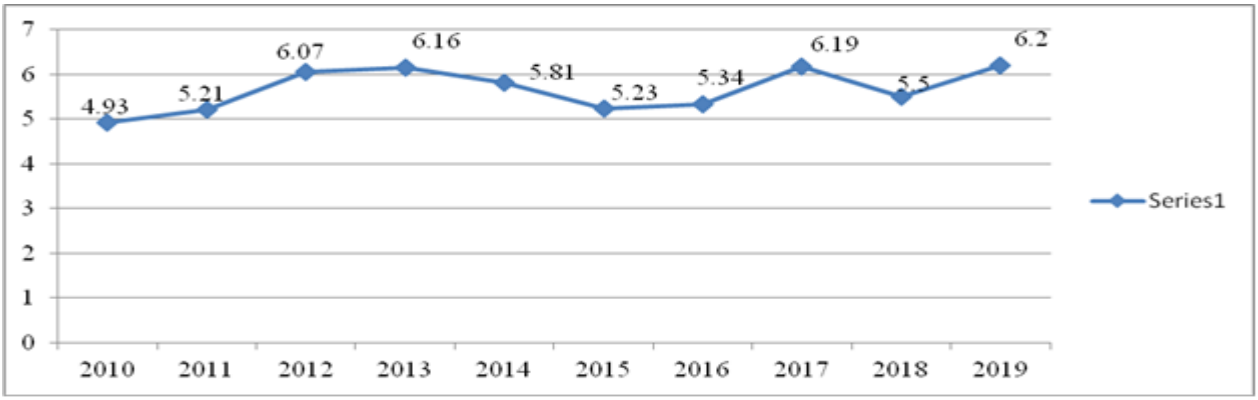

Fig.13. Pork average annual acquisition price per kilogram live weight at the farm gate (Producer's price- Lei/kg)
Source: Own design based on the data from [25].

Analyzing the monthly price in the two years, we may easily notice that at the beginning of the year 2019, in the first months, the average acquisition price was lower than in the same months of the year 2018. But, starting from May 2019, the average monthly price increased by +8.5% in May, + 11.4% in June, +13.9% in July, +16% in August, +26.2% in September, +30.6 % in October, + 33% in November and +47.6% in December.

Therefore, the pork crisis in the international market in terms of the price boom and intensified export was caused by ASF in China, South Korea, Vietnam, Mongolia which absorb a high amount of pork to cover the internal market requirements. Since April 2019, pork carcass price increased month by month and even from a week to another, and it continued to be a lack of pork supply in the international market. This was caused by the Asian traders who pay the pork amounts in advance for the months of August-September and bids higher prices up to 20% for live animals weighing 80-110 kg.

In the 30th week of the year 2019, the price per pig E class carcass in Romania and other EU countries looked as presented in Table 5.

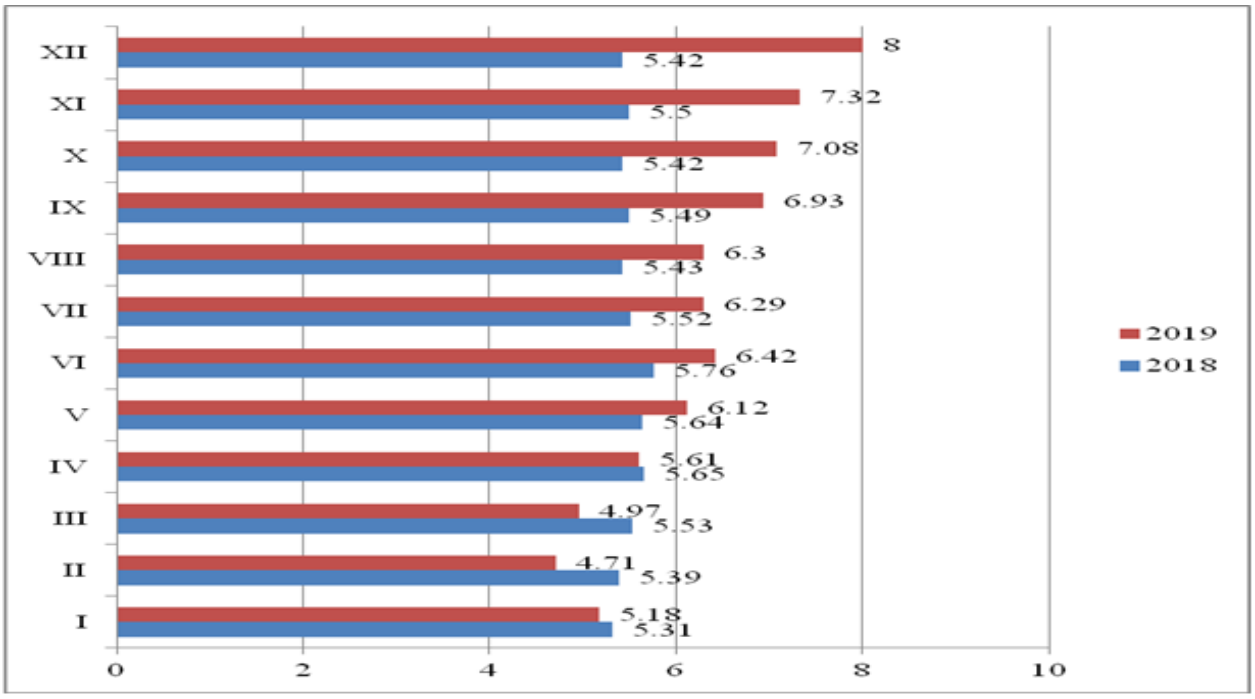

Fig.14. Pork average monthly acquisition price at farm gate per kg live weight in the year 2019 compared to 2018 (Lei/kg)
Source: Own design based on the data from [25].

Table 5. Average pork E class carcass price in Romania versus other EU countries (Euro/carcass)

EU-28	Romania	Spain	Germany	Poland	France
173.01	190.62	181.39	179.17	167.57	166.00
RO vs EU-28 17.69Euro 10.2%	-	RO vs ES 9.23Euro 5.1%	RO vs DE 11.45Euro 6.44%	RO vs PL 23.08Euro 13.8%	RO vs FR 24.62Euro 14.8%

Source: [28].

For taking the advantage of this situation the Dutch farmers do not sell piglets and pork carcasses any more intra-EU, only in small amounts. For this reason, the price on the European market increased by 15% for live animals and by 18% for cold carcass even from April 2019. Under this situation, it is expected as pork crisis to continue, and on the EU market poultry meat to grow and to exceed pork production in 2020 and in the coming years [28]. Therefore, the Romanian producers are under the pressure of the lack of piglets and fattened pigs to deliver to the processing industry, and the processors are under the pressure of the lack of raw material and the imports at high price.

CONCLUSIONS

The analyzed aspects in this paper pointed out that the pork market crisis has deeply affected pork production and trade.

Pork production was firstly affected by the reduction of pig livestock, on one side, in the farms which failed because they could not resist to the market pressure, and on the other side due to the African Swine Fever which obliged the authorities to diminish the pig livestock with about 486,000 heads, of which about 10% sows. At the end of 2018, Romania had 3,925 thousand pigs, by 27.7% less than in 2010, and in May 2019, it had 3,726 thousand heads. However, in 2018, pork production reached 426,100 Tons (equivalent fresh pork carcass) registering a slight increase by 3.35 % compared to 2014. It could be considered that it has relatively stagnated at the same level due to the reduction of the number of pigs, but also it was sustained by the import of pigs and carcasses in the processing industry.
Pork consumption increased reaching 38.3 kg/capita in 2018, a record by 15% higher than in 2010 when a Romanian consumed 33

kg pork. However, the statistics shows that pork consumption is in competition with poultry meat, whose consumption has grown much faster by 47.8% so that in 2018 it reached 26.9kg/capita compared to 18.2 kg/capita in 2010. Pork consumption in Romania is below the EU average, which accounts for 41 kg/capita and far away of 54.9 kg/capita consumed in Spain which is on the top. Romania's pork trade is dominated by imports, which resulted in a negative trade balance that it is expected to continue in the coming years. In 2018, Romania imported 361,154 Tons pork by 72% more than in 2014, and exported 34,144 Tons by 3% more than in 2014. Therefore, in 2018, the trade balance accounted for -327,010 Tons, the deficit being by 87.3 % higher than in 2014.

The imports had a negative impact in the economy if we take into account the level of the main import ratios. In 2018, import represented 85% of pork production, 48.3 % of pork consumption, import dependency being 48%, and self sufficiency rate 56.5%. All these ratios have a higher level than in 2014. Also, the ratio export/import registered the lowest level as never before, just 9%. All these reflects that consumption is assured mainly from import and in a small proportion by the internal production. Taking into account the values of import and export, in 2018, Romania registered Euro - 488.8 Million trade balance, 2.22 times higher than in 2012. The ratio export value/import value being 5.7 % compared to 9% in case of the ratio based on the exported and imported pork quantities. This means that the import price is higher than the export price, and obviously, this reflects the inefficiency of Romania's pork trade.

The average acquisition price at the farm gate increased by about 25% in the period 2010-2018, accounting for Lei 6.2 per kg live weight in 2018. As a consequence of the outbreak of the African Swine Fever, from April 2019, the farm gate price increased from Lei 5.61 to Lei 8 in the month of December, that is by 42.6%, and this was reflected in the consumer's price as well.

Therefore, Romania's pork sector is in a very difficult situation at present and the pork market crisis is expecting to continue.

Among the measures which could diminish the negative effects of this crisis, caused by the African Swine Fever, there are recommended the following ones:

- severe sanitary and veterinary measures has to be taken by the National Sanitary and Veterinary Authority and for Food Security (ANSVSA)to prevent the extend of the African Swine Fever to other farms, in this way to stop the decline of pig number and sows;
-pig raising in the individual households must be stopped, because in their case the regulation of bio-security are not entirely respected, and pig farming and processing has to continue only in industrialized units where the hygiene, sanitary and veterinary conditions could be much better assured;
-severe measures and tools have to be taken by the public authorities for the neutralization of the ill animals and the destroy of the dead animals;
-the compliance of the regulations regarding animal transportation;
-severe controls and disinfection measures of the trucks transporting animals;
-state intervention in the limitation of the pork imports to keep the pork price under control in the internal market;
-interdiction of pig raising in free spaces (forests, pastures etc), out of the household or farm;
-interdiction of the organization of animal fears on Romania's territory;
-interdiction of trade, transportation and slaughter of the animals which are not sanitary and veterinary authorized;
-interdiction of slaughter of the animals raised in non professional units without traceability;
-severe control measures at the frontiers for not allowing the import of contaminated meat products;
-important measures have to be taken by pig breeders to assure good conditions for the sow livestock: hygienic housing, high quality feed, artificial insemination in order to obtain a corresponding number of piglets per sow;

-assurance of good raising conditions for sows having piglets so that the losses till the weaning to be at minimum level: corresponding temperature, hygiene, feeding and watering in the sheds and boxes;
-the strict application of the modern technologies in pig fattening for assuring a high daily gain, and a corresponding live weight at slaughter with a reasonable production cost;
-the small pig breeders with less than 5 pigs have to the respect the new regulations issued by ANSVSA in 2019 regarding the interdiction to feed the pigs with food scraps from the kitchen, to keep reproduction animals and unsterilized boars; the breeders have to apply the strict hygiene rules in the sheds, boxes, and of the farmer and before slaughter, the pigs have to be sanitary and veterinary controlled and the meat will be used only for the family consumption;
-animals destined to reproduction and fattening to be raised and slaughtered only in specialized units;
- measures to improve pork carcass quality, in close relationship with the breed, lines used for fattening, and live weight at slaughter;
- intensification of Romanian pork promotion on the external markets for intensifying export;
- assuring the highest quality of the pork destined to be exported in order to get a better price.

Therefore, both the breeders and processors have to join their efforts to continue the development of the pork sector in Romania and assure its profitability and competitiveness.

REFERENCES

[1]Ahmad, R.S., Imran, A., Hussain, M.B., 2018, Nutritional Composition of Meat, Meat Science and Nutrition, Muhammad Sajid Arshad, IntechOpen, DOI: 10.5772/intechopen.77045, https://www.intechopen.com/books/meat-science-and-nutrition/nutritional-composition-of-meat, Accessed pn Jan.16, 2020.

[2]Anonymous, 2013, Meat sector after Romania's access into the EU (Sectorul de carne dupa aderarea Romaniei la UE), http://www.meat-milk.ro/sectorul-de-carne-dupa-aderarea-romaniei-la-ue/, Accessed on Jan.16, 2020.

[3]Anonymous, 2018, BR Analysis! Consequences of swine fever: Over 350,000 pigs were slaughtered. Imports replace Romanian pork meat with cheaper products, 2018, http://business-review.eu/news/br-analisys-the-paradox-of-swine-fever-we-may-lose-10-pct-of-the-pigs-but-meat-might-get-cheaper-183107, Accessed on Jan.16, 2020.

[4]Anonymous, 2020, Pork, AHDB, EU per capita consumption, https://pork.ahdb.org.uk/prices-stats/consumption/eu-per-capita-consumption/, Accessed on Jan.16, 2020

[5]Anonymous, 2020, Pork AHDB, EU Self sufficiency, https://pork.ahdb.org.uk/prices-stats/consumption/eu-self-sufficiency/, Accessed on Jan.16, 2020.

[6]DAFC, 2019, Market News for Pig Meat Week 47, 18 November 2019.

[7]EU, 2020, Pork, https://ec.europa.eu/info/food-farming-fisheries/animals-and-animal-products/animal-products/pork_en, Accessed on Jan. 16, 2020.

[8]Eurostat, 2017, Pork production up in the EU, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20170919-1, Accessed on Jan. 4, 2020

[9]FAOSTAT, 2020, Data, Livestock primary, www.fao.org, Accessed on Jan. 16, 2020.

[10]Hopkins, V.,Peel, M., Terazono,E.,2019, Eastern Europe sees sharp rise in swine fever outbreaks, Financial Times, https://www.ft.com/content/5d14ec1e-b53d-11e9-bec9-fdcab53d6959, Accessed on Jan. 16, 2020.

[11]Hoste, R.,2015, Romania: half of EU pig farms, https://www.researchgate.net/publication/316237885_Romania_half_of_EU_pig_farms, Accessed on Jan 16.2020

[12]Marquer, P., Tabade, T., Forti, R., 2014, Pig farming in the European Union: considerable variations from one Member State to another, Agriculture and Fishery, Eurostat Statistics in focus 15, pp.3.

[13]Mc Cullough, C., 2017, Romania, a pig country with a great potential, Pig Progress, https://www.pigprogress.net/Finishers/Articles/2017/10/Romania-a-pig-country-with-great-potential-188694E/, Accessed on Jan.16, 2020.

[14]McCullough, C., 2017, Romanian pork consumption still lower than EU average, https://www.wattagnet.com/articles/32272-romanian-pork-consumption-still-lower-than-eu-average, Accessed on Jan.16, 2020.

[15]Moeller, S.J., Crespo, F.L., 2004, Overview of world swine and pork production, Agricultural Sciences, Vol.I., ©Encyclopedia of Life Support Systems (EOLSS), https://www.eolss.net/sample-chapters/C10/E5-24-03-04.pdf, Accessed on Jan.16, 2020.

[16]Murphy, K.J., Thomson, R.L., Coates, A.M., Buckley, J.D., Howe, P.R.C, 2012, Effects of Eating Fresh Lean Pork on Cardiometabolic Health Parameters, Nutrients 4(7):711–723.

[17]NIS, Food Balances, 2004-2019, www.insse.ro, Accessed on Jan.16, 2020.
[18]NIS, 2013, Press Release No.151/28 June 2013, Meat, Milk and Dairy products Production achieved in industrialized units in the year 2012.
[19]NIS, 2015, Press Release No.159/30 June 2015, Meat, Milk and Dairy products Production achieved in industrialized units in the year 2014.
[20]NIS, 2016, Press Release No.163/30 June 2016, Meat, Milk and Dairy products Production achieved in industrialized units in the year 2015.
[21]NIS, 2017, Press Release No.158/29 June 2017, Meat, Milk and Dairy products Production achieved in industrialized units in the year 2016.
[22]NIS, 2018, Press Release No.161/29 June 2018, Meat, Milk and Dairy products Production achieved in industrialized units in the year 2017.
[23]NIS, 2019, Press Release No.163/28 June 2019, Meat, Milk and Dairy products Production achieved in industrialized units in the year 2018.
[24]NIS, 2019, Pig livestock declined in Romania by 403,011 heads; the ASF made havoc in the South-Est of the country (Efectivele de porci au scazut in Romania cu 403.011 capete; PPA a facut ravagii in sud-estul tarii), https://lantulalimentar.ro/ins-efectivele-de-porci-au-scazut-in-romania-cu-403-011-de-capete-ppa-a-facut-ravagii-in-sud-estul-tarii/, Accessed on Jan.16, 2020.
[25]NIS, 2019, Tempo online data base, www.insse.ro, Accessed on Jan.16, 2020.
[26]Petrescu-Mag, V., Stoian, R.O., Todoran, C., 2015, Pork production in Romania, Porcine Research, Vol.7 (1):32-38.
[27]Pitts, N., Whitnall, T., 2019, Impact of African swine fever on global markets, https://www.agriculture.gov.au/abares/research-topics/agricultural-commodities/sep-2019/african-swine-fever, Accessed on Jan. 16, 2020.
[28]Popa, C., 2019, Romania came on the top of pork price increase (România a ajuns în topul scumpirilor la carnea de porc), https://www.revista-piata.ro/business/special/item/14799-romania-a-ajuns-in-topul-scumpirilor-la-carnea-de-porc, Accessed on Jan.16, 2020.
[29]Popescu, A., 2009, Evolution of World Pork Market, Scientific Papers Series D, Vol.LII, Animal Science (Lucrari stiintifice, Seria D, Vol LI, Zootehnie), p. 263-269.
[30]Popescu, A., 2009, Considerations concerning Romania's meat market, Scientific Papers Series D, Vol.LII, Animal Science (Lucrari stiintifice, Seria D, Vol LI, Zootehnie), p. 270-275.
[31]Popescu, A.,2010, Considerations concerning Romania's Meat Market, 2010, Scientific Papers, Series D, vol. I, Animal Science: 270-275.
[32]Popescu, A., 2012, Study concerning the Trends in Pork Market in Romania, Scientific Papers- Series Animal Science (Lucrari stiintifice-Seria Zootehnie Iasi), Vol.57(17):99-103.
[33]Popescu, A., 2012, Study concerning the Economic Efficiency in Pig Fattening, Scientific Papers - Series Animal Science, (Lucrari stiintifice-Seria Zootehnie Iasi), Vol. 58(17):49-53.
[34]Popescu, A., 2012, Research concerning the Economic Efficiency in Pig Fattening in Farms of Various Sizes. Scientific Papers: Animal Science and Biotechnologies, 45(2), pp.397-403.
[35]Popescu, A., 2013, Research on Consumer Behaviour on Bucharest Meat Market, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.13(1):301-308.
[36]Popescu, A., 2015, Research on the Pork Production Trends in the EU-28, the CEECs and Romania, Proceedings of 25th IBIMA Conference Innovation Vision 2020: from Regional Development Sustainability to Global Economic Growth, Amsterdam, The Netherlands, May 7-8, 2015, pp.1407-1422
[37]Popescu, A., 2016, Research on concentration of pork production in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(1):405-410.
[38]Sandu, M., Sandu, S., Paraschivescu, M.T., 2015, Evaluation of Romanian livestock sector from the perspective of availability of food products, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 15(2):321-326.
[39]Statista, 2019, Value of meat of swine exported from Romania from 2012 to 2018 (1,000 Euros), https://www.statista.com/statistics/761917/meat-of-swine-export-value-romania/, Accessed on Jan. 16, 2020.
[40]Statitsta, 2019, Value of meat of swine fresh, chilled or frozen imported to Romania from 2012 to 2018 (1,000 Euros), https://www.statista.com/statistics/761811/meat-of-swine-fresh-chilled-frozen-import-value-romania/, Accessed on Jan. 16, 2020.
[41]Statista, 2020, Number of pigs worldwide from 2012 to 2019 (in million head) https://www.statista.com/statistics/263963/number-of-pigs-worldwide-since-1990/, Accessed on Jan. 16, 2020.
[42]Vaduva, I., 2019, Three reasons for which the Romanian pork sector is suffering (Trei motive pentru care sectorul românesc al cărnii de porc are de suferit), https://www.revistafermierului.ro/romania-agricola/zootehnie/item/3885-trei-motive-pentru-care-sectorul-romanesc-al-carnii-de-porc-are-de-suferit.html, Accessed on Jan.16, 2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

TRENDS IN PORK MARKET IN THE EUROPEAN UNION AND IN ITS MAIN PRODUCING COUNTRIES IN THE PERIOD 2007-2018

Agatha POPESCU[1,2,3]

[1]University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest Romania, Phone: +40213182564, Fax: +40213182888, Email: agatha_popescu@yahoo.com
[2]Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu-Șișești", 61 Marasti Boulevard, District 1, 011464, Bucharest Romania, Phone: +40213184450, +40213184451, Fax: +40-21-310.49.23, Email: agatha_popescu@yahoo.com
[3]Academy of the Romanian Scientists, 3 Ilfov Str., District 5, Phone: +40213147491, Email: agatha_popescu@yahoo.com

Corresponding author: agatha_popescu@yahoo.com

Abstract

The paper analyzed pork market in the EU and in the top 10 pork producing countries in the period 2007-2018 based on the statistical data using dynamics analysis based on fixed basis index, and trend analysis based on polynomial and linear equations. The pig number declined in the EU, accounting for 148.2 million heads in 2018. In this year, there were slaughtered 259.3 million pigs from which there were obtained 23.84 million tonnes pork, by 3.8% more than in 2007. About 64% of the EU pork output is carried out in Germany, Spain, France, Denmark and Netherlands. The EU pork exports reached 3.93 million tonnes in 2018, 2 times more than in 2007. The pork imports are not significant and declined. The EU export value was double in 2018, accounting for Euro 7.3 billion, of which 71% is due to Spain, Germany, Denmark and Netherlands. The EU-28 is the top pork exporter in the world, its trade balance reached Euro 7.2 Billion in 2018, being 2.3 times higher than in 2007. The highest trade balance is registered by Spain, Germany, Denmark, Netherlands, Italy, and France. The average pork carcass price was Euro 142.04 in 2018 at the EU level. Pork is the most consumed meat in the EU, an inhabitant consuming 35 kg per year, 3 times more than the world average. As a final conclusion, the main trends which will continue in the near future in the EU pork market are the following ones: the decline in pig livestock, the slight growth of pork production, the intensification of exports, the decrease in imports and a slight decline of consumption.

Key words**:** *pork market, EU, production, consumption, export, import, trade balance, price, trends, forecast*

INTRODUCTION

Pork is the most preferred meat in the EU and accounts for about 50% of the total meat supply [21].
In fact pork was the most consumed meat in the world for a long period of time, and only during the last decade it passed on the 2nd position in favor of poultry meat considered healthier and cheaper than pork [10].
The EU is among the top pork producers in the world, coming on the 2nd position after China and being followed by the USA. Also, the EU is the largest pork exporter worldwide [23, 24]. The EU enlargement in 2004, 2007 and 2013 has favored the increase of the number of pigs and farms, production in pig live weight, and in carcass weight equivalent, offer, extended the free internal market among the 28 member states and also stimulated exports [17, 24]. Nowadays, the variations in pig number, pork production, consumption, demand/offer ratio, price, and trade characterize the so called "hog cycle" under the actual conditions regarding the structural and technological changes in agriculture worldwide. The analysis of the cyclical fluctuation on pork market using data from various countries, but also including the main pork producing countries of the EU, proved that "the changes in meat supply are determined by the specific condition in each country, while the changes in pork price are due to the broad convergence of cycle between countries" [22]. The changes both on the internal and regional markets concerning

demand and price in the Asian market due to the African Swine Fever, have moved the poles of attention on that market. New flows of pork amounts have started to be delivered from the main EU producing and exporting countries attracted by the high demand and price boom.

In this context, the goal of this study was to analyze the dynamics of the EU-28 pork market and in the 10 top producing countries, pointing out the main trends in the period 2007-2018 regarding pig livestock, pork production, pork price, consumption, export, import and trade balance.

MATERIALS AND METHODS

The empirical data were picked up from mainly Eurostat data base, EU Commission Reports, but also from USDA and OECD-FAO Reports. Pork market way analyzed at the EU level and also in its main pork producing countries: Germany, Spain, Denmark, Netherlands, France, Italy, Belgium, United Kingdom, Poland, Austria, and Romania.The attention was given to the following aspects: (i)pig livestock, (ii)farms structure, (iii)production cost, (iv) live weight at slaughter, (v) slaughtered number of pigs, (vi)pork production, (vii) average carcass weight, (viii) exported and imported amount of pork, (ix) pork export and import value, (x) trade balance, (xi) pork consumption, (xii) pork price. The methods used in this research included:

Dynamics analysis in the interval 2007-2018, based on the formula of the Fixed basis index: $I_{FB(\%)} = (Y_n/Y_0)100$, where: Y_n is the level of the variable X in the year n and Y_0, the value of the variable X in the year 0.

Trend line was determined using the illustration of the data in graphics and the various regression models especially polynomial, $y= ax^2 + bx +c$ and linear $y = bx +a$, according to the distribution of values.

Graphical illustration was used to present the data in a more comprehensive and easy to be understood way for the most of the indicators.

Comparison method used to analyze the obtained results allowed to emphasize the differences between the top pork producing countries in the EU. The results were presented graphically and also in tables accompanied by suitable comments. The main ideas resulting from this studied have been presented in the conclusions drawn at the end.

RESULTS AND DISCUSSIONS

The number of pigs in the EU

The fact that pork is the most preferred meat by the EU consumers explains why pig livestock is well represented among the species which supply a high quality protein for human diet.

Besides the expectations, pig number registered a general decreasing trend during the last decade. In 2018, in the EU-28, there were 148.2 million pigs, by 7.91 % less than in 2007, when their number accounted for 160.9 million. For its swine inventory, the EU comes on the 2nd position with a share of 19% after China (56.4%) in the world pig livestock which accounted for 781 million heads in 2018 [19]. The variation of the number of pigs from a year to another and the declining trend in the analyzed period have been determined by a large range of factors among which the most important ones are: herd size and growing systems existing in each member state, breed structure and its reproduction and production performances, sows livestock, number of piglets per sow at birth and weaning, feeding system, the increased price for farm inputs, the lack of subsidies for pig farming, and in addition the African Swine Fever which affected not only the Asian countries, mainly China, but also European countries such as: Romania, Poland, Bulgaria, Slovenia, Belgium, Lithuania etc [9]. The top 10 pig growing countries in the EU-28 are Spain, Germany, France, Denmark, Netherlands, Poland, Italy, Belgium, Romania and Austria, whose pig population represents 86% of the EU swine livestock, and as a consequence these countries have influenced the dynamics of the pig livestock, pork production and trade.

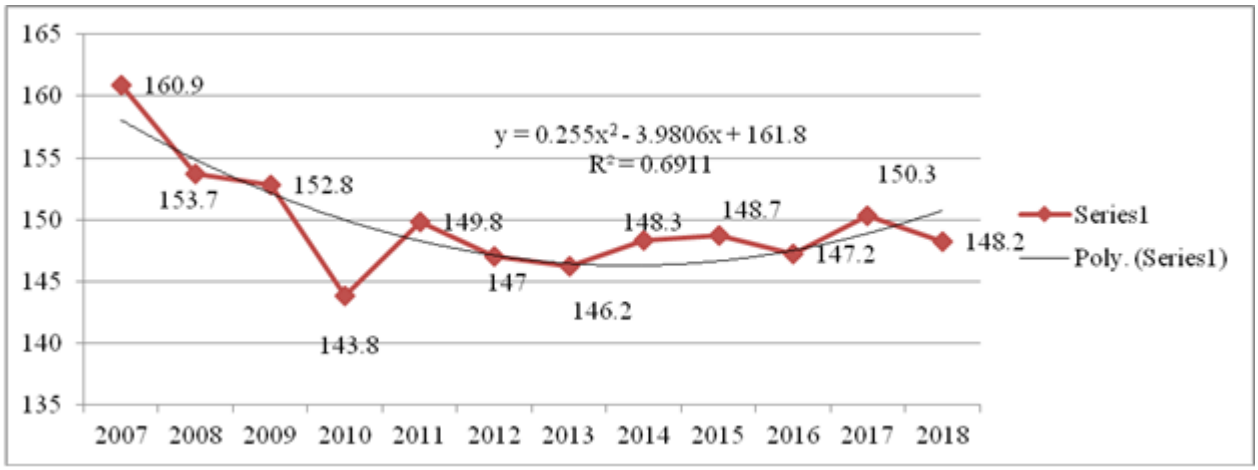

Fig.1. Dynamics of the EU-28 pig livestock, 2007-2018 (Million heads)
Source: Own design and calculation based on the data from [3].

In 2018 versus 2007, the number of pigs increased in Spain by +18.18%, Netherlands +1.91%, stagnated in Belgium at 100.14%, and declined in: Romania by - 40.21%, and Poland -37.42%, countries which were very much affected by ASF in 2018, Austria - 15.52%, France - 8.4%, Italy -8.42%, Denmark -4.01% and Germany -2.47%.
As a result, the share of the number of pigs in these countries in the EU-28 pig livestock changed in 2018 compared to 2007, the most significant variations being registered in Poland and Romania (Fig.2 and Table 1).

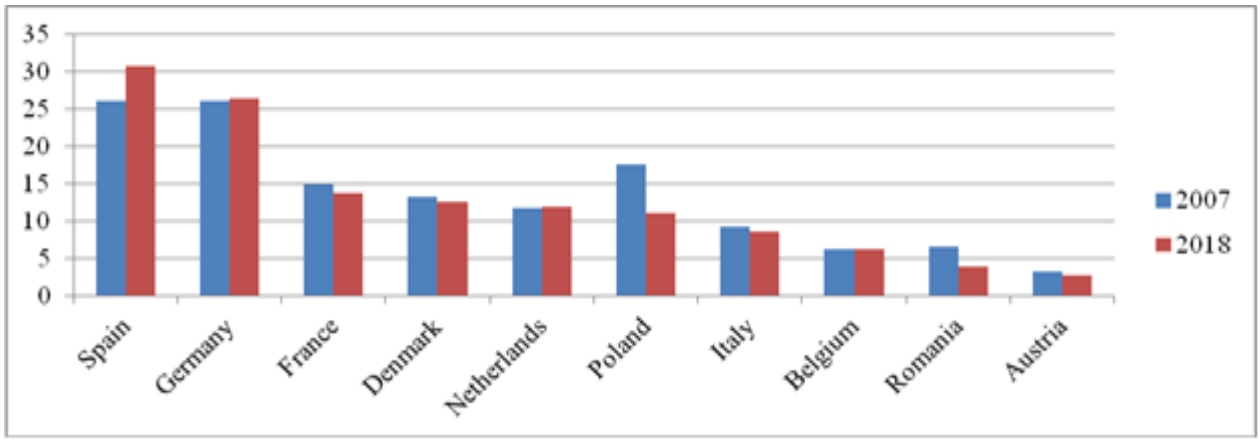

Fig.2. The number of pigs in the EU top 10 pig growing countries in 2018 versus 2007 (Million heads)
Source: Own design based on the data from [3].

Table 1.The changes in the number of pigs in the EU-28 top 10 pig growing countries, 2018 versus 2007

	Change 2018/2007 %	Share of the no. of pigs in the EU pig livestock (%)	
		2007	2018
EU-28	92.10	100.0	100.0
1.Spain	118.19	16.19	20.79
2.Germany	97.53	16.84	17.84
3.France	91.60	9.30	9.25
4.Denmark	95.99	8.18	8.53
5.Netherlands	101.91	7.28	8.05
6.Poland	62.58	10.95	7.44
7.Italy	91.58	5.76	5.73
8.Belgium	100.14	3.85	4.18
9.Romania	59.79	4.08	2.65
10.Austria	84.48	2.04	1.87

Source: Own calculations based in the data from [3].

Pig farming in the EU is running in various sized farms, most of them being small or medium sized holdings. About 85.5% of the number of farms in the EU are raising 1-9 pigs and just 1.6% of the number of farms are growing over 1,000 pigs (Fig.3). The smallest farms raising 1-9 pigs being in Romania (98.8%), Bulgaria (97.2%), Lithuania (97.2), Latvia (93.1%), Portugal (92.9%) and Hungary (90.6%) and the lowest number of small farms are in Finland (3.8%), Netherlands (5.4%), Denmark (65%) and Belgium (6.6%). The largest farms raising over 1,000 pigs are in Denmark (69.6%), Netherlands (51.2%) and Belgium (45.1%) [20].

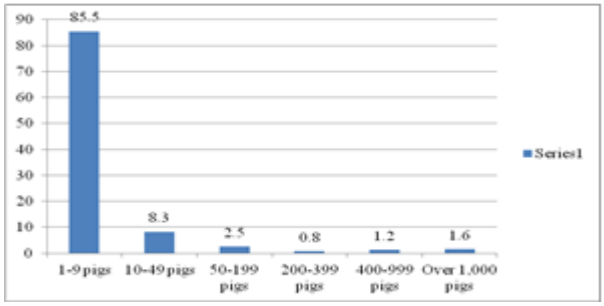

Fig.3.Pig farm structure based on the herd size in 2017(%)
Source: Own design based on the data from [20].

The raising system and the farm inputs price have a deep impact on production cost, an important factor which is permanently controlled by farmers in close connection with the price offered per kg live weight by processors at delivery.

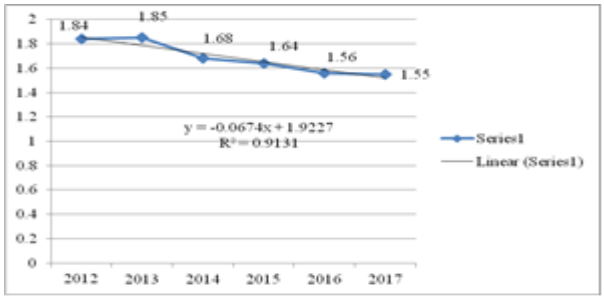

Fig.4.The average production cost in pig farming (Euro/kg deadweight)
Source: Own design based on the data from [1].

The EU average product cost in pig growing varied between Euro 1.84/kg dead weight in 2012 to Euro 1.55/kg in 2017, meaning a decline of 15.77% (Fig.4.). In general, in all the main pig growing countries of the EU, pig production cost declined during the last year as follows: in Denmark by -20.2%, Belgium -18.3%, United Kingdom -18.3%, Spain -17%, Germany -15.2%, Austria -11.2%, Netherlands -7.2%, France - 7.1%, and Italy -5.1%. In 2018, the highest production cost was noticed in Italy, accounting for Euro 1.88/kg and the lowest cost was registered in Denmark, Euro 1.35/kg (Fig.5).

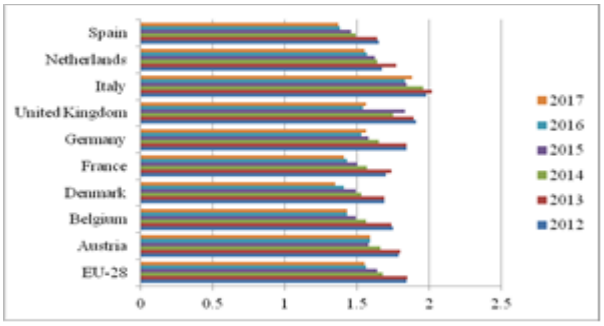

Fig.5.Dynamics of pig production cost in the EU and the main growing countries (Euro/kg deadweight)
Source: Own design based on the data from [1].

Within the production cost, the variable costs have the highest share which varied between 83.2 % in Spain, the highest level and 70.4% in Austria, the lowest level in the year 2017. Feed is the most costing item which has a deep impact on production cost. Its share in production cost ranged between 54.6%, the lowest level in Austria, and 66.6% in Spain, the highest level [1].

The average live weight at slaughter is about 120 kg, varying between 168 kg in Italy and 109 kg in United Kingdom. Its level depends on the used breeds and cross breeds, fattening system, feeding, and daily gain (Fig.6).

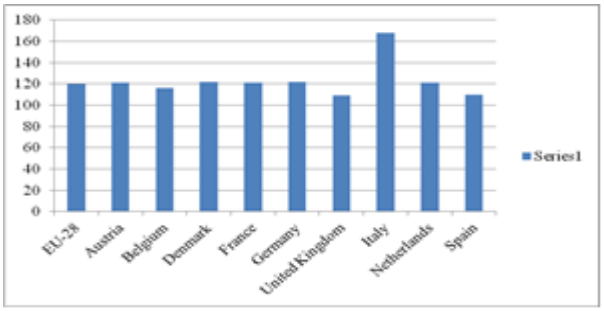

Fig.6. Pig average live weight at slaughter in the EU and the main growing countries in the year 2017 (kg/ pig live weight)
Source: Own design based on the data from [1].

The slaughtered number of pigs increased in the EU, both from internal sources and from import.

In 2018, it accounted for 259,317 thousand heads, of which 85.32% were slaughtered in the top 10 pig growing countries.

The share of the slaughtered pigs in these countries in the EU-28 slaughtered pigs in 2018 was the following one: Germany 21.8%, Spain 20.2%, France 9.05%, Poland 8.7%, Denmark 7%, Netherlands 6.15%, Belgium 4.3%, Italy 4.3%, Austria 2% and Romania 1.6% (Fig.7).

Pork production increased in the period 2007-2018 by 3.8% from 22,972 thousand tonnes in 2007 to 23,846 thousand tonnes in 2018 (Fig.8).

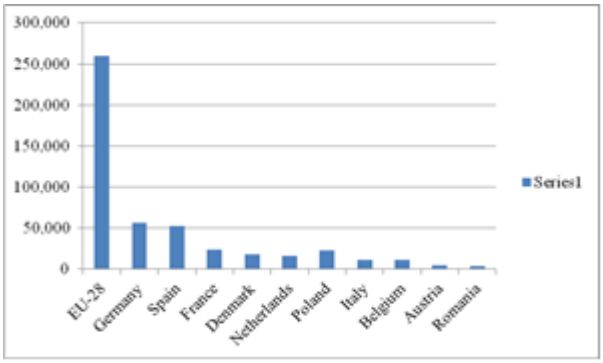

Fig.7.The number of slaughtered pigs in the main growing countries of the EU in 2018 (Thousand heads)
Source: Own design based on the data from [3].

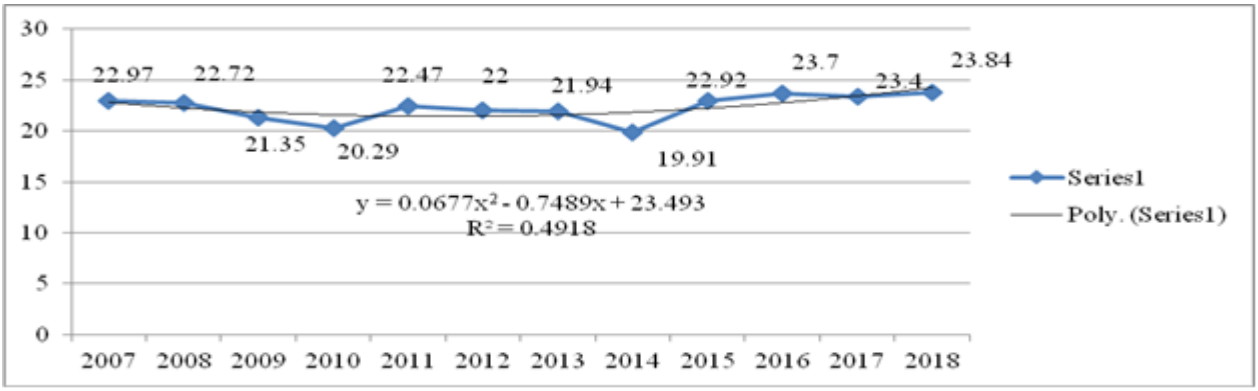

Fig.8.Dynamics of the EU-28 pork production, 2007-2018 (Million tonnes)
Source: Own design based on the data from [3, 5, 6].

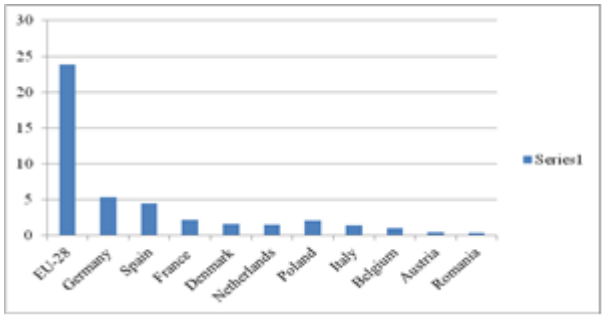

Fig.9. Pork production in the EU-28 and the top 10 main producing countries in 2018 (Million tonnes)
Source: Own design based on the data from [4].

In 2018, the highest pork production was achieved by Germany, followed by Spain, France, Denmark and Netherlands, which together produced 15,172 thousand tonnes, representing 63.6% of the EU-28 pork output.

The contribution of the top 10 producing countries to the EU-28 pork output in 2018 was the following one: Germany 22.4%, Spain 19%, France 9.2%, Poland 8.7%, Denmark 6.6%, Netherlands 6.4 %, Italy 6.2%, Belgium 4.5%, Austria 2.1% and Romania 1.6% (Fig.9).

The EU-28 is ranked the 2nd in the world after China for its performance in pork production. Its contribution to the global pork output accounted for 21.3 % in 2018 compared to 47.8% China and 10.57% the USA. About 79.3% of the global pork production is achieved by China, EU and USA [24, 25].

The average carcass weight in the EU accounted for 93 kg in the year 2017, reflecting a slaughtering rate of 77.5%. The average pork carcass weight is higher than the EU average in almost all the pig growing countries, except United Kingdom and Spain, where it accounts for 83 kg, reflecting a slaughtering rate of 76.1% and, respectively, 75.4% (Fig.10).

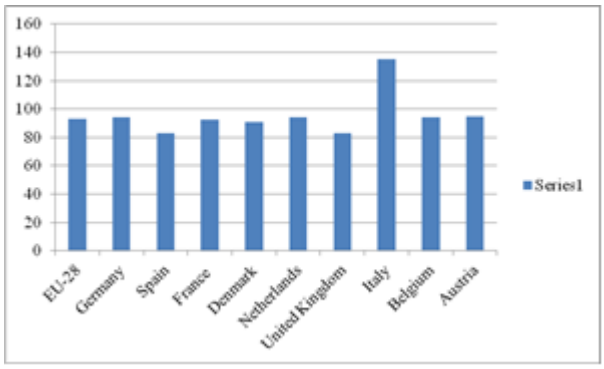

Fig.10.The average carcass weight-cold in the main EU pork producing countries, 2017 (kg)
Source: Own design based on the data from [1].

Pork export, import and trade balance

Pork exported and imported quantities

The EU-28 is an important pork exporter in the world, a fact reflected by the level of the amount of exported pork which are increasing year by year. But, the EU imports just small amounts of pork which are in a continuous decline [2].

In 2018, the EU-28 exported 3,939 thousand tonnes pork by 93.91 % more than in 2007 and imported only 34.1 thousand tonnes, by 30.8% less than in 2007. The highest exported amount was 4,239 thousand tonnes in 2016 and the highest imported amount of pork was registered in 2008 and accounted for 71 thousand tonnes.

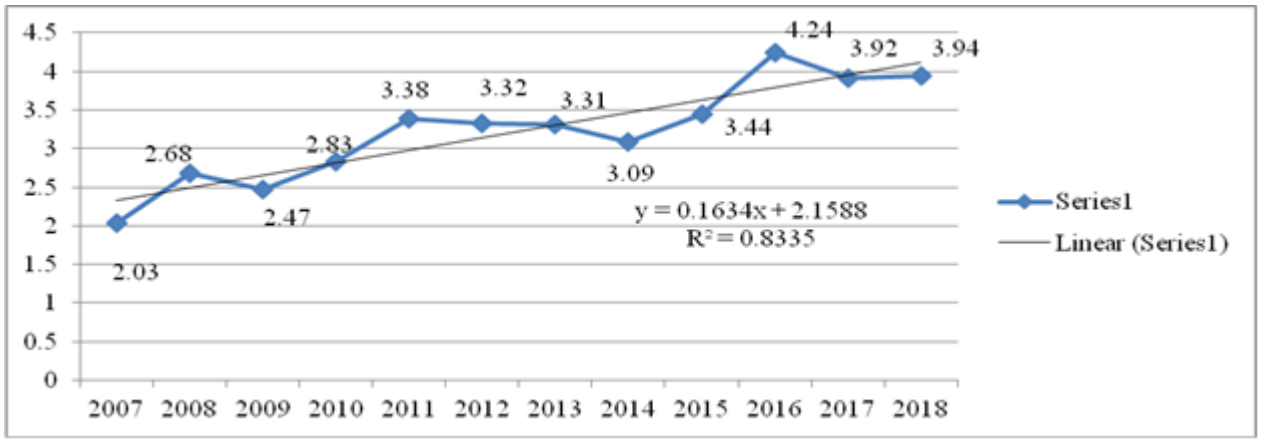

Fig.11.Exported pork amounts by the EU-28, 2007-2018 (Million tonns CWE)
Source: Own design based on the data [2, 7].

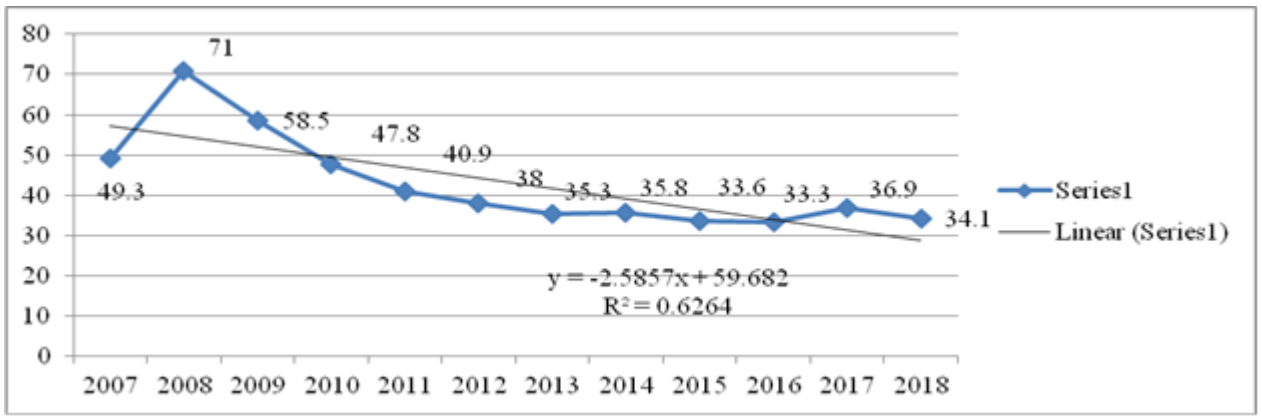

Fig.12. Imported pork amounts by the EU-28, 2007-2018 (1,000 tonns CWE)
Source: Own design based on the data [2, 7].

The top pork exporting countries in the EU are: Germany 22.6%, Spain 22.1%, Denmark 14.9%, Netherlands 12.2%, summing 71.8% of the EU exports in 2018.

In the same year, the top pork importing countries were Germany 53.1%, Netherlands 5.9%, Denmark 6.45, and United Kingdom 5%, totalizing 70.4% of the EU imports (Table 2).

Table 2. Pork exported and imported amounts in the EU and the top producing countries in 2018 versus 2007(Thousand tonnes)

	Pork exported quantity (Thousand tonnes)				Pork imported quantity (Thousand tonnes)			
	2007	2018	2018/2007%	Share in the EU-28 in 2018 %	2007	2018	2018/2007%	Share in the EU-28 in 2018 %
EU-28	2,031	3,939	193.9	100	49.3	34.1	69.2	100.0
Belgium	108.0	75.9	70.3	1.9	N.d.	N.d.	N.d.	N.d.
Denmark	600.0	585.5	97.6	14.9	1.2	2.2	183.3	6.4
Germany	334.6	891.6	266.5	22.6	13.7	18.1	132.1	53.1
Spain	166.3	869.7	522.9	22.1	1.0	0.3	30.0	0.9
France	187.0	231.6	123.8	5.9	4.4	1.0	22.7	2.9
Italy	52.6	103.4	196.6	2.6	10.1	0.9	8.9	2.6
Netherlands	212.7	480.0	225.6	12.2	2.5	2.0	80.0	5.9
Austria	69.1	49.1	71.0	1.2	2.7	0.4	14.8	1.2
Poland	78.8	252.6	320.5	6.4	1.6	0.3	18.7	0.9
United Kingdom	22.5	146.4	650.7	3.7	5.9	1.7	28.8	5.0
Total	1,821.6	3,685.8	201.2	93.6	43.1*	26.9*	62.4*	79.8*

Note:*Except Belgium.
Source: Own calculations based on the data from [7].

The value of the EU-28 pork export, import and trade balance

The pork export value increased 2.27 times in the analyzed period from Euro 3.2 Billion in 2007 to Euro 7.3 Billion in 2018 (Fig.13).

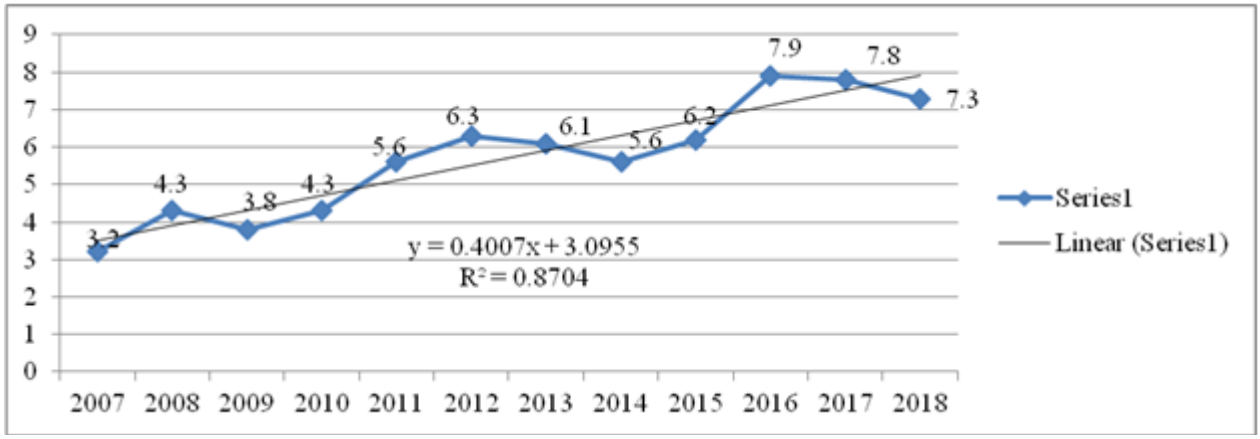

Fig.13. Dynamics of the EU-28 pork export value, 2007-2018 (Euro Billion)
Source: Own design based on the data from [7].

The highest export value is registered by Spain, followed by Germany, Denmark and Netherlands, all these four countries together contributing by 71% to the EU-28 pork export value in 2018.

In the period 2007-2018, the pork export value increased 8.3 times in United Kingdom, 6.27 times in Spain, 4.7 times in Germany and 3.3 times in Poland, 2.9 times in Netherlands, 2.5 times in Italy, 1.5 times in France and only one time in Denmark and by 18.3% in Belgium (Table 3).

The import value is very low and registered a decreasing trend so that in 2018, it accounted for Euro 0.62 Billion, being by 21.6% lower than in 2007 (Fig.14).

The import value is much lower than export value in the main producing countries. the highest pork import value is in Germany, followed by Denmark, France, United Kingdom, but also in Italy and Spain, these six countries contributing by 66.4 % to the EU pork import value.

In 2018 compared to 2007, the import value increased 4 times in Netherlands, 2 times in

Austria, 1.6 times in Denmark, 1.4 times in Spain, and 1.1 times in Germany. But, in the other producing countries, it decreased as follows: France =34%, Italy -74.7%, Poland -94.6%, United Kingdom -56.6% (Table 4).

Table 3. Dynamics of the pork export value in the main EU producing countries, 2018 versus 2007 (Euro Million)

	2007	2018	2018/2007%	Share in 2018 in the EU export value %
EU-28	3,198	7,274	227.4	100.0
Belgium	130.8	106.9	81.7	1.5
Denmark	1,189	1,254	105.5	17.2
Germany	287.5	1,379	479.6	18.9
Spain	273.8	1,719	627.8	23.6
France	253.3	400.6	158.1	5.5
Italy	175.5	441.1	251.3	6.1
Netherlands	284.5	825.0	290.0	11.3
Austria	130.3	119.0	81.3	1.6
Poland	106.2	359.3	338.2	4.9
United Kingdom	24.5	205.0	836.7	2.8
Total	2,855.4	6,808.9	238.5	93.6

Source: Own calculations based on the data from [7].

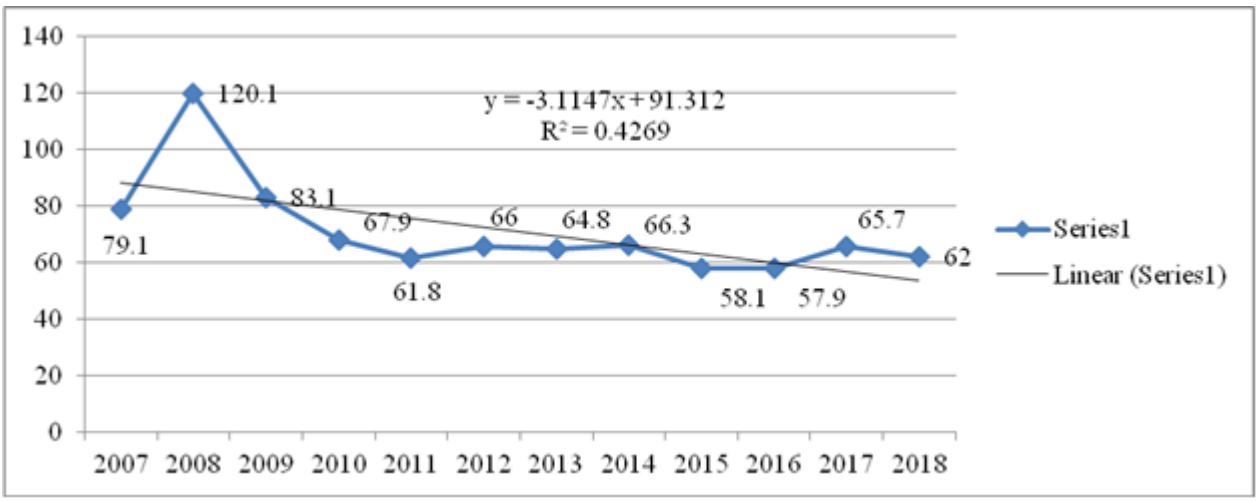

Fig.14. Dynamics of the EU-28 pork import value, 2007-2018 (Euro Million)
Source: Own design based on the data from [7].

Table 4. Dynamics of the pork import value in the main EU producing countries, 2018 versus 2007 (Euro Million)

	2007	2018	2018/2007%	Share in 2018 in the EU import value %
EU-28	79.1	62.0	78.3	100.0
Belgium	N.d.	N.d.	N.d.	N.d.
Denmark	4.6	7.5	163.0	12.1
Germany	12.1	14.0	115.7	22.6
Spain	2.5	3.6	144.0	5.8
France	10.0	6.6	66.0	10.6
Italy	15.4	3.9	25.3	6.3
Netherlands	0.5	2.0	400.0	3.2
Austria	1.4	2.8	200.0	4.5
Poland	3.7	0.2	5.4	0.3
United Kingdom	12.9	5.6	43.4	9/0
Total*	63.1	46.2	73.2	74.5

Note:*without Belgium
Source: Own calculations based on the data from [7].

As a result of the dynamics of the pork export and import values, the EU-28 pork trade balance was a positive one in each year and increased 2.31 times from Euro 3.1 Billion in 2007 to Euro 7.2 Billion in 2018 (Fig.15).

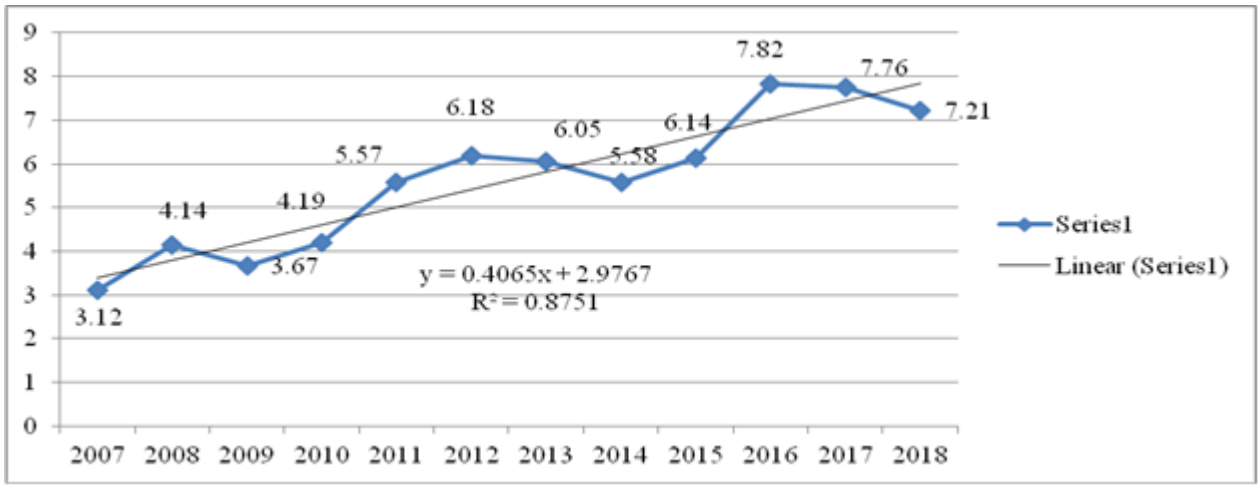

Fig.15. Dynamics of the EU-28 pork trade balance, 2007-2018 (Euro Billion)
Source: Own design based on the data from [7].

In all the main pork producing countries if the EU-28, pork trade balance is a positive one, reflecting that these states are net exporting countries.

The highest trade balance is registered by Spain, Germany, Denmark, Netherlands, followed by Italy, France and Poland, all these six countries contributing by 88% to the EU-28 pork trade balance.

In 2018, pork trade balance was higher compared to 2007 in almost all the main producing countries.

The highest growth rate was registered by Spain +6.3 times, Germany +4.9 times, Poland +3.5 times, Netherlands +2.9 times, Italy +2.7 times, only in Austria, trade balance declined by about 10% (Table 5).

Table 5. Dynamics of the pork trade balance in the EU-28 and the main producing countries in 2018 versus 2007 (Euro Million)

	2007	2018	2018/2007%	Share in 2018 in the EU pork trade balance value %
EU-28	3,118.9	7,212	231.2	100.0
Belgium	N.d.	N.d.	N.d.	N.d.
Denmark	1,184.4	1,246.5	105.2	17.3
Germany	275.4	1,365.0	495.6	18.9
Spain	271.3	1,715.4	632.3	23.8
France	243.3	394.0	114.8	5.5
Italy	160.1	437.2	273.1	6.1
Netherlands	284.0	823.0	289.7	11.4
Austria	129.9	116.2	90.1	1.6
Poland	102.5	359.1	350.3	5.0
United Kingdom	11.6	199.4	1,718.9	2.8
Total*	2,662.5	6,655.8	249.9	92.2

Note:*without Belgium
Source: Own calculations based on the data from [7].

Among the most important pork growing and producing countries is also Romania, as mentioned before considering the pig livestock and the number of farms. Despite of the high potential for producing pork, in Romania this sort of meat being on the top position as it is a traditional meat preferred by consumers, the decline of the pig number, the

small sized farms where pigs are traditionally grown, the breed structure, the problems related to the increased prices of the farm inputs, the lack of subsidies in pig sector, the health pig problems in a few farms due to the African Swine Fever mainly in the last two years 2018 and 2019, have affected the livestock and slaughtering performance, and also pork trade.

Romania is facing "a pork market crisis" characterized by the lack of biological material, in terms of sows to produce piglets, so that it is a lack of piglets and their price increased. The increased production cost determined a higher price at the farm gate, a nonconvenient situation for pig slaughtering houses which have intensified the imports of pigs and pork carcasses to assure a cheaper raw material.

The outbreak of the ASF in Asia, mainly in China determined a high growth rate of pork demand and the boom of pork price, which represent a real opportunity for the EU most important producing and exporting countries to intensify pork production and sell especially on the China market. In this purpose, they decided to limit the supply of sows, piglets and carcasses on the EU market.

Under these conditions, the Romanian farmers are not able to assure the needed piglets for covering the fattening capacity and the processors are not able to assure the raw material in terms of carcasses for covering the processing capacity.

The health problems caused by the classic pig fever and in addition determined by the ASF, reduced the chance of Romania to be among the top pork exporting countries of the EU [11, 12, 13, 14, 15, 16, 18].

Average annual pork carcass price increased from Euro 135.17/100 kg carcass Grade E in 2007 to Euro 142.04 in 2018, meaning a growth rate of 5.08%.

However, in 2019, pork carcass price reached Euro 169.08%, meaning +19.03% more than in 2018. This was caused by the high demand of pork in the Asian market, especially in China, which intensified the exports of the EU main exporting countries on this market where pork price has exploded. In this way, the EU market is facing the pork crisis, characterized by the lack of piglets and the lack of pork carcasses.

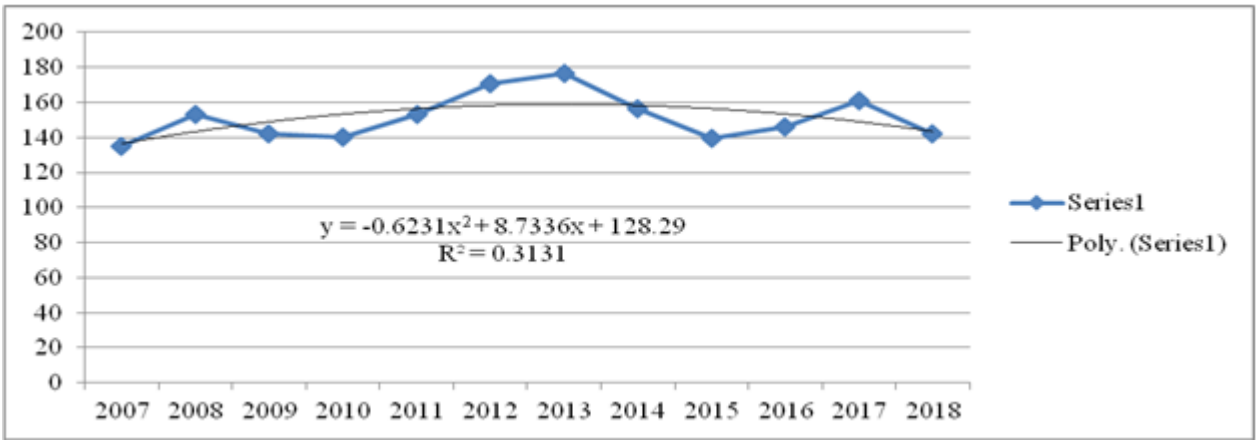

Fig.16.Dynamics of the average annual pork carcass Grade E price in the EU-28 (Euro/100 kg carcass)
Source: Own design based on the data from [2, 3].

In 2018, in the main EU pork producing countries, the average pork carcass price was higher than in 2007 by +16.5% in Italy, +8.7% in Denmark, +8.6% in Poland, +7.9% in Austria, +4.9 % in Germany, +2.4% in France, and +2.2% in Netherlands.

In the same year, in other countries, the average carcass price was lower than in 2007 like in: Belgium -10.3%, Romania -0.7%, and Spain -0.35%.

The highest average carcass price accounted for Euro 168 in Italy and the lowest price Euro 116 in Belgium in 2018. In 2019, the carcass price registered a boom in the main EU producing countries. The growth rate in 2019 compared to 2018 was +28.4% in

Denmark, +25.3% in Netherlands, +22.8% in Belgium, +21.6% in France, +21.5% in Germany, +19.6% in Spain, +19.3% in Poland, +18.1% in Austria and +15.4% in Romania. In 2019, the highest carcass price accounted for Euro 177.5 in Germany and the lowest price Euro 142.5 in Belgium (Table 6).

Table 6.Average annual pork carcass Grade E price in the top EU producing countries, 2007-2019 (Euro/100 kg carcass)

	2007	2010	2013	2016	2018	2018/2007 %	2019	2019/2018 %
Belgium	129.2	130.3	159.6	129.1	116.0	89.7	142.5	122.8
Denmark	117.7	126.3	159.3	136.8	128.0	108.7	164.4	128.4
Germany	139.1	144.4	174.8	151.8	146.0	104.9	177.5	121.6
Spain	139.1	145.7	195.6	139.4	138.8	99.7	166.1	119.7
France	127.7	129.9	165.4	138.8	130.8	102.4	159.1	121.6
Italy	144.2	150.2	188.9	159.6	168.0	116.5	N.d.	-
Netherlands	123.6	128.8	158.2	132.0	126.3	102.2	158.3	125.3
Poland	128.4	134.9	174.8	145.0	139.5	108.6	166.5	119.3
Austria	137.8	137.8	172.9	150.0	148.7	107.9	175.7	118.1
Romania	151.1	153.4	184.6	145.2	150.0	99.3	173.1	115.4

Source: Own calculations based on the data from [4].

Pork consumption is slightly decreasing despite that pork is the most consumed meat, being followed by chicken, beef and veal and sheep meat. At present, the EU population's needs are covered by the internal production, the self sufficiency rate being 110 % [6].

In 2019, the population of the EU consumed 20,685 thousand metric tonnes of pork (carcass weight equivalent, CWE), by 0.9% less than in 2015 and by 2.3 % less than in 2018.

The EU-28 pork consumption represents 19.6% of the world pork consumption, the EU being situated on the 2nd position after China from this point of view.

While in the EU pork consumption is declining, in the USA it is increasing (Fig.17).

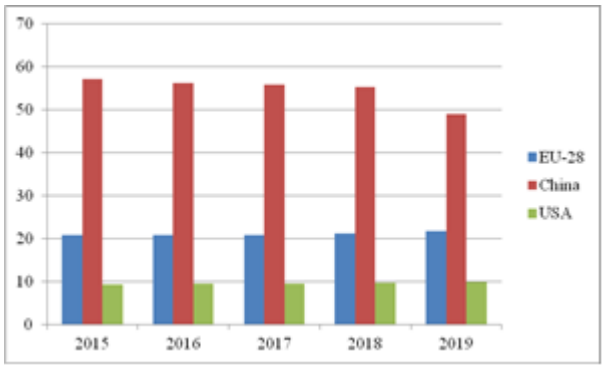

Fig.17.Dynamics of pork consumption in the EU compared to pork consumption in China and in the USA, 2015-2019 (Million tonnes)

Source: Own design based on the data from [25].

The decline in pork consumption in the EU is caused by many reasons such as:

-the tendency of the people to shift towards vegetables considered by doctors and nutritionists as a healthier source of protein than the protein of animal origin;

-the need to assure the environment protection and take into consideration the climate change caused by the gases released by animals;

-the ageing of the population in the EU will determine a lower consumption of food per capita;

-the decline of pork production expected on the internal EU market in the next years;

-the increased preference of the EU consumers for poultry meat which contains high value protein, less cholesterol and it is cheaper than pork;

-the slight growth in the sheep meat demand due to the desire of a diversified diet and changes in the EU population structure taking into account the religious beliefs and migration during the last years.

Taking all these reasons into consideration and based on the statistical data, it is expected as in 2020 the total meat consumption in the EU to reach 69.8 kg/inhabitant, of which pork 31.3 kg, poultry meat 25.6 kg, beef and veal 10.8, and 1.8 kg sheep meat.

The forecast for 2030 is that an EU inhabitant will consume 68.7 kg meat, of which pork 30.2kg, poultry 26.6 kg, beef 10 kg and sheep

meat 1.8kg. Therefore, pork consumption will decline in favor of poultry meat.

Also, in 2030, it is prospected that pork production and consumption to decline by 8%, and, respectively by18%, while pig farm gate price to increase stimulating farmers to produce more for the external markets, the pork export being expected to double its figure in 2030 and the import to stagnate [2].

Table 7 presents the images of the future situation of the EU meat supply balance for the 2028 horizon. The figures show the trends mentioned above regarding pork production import, export and consumption (Table 7).

Table 7.The forecast of the EU Meat Supply Balance for the 2028 Horizon

		Production (kt CWE)	Import (kt CWE)	Export (kt CWE)	Consumption (kt CWE)	Consumption per capita (kg RWE/capita)
Meat	2016-2018	43,462	3.05	6,002	39,015	70.3
	2028 Forecast	43,986	1.48	6,206	39,209	70.9
Pork	2016-2018	22,872	156	3,168	19,842	35.0
	2028 Forecast	22,886	167	3,275	19,761	34.8
Poultry	2016-2018	12,839	864	2,247	11,712	23.3
	2028 Forecast	13,640	923	2,380	12,182	24.2
Beef and veal	2016-2018	7,141	379	546	6,749	10.7
	2028 Forecast	6,826	375	496	6,518	10.3
Sheep meat	2016-2018	610	114	41	713	1.4
	2028 Forecast	634	201	55	747	1.5

Source: [8].

CONCLUSIONS

This study pointed out the role and importance of the EU as pork producer and exporter, and this is sustained by the performance carried out in the top producing countries: Germany, Spain, Denmark, Netherlands, France, Italy, Belgium, Poland, Austria, United Kingdom and Romania.

The pig number declined by 8% at the EU level being determined by the reduction of pig population in the main growing countries analyzed in this study, except Spain, Germany and Netherlands.

About 65% of the EU pig livestock is grown in Spain, Germany, France, Denmark and Netherlands.

The largest farms raising more than 1,000 pigs are in Denmark, Netherlands and Belgium, but they represent only 1.6% of the EU pig farms, while 85.5% farms are small sized holdings raising less than 1o pigs.

Production cost declined reaching Euro 1.55/kg deadweight. The share of the variable costs exceeds 70 % and feeding cost represents at least 55 % in the production cost.

About 85% of the number of slaughtered pigs in the EU are slaughtered in the top 10 producing countries, of which 67% are slaughtered in five countries: Germany, Spain, France, Poland, and Denmark.

From the 259.3 million slaughtered pigs in 2018 it was obtained 23.84 million tonnes pork, by 3.8% more than in 2007. Therefore, pork production has not raised too much in the analyzed interval. About 64% of the EU pork output is carried out in Germany, Spain, France, Denmark and Netherlands.

The EU pork exports were higher and higher, so that in 2018 they reached 3.93 million tonnes being almost double than in 2007. The pork imports are non significant for the EU and have a decreasing trend.

The EU export value accounted for Euro 7.3 billion, being more than double in 2008 compared to 2007. About 71 % of the EU export value is due to Spain, Germany, Denmark and Netherlands.

As pork imports declined from a quantitative point of view, the import value also decreased accounting for Euro 62 million in 2018, being by 22 % smaller than in 2007. About 66% of the import value is due to Germany, Denmark, France, United Kingdom, Italy and Spain.

The EU-28 is the top pork exporter in the world, its trade balance being a positive one and in 2018 reached Euro 7.2 Billion, being 2.3 times higher than in 2007. Spain,

Germany, Denmark, Netherlands, Italy, France have the highest trade balance.

The average price of pork carcass increased by 5% in the studied period, reaching Euro 142.04 in 2018 at the EU level.

Pork is the most consumed meat in the EU, accounting for kg/inhabitant at present, but it is expected to decline in favor of poultry meat for health and price reasons.

In 2018, the EU population consumed 20.6 million tonnes pork, representing about 19.6% of the global consumption. An EU inhabitant consumes about 35 kg pork in average per year, 3 times more than the world average, and this amount represent 47.3% of the annual meat consumption.

The analysis pointed out that the main trend in the near future for the EU pork market are the following ones: the decline of the pig livestock, a slight growth of pork production, exports will be intensified, imports will decline and also consumption will decrease.

REFERENCES

[1]Davis, C., 2019, 2017 Pig cost of production in selected countries, http://agricultura.gencat.cat/web/.content/de_departament/de02_estadistiques_observatoris/27_butlletins/02_butlletins_nd/documents_nd/fitxers_estatics_nd/2018/0219_2018_SProductius_Porci_Produccio-cost-2017-MON-INTERPIG-UK.pdf, Accessed on Jan.25, 2020.

[2]EU Commission, 2020, EU Agricultural Outlook for Markets and Income 2019-2030, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/agricultural-outlook-2019-report_en.pdf, Accessed on Jan.25, 2020.

[3]EU CMO Committee, 2019, Pig Market Situation Europa, 12 Dec. 2019, Livestock, EU evolution of Total Pig, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/pig-market-situation_en.pdf, Accessed on Jan.25, 2020.

[4]EU Commission, 2019, Meat Market Observatory-Pig, https://ec.europa.eu/info/food-farming-fisheries/farming/facts-and-figures/markets/overviews/market-observatories/meat_en, Accessed on Jan.25, 2020

[5]EU, 2020, Pig meat statistics, https://ec.europa.eu/info/food-farming-fisheries/farming/facts-and-figures/markets/overviews/market-observatories/meat/pigmeat-statistics_en, Accessed on Jan. 25, 2020.

[6]Eurostat, 2017, Pork production up in the EU, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20170919-1, Accssed on Jan. 25, 2020

[7]Eurostat, Easy COMEXT, 2020, http://epp.eurostat.ec.europa.eu/newxtweb/, Accessed on Jan.25, 2020.

[8]OECD -FAO, 2020, OECD-FAO Agricultural Outlook 2019-2028, Annex C, Meat and Pig Meat projections: Production and Trade, and Consumption, http://www.fao.org/3/ca4076en/ca4076en.pdf, Accessed on Jan.25, 2020.

[9]Pitts, N., Whitnall, T., 2019, Impact of African swine fever on global markets, https://www.agriculture.gov.au/abares/research-topics/agricultural-commodities/sep-2019/african-swine-fever, Accessed on Jan. 25, 2020

[10]Popescu, A., 2009, Evolution of World Pork Market, Scientific Papers Series D, Vol.LII, Animal Science (Lucrari stiintifice, Seria D, Vol LI, Zootehnie), p. 263-269.

[11]Popescu, A., 2009, Considerations concerning Romania's meat market, Scientific Papers Series D, Vol.LII, Animal Science (Lucrari stiintifice, Seria D, Vol LI, Zootehnie), p. 270-275.

[12]Popescu, A.,2010, Considerations concerning Romania's Meat Market, 2010, Scientific Papers, Series D, vol. I, Animal Science: 270-275.

[13]Popescu, A., 2012, Study concerning the Trends in Pork Market in Romania, Scientific Papers- Series Animal Science (Lucrari stiintifice-Seria Zootehnie Iasi), Vol.57(17):99-103.

[14]Popescu, A., 2012, Study concerning the Economic Efficiency in Pig Fattening, Scientific Papers - Series Animal Science, (Lucrari stiintifice-Seria Zootehnie Iasi), Vol. 58(17):49-53.

[15]Popescu, A., 2012, Research concerning the Economic Efficiency in Pig Fattening in Farms of Various Sizes. Scientific Papers: Animal Science and Biotechnologies, 45(2), pp.397-403.

[16]Popescu, A., 2013, Research on Consumer Behaviour on Bucharest Meat Market, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.13(1):301-308.

[17]Popescu, A., 2015, Research on the Pork Production Trends in the EU-28, the CEECs and Romania, Proceedings of 25th IBIMA Conference Innovation Vision 2020: from Regional Development Sustainability to Global Economic Growth, Amsterdam, The Netherlands, May 7-8, 2015, pp.1407-1422

[18]Popescu, A., 2016, Research on concentration of pork production in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(1):405-410.

[19]Statista, 2020, Number of pigs worldwide from 2012 to 2019 (in million head) https://www.statista.com/statistics/263963/number-of-pigs-worldwide-since-1990/, Accessed on Jan. 25, 2020.

[20]Statistics 2017 Pig meat, Danish Agriculture & Food Council.

[21]Stępień, S, Polcyn, J., 2014, Pig meat market in selected EU countries under the conditions of economic

integration: A comparative analysis of old and new member states, Oeconomica, http://www.oeconomica.uab.ro/upload/lucrari/1820162/14.pdf, Accessed on Jan.25, 2020.
[22]Stępień, S, Polcyn, J., 2016, The phenomenon of cyclical fluctuations on the pork market - global perspective, Management, Vol. 20, No. 1, 382-396.
[23]Stupnišek, I., 2019, Analysis of the world and Croatian pork market, Agronomy Journal, Vol.81(1), https://hrcak.srce.hr/index.php?show=clanak&id_clanak_jezik=329094&lang=en, Accessed on Jan.25, 2020.
[24]Szücs, I., Vida, V., 2017, Global tendencies in pork meat-Production, Trade and Consumption, Applied Studies in Agribusiness and Commerce-APSTRACT, Vo.II.No.3-4, 105-112.
[25]USDA, 2019, Livestock and Poultry: World Markets and Trade, https://apps.fas.usda.gov/psdonline/circulars/livestock_poultry.pdf, Accessed on Jan.4, 2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

PRICE ELASTICITY OF PRODUCTION IN ROMANIA'S AGRICULTURE- A TERRITORIAL APPROACH BY MICRO-REGION

Agatha POPESCU[1], Nela-Loredana CARABA-MEITA[2]

[1]University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest Romania, Phone: +40213182564, Fax: +40213182888, Email: agatha_popescu@yahoo.com
[2]Craiova University, Faculty of Economy and Business Administration, 13 Alexandru Ioan Cuza Street, Craiova 200764, Romania, Email: loredanameita@yahoo.co.uk

Corresponding author: agatha_popescu@yahoo.com

Abstract

The paper analyzed price elasticity of production for short run for wheat, maize, sunflower, milk, pork, beef and honey in Romania and in its eight micro-regions in the period 2016-2018. Elasticity coefficients were determined using Cook's formula. At Romania's level, the price growth by 1 % will determine the increase of output for wheat, maize, milk, and pork, but lower than price growth rate. Considering that other factors of influence are constant, the growth of the acquisition price will favor the increase of production in the territory of Romania as follows: for wheat in NW, SE, Bucharest Ilfov and S W Oltenia micro-regions; for maize in almost all the micro-regions except Bucharest-Ilfov and West; for sunflower in BIF and SW Oltenia; for pork, in the Center, SE, S Muntenia, SW Oltenia and West regions; for beef only in NW and NE regions; for milk in NW and S Muntenia; for honey in the Center, NE, S Muntenia, and SW Oltenia.

Key words**:** *elasticity, price, agricultural production, micro-regions, Romania*

INTRODUCTION

Agriculture is an important sector in Romania's economy. In 2018, the value of agricultural production was Lei 940.5 Billion by 9.5% higher than in 2017. The contribution of agriculture to Romania's GDP was 4.4%. In 2018, the share of vegetal sector in agriculture GDP was 70.8%, while the weight of animal sector was 27.7%. However, compared to 2017, in 2018, vegetal production increased by 12.9%, while animal production declined by 1.8% [15].

The performance in agriculture is influenced by many factors such as: soil structure, farms structure, size and endowment, cultivated crops and grown animal species, cropping and animal growing systems, climate change, farmers' managerial skills, farm inputs price, and selling price of agricultural products.

Romania's agriculture is deeply oriented to cereal cropping, wheat and maize being the main cultivated crops, and the performance in the cereal sector is due mainly to the large cultivated areas, and less to the yields which are lower than in other EU countries. However, Romania is not only an important cereal producer, but also a main exporting and importing country in the EU [42, 70].

Romania is also the most important producer and exporter of sunflower seeds in the EU. Sunflower is the main oil seed crop, being cultivated on large surfaces [41, 43].

Milk sector is a key sector of animal production, as milk is a strategic product. Despite that Romania has a high potential to produce milk, due to the low acquisition price, dairy farming has become an activity at the threshold of profitability in most of the farms. That is why in the last decades, the cattle stock declined, and milk yield is still low due to low forage production caused by droughts during the last decade with a negative influence on milk production [18, 20, 26, 28].

Milk quality does not corresponding to the standards in many farms, mainly in the smallest ones, which explains partially the low acquisition price offered by processors and the collected milk amount. In this situation, farmers are not able to cover production costs [33, 36, 37].

As a consequence the demand/offer ratio is not balanced and to cover the domestic consumption, Romania is obliged to import milk and dairy products to satisfy consumers' needs [5, 34, 54, 62, 68].

Meat is another product which plays an important role in animal production and consumers' diet. In 2018, a Romanian consumed 76.6 meat kg, of which 38.3 kg pork, 27 kg poultry meat, 19 kg beef and the remaining is represent by sheep and goat meat. In 2018, total meat consumption was by 5 kg higher than in 2017 and by 10 kg higher than in 2016. Pork is the most consumed meat sort by Romanians as it is a traditional food [3, 49, 65].

Meat supply was assured both by the domestic production but also from import. This is due to the decline of the livestock mainly regarding cattle and swine species, determined by the low feed resources, increased farm inputs price, high production cost and low acquisition price per kg live weight. In 2018, in case of pigs, the acquisition price raised for stimulating pigs fattening and also due to the pork crisis in China caused by the African Swine Fever, which resulted in a lack of piglets and carcasses in the EU market [17, 57, 61].

Romania is an important honey producing and exporting country in the EU due to large diversity of flora for pickings, the long tradition in apiculture, the increasing number of apiaries, honey yield and production, the low domestic consumption, but the high demand in the other EU countries [27, 80].

More and more beekeepers raise more than 100 bee families for increasing the profitability and the subsidies are a real incentive to produce more for export. However, the climate change has affected pickings during the last years [22, 24, 47].

The agricultural products obtained by farmers are destined to be delivered in the market. Evaluated at the prices per measure unit in close relationship with their quality, agricultural productions bring incomes which have to cover production costs in order to assure farm profitability.

Therefore, the difference between selling price and production cost, could assure or not the profitability of a product. However, at the farm level, besides the production cost, production performance and mainly marketed production is another item which determines profitability in close relationship with the acquisition price.

Between production and price it is a close relationship, in which production, Q, could be considered the dependent variable, and price, P, the independent variable, which together may describe the supply function or curve along which there is a multitude of output-price pairs in various moments, m.

By definition, the price elasticity of production is the percentage change of production, ΔQ corresponding to 1 % change of price, $\Delta P = 1$ %.

The price decline could determine farmers to diminish production, while the price growth will encourage farmers to produce more, either at a higher or at a lower growth rate than the increase rate of the price [7, 81].

In this context, the paper objective was to analyze the relationship between production and price for the selected agricultural products: wheat, maize, sunflower seeds, milk, pork, beef, and honey carried out in Romania for short-run, 2016-2018.

The statistical data were used to estimate the price elasticity of production both at the country level, and also in the territory by the eight micro-regions of development and the analysis of elasticity level and signs allowed to distinguish the differences between regions.

Finally, the paper aimed to establish in which micro-regions, production could positively respond to the growth of the acquisition price.

MATERIALS AND METHODS

The study is based on the available data picked up from the National Institute of Statistics, Tempo Online data base for the period 2016-2018,

The formula used for the calculation of elasticity of production, E_{QP} is:

$$E_{QP} = \frac{\Delta Q\%}{\Delta P\%} = \frac{\frac{\Delta Qm}{Q_0}}{\frac{\Delta Pm}{P_0}} = \frac{\Delta Qm}{\Delta Pm} \cdot \frac{P_0}{Q_0}$$

where:
ΔQ% is the percentage deviation of production,
ΔP% is the percentage change of price,
$\frac{\Delta Qm}{\Delta Pm}$ = 1/tangent slope to production curve,
ΔQm = Q_1 - Q_0, that is the production change in the moments 1 and zero
$\Delta Pm = P_1 - P_0$ is the price change in the moments 1 and zero
P_0, Q_0 represents the point of the production (supply) curve where elasticity was computed.
The calculations were made based on the values of the m moments of the chronological series compared to the value in the previous year [4, 69].
The results have been interpreted according to [6] as follows:
(i)If the production elasticity is negative, $E_{QPm} < 0$, this means that the production would decline when the price increases;
(ii)If production elasticity is positive, but lower than 1, ($0 < E_{QPm} < 1$), production would increase when the price will go up, but the increase of production will have a lower growth rate than the price increase rate;
(iii)If production elasticity is positive, but higher than 1, ($E_{QPm} > 1$), production would increase with a higher growth rate than the price increase rate.
Therefore, price elasticity of production depends both on the production level and price level, under the condition that all the other factors of influence are constant.
In practice, this situation is available for short-run, that is for 2-3 years, but for long-run, the economic and technical circumstances could change.
Because the conditions of production vary from a farm to another, from a region to another, from a country to another, there is a large variability of price elasticity which needs adjustments.
For this reason, in this study, it was estimated the production elasticity in Romania's agriculture for short-run, more exactly for two years, 2017 and 2018.
The elasticity was estimated for following agricultural productions:
(a)In vegetal sector, for the most representative crops in Romania: wheat, maize and sunflower.
(b)In animal sector, for the most representative productions: milk production, meat production in live weight of the slaughtered pigs and bovines, and extracted honey.
The elasticity of these productions was determined in all the eight micro-regions of development of Romania: North West (NV), Center (C), North East (NE), South East (SE), South Muntenia (SM), Bucharest Ilfov (BIF), South West Oltenia (SWO) and West (W) for reflecting the differences between the micro-regions.
Also, the elasticity is determined at the level of Romania to show that the results may substantially very compared to the elasticity in the territory.
The results were illustrated in graphics and tables, being accompanied by comments and finally the main conclusions have been drawn.

RESULTS AND DISCUSSIONS

Evolution of agricultural productions and of average product acquisition price at the level of Romania

Wheat, Maize, Sunflower

Wheat production increased by 40 % in the interval 2013-2018, from 7.29 million tons in 2013 to 10.14 million tons in 2018. This was favored both by the growth of the cultivated area, which reached over 2.1 million ha and by the yield which accounted for 4,803 kg/ha in 2018 [9].
The largest surfaces cultivated with wheat are in the following micro-regions: South Muntenia 28.37%, South East 22 %, South West Oltenia 19.72% and West 10.43% of the total cultivated area. Smaller surfaces are also cultivated in the other micro-regions: North East 7.27%, North West 6.96%, Center 4.31% and Bucharest Ilfov 0.89 %.
The highest contribution to wheat production is given by the following micro-regions: South Muntenia 29.75%, South East 22.8%,

South West Oltenia 19.1 % and West 15.47%, followed by the other micro-regions with lower shares.

Therefore, total wheat production is closely linked to the cultivated areas, but of course of the yield levels, depending on soil conditions, wheat varieties, applied technologies, local climate etc [79].

Maize was cultivated in Romania on 2.37 million ha in 2018, compared to 2.51 million ha in 2013, meaning a decline which will continue in the coming years, because the maize yield registered a continuous growth. In 2018, maize yield was 7,740 kg/ha by 72.4% higher than in 2013. As a result, in 2018, Romania produced 18.3 million tonnes of maize grains by 61.6% more than in 2013 [10, 67].

The highest contribution to the country maize production is brought by the following micro-regions: South Muntenia 18.2 %, West 18.1 %, South East 17.5%, and North East 15.9%. The other micro regions contribute by a lower percentage: North West 11.1 %, Center 7 %, and Bucharest Ilfov 0.45% [55, 56].

Sunflower production increased by 42.8% in the period 2013-2018, accounting for 3 million tonnes in 2018. This was due to a slight increase of about 2.1 % in the cultivated area, which reached 1.09 million ha in 2018 and of a high growth rate of 40.7% of sunflower yield, which accounted for 2,805 kg/ha in the same year 2018 [11].

The highest contribution to the total production of sunflower seeds is given by: South East region 31.9%, South Muntenia 22.4%, South West Oltenia 14.7%, and West 13.7%. The other micro regions contributed by: North East 9.61%, North West 5.52%, Bucharest Ilfov 1.07% and Center 0.96%.

Romania came on the top position in the EU for its sunflower seeds output, and also it is among the main exporting countries of the EU [41, 72].

In the last three years of the analysis, 2016-2018, wheat production increased from 8.4 million tonnes in 2016 to 10.14 million tonnes in 2018, meaning +20.3%.

Maize production also increased but by a higher rate, +70.4% from 10.7 million tonnes in 2016 to 18.6 million tonnes in 2018. Sunflower production increased by 50.6% from 2 million tonnes in 2016 to 3.1 million tonnes in 2018 (Fig.1).

This was due to the large surfaces cultivate with these crops in various regions of the country and the performance in yields per surface unit despite of the droughts and other extreme climate phenomena which affected a part of the output.

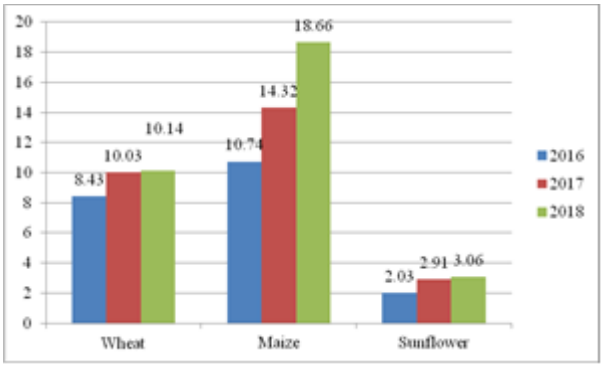

Fig.1. Dynamics of Wheat, Maize and Sunflower Production, Romania, 2016-2018 (Million tonnes)
Source: Own design based on the data from [14].

Wheat, maize and sunflower acquisition price varied from a year to another in close relationship with output and demand ratio. Its level influenced the profitability in case of each crop [9, 10, 11, 39, 40, 58].

In case of wheat, in 2018 the average acquisition price was 0.71 Lei/kg compared to Lei 0.85/kg in 2013, meaning by -16.5% less. In case of maize, the average price varied between Lei 0.74 per kg in 2013 and Lei 0.63 in 2018, when it was by 15% smaller. In case of sunflower seeds, the average price accounted for Lei 1.59 per kg in 2013 and Lei 1.37 in 2018, meaning a reduction of 14%.

The highest acquisition price was registered in the year 2012, when the country was facing a terrible draft which led to a lower production performance. In this year, the average acquisition prices reached the highest level per kg as follows: Lei 0.91 for wheat, Lei 0.87 for maize and Lei 1.84 for sunflower seeds [16].

In the analyzed period 2016-2018 in this paper, the average acquisition price of wheat increased by 7.9 %, from Lei 0.63 per kg in 2016 to Lei 0.68 in 2018, the price of maize

remained constant at Lei 0.62/kg and the price of sunflower seeds declined by 12.6%, from Lei 1.51 per kg in 2016 to Lei 1.32 in 2018 (Fig.2).

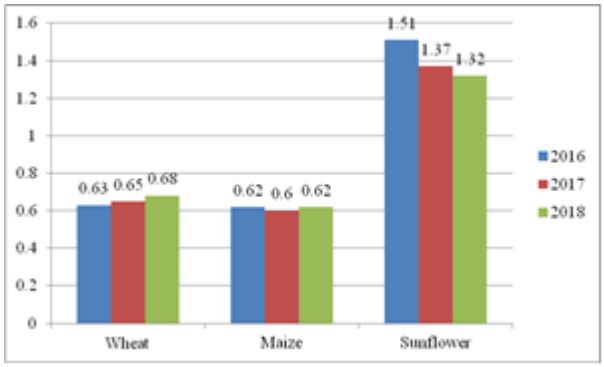

Fig.2. Dynamics of the average acquisition price of Wheat, Maize and Sunflower, Romania, 2016-2018 (Lei/kg)
Source: Own design based on the data from [14].

Milk

Milk sector registered in general a decreasing evolution in Romania, due to the most numerous subsistence and semi-subsistence farms raising in average 2-3 cows, and carrying out a low yield per cow. This does not allow them to resist to the pressure of the competition in the market.

After the period when milk quota was applied till April 2015, dairy farmers were facing huge problems regarding production allowed per farm in close relationship with the performance per cow and the number of cows [19, 21, 23, 73].

The funds from the EU favored the creation of new and modern dairy farms and the modernization of large old farms. However, the number of farms which are market oriented, applying modern technologies which could assure a high yield, production and of high quality represents just a small number of dairy farms [25].

In 2018, Romania had 1.17 million dairy cows which achieved 3.93 million tonnes milk, meaning a yield of 3,360 kg/cow/year. This yield was by 46.5 % higher than in the year 1990 when a cow was able to produce just 2,292 kg milk. The general trend regarding the dairy cows livestock is a decreasing one. In 2018, the number of dairy cows was by 64.6% smaller than in 1990 when Romania had 1.81 million dairy cows [53, 59].

This decreasing trend is similar to the one at the EU-28 level, where the number of cows accounted for 22.6 million heads in 2018 being by 13% less numerous than in 1990. But, the decline in the number of dairy cows was compensated by the increase in cow yield, which reached 7,407 kg/year, the average EU level in 2018, being by 34% higher than in the year 2000 (5,525 kg/cow). Therefore in 2018, the EU produced 167.4 million tonnes milk by 11.3% more than in the year 2000 (150.3 million tonnes) [2, 12].

Romania is far away of the average milk yield in the EU and of the milk performance in the top producing countries in the EU.

Milk yield and production varies between farms according to the number of dairy herd, breed, feeding, reproduction performance, milking system, applied technologies, farmers' managerial skills. For this reason, milk quality is also different according to the milking systems, maintenance and hygiene conditions of the cows, sheds etc.

Many farms have milk quality problems for which milk processors either refuse milk collection or offer a low acquisition price affecting economic efficiency and profitability in dairy farming [8, 29, 30, 31, 32, 73, 75, 77]. In the period 2016-2018 to which this research refers, milk production registered a decline in Romania from 44.5 Million hl in 2016 to 43.1 Million hl in 2018, meaning a reduction of 3.1%. This decrease is determined mainly by the reduction of the cow livestock and by the low milk yield which in average at the country level accounts for 3,360 kg/cow/year (Fig.3).

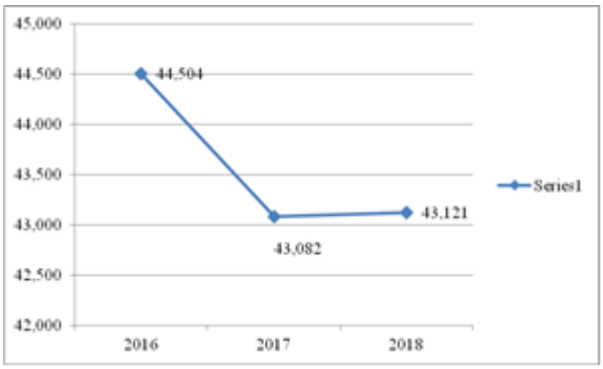

Fig.3. Dynamics of Milk Production, Romania, 2016-2018 (Thousand Hl)
Source: Own design based on the data from [14].

Milk price at delivery plays a very important role in the profitability in dairy farming, because it needs to cover production cost. The income that the farmer receives depends on the marketed milk and milk price, and this income has to cover all the production costs to assure profit [51, 52, 60, 76].

Milk price has slightly increased from a year to another, being also different from a season to another, in general in winter season, in the months of December, January and February, milk price is higher, while in summer season, in the months of June, July and August milk price has the lowest level.

In 2018, average acquisition milk price at farm gate accounted for Lei 1.27/kg or Euro 27.18/100 kg [1].

In the present study, the analysis showed that milk price increased by 10.4% from Lei 1.15 per liter in 2016 to Lei 1.27 in 2018, but its level is still low and in many farms it is not enough to cover production cost, affecting farm profitability (Fi.4).

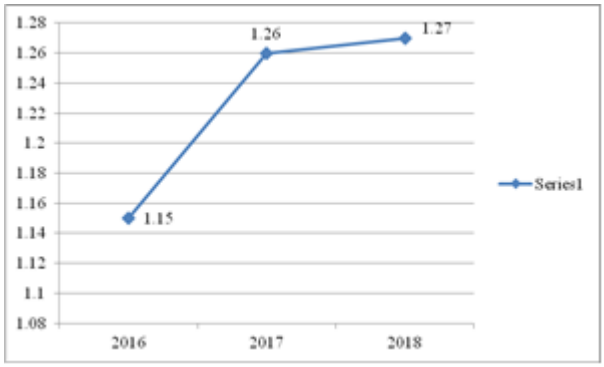

Fig.4. Dynamics of the average acquisition price of Milk, Romania, 2016-2018 (Lei/liter)
Source: Own design based on the data from [14].

Pork and Beef (Pig and Bovine- live weight)

Meat market is dominated by pork which is a traditional meat in Romania. Pork production in carcass equivalent depends on the number of slaughtered pigs and average live weight at slaughter [17, 38].

The economic efficiency in pig fattening is the reason for pig breeders to continue their business or to quip. This means that the price per kg live weight to cover production cost and assure a profit to the breeder [35, 46].

The pig livestock registered a continuous decreasing trend, in 2018, Romania had 3.92 million pigs by -24.4 % less than in 2013 (5,18 million heads).

The live weight of the slaughtered pigs in industrialized processing units accounted for 470.1 thousand tonnes in 2018 being by +17.5% higher than in 2013, when it was 400.2 thousand tonnes [13].

In case of beef production, whose level also depends on the number of slaughtered animals and their live weight at slaughter, it was noticed a similar decreasing trend regarding livestock with a negative impact on output. In 2013, the weight of the slaughtered bovines was 232.6 thousand tonnes and the average weight at slaughter accounted for 327 kg/head. In 2018, the live weight of the slaughtered bovines was 187.82 thousand tonnes, by 19.3 % lower than in 2013.

In the analyzed interval, 2016-2018, pork and beef production in terms of the slaughtered pigs and bovines live weight decreased due to the decline of the livestock of these two species.

The live weight of the slaughtered pigs declined by 6.5% from 588.1 thousand tonnes in 2016 to 549.8 thousand tonnes in 2018, while the live weight of the slaughtered bovines went down by 8.85% from 205.9 thousand tonnes in 2016 to 187.8 thousand tonnes in 2018 (Fig.5).

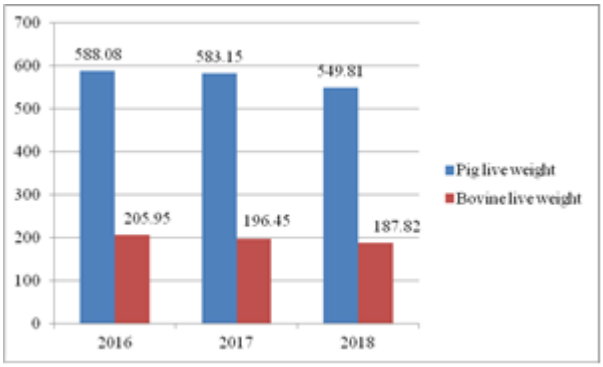

Fig.5. Dynamics of Meat production: Pig and Bovine live weight (Thousand Tonnes)
Source: Own design based on the data from [14].

The price per kilogram live weight had a positive increasing trend to stimulate farmers to improve production performance. Pig price increased by 3% from Lei 5.34 per kg live weight in 2016 to Lei 5.5 in 2018, while bovine price went up by 19.9% from Lei 5.93 in 2016 to Lei 7.11 in 2018. (Fig.6).

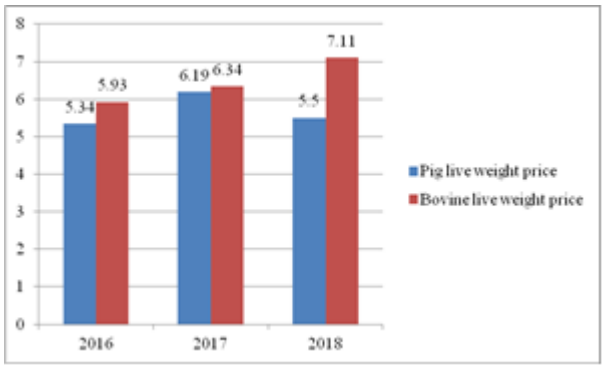

Fig.6. Dynamics of the average acquisition price of Pigs and Bovines, Romania, 2016-2018 (Lei/kg live weight)
Source: Own design based on the data from [14].

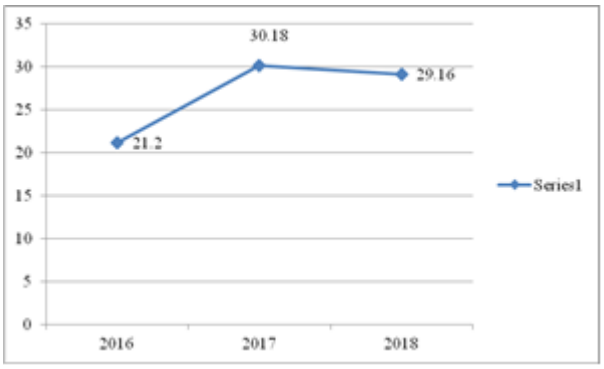

Fig.7. Dynamics of Extracted honey production (Thousand Tonnes)
Source: Own design based on the data from [14].

The increased growth rate of the pork price from 2017 to 2018 is explained by the "pork market crisis" which started due to the lack of piglets and carcasses determined by the EU Western producers who have been oriented to intensify their exports on the China market where the demand and price are very high as a result of the African Swine Fever.

Extracted Honey

Honey production increased along the time due to the extent of the apiaries number, bee families and bee hives, the increased honey production, and yield per bee family. The economic efficiency of an apiary is assured by the apiary size, more exactly the higher the number of bee families, usually more than 100, the higher the profitability [44, 48, 50].

Romania is not only an important honey producing country in the EU, but also an exporting country. Because, consumption per capita is low in Romania, about 0.5-0.6 kg honey per year, an important amount of honey is exported. And Romania honey has a high quality being required on the EU market [66, 71, 78].

In the analyzed interval, 2016-2018, the extracted honey production increased by 37.5% from 21.2 thousand tonnes in 2016 to 29.2 thousand tonnes in 2018, due to the growth of the number of bee families and hives and performance per apiary. The year 2018 was affected partially by unfavorable climate conditions which produced a slight decline of production compared to the year 2017, when it was recorded a peak of production (Fig.7).

Honey price offered by the Association of Beekeepers is still low in Romania, but the subsidies offered by the Government to encourage beekeepers to produce more honey have had a very good impact on beekeepers income and profit [45, 63, 64].

In the analyzed period in this study, 2016-2018, honey price registered an increasing trend, 10.4% growth rate, so that in 2018, a kilogram of honey was sold in the market for Lei 16.68 compared to Lei 15.11 in 2016 (Fig.8).

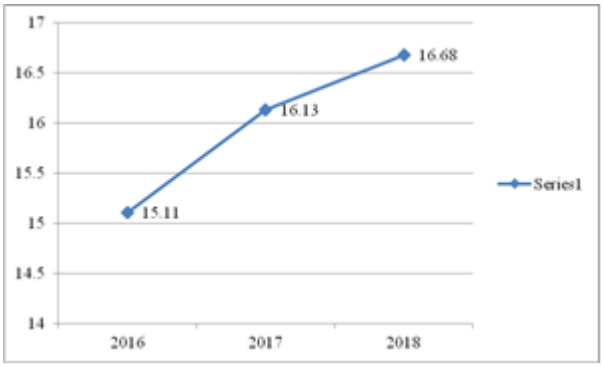

Fig.8. Dynamics of the average acquisition price of Honey, Romania, 2016-2018 (Lei/kg)
Source: Own design based on the data from [14].

The price elasticity of production at the level of Romania for the agricultural products analyzed in this study is presented in Fig.9.

In case of wheat, it was noticed that the price increase by 1% assures a production growth higher than the price increase in 2017 and lower than the price growth in 2018.

In case of maize, the price had a negative effect on production, but in 2018, the price had a benefic impact on the output.

Sunflower production was not stimulated by price level in this year, as the price went down.

In case of pork (live weight), an increase of price will stimulate production, but twice less than the price growth rate.

Milk production is positively influenced by price growth, but its growth rate is still below the price increase rate.

Beef production is not encouraged by price increase, and continued to decline.

Honey production was advantaged by the price increase in 2017, when its growth rate exceeded the price increase rate, but in 2018, despite of the high price, production went down for other reasons, especially due to the climate extreme conditions which affected pickings (Fig.9).

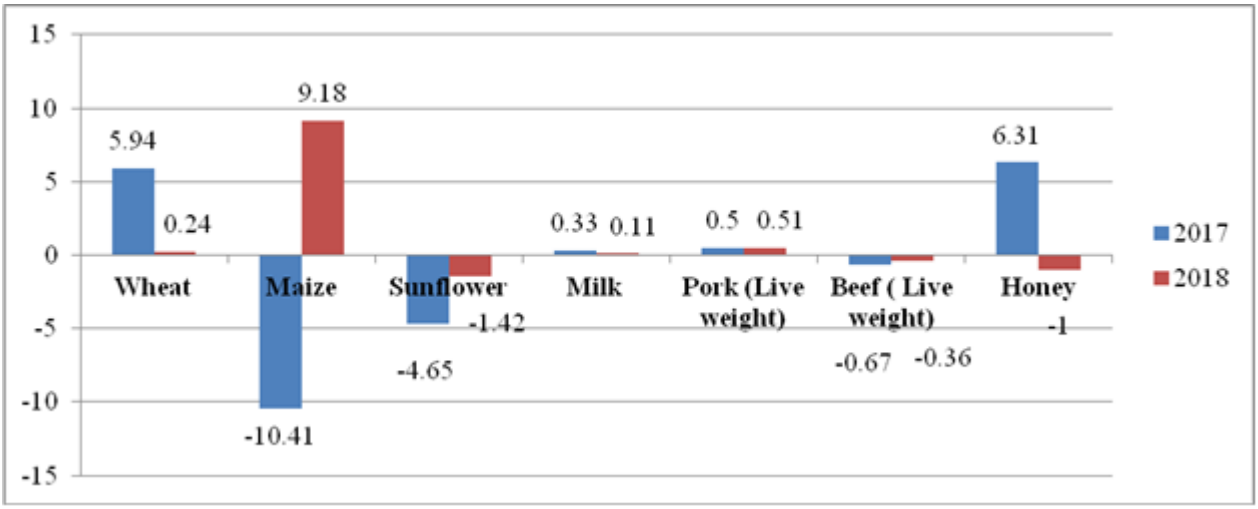

Fig.9. Price elasticity of production for the main agricultural products in Romania in 2017 and 2018.
Source: Own design and calculation.

The price elasticity of production by micro-region of Romania

Due to the lack of space, the productions and prices at the level of each micro-region are not presented in this study, but they were used for calculating the elasticity of production for the main agricultural products studied within this research.

Wheat, Maize and Sunflower price elasticity of production is presented in Table 1.

Wheat production elasticity

Wheat production elasticity in relation to price level was positive in NW, SE, Bucharest-Ilfov and SW Oltenia regions both in 2017 and 2018 reflecting a good impact of price increase. In 2018, production growth exceeded price increase rate only in Bucharest Ilfov region, in all the other regions was lower than the price growth rate in the micro-regions mentioned before.

In the Center, NE and West micro regions, in 2017, the wheat production elasticity was negative, reflecting that price increase did not favor the output, but in 2018, the price increase had a relatively good impact, the price growth being higher than the production performance.

The S Muntenia region is the only one where the wheat production elasticity had negative values both in 2017 and 2018, reflecting that the price and, for sure other factors such as climate change, had not a good impact (Table 1).

Maize production elasticity

In 2017, the maize production elasticity had negative values in almost all the micro-regions, except S Muntenia were it had the value zero, and Bucharest Ilfov region where production increased with a higher growth rate than price increase rate. In 2018, the maize price increase had a very good impact on production performance except Bucharest Ilfov and W micro-regions (Table 1).

Sunflower production elasticity

In 2017, the elasticity of sunflower registered negative values in almost all the micro-regions, except the NW region where it had a positive value and West were its value was

zero. In 2018, the price increase did not favor sunflower output in many micro-regions: NW, C, SE, S Muntenia and W, but it had a slight positive influence in NW, and was zero in W region (Table 1).

Table 1. Price elasticity of production for Wheat, Maize and Sunflower by micro-region of Romania in 2017 and 2018

	Wheat production elasticity		Maize production elasticity		Sunflower production elasticity	
	2017	2018	2017	2018	2017	2018
NW	7.17	0.17	-5.24	5.75	6.13	-0.27
C	-6.46	0.17	-3.22	2.77	-8.45	-8.09
NE	-1.36	0.20	-4.89	17.47	-6.35	0.68
SE	4.38	0.38	-21.00	4.96	-5.75	-3.26
SM	-8.70	-0.40	0	7.23	-12.55	-2.82
BIF	2.96	5.27	22.93	-4.21	-3.35	1.31
SWO	7.19	0.19	-6.32	1.34	-8.61	1.48
W	-1.47	0.76	-1.49	-10.75	0	-0.222

Source: Own results.

Pork and Beef price elasticity of production by micro-region is presented in Table 2.

In case of pork production, in 2017 and 2018, the micro regions where the price increase had a favorable influence were Center, SE, S Muntenia, and SW Oltenia. In the other micro regions: NW, NE and W, pork output was not positively influenced by the acquisition price increase (Table 2).

In case of beef production, in 2017, the regions with a good impact of price increase were: NW, NE, and SE, while in the Center, S Muntenia and SW Oltenia the price increase did not favor production which for sure was affected by other factors. In the W micro-region the elasticity was zero. In 2018, a weak positive impact of the price increase was noticed only in NW and NE micro-regions, and in all the other micro-regions the price growth did not have any good impact on production (Table 2).

Table 2. Price elasticity of production for Pork and Beef (Live weight) by micro-region of Romania in 2017 and 2018

	Pork elasticity		Beef elasticity	
	2017	2018	2017	2018
NW	-0.18	-1.92	22.70	0.93
C	0.51	12.56	-2.41	-0.09
NE	-1.37	-1.66	0.04	1.59
SE	0.08	1.14	0.67	-0.08
SM	0.06	2.14	-0.23	-0.88
BIF	Nd	Nd	Nd	Nd
SWO	0.12	1.90	-3.19	-0.44
W	-0.05	-0.55	0	0

Nd- No data.
Source: Own calculation.

Milk and Honey price elasticity of production by micro-region is presented in Table 3.

In case of milk production, the elasticity was in general positive and weak, except SE region, where it was very high compared to the price increase, and NE were it had a negative value. In 2018, only in the NW region, the elasticity was positive having a high value reflecting a higher growth rate of production compared to the price increase rate. In S Muntenia the elasticity was positive but very small, while in C, NE and SE it had negative values, reflecting that milk output was not influence by price, and its decline was caused by other factors, mainly by the reduction of the cow livestock and the drought which affected feed production (Table 3).

In case of honey production, in 2017, the price increase had a positive and high impact on honey output in the C, NE, S Muntenia and SW Oltenia micro-regions, while in NW, SE and W it had a negative impact. In 2018, in almost all the micro regions the price increase had a negative impact on honey production, except W region (Table 3).

Table 3. Price elasticity of production for Milk and Honey by micro-region of Romania in 2017 and 2018

	Milk elasticity		Honey elasticity	
	2017	2018	2017	2018
NW	0.05	4.25	-2.46	-0.79
C	0.11	-0.04	1.27	-88.00
NE	-0.65	-0.08	1.22	-0.04
SE	11.62	-0.15	-20.15	-2.42
SM	0.8	0.008	1.19	-0.06
BIF	Nd	Nd	Nd	Nd
SWO	Nd	Nd	9.09	-0.07
W	Nd	Nd	-6.34	2.09

Note: Nd- No data.
Source: Own calculation.

CONCLUSIONS

The paper analyzed the situation of production and acquisition price, and the relationship between these two indicators by means of elasticity coefficient, considering that price level has a deep influence on production level.

For short run, more exactly for the period 2016-2018, price elasticity of production was analyzed both at the country level and at each micro-region level for the main agricultural products: wheat, maize, sunflower seeds, milk, pork and beef in terms of live weight, and honey.

At Romania's level, it was noticed that the price increase by 1 % will determine production growth in case of wheat, maize, milk, and pork, but the growth rate of production remains behind the increase rate of price. In case of sunflower, beef and honey, the increase of price has a negative impact on production.

In 2018, for an increase of 1 % acquisition price, wheat production raised by 0.24%, maize output by 9.18%, milk production by 0.11%, and pork production by 0.51%, while the production decline was - 1.42% for sunflower, -0.25% for beef and -1 % for honey.

The level of price elasticity at the country level is blurring the differences existing in the territory among the micro-regions.

In case of wheat, in 2017 and 2018, the price increase by 1% has stimulated the production growth only in the NW, SE, Bucharest Ilfov and S W Oltenia micro-regions. However, price elasticity variations were noticed in the other regions from a year to another, where in 2017 the price increase did not stimulate production, and this means that other factors have affected it. In 2018, in these micro regions it was possible as price increase by 1% to lead to a production increase but with a lower growth rate than price increase rate.

In case of maize, in 2017, the price growth by 1 % did not stimulated production, on the contrary, it declined by various percentages, reflecting that other factors had a deeper impact. But, in 2018, the price increase stimulated production in almost all the regions, except Bucharest Ilfov and West.

In case of sunflower, the price increase had a negative influence on production in almost all the regions, except NW in 2017 and NE, BIF and SW Oltenia in 2018.

In case of pork, in 2017 and 2018, the price increase by 1% stimulated production in the Center part, SE, S Muntenia, SW Oltenia and West regions even by more than 1 %. In the other micro-regions, pork production is negatively influenced by price increase.

In case of beef, the price growth had a positive influence on output only in the NW and NE regions both in 2017 and 2018.

In case of milk, the price increase by 1% sustained production mainly in the NW and a

little S Muntenia, in all the other regions it had a negative impact, reflecting that other factors have a deeper influence on milk output than price.

In 2017, honey production registered a higher growth rate than the price increase by 1% in the Center region, NE, S Muntenia, and SW Oltenia. But, in 2018, in almost all the regions except West region, the increased price had a negative impact on honey output because climate extreme phenomena affected the pickings and caused important damages to beekeepers.

As a final conclusion, if the other factors of influence are considered stable, the growth of production is sustained by the increase of the acquisition price in the following micro-regions:

- for wheat in NW, SE, Bucharest Ilfov and S W Oltenia micro-regions;
-for maize in almost all the micro-regions except Bucharest-Ilfov and West;
-for sunflower in BIF and SW Oltenia in 2018;
- for pork, in the Center, SE, S Muntenia, SW Oltenia and West regions;
- for beef only in NW and NE regions;
-for milk in NW and S Muntenia;
-for honey in the Center, NE, S Muntenia, and SW Oltenia.

If other factors have a deeper influence on production, either the farmers have to manage much better their business or the level of the acquisition price has to be much higher.

REFERENCES

[1]Anonymous, 2020a, Farm-gate milk prices, Romania, CLAL, https://www.clal.it/en/index.php?section=latte_romania Accessed on Jan.30, 2020.

[2]Anonymous, 2020b, Less dairy cows in the EU, but more productive/The European farms produce the highest milk amount worldwide (Vaci de lapte mai puține în Uniunea Europeană, dar mai productive / Fermele europene produc cea mai mare cantitate de lapte la nivel mondial, 2020), https://www.g4media.ro/vaci-de-lapte-mai-putine-in-uniunea-europeana-dar-mai-productive-fermele-europene-produc-cea-mai-mare-cantitate-de-lapte-la-nivel-mondial.html, Accessed on Jan.30, 2020.

[3]Anonymous, 2020c, Meat consumption per inhabitant reached in 2018 a historical record in Romania. The phenomenon is associated with the wages growth (Consumul de carne pe cap de locuitor a atins in 2018 un record istoric in Romania, Fenomenul asociat cu cresterea veniturilor,), Mediafax, https://www.mediafax.ro/social/consumul-de-carne-pe-cap-de-locuitor-a-atins-in-2018-un-record-istoric-in-romania-fenomenul-asociat-cu-cresterea-veniturilor-18740070, Accessed on Jan.30, 2020.

[4]Cook, S.J., 2009, The intellectual Foundation of Alfred Marshall's Economic Science. A Rounded Scientific and Encyclopaedic Publishing House, Bucharest, pp.35.

[5]Dobra, I.B., Șandru, F.L., 2016, Analytical Overview on the Romanian Dairy Market in the Context of Economic Changes, Academic Journal of Economic Studies Vol. 2, No.4, December 2016, pp. 172–186, http://www.ajes.ro/wp-content/uploads/AJES_article_1_82_3.pdf, Accessed on Jan.30, 2020.

[6]Hanf, C.H., 1981, Relationship between milk production and price variations in the EC, European Commission, Agricultural Studies, pp.12-13, http://aei.pitt.edu/36837/1/A67.pdf, Accessed on Jan.30, 2020.

[7]Havlicek, J., 1989, Waugh, Frederick V. Demand and Price Analysis—Some Examples from Agriculture. Washington DC: U.S. Department of Agriculture, Econ. Res. Serv., Econ. and Statist. Anal. Div. Tech. Bull. No. 1316, Nov. 1964, vi + 94pp., American Journal of Agricultural Economics, Vol.71(3), 820–821, https://academic.oup.com/ajae/article-abstract/71/3/820/154521, Accessed on Jan.30, 2020.

[8]INSSE, 2019, Animal production obtained in the year 2018 (Producţia animală obţinută în anul 2018), OPress Release No.160, June 28, 2019), Comunicat de presa nr.160/28 iunie 2019, http://www.insse.ro/cms/sites/default/files/com_presa/com_pdf/prod_anim18r.pdf, Accessed on Jan.30, 2020

[9]MADR, 2020a, Wheat (Grau), Ministry of Agriculture and Rural Development, https://www.madr.ro/culturi-de-camp/cereale/grau.html,Accessed on Jan.30, 2020.

[10]MADR, 2020b, Maize (Porumb), Ministry of Agriculture and Rural Development, https://www.madr.ro/culturi-de-camp/cereale/porumb.html, Accessed on Jan. 30, 2020.

[11]MADR, 2020c, Sunflower (Floarea soarelui), Ministry of Agriculture and Rural Development, https://www.madr.ro/culturi-de-camp/plante-tehnice/floarea-soarelui.html, Accessed on Jan. 30, 2020.

[12]MADR, 2020d, Bovines, 2007-2013, Livestock and production (Bovine: Efective si productii), Technical and Operative Report regarding productions in Bovines on June 30,2017, (Raport tehnic-operativ privind productiile la bovine la data de 30 iunie 2017), https://www.madr.ro/cresterea-animalelor/bovine.html, Accessed on Jan. 30, 2020.

[13]NIS, 2019, Press Release No.163/28 June 2019, Meat, Milk and Dairy products Production achieved in industrialized units in the year 2018.

[14]NIS, 2020, Tempo Online, http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table, Accessed on Jan.30, 2020.
[15]Pana, M., 2019, Agriculture Balance in 2018-Contribution to GDP, Generalized decline in animal husbandry, increase for vegetal sector in the West (Bilantul agriculturii in 2018-Contributia la PIB, Scadere generalizata in zootehnie, cresteri la vegetale in vest), https://cursdeguvernare.ro/bilantul-agriculturii-2018-contributia-la-pib-scadere-generalizata-in-zootehnie-cresteri-la-vegetale-in-vest.html, Accessed on Jan.30, 2020.
[16]Petre, I.L., 2017, The effect of maize production and consumption on prices in Romania. Agrarian Economy and Rural Development - Realities and Perspectives for Romania, Vol. 8, 45-52.
[17]Pirvutoiu I., Popescu Agatha, 2011, Study on the Trends in Romania's Meat Market, 11th International Symposium on "Prospects of Agriculture and Rural Areas in the Context of Durable Development", UASVM Bucharest, June -23, 2001, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.11, Issue 2/2011, p.133-139.
[18]Popescu Agatha, 2003, Financial Analysis in Dairy Farming, The 2nd International Symposium on "Prospects for the 3rd Millenium Agriculture", USAMV Cluj-Napoca, 9-11 oct.2003, Bulletin of UASVM Cluj-Napoca, Animal Science and Biotechnologies, (Zootehnie si Biotehnologii), Vol.59, p.11-1.
[19]Popescu Agatha, 2004a, Prospects for dairy farm management under milk quota. The International symposium on"Prospects for the 3rd Millenium Agriculture", USAMV Cluj-Napoca, 20-23 oct.2003, Bulletin of UASVM Cluj-Napoca, Animal Science and Biotechnologies, (Zootehnie si Biotehnologii), Vol.60, p.14 - 20.
[20]Popescu Agatha, 2004b, Financial Statement - a tool in decision making in dairy farming. The International symposium on"Prospects for the 3rd Millenium Agriculture", USAMV Cluj-napoca, 20-23 Oct.2003, Bulletin of UASVM Cluj-Napoca, Animal Science and Biotechnologies, (Zootehnie si Biotehnologii), Vol.60, p.384 - 389.
[21]Popescu Agatha, Muresan, G., 2004, Analysis in dairy farming in Arad County achievements and prospects under the background of Romania's entry into the E.U. The International symposium on "Prospects for the 3rd Millenium Agriculture", USAMV Cluj-Napoca, 20-23 Oct.2003, Bulletin of UASVM Cluj-Napoca, Animal Science and Biotechnologies, (Zootehnie si Biotehnologii), Vol.60, p.385.
[22]Popescu Agatha, 2005a, Researches concerning the increase of profitability in beekeeping by creating of commercial apiaries, Bulletin of the University of Agricultural Science and Veterinary Medicine, Animal Husbandry and Biotechnology, Vol. 61, 188-191.
[23]Popescu Agatha, 2005b, Research concerning dairy cows, farm structure and milk performances in the proximity of the capital, The 4th International Symposium "Prospects of the 3rd Millennium Agriculture, 6-7 Oct.2005, Bulletin of UASVM Cluj-Napoca, Romania, Series Animal Science, Biotechnologies and Veterinary Medicine, (Zootehnie si Biotehnologii si Medicina Veterinara), Vol.61, p.399-403.
[24]Popescu Agatha, 2005c, Research on the possibility to increase profitability in an apiary of 50 bee families, The 4th International Symposium "Prospects of the 3rd Millennium Agriculture, 6-7 Oct.2005, Bulletin of UASVM Cluj-Napoca, Romania, Series Animal Science, Biotechnologies and Veterinary Medicine, (Zootehnie si Biotehnologii si Medicina Veterinara), Vol.61, p.404-407.
[25]Popescu Agatha, 2006a, Research concerning the economic impact of investments in dairy farms of various size, International Symposium "Prospects of Agriculture in the 3rd Millennium", UASVM Cluj-Napoca, 5-6 October 2006, Bulletin of UASVN Cluj-Napoca, Romania, Series Animal Science, Biotechnologies and Veterinary Medicine, (Zootehnie si Biotehnologii si Medicina Veterinara), No.62, p.8-12.
[26]Popescu Agatha, 2006b, Study upon milk market in the EU countries, International Symposium "Prospects of Agriculture in the 3rd Millennium", UASVM Cluj-Napoca, 5-6 October 2006, Bulletin of UASVN Cluj-Napoca, Romania, Series Animal Science, Biotechnologies and Veterinary Medicine, (Zootehnie si Biotehnologii si Medicina Veterinara), No.62, p.214.
[27]Popescu Agatha, 2006c, Study upon Honey Market in the EU Countries, International Symposium "Prospects of Agriculture in the 3rd Millennium", UASVM Cluj-Napoca, 5-6 October 2006, Bulletin of UASVN Cluj-Napoca, Romania, Series Animal Science, Biotechnologies and Veterinary Medicine, (Zootehnie si Biotehnologii si Medicina Veterinara), No.62, p.2015.
[28]Popescu Agatha, 2006d, Financial management in dairy farms, Dominor Publishing House, Bucharest, (Managementul financiar in fermele de vaci, Ed. Dominor, Bucuresti), p.69.
[29]Popescu Agatha, 2007, Considerations upon economic efficiency in dairy farms by gross margin assessment, International Scientific Symposium "Performance and Competitiveness in Animal Production", UASVM Iasi, May 4-5, 2007, Scientific Papers Series Animal Science (Lucrari stiintifice Seria Zootehnie), Iasi, Vol.50, p. 670-672.
[30]Popescu Agatha, 2009a, A comparative study concerning economic efficiency for various levels of milk yield, International Symposium "Modern Animal Production – Science, Creativeness and Innovation, UASVM Iasi, Faculty of Animal Science, April 9-10, 2009, UASVM Iasi Sientific Papers Series Animal Science (Lucrari stiintifice Seria Zootehnie), Iasi, Vol.52 (14), p.525-530.
[31]Popescu Agatha, 2009b, Analysis of Milk Production and Economic Efficiency in Dairy Farms, Lucrari stiintifice Zootehnie si Biotehnologii

(Scientifical Papers: Animal Sciences and Biotechnologies), Timişoara,Vol.42(1):507-513.
[32]Popescu Agatha, 2010a, Research concerning Gross Margin Forecast based on Milk Yield using the Least Square Method of Regression Analysis, International Symposium on "Prospects of Agriculture and Rural Areas Development in the context of Global Climate Change", 5-6 May, 2010, UASVM Bucuresti, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.10(2)/2010, p.173-178.
[33]Popescu Agatha, 2010b, Research concerning the Use of Regression Function in Gross Margin Forecast, The 9th International Symposium on The Prospects of the 3rd Millennium Agriculture, Cluj Napoca Sept. 30-Oct. 2, 2010, Bulletin of UASVM Cluj-Napoca, Romania, Horticulture-Management, Vol.67(2):197-202.
[34]Popescu Agatha, 2011, Research concerning the Correlation between Demand and Offer in the Romanian Milk Market, International Symposium "Bioengineering of Animal Productions", Timisoara, May 26-27, 2011, Scientific Papers: Animal Sciences and Biotechnologies, Timisoara, Vol.44(2):504-507.
[35]Popescu Agatha, 2012a, Study concerning the Economic Efficiency in Pig Fattening, International Symposium " Modern Animal Science, factor of sustainable development" ("Zootehnia moderna, factor la dezvoltarii durabile"), April 26-27, 2012, UASVM Iasi, Scientific Papers Series Animal Science (Lucrari stiinifice-Seria Zootehnie), Iasi, Vol. 58(2):179-183.
[36]Popescu Agatha, 2012b, Economia productiei in ferma de vaci Ed.EIKON Cluj Napoca, coeditare cu Ed.RawexComs, (Production economy in dairy farms, EIKON publishing House in co-editing with Rawex-Coms Publishing House), Bucharest, p. 155.
[37]Popescu Agatha, 2012c, Marja bruta in fermele vegetale si animale, Ed.EIKON Cluj Napoca, coeditare cu Ed.RawexComs, Bucuresti, (Gross margin in the vegetal and animal farms, EIKON publishing House in co-editing with Rawex-Coms Publishing House), Bucharest, p.146.
[38]Popescu Agatha, 2012d, Study concerning the Trends in Pork Market in Romania, International Symposium " Modern Anamal Science, factor of sustainable development" (Zootehnia moderna, factor la dezvoltarii durabile"), April. 26-27, 2012, UASVM Iasi, Scientific Papers Series Animal Science, (Lucrari stiinifice-Seria Zootehnie Iasi), Vol.57(2), p.184-188.
[39]Popescu Agatha, 2012e, Research concerning the Use of Gross Margin in the Profitability Analysis in Wheat and Barley Cropping, Scientific Papers Agricultural Management, Series I, Vol.XIV (2):155-162.
[40]Popescu Agatha, 2012f, Research regarding Gross Margin Forecast based on Average Production in Wheat Cropping, Scientific Papers Agricultural Management, Series I, Vol.XIV (2):163-170.
[41]Popescu Agatha, 2012g, Considerations on the Importance of Sunflower among the Oil Seed Crops in Romania in the period 1990-2009, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.12(2):117-122.
[42]Popescu Agatha, 2012h, Considerations on the Importance of Maize among Cereal Crops in Romania in the period 1990-2009, 12th International Symposium on "Prospects of Agriculture and Rural Areas in the Context of Durable Development", UASVM Bucharest, May 17-18, 2012, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.12, Issue 2/2012, p.123-128,
[43]Popescu Agatha, 2012i, Research regarding oilseeds crops development in Romania in the EU context, Journal of Agricultural Economics, Ekonomika Poljoprivrede, Vol.1/2012 Institute for Agricultural Economics, Belgrade, Serbia, UDC 633.85(498):EU, p.129-138.
[44]Popescu Agatha, 2012j, Research regarding Apiaries Structure and its Relationship with Honey Production, The 11th International Symposium on The Prospects of the 3rd Millennium Agriculture Cluj Napoca, Sept 27-29, 2012, Bulletin of UASVM Cluj-Napoca, Romania, Animal Science and Biotechnology, Vol.69(1-2)/2012, p.332-334.
[45]Popescu Agatha, 2012k, Research on Beekeepers Income Estimation based on Honey Production. The 9th International Symposium on The Prospects of the 3rd Millennium Agriculture Cluj Napoca, Sept 27-29, 2012, Bulletin of UASVM Cluj-Napoca, Romania, Animal Science and Biotechnology, Vol.69(1-2)/2012, p.185-191.
[46]Popescu Agatha, 2012l, Research concerning the Economic Efficiency in Pig Fattening in Farms of Various Sizes. Scientific Papers: Animal Science and Biotechnologies, 45(2):397-403.
[47]Popescu Agatha, 2013a, Study concerning the Trends in Romania's Honey Market, Scientificc Papers Series Animal Science (Lucrari stiinifice-Seria Zootehnie), Iasi, Vol. 59, p.153-158.
[48]Popescu Agatha, 2013b, Research concerning Apiary Size, Honey Yield and Beekeepers' income in Teleorman County, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.13(1):293-300.
[49]Popescu Agatha, 2013c, Research on Consumer Behaviour on Bucharest Meat Market, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.13(1):301-308.
[50]Popescu Agatha, 2013d, Research concerning the Actual Statement of Apiculture in Calarasi County, Scientific Papers: Animal Sciences and Biotechnologies, Timisoara, Vol.46 (1):397-403.
[51]Popescu Agatha, 2014a, Research on milk cost, return and profitability in dairy farming, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(2):219-222.
[52]Popescu Agatha, 2014b, Research on profit variation depending on marketed milk and production

cost in dairy farming, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(2):223-230.
[53]Popescu Agatha, 2015a, Research on the trends in milking livestock and milk production in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1):377-386.
[54]Popescu Agatha, 2015b, Research on the trends in milk production and consumption in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(1):387-392.
[55]Popescu Agatha, 2015c, Research on the distribution and concentration of the farms cultivating maize for grains in Romania using the Gini Coefficient, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(3):253-260.
[56]Popescu Agatha, 2015d, Analysis of the evolution and distribution of maize cultivated area and production in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(3):261-264.
[57]Popescu Agatha, 2015e, Research on the Pork Production Trends in the EU-28, the CEECs and Romania, Proceedings of 25th IBIMA Conference Innovation Vision 2020: from Regional Development Sustainability to Global Economic Growth, Amsterdam, The Netherlands, May 7-8, 2015, pp.1407-1422.
[58]Popescu Agatha, 2015f, Regression and Elasticity of Maize Price and Production in Romania, Proceedings of 26th IBIMA Conference Innovation Management and Sustainable Economic Competitive Advantage: From Regional Development to Global Growth, Madrid, Spain, November 11-2, 2015, pp.2205-2213.
[59]Popescu Agatha, 2015g, Regression modeling in prediction milk production depending on the dairy bovine livestock, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(4):225-230.
[60]Popescu Agatha, 2015h, Multiple correlation and regression in predicting milk price, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.15(4):231-238.
[61]Popescu Agatha, 2016a, Research on concentration of pork production in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(1):405-410.
[62]Popescu Agatha, 2016b, The milk market concentration and competition thresholds in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(2):247-253.
[63]Popescu Agatha, 2016c, The effect of Honey Production on Beekeepers' Income. A Study Case in South Muntenia Development Region of Romania, Proceedings of 28th IBIMA Conference Vision 2020: Innovation Management, Development Sustainability, and Competitive Economic Growth, Sevilla, Spain, November 9-10, 2016, pp.919-934.
[64]Popescu Agatha, 2016d, Regression and Elasticity of the Average Delivery Price and Production of Honey in Romania, Proceedings of 28th IBIMA Conference Vision 2020: Innovation Management, Development Sustainability, and Competitive Economic Growth, Sevilla, Spain, November 9-10, 2016, pp.935-944.
[65]Popescu Agatha, 2016e, Considerations on beef production, consumption and trade balance in Romania (2007-2015), Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.16(4):267-277.
[66]Popescu Agatha, 2017a, Honey production in Romania, 2007-2015 and 2026-2020 forecast, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(1):339-350.
[67]Popescu Agatha, 2017b, Maize culture- An intensive or extensive production system in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(1):351-356.
[68]Popescu Agatha, 2017c, Trends in milk market and milk crisis impact in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(2):281-290.
[69]Popescu Agatha, 2017d, Elasticity of apple price depending on offer in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,Vol.17(3):333-337.
[70]Popescu Agatha, 2018a, Maize and Wheat - Top agricultural products produced, exported and imported by Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.18(3):339-352.
[71]Popescu Agatha, 2018b, Honey production and trade before and after Romania's accession into the European Union, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.18(4): 229-248.
[72]Popescu Agatha, 2018c, Romania's sunflower seeds production, export and import-Analysis of the 2007-2017 period and forecast for 2018-2022 horizon, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.18(4):261-270.
[73]Popescu Agatha, Angel Elena, 2009, Analysis of Milk Quality and its importance for milk processors, Scientifical Papers Animal Sciences and Biotechnologies), Vol. 42(1):501-506.
[74]Popescu Agatha, Rasmussen, S., Ciocan, H., 2010, Forecast of Dairy Cows based on Milk Yield under Milk Quota, Bulletin of UASVM Cluj-Napoca Romania, Horticulture-Management, No.67(2):p.287.
[75]Popescu Agatha, Condei Reta, 2014, Study on the average marketed milk as a measure of profitableness threshold in dairy farms, Scientific Papers Series

Management, Economic Engineering in Agriculture and Rural Development, Vol.14(4):219-222.
[76]PopescuAgatha, David Livia, 2014, Research on regression modeling of profit related to milk yield in dairy farming, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.14(4):211-218.
[77]Popescu Agatha, Angel Elena, 2019, Cow raw milk quality and its factors of influence in relationship with milk price, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.19(1):421-440.
[78]Popescu Agatha, Guresoaie Ion, 2019, Consumer's behaviour towards honey purchase- A case study in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.19(1): 451-470.
[79]Soare, B.E., Analysis of the situation of the wheat crop on macro-regions in Romania,142-149, http://cafee.ase.ro/wp-content/uploads/file201816.pdf, Accessed on Jan. 30, 2020.
[80]Ward, R.W., 2014, Honey Demand and the Impact of the National Honey Board's Generic Promotion Programs,
http://www.natureplica.com/wp-content/uploads/2014/06/National-Honey-Board-on-Honey-Demand.pdf, Accessed on Jan. 30, 2020.
[81]Waugh, F.Y., 1964, Demand and price analysis. Some examples from agriculture,
Washington DC: U.S. Department of Agriculture, Econ. Res. Serv., Econ. and Statist. Anal. Div. Tech. Bull. No. 1316, Nov. 1964, 94pp.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

REMOTE SENSING IN THE ANALYSIS AND CHARACTERIZATION OF SPATIAL VARIABILITY OF THE TERRITORY. A STUDY CASE IN TIMIS COUNTY, ROMANIA

Cosmin Alin POPESCU[1], Mihai Valentin HERBEI[1], Florin SALA[2]

[1]Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Remote Sensing and GIS, Timișoara, 300645, Romania; Emails: cosmin_popescu@usab-tm.ro; mihai_herbei@yahoo.com
[2]Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Soil Science and Plant Nutrition, Timișoara, 300645, Romania; Email: florin_sala@usab-tm.ro

Corresponding author: florin_sala@usab-tm.ro

Abstract

The present study used satellite images analysis to evaluation and characterization of land spatial variability in the Livezile-Dolat Protected Area, Timis County, Romania. Based on the spectral information, the indices NDVI, SAVI, NBR, GLI, GNDVI and CIgreen were calculated. On the basis of ISODATA algorithm, an unsupervised analysis was performed, and 15 classes resulted. The coefficient of variation (CV) expressed a high variability in terms of the surfaces size on the set of 15 obtained classes (CV_{Class}=43.2658). Based on the NDVI index, 8 groups of values were obtained, covering an area of 6,542.801 ha; 9 groups of values covering the surface of 6,555.21 ha in the case of SAVI, and 6 groups of values covering the area of 6,542.955 ha in the case of CIgreen were obtained. Data series for each index studied (654,361 values per series) were analyzed to evaluate the variance (V) and coefficient of variation (CV). The highest value of the variance was identified for the CIgreen index ($V_{CIgreen}$=0.892885), and the lowest at the GLI index (V_{GLI}=0.001912), the other indices having intermediate values of the variance (V_{GNDVI}=0.013837, V_{NDVI}=0.028027, V_{SAVI}=0.063048). Based on the values of the coefficient of variation (CV), a high degree of spatial variability was found in the set of GLI index values (CV_{GLI}=80.40968) and the lowest spatial variability in the GNDVI index data set (CV_{GNDVI}=23.85455), and intermediate values for the other studied indices (CV_{NDVI}=28.76762, CV_{SAVI}=28.76861, $CV_{CIgreen}$=57.57606).

Key words**:** *ISODATA, spatial variability, unsupervised classification, variation coefficient*

INTRODUCTION

Terrestrial areas, by their specificity and complexity, have a high diversity and are studied at different levels of understanding, in relation to the issues addressed; from the global, national, regional level, to the level of administrative units, vegetative associations, farm, crop plot, or even soil unit, respectively agrochemical plot [15], [3], [25], [62], [60].
The functionality of the natural ecosystems, the productivity and the performance of the agricultural ecosystems, are permanently studied in relation to the type of ecosystem (natural or anthropic), the level of technology, the factors of production, pedo climatic conditions, products specificity, the retail market etc. [8], [9], [50], [46], [42], [43], [45]. The facilities offered by "digitalization" are considered to have a very high potential for the optimization of agricultural production processes, technologies innovation, as management support decision in farm or environmental management [11]. Imaging analysis is increasingly present in studies, researches and evaluations of natural or agricultural ecosystems, as a result of the facilities and advantages it offers [67], [18], [19], [29], [23], [64].
In relation to the scale at which the analysis is performed, satellite images (Landsat, Sentinel 2, MODIS etc.), aerial images (utility aircraft,

UAV), or real-time terrestrial images taken with high resolution cameras, fixed on different agricultural machines are used [12], [54], [70], [65]. Spectral cameras have evolved a lot, so the captured images are at high resolutions and more and more accurately capture the realities at the plant level, agricultural crops, or natural ecosystems [36], [56], [71].
In relation to the objectives pursued, the digitization and image analysis addressed topics at foliar level [10], [53], at plant level and plant communities [40], [49], at agricultural field level [41], [58]. Digitization is very useful for the analysis and decision-making process in order to optimize the production process and can integrate and capitalize very efficiently various models and scenarios from experimental studies [51], [52].
Imaging analysis has found utility for floristic composition study, land classification and crop identification [24], [68], [39], plant health study [44], evaluation the plants response to stress factors [69], [32], [28], study of weed presence [63], [57], crop growth dynamics evaluation [17], chlorophyll content measure [6], [7], physiological processes evaluation [26], estimation of biomass production [5], [20], or the study of rural or urban anthropic areas [37], [38].
Diversity and spatial variability of the land and the vegetal cover are faithfully reflected in the variation of the specific indices, which capture and quantify the level of hetero-geneity of the studied area [59], [34], [2].
The present study used the imaging analysis based on the satellite images, for the analysis and characterization of a territory under the aspect of spatial variability in the area of Livezile-Dolat, Timis County, Romania.

MATERIALS AND METHODS

The aim of the study was to analyze and characterize the spatial variability of a territory, based on satellite images, in the Sentinel 2 satellite system, a territory that includes a complex, agricultural, anthropic and natural territory, in the context of a protected natural area, Fig. 1.

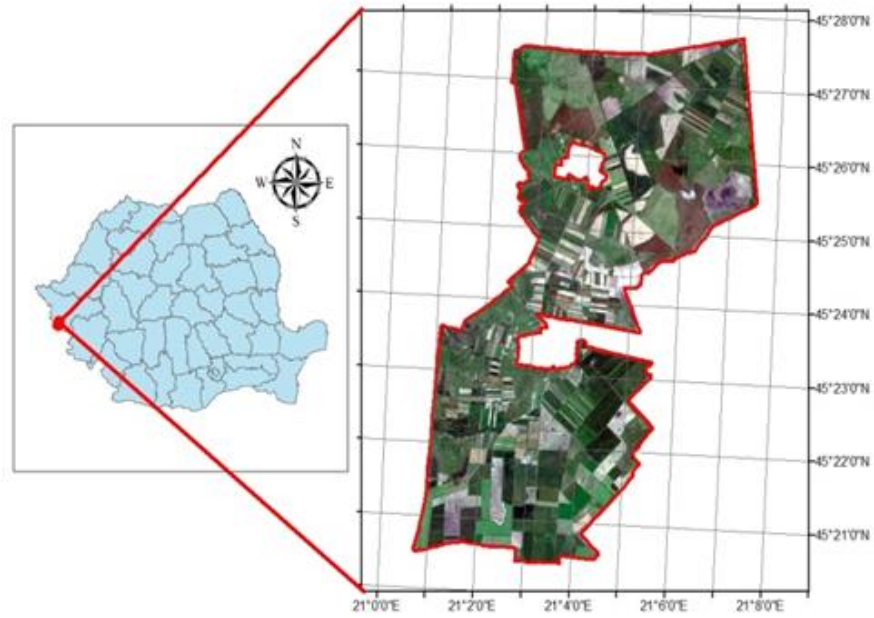

Fig. 1. Studied territory, Protected Natural Area Livezile-Dolat, Timis County, Romania
Source: original map, generated with ArcGIS based on Sentinel 2 spectral data package [55].

Study area is located in the South West part of Timiș County, Romania and is characterized by a high degree of complexity, given by agricultural, anthropic and natural areas within the Natural Protected Area Livezile-Dolat (Directive 2009/147/EC of the

European Parliament and of the Council of 30 November 2009 on the conservation of wild birds - Birds Directive, Category of Special Bird Protection Area, code ROSPA0126).

From an administrative point of view, the Livezile-Dolat studied area is included in the 5 West Development Region, entirely on the territory of Timiș County, respectively variable distributed on the territory of five territorial administrative units: Livezile (65%), Ghilad (26%), Banloc (9 %), respectively Giera (<1%). The total area of the Livezile-Donat area is 6,565.00 ha [35], Fig. 1.

In this study, the Sentinel 2 remote sensing system was used, more precisely a scene taken on the date of 27.05.2018. Sentinel 2 represents the European Earth Observation Space mission that debuted in 2015. Sentinel 2 satellites are positioned on a solar synchronous orbit at an altitude of 786 km and take images on 13 spectral bands, of which 5 in near infrared, at 10, 20 and 60 m spatial resolution, 10 days temporal resolution, and 12 bit radiometric resolution. The data format provided was jp2 and xml, and the footprint of the images is 290 x 290 km [55].

The experimental data in the form of spectral information in the Red, Green, Blue, NIR bands were initially analyzed and processed to determine specific indices (NDVI, SAVI, NBR, GLI, GNDVI, and CIgreen). An unsupervised classification of digital images and territory was made. The type of distribution of the values of the studied indices, descriptive statistical parameters, correlation level, coefficient of variation, and variance were analyzed.

ERDAS Ymage, and ArcGIS v.10.6 softwares was used for the analysis and processing of satellite images, and for the processing of experimental data, the PAST software [16] and STATISTICA were used.

RESULTS AND DISCUSSIONS

In the analysis of digital images, unsupervised classification implies the generation of pixel groups with specific geographical representation, but without knowing the reality that they classify. After the unsupervised classification obtained, the significance of the pixels in the analyzed digital image, expressed in the classes generated, is verified and confirmed with the reality in the field.

The unsupervised classification is based on mathematical algorithms such as ISODATA (Iterative Self Organizing Data Analysis) and K-Means, and in the present study the classification was made based on the ISODATA algorithm [4]. The ISODATA algorithm for images analysis and classification is based on determining the minimum spectral distance for cluster formation, based on the affinity of the spectral information.

The analysis and classification equation based on the spectral distances, is actually based on the equation used to determine the Euclidean distances, relation (1), [61], [33], [1].

$$SD_{xyc} = \sqrt{\sum_{i-1}^{n} (\mu_{ci} - X_{xyi})^2} \quad (1)$$

where: n - number of bands; i - band number; c - particular class; X_{xyi} - data file value of pixel x, y in band i; μ_{ci} - mean of data file values (digital numbers) in band i for the sample the class c; SD_{xyc} - spectral distance from pixels x, y to the mean of class c

Of the 13 spectral bands provided by Sentinel 2, in the present study for natural color imaging - RGB, spectral bands 4 (Red), 3 (Green) and 2 (Blue) were used, which have a spatial resolution of 10 m.

For false color image (NIR-Red-Green) spectral bands 8 (Nir), 4 (Red), and 3 (Green) were used. This image was subjected to an unsupervised classification, resulting in a number of 15 classes, with the configuration presented in table 1. The spatial distribution of the classes determined in the study area is presented in Fig. 2.

Based on the spectral bands 8 (NIR1), 8a (NIR5), 12 (SWIR2), 4 (RED), 3 (GREEN, and 2 (BLUE), 6 indices were calculated for the characterization of the studied area.

The Normalized Difference Vegetation Index

*(*NDVI) [47], [48], [66] was calculated based on relation (2).

$$NDVI = \frac{NIR - RED}{NIR + RED} = \frac{BAND8 - BAND4}{BAND8 + BAND4} \quad (2)$$

Table 1. The structure by classes and surfaces resulting from the unsupervised classification of the studied area (Protected Natural Area Livezile-Dolat, Timis County, Romania)

Class	Sum of Arias	Percent
1	213.33	3.25
2	406.75	6.20
3	316.41	4.83
4	425.56	6.49
5	261.84	3.99
6	406.94	6.21
7	500.98	7.64
8	557.36	8.50
9	730.11	11.13
10	287.34	4.38
11	794.57	12.12
12	451.18	6.88
13	661.04	10.08
14	420.13	6.41
15	123.66	1.89
Total	6,557.2	100

Source: original data, resulted by unsupervised classification of false color image generated by ArcGIS.

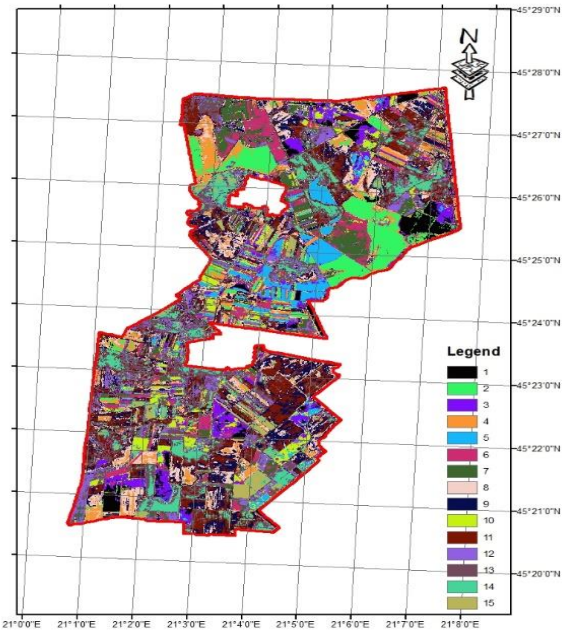

Fig. 2. Unsupervised classification of the studied area (Protected Natural Area Livezile-Dolat, Timis County, Romania)
Source: original map, generated based on false color image; Sentinel 2 spectral data package [55], ArcGIS software.

The range of variation of the NDVI values, and the corresponding surfaces, are presented in table 2. Based on the NDVI index, an area of 6,542.801 ha was covered, compared to the total area of 6,565.00 ha, which represents 99.66%. NDVI variation range, in relation to pixels number for studied area is presented in Fig. 3. The graphical representation of the NDVI index for the studied area, in the form of map, is presented in Fig. 4.

Table 2. Range of variation and related area in case of NDVI index for the studied area (Protected Natural Area Livezile-Dolat, Timis County, Romania)

Group	Range of variation	Area	%
1	-0.054886- 0.229541	314.7178	4.81
2	0.229541 – 0.306792	349.843	5.35
3	0.306792 – 0.384044	376.63	5.76
4	0.384044 – 0.457784	467.1389	7.14
5	0.457784 – 0.531524	585.3623	8.95
6	0.531524 – 0.605265	704.0567	10.76
7	0.605265 – 0.671982	1,015.168	15.51
8	0.671982 – 0.724653	1,366.179	20.88
9	0.724653 – 0.844042	1,363.706	20.84
Total		6,542.801	100.00

Source: original data, obtained by NDVI values analysis.

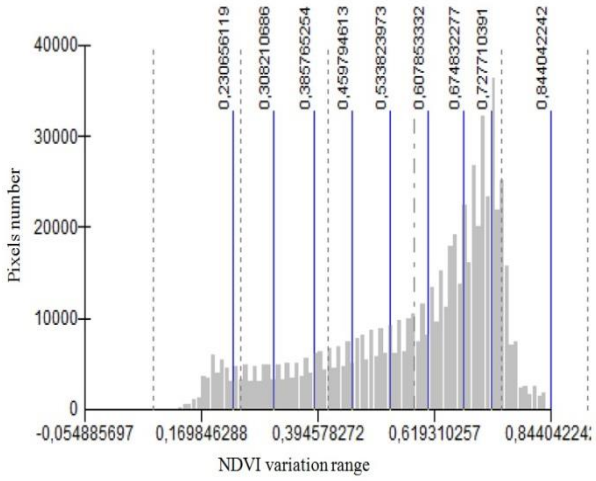

Fig. 3. NDVI variation range in relation to pixels number for studied area
Source: original graph, generated based on NDVI values, ArcGIS software.

The Normalized Burn Ratio index (NBR) was determined according to the relation (3), [27]. Graphical distribution of NBR index values for the studied area, in the form of map, is presented in Fig. 5.

$$NBR = \frac{NIR - SWIR}{NIR + SWIER} = \frac{BAND8a - BAND12}{BAND8a + BAND12} \quad (3)$$

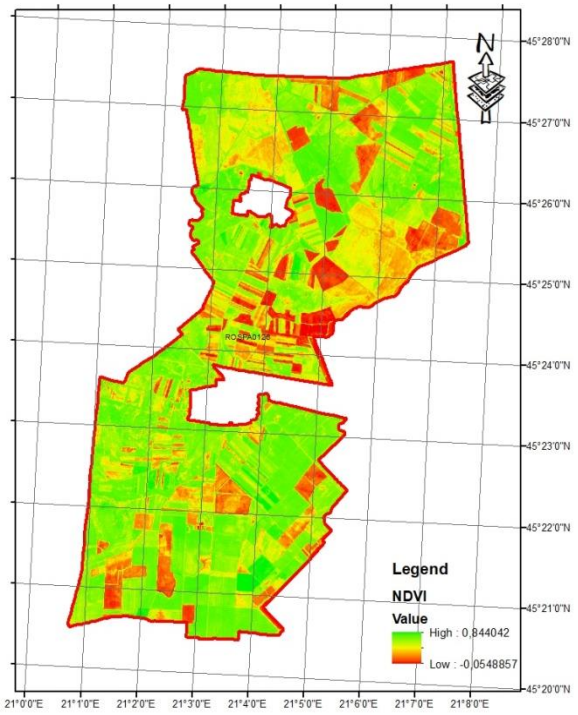

Fig. 4. Map with the spatial distribution of NDVI index values
Source: original map, generated based on NDVI values, ArcGIS software.

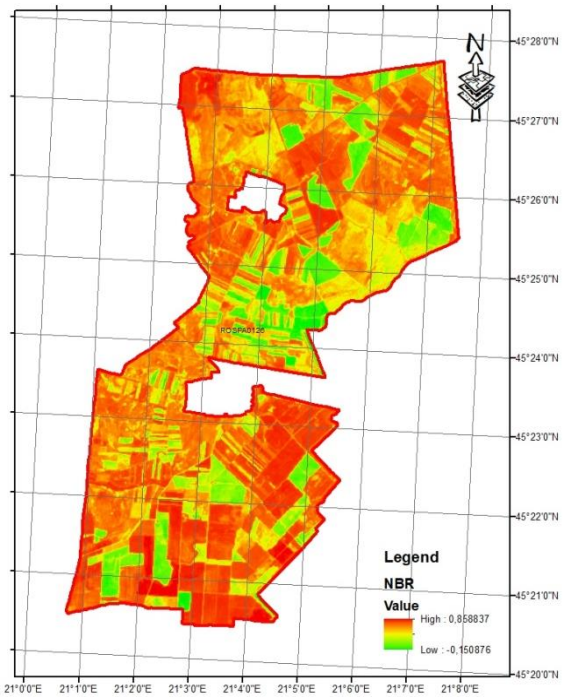

Fig. 5. Map with the spatial distribution of NBR index values
Source: original map, generated based on NBR values, ArcGIS software.

SAVI (Soil Adjusted Vegetation Index), relation (4), was proposed and developed as a modification of the vegetation index [21], with differences normalized in order to correct the influence of the soil luminosity in the conditions in which the vegetation land cover is low.

$$SAVI = \frac{NIR - RED}{NIR + RED + L}(1+L) = \frac{BAND\ 8 - BAND\ 4}{BAND\ 8 + BAND\ 4}(1+L) \quad ; \quad L = 0.5 \qquad (4)$$

The range of variation of the SAVI values and the corresponding surfaces are presented in table 3. SAVI variation range in relation to pixels number for studied area is presented in Fig. 6.

Table 3. The range of variation and the related area in the case of the SAVI index for the studied area

Group	Range of variation	Area	%
1	-0.082325 – 0.344284	315.31	4.81
2	0.344284 – 0.460152	350.23	5.34
3	0.460152 – 0.576021	377.76	5.76
4	0.576021 – 0.686623	468.19	7.14
5	0.686623 – 0.797226	586.54	8.95
6	0.797226 – 0.907828	706.21	10.77
7	0.907828 – 1.007896	1,017.4	15.52
8	1.007896 – 1.086898	1,368.92	20.88
9	1.086898 – 1.265968	1,364.65	20.82
Total		6,555.21	100

Source: original data, obtained by SAVI values analysis.

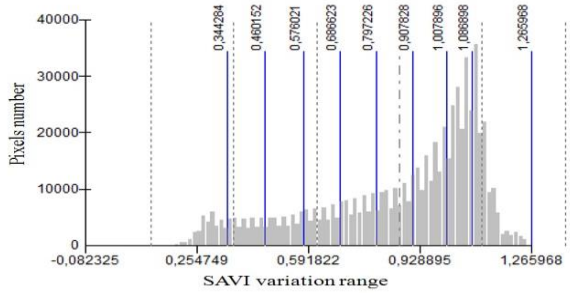

Fig. 6. SAVI variation range in relation to pixels number for studied area
Source: original graph, generated based on NBR values, ArcGIS software.

Based on the SAVI index, an area of 6,555.21 ha was covered, compared to the total area of 6,565.00 ha, which represents 99.81%. The numerical values and the graphical distribution of the SAVI index express with high accuracy the situation in the studied area, in a variation interval between -0.082325 and 1.265968. Graphical distribution of the SAVI index values for the studied area, in the form of map, is presented in Fig. 7.

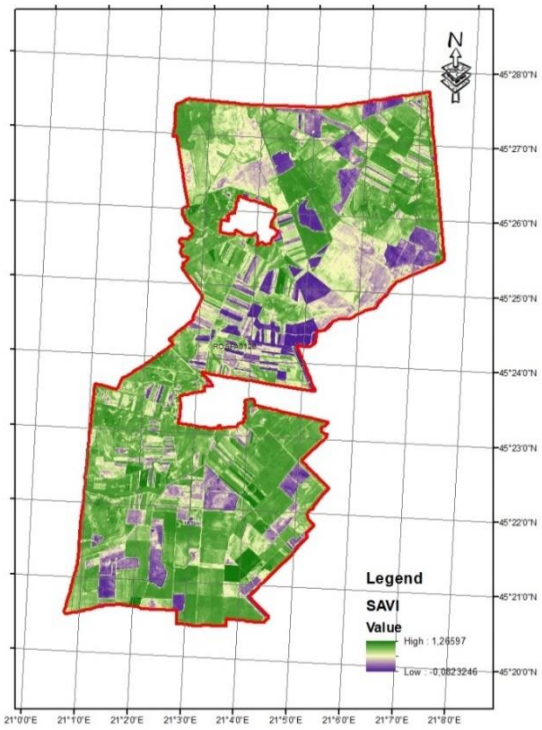

Fig. 7. Map with the spatial distribution of SAVI index values
Source: original map, generated based on SAVI values, ArcGIS software.

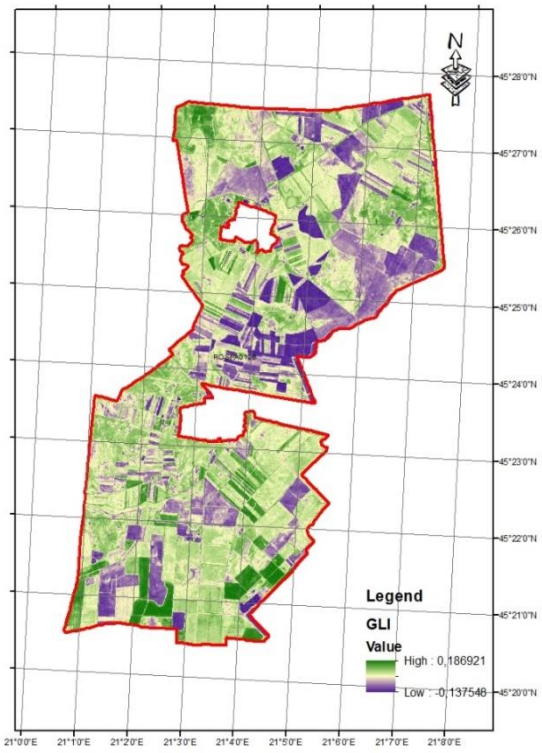

Fig. 8. Map with the spatial distribution of GLI index values
Source: original map, generated based on GLI index values, ArcGIS software.

Green Leaf Index (GLI), was determined based on the relation (5), [31], [22]. GLI values range from -1 to +1. The negative values represent the soil and the "non-living features" of the soil, while the positive values represent the leaves and the green stems. Graphical distribution of the GLI index values for the studied area, in the form of map, is presented in Fig. 8.

$$GLI = \frac{2 \cdot GREEN - RED - BLUE}{2 \cdot GREEN + RED + BLUE} = \frac{2 \cdot BAND\ 3 - BAND\ 4 - BAND\ 2}{2 \cdot BAND\ 3 + BAND\ 4 + BAND\ 2} \quad (5)$$

Green NDVI, relation (6), [13], [30], is similar to NDVI, except that it measures the green spectrum from 540 to 570 nm instead of the red spectrum. This index is more sensitive to chlorophyll concentration than NDVI.

$$GNDVI = \frac{NIR - GREEN}{NIR + GREEN} = \frac{BAND\ 8 - BAND\ 3}{BAND\ 8 + BAND\ 3} \quad (6)$$

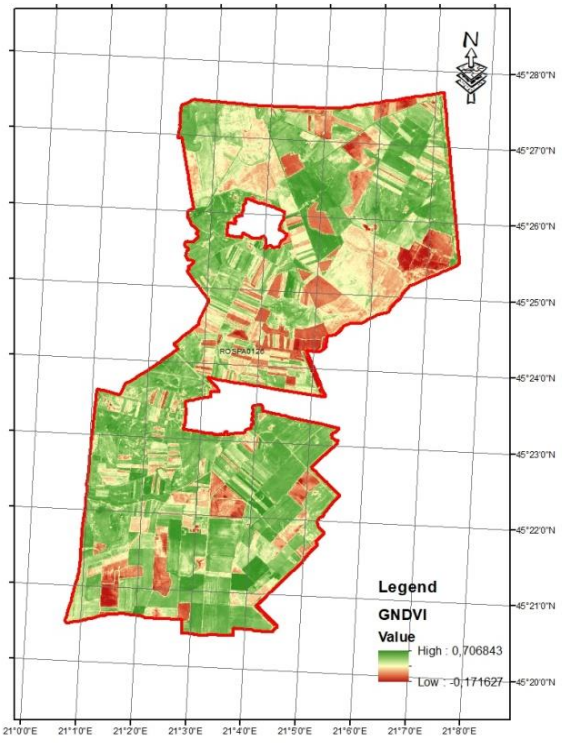

Fig. 9. Map with the spatial distribution of GNDVI index values
Source: original map, generated based on GNDVI index values, ArcGIS Software.

GNDVI uses the green band in the visible spectrum (instead of red as in the NDVI) and

the NIR band. The use of green band is useful for measuring photosynthesis rates and monitoring plant stress. The graphical distribution of the GNDVI index for the studied area, in the form of map, is presented in Fig. 9.

Chlorophyll index green (CIgreen), relation (7), [14], [22], was used to estimate the chlorophyll content of leaves, in a wide range of plant species.

$$CI\ green = \frac{NIR}{GREEN} - 1 = \frac{BAND\ 8}{BAND\ 3} - 1 \qquad (7)$$

The CIgreen marginal values are sensitive to small variations in chlorophyll content and are consistent with most species. The range of variation of CIgreen values and the corresponding area are presented in Table 4.

Table 4. The range of variation and the related area in the case of the CIgreen index for the studied area

Group	Values	Area (ha)	Percentage
1	-1	0.02	0.0003
2	0.99 - 0	805.2145	12.3066
3	0.001-1	2,023.497	30.9264
4	1.01-2	0.00	0.00
5	2.01-3	2,491.385	38.0774
6	3.01-4	1,222.839	18.6894
Total		6,542.955	100.00

Source: original data, resulted by CIgreen values analysis.

CIgreen variation range in relation to pixels number for studied area is presented in fig. 10. Based on the CIgreen index, an area of 6,542.955 ha was covered, compared to the total area of 6,565.00 ha, which represents 99.66%. Graphical distribution of the CIgreen index values for the studied area, in the form of map, is presented in Fig. 11.

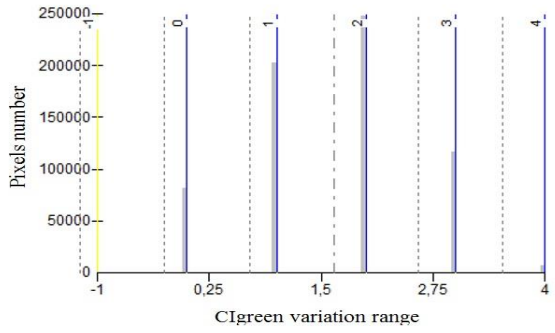

Fig. 10. CIgreen variation range in relation to pixels number

Source: original graph, generated based on CIgreen values, ArcGIS Software.

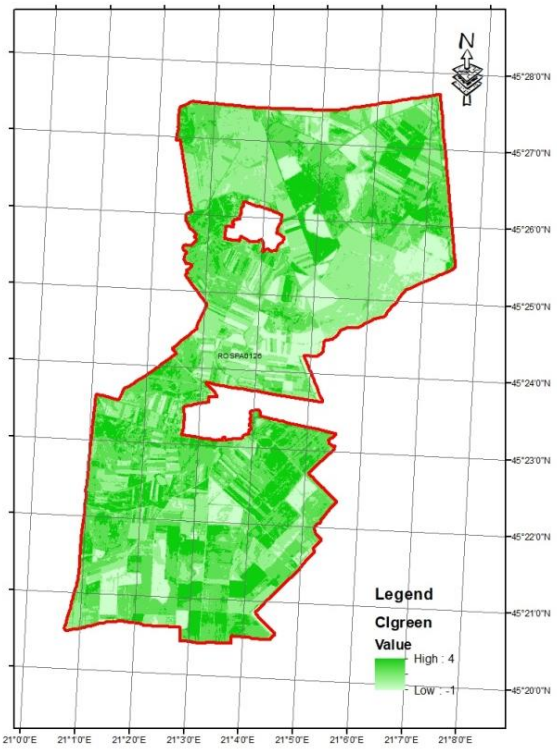

Fig. 11. Map with the spatial distribution of CIgreen index values

Source: original map, generated based on CIgreen index values, ArcGIS Software.

Descriptive statistical analysis of the experimental data set for the indices used in the analysis and classification of the studied area (a total number of 654,361 data), led to the values presented in Table 5. From the analysis of the respective data, a high variance of the CIgreen index was found, and the coefficient of variation highlighted the highest value of the GLI index. The correlation analysis led to the data in table 6, and showed the existence of very high positive correlations between most indices, high correlation between GLI and GNDVI, respectively a medium level correlation between GLI and CIgreen.

Table 5. Statistical parameters of the values of the studied indices

	NDVI	SAVI	CIgreen	GNDVI	GLI
N	654,361	654,361	654,361	654,361	654,361
Min	-0.05489	-0.08232	-1	-0.17163	-0.13755
Max	0.844042	1.26597	4	0.706843	0.186921
Mean	0.581945	0.872804	1.641178	0.493111	0.054374
Std. error	0.000207	0.00031	0.001168	0.000145	5.40E-05
Variance	0.028027	0.063048	0.892885	0.013837	0.001912
Coeff. var	28.76762	28.76861	57.57606	23.85455	80.40968

Source: original data, resulted from studied indices analysis.

Table 6. Correlation table between the values of the studied indices

	NDVI	SAVI	Cigreen	GNDVI	GLI
NDVI					
SAVI	0.999				
Cigreen	0.907	0.907			
GNDVI	0.982	0.982	0.933		
GLI	0.903	0.903	0.771	0.847	

Source: original data, resulted from studied indices analysis.

CONCLUSIONS

The unsupervised classification, based on the ISODATA algorithm, of a false color image (NIR-Red-Green), spectral bands 8 (Nir), 4 (Red), and 3 (Green) resulted in 15 classes representing 6,557.2 ha from study area. Calculated indices (NDVI, SAVI, NBR, GLI, GNDVI, CIgreen) based on spectral data, bands 8 (NIR1), 8a (NIR5), 12 (SWIR2) and 4 (RED), 3 (GREEN), 2 (BLUE) facilitated characterization of the territory, and they have faithfully surprised the spatial variability of the studied area. A high degree of spatial variability was found in the set of GLI index values (CV_{GLI} = 80.40968) and the lowest spatial variability in the GNDVI index data set (CV_{GNDVI} = 23.85455).

ACKNOWLEDGMENTS

The authors thanks to the GEOMATICS Research Laboratory, BUASMV "King Michael I of Romania" from Timisoara, for the facility of the software use for this study.

REFERENCES

[1]Abbas, A.W., Minallh, N., Ahmad, N., Abid, S.A.R., Khan, M.A.A., 2016, K-Means and ISODATA clustering algorithms for landcover classification using remote sensing, Sindh Univ. Res. Jour. (Sci. Ser.), 48(2):315-318.
[2]Ali, A., Martelli, R., Lupia, F., Barbanti, L., 2019, Assessing multiple years' spatial variability of crop yields using satellite vegetation indices, Remote Sens., 11(20):2384.
[3]Antle, J.M., Jones, J.W., Rosenzweig, C., 2017, Next generation agricultural system models and knowledge products: Synthesis and strategy, Agric. Syst., 155:179-185.
[4]Ball, H.G., Hall, D.J., 1965, ISODATA, a novel method of data analysis and pattern classification, Stanford Research Institute Menlo Park, California, Technical Report April 1965, for Information Sciences ranch Office of Naval Research Contract Nonr 4918(00) SRI Project 5533.
[5]Bendig, J., Bolten, A., Bennertz, S., Broscheit, J., Eichfuss, S., Bareth, G., 2014, Estimating biomass of barley using crop surface models (CSMs) derived from UAV-based RGB imaging, Remote Sens., 6(2014): 10395-10412.
[6]Carmona, F., Rivas, R., Fonnegra, D.C., 2015, Vegetation Index to estimate chlorophyll content from multispectral remote sensing data, Eur. J. Remote Sens., 48:319-326.
[7]Croft, H., Arabian, J., Chen, J.M., Shang, J., Liu, J., 2019, Mapping within-field leaf chlorophyll content in agricultural crops for nitrogen management using Landsat-8 imagery, Precis. Agric., 2019:1-25.
[8]Dobrei, A., Poiana, M.A., Sala, F., Ghita, A., Gergen, I., 2010, Changes in the chromatic properties of red vines from *Vitis vinifera* L. cv. Merlot and Pinot Noir during the course of aging in bottle, J. Food, Agri. Environ., 8(2): 20-24.
[9]Dobrei, A., Dobrei, A.G., Nistor, E., Iordanescu, O.A., Sala, F., 2015, Local grapevine germplasm from Western of Romania - An alternative to climate change and source of typicity and authenticity, Agric. Agric. Sci. Procedia, 6:124-131.
[10]Drienovsky, R., Nicolin, A.L., Rujescu, C., Sala, F., 2017, Scan LeafArea – A software application used in the determination of the foliar surface of plants, Res. J. Agric. Sci., 49(4):215-224.
[11]Fielke, S., Taylor, B., Jakku, E., 2020, Digitalisation of agricultural knowledge and advice networks: A state-of-the-art review, Agric. Syst., 180:102763.
[12]Fonji, S.F., Taff, G.N., 2014, Using satellite data to monitor land-use land-cover change in North-eastern Latvia. SpringerPlus, 3:61.
[13]Gitelson, A., Kaufman, Y., Merzlyak, M., 1996, Use of a green channel in remote sensing of global vegetation from EOS-MODIS, Remote Sens. Environ., 58(3):289-298.
[14]Gitelson, A.A., Viña, A., Arkebauer, T.J., Rundquist, D., Keydan, G., Leavitt, B., 2003, Remote estimation of leaf area index and green leaf biomass in maize canopies, Geophys. Res. Lett., 30(5):52-1-52-4.
[15]Govedarica, M., Ristic, A., Herbei M.V., Sala, F., 2015, Object oriented image analysis in remote sensing of forest and vineyard areas, BulletinUASVM Horticulture 72(2):362-370.
[16]Hammer, Ø., Harper, D.A.T., Ryan, P.D., 2001, PAST: Paleontological statistics software package for education and data analysis, Palaeontol. Electron., 4(1):1-9.
[17]Herbei, M.V., Sala, F., 2015, Use Landsat image to evaluate vegetation stage in sunflower crops. AgroLife Sci. J., 4(1):79-86.
[18]Herbei, M., Sala, F., Boldea, M., 2015a, Relation of Normalized Difference Vegetation Index with some spectral bands of satellite images. AIP Conf. Proc.,

1648:670003-1 – 670003-4.
[19]Herbei, M., Sala, F., Boldea, M., 2015b, Using mathematical algorithms for classification of Landsat 8 satellite images. AIP Conf. Proc., 1648:670004-1 – 670004-4.
[20]Herbei, M., Sala, F., 2016, Biomass prediction model in maize based on satellite images. AIP Conf. Proc., 1738:350009-1 – 350009-4.
[21]Huete, A.R., 1988, A Soil-Adjusted Vegetation Index (SAVI), Remote Sens. Environ., 25(3):295-309.
[22]Hunt, E.R., Daughtry, C.S.T., Eitel, J.U.H., Long, D.S., 2011, Remote sensing leaf chlorophyll content using a visible band index, Agron. J., 103(4):1090-1099.
[23]Iagăru, P., Pavel, P., Iagăru, R., 2019, Implementation of the concept agriculture of precision a way to improve the management of agricultural enterprises, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(1): 229-234.
[24]Kalaba, F.K., Quinn, C.H., Dougill, A.J., Vinya, R., 2013, Floristic composition, species diversity and carbon storage in charcoal and agriculture fallows and management implications in Miombo woodlands of Zambia, For. Ecol. Manag., 304:99-109.
[25]Kalaugher, E., Beukes, P., Bornman, J.F., Clark, A., Campbell, D.I., 2017, Modelling farm-level adaptation of temperate, pasture-based dairy farms to climate change. Agric. Syst., 153:53-68.
[26]Kasampalis, D.A., Alexandridis, T.K., Deva, C., Challinor, A., Moshou, D., Zalidis, G., 2018, Contribution of remote sensing on crop models: A review. J. Imaging, 4:52.
[27]Key, C.H., Benson, N., Ohlen, D., Howard, S., McKinley, R., Zhu Z., 2002, The normalized burn ratio and relationships to burn severity: ecology, remote sensing and implementation, Proceedings of the Ninth Forest Service Remote Sensing Applications Conference. American Society for Photogrammetry and Remote Sensing, Bethesda, MD, J.D. Greer, ed. Rapid Delivery of Remote Sensing Products.
[28]Khanna, R., Schmid, L., Walter, A., Nieto, J., Siegwart, R., Liebisch, F., 2019, A spatio temporal spectral framework for plant stress phenotyping, Plant Methods, 15:13.
[29]Knickel, K., Maréchal, A., 2018, Stimulating the social and environmental benefits of agriculture and forestry: An EU-based comparative analysis, Land Use Policy, 73:320-330.
[30]Le Maire, G., François, C., Dufrêne, E., 2004, Towards universal broad leaf chlorophyll indices using PROSPECT simulated database and hyperspectral reflectance measurements. Remote Sens. Environ. 89(1):1-28
[31]Louhaichi, M., Borman, M., Johnson, D., 2001, Spatially located platform and aerial photography for documentation of grazing impacts on wheat. Geocarto Int., 16(1):65-70.
[32]Lowe, A., Harrison, N., French, A.P., 2017, Hyperspectral image analysis techniques for the detection and classification of the early onset of plant disease and stress, Plant Methods, 13:80.
[33]Melesse, A.M., Jordan, J.D., 2002, A comparison of Fuzzi vs. Augmented-ISODATA classification algorithms for cloud-shadow discrimination from Landsat images, Photogramm. Eng. Rem. S., 68(9):905-911.
[34]Militino, A.F., Ugarte, M.D., Pérez-Goya, U., 2018, An introduction to the spatio-temporal analysis of satellite remote sensing data for geostatisticians. In: Daya Sagar B., Cheng Q., Agterberg F. (eds) Handbook of Mathematical Geosciences. Springer, Cham., 239-253.
[35]M.M.A.P., 2016, Regulation of June 28, 2016 on Natura 2000 site ROSPA0126 Livezile-Dolaţ, Official Monitor 805 bis (Regulamentul din 28 iunie 2016 sitului Natura 2000 ROSPA0126 Livezile-Dolaţ, Monitorul Oficial 805 bis), 12.10.2016.
[36]Murillo-García, F.G., Alcántara-Ayala, I., Ardizzone, F., Cardinali, M., Fiourucci, F., Guzzetti, F., 2015, Satellite stereoscopic pair images of very high resolution: A step forward for the development of landslide inventories, Landslides, 12:277-291.
[37]Oncia, S., Herbei, M., Popescu, C. 2013a, Study of territorial and infrastructure development in the Petrosani city - The Hunedoara county using GIS elements, J. Environ. Prot. Ecol., 14(1):225-232.
[38]Oncia, S., Herbei, M., Popescu, C., 2013b, Sustainable development of the Petrosani City, the Hunedoara County based on GIS analysis, J. Environ. Prot. Ecol., 14(3):232-240.
[39]Pande, C.B., Moharir, K.N., Khadri, S.F.R., Patil, S., 2018, Study of land use classification in an arid region using multispectral satellite images. Appl. Water Sci., 8:123.
[40]Paz-Kagan, T., Silver, M., Panov, N., Karnieli, A., 2019, Multispectral approach for identifying invasive plant species based on flowering phenology characteristics. Remote Sens., 11:593.
[41]Peralta, N.R., Assefa, Y., Du, J., Barden, C.J., Ciampitti, I.A., 2016, Mid-season high-resolution satellite imagery for forecasting site-specific corn yield, Remote Sens., 8:848.
[42]Popescu, A., 2018, Maize and wheat - top agricultural products produced, exported and imported by Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18(3):339-352.
[43]Popescu, A., Dinu, T.A., Stoian, E., 2018, Sorghum - an important cereal in the world, in the European Union and Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18(4):271-284.
[44]Prakash, K., Saravanamoothi, P., Sathishkumar, R., Parimala, M., 2017, A study of image processing in agriculture, Int. J. Adv. Netw. Appl., 9(1):3311-3315.
[45]Prăvălie, R., Sîrodoev, I., Patriche, C., Roșca, B., Piticar, A., Bandoc, G., Sfîcă, L., Tișcovschi, A., Dumitrașcu, M., Chifiriuc, C., Mănoiu, V., Iordache, Ș., 2020, The impact of climate change on agricultural productivity in Romania. A country-scale assessment based on the relationship between climatic water

balance and maize yields in recent decades, Agric. Syst., 179:102727.
[46]Rawashdeh, H.M., Sala, F., 2016, Effect of iron and boron foliar fertilization on yield and yield components of wheat, Rom. Agric. Res., 33:241-249.
[47]Rouse, J.W.Jr., Haas, R.H., Schell, J.A., Deering, D.W., 1973a, Monitoring the vernal advancement and retrogradation (green wave effect) of natural vegetation. Prog. Rep. RSC 1978-2, Remote Sensing Center, Texas A&M Univ., College Station, 93p. (NTIS No. E73-106393).
[48]Rouse, J.W., Haas, R.H., Schell, J.A., Deering, D.W., 1973b, Monitoring vegetation systems in the Great Plains with ERTS, Third ERTS Symposium, NASA SP-351 I:309-317.
[49]Runnström, M.C., Ólafsdóttir, R., Blanke, J., Berlin, B., 2019, Image analysis to monitor experimental trampling and vegetation recovery in icelandic plant communities, Environ., 6(9):99.
[50]Sala, F., Boldea, M., 2011, On the optimization of the doses of chemical fertilizers for crops, AIP Conf. Proc., 1389:1297-1300.
[51]Sala F., Boldea, M., Rawashdeh, H., Nemet, I., 2015, Mathematical model for determining the optimal doses of mineral fertilizers for wheat crops, Pak. J. Agric. Sci., 52(3):609-617.
[52]Sala, F., Rujescu, C., Constantinescu, C., 2016, Causes and solutions for the remediation of the poor allocation of P and K to wheat crops in Romania, AgroLife Sci. J., 5(1):184-193.
[53]Sala, F., Iordănescu, O., Dobrei, A., 2017, Fractal analysis as a tool for pomology studies: Case study in apple, AgroLife Sci. J., 7(2):224-233.
[54]Scheffield, K., Morse-McNabb, E., 2014, Using satellite imagery to asses trends in soil and crop productivity across landscapes. IOP Conf. Series: Earth Environ. Sci. 25(2015):012013.
[55]Sentinel-2 Missions, Sentinel online, ESA Sentinel, https://sentinel.esa.int/web/sentinel/missions/ sentinel-2, Accessed on Sept.20, 2019.
[56]Shamshiri, R.R., Weltzien, C., Hameed, I.A., Yule, I.J., Grift, T.E., Balasundram, S.K., Pitonakova, L., Ahmad, D., Chrowdhary, G., 2018, Research and development in agricultural robotics: A perspective of digital farming, Int. J. Agric. Biol. Eng., 11(4):1-14.
[57]Shaw, D.R., 2005, Remote sensing and site-specific weed management, Front. Ecol. Environ., 3(10):526-532.
[58]Sicre, C.M., Fieuzal, R., Baup, F., 2020, Contribution of multispectral (optical and radar) satellite images to the classification of agricultural surfaces. Int. J. Appl. Earth Obs. Geoinf., 84:101972.
[59]Silveira, E.M.O., Mello, J.M., Júnior, F.W.A., Reis, A.A., Withey K.D., Ruiz, L.A., 2017. Characterizing landscape spatial heterogeneity using semivariogram parameters derived from NDVI images, Cerne, 23(4):413-422.
[60]Stupen, N., Stupen, M., Stupen, O., 2018, Electronic agricultural maps formation on the basis of GIS and earth remote sensing, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18(4):347-352.
[61]Swain, P.H., Davis, S.M., 1978, Remote Sensing: The Quantitative Approach, McGraw Hill Book Company, New York, N.Y., 396 pp.
[62]Therond, O., Duru, M., Roger-Estrade, J., Richard, G., 2017, A new analytical framework of farming system and agriculture model diversities. A review, Agron. Sustain. Dev. 37:21.
[63]Thorp, K.R., Tian, L.F., 2004, A review on remote sensing of weeds in agriculture, Precis. Agric., 5(5):477-508.
[64]Tian, H., Wang, T., Liu, Y., Qiao, X., Li, Y., 2019, Computer vision technology in agricultural automation - A review. Inform. Process. Agric., in press.
[65]Todorova, L., Tcacenco, A., 2019, Study regarding peculiarities of introducing and developing effective digital technologies in the agrifood sector. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(4):341-344.
[66]Tucker, C.J., 1979, Red and photographic infrared linear combinations for monitoring vegetation, Remote Sens. Environ., 8(2):127-150.
[67]Vibhute, A., Bodhe, S.K., 2012, Applications of image processing in agriculture: A survey. Int. J. Comput. Appl., 52(2):34-40.
[68]Vorobiova, N.S., 2016, Crops identification by using satellite images and algorithm for calculating estimates. CEUR Workshop Proc., 1638:419-427.
[69]Wang, R., Cherkauer, K., Bowling, L., 2016, Corn response to climate stress detected with satellite-based NDVI time series, Remote Sens., 8:269.
[70]Wolfert, S., Ge, L., Verdouw, C., Bogaardt, M.-J., 2017, Big data in smart farming - A review. Agric. Syst. 153:69-80.
[71]Yang, C., 2018, High resolution satellite imaging sensors for precision agriculture, Front. Agric. Sci. Eng., 5(4):393-405.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

SUPPORTING THE SOYBEAN PRODUCTION AND PROCESSING SECTOR IN THE CONTEXT OF CONCERN FOR SUSTAINABLE DEVELOPMENT

Veronica PRISACARU, Tatiana SEVCIUC

Moldova State University, 60 Alexe Mateevici str., MD-2009, Chisinau, Republic of Moldova, Phone: mobile +373 69297575, Emails: veronica.prisacaru@usm.md, sevciuctatiana@mail.ru

Corresponding author: veronica.prisacaru@usm.md

Abstract

This investigation is focused on the following objectives: a) synthesizing the theoretical approaches of soybean cultivation, elucidating the multiple economic and ecologic benefits of the soybeans; b) analyzing the trends of the soybean production and consumption in the world and, distinctly, in the Republic of Moldova, elucidating the related problems and possible solutions. In order to achieve the stated objectives, the following research methods were used: the synthesis of theoretical approaches to the subject; analysis of the indicators that reveal soybean production and consumption trends; generalization of the problems related to soybean cultivation and consumption in the world and in the Republic of Moldova; synthesis of strategic provisions regarding the soybean sector in the world and, distinctly, in the in the EU and the Republic of Moldova; formulation of conclusions and proposals regarding the necessary measures to be taken to facilitate the achievement of the proposed strategic objectives. The authors' proposals concern a number of legal and organizational aspects needed to be improved in the Republic of Moldova in order to facilitate the development and increase the performance of the soybean production and processing sector.

Key words**:** *environmental problems, soybean production, sustainable development, Republic of Moldova*

INTRODUCTION

Originally from East Asia, soybeans have been grown for over 3000 years. Currently, over 3,500 varieties of soybean are used throughout the world.

Soybean was imported into Europe over 150 years ago. It is considered that Professor Friedrich Haberlandt, director of the University of Natural Resources and Life Sciences in Vienna, was the one who, during the Austro-Hungarian Empire, initiated the first extensive studies on soybean cultivation in Europe. At the 1873 Vienna World Fair, Haberlandt presented a variety of soybean suitable for cultivation in Central Europe. Starting with 1875, Haberlandt carried out experimental research on the soybean in parallel with the work on his famous book "Die Sojabohne - Ergebnisse der Studie und Versuche new field culture deserves to be cultivated." Haberland`s work, considered a masterpiece, was published in 1878. Although in Europe the interest in growing the soybean disappeared with Haberlandt`s death, in the United States the research initiated by him continued and led to an impressive expansion of soybean plantations [14].

The significance of the soybean, the need to pay particular attention to the respective culture is argued by its following benefits:

- soybean represents food and feed crop of undoubted value due to the high content of protein substances, this being 38.5%, while other similar crops such as peas and beans, respectively, have a protein content of 27.8 and 24.6% [24]. Soy proteins contain all the essential amino acids. In the composition of the seeds and the green soybean mass there are also carbohydrates, mineral salts, vitamins, ferments and other substances. Soybean hay and flour have a high nutritional value: one kg of soybean hay contains 1.51 g of nutrients, 96g of protein, 15.6g of calcium, 2.2g of phosphorus and over 50g of carotene. Soybean albumin is characterized by a high degree of dissolution in water, which simplifies its use in the food and technical industry [5];

- due to the successful combination of precious chemicals, soybean is widely used as a raw material in the cosmetics, chemical and pharmaceutical industries [14];
- soybean has an essential contribution to increasing soil fertility. Thus, as a result of the symbiotic activity, soil accumulates about 108-120 kg/ha of biological nitrogen, the contribution of the beans being 78-80 kg/ha and of the peas - 48-50 kg/ha [3, 7, 23].

The multiple benefits of the soybean along with other legumes led the UNO to declare 2016 the International Year of Pulses [25].

MATERIALS AND METHODS

The objectives of this investigation have been achieved using the following methods: the synthesis of theoretical approaches to the subject; analysis of the statistic indicators revealing the evolution of soybean production and consumption; generalization of the problems related to soybean cultivation and consumption in the world and in the Republic of Moldova; synthesis of strategic provisions regarding the soybean sector in the world and, distinctly, in the EU and the Republic of Moldova; formulation of conclusions and of proposals regarding he necessary measures to be taken to facilitate the achievement of the proposed strategic objectives.

The research was carried out within the EU project "Increasing the competitiveness of the agri-food sector by integrating it into the internal and global value chains, especially the soybean crop sector". To achieve the established objectives, the available statistical data on the evolution of the sector were used, as well as a series of strategic documents and analytical studies.

RESULTS AND DISCUSSIONS

Today, worldwide, soybean plantations occupy more than 50% of the areas cultivated with oilseeds, which constitutes about 6% of agricultural land [14].

According to official data, in 2018 global soybean production worldwide accounted for over 360 million tonnes [17]. Thus, in comparison with the year 1960 when about 17 million tonnes were obtained annually [14], we find that for 6 decades the volume of production increased 21 times. By 2030 it is expected to increase soybean production by a further 28% and reach a level of approximately 434 million tonnes, and by 2050, according to the FAO forecast, annual soybean production will amount to around 515 million tonnes [15].

Almost 80% of the total quantity of soybean produced worldwide is provided by 3 countries: the USA, Brazil and Argentina. The contribution of different countries to the production of the soybean is shown in Figure 1.

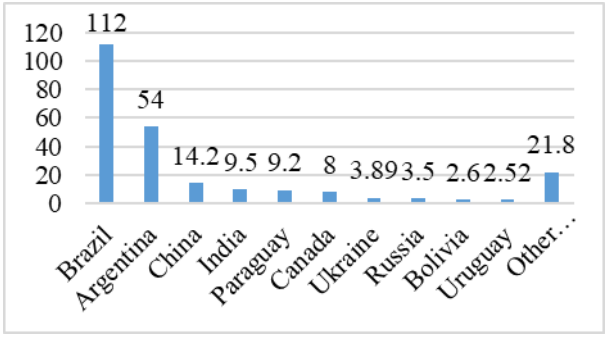

Fig. 1. The contribution of different countries in the production of the soybean in 2018, thousand tonnes
Source: Elaborated by authors based on [17].

The largest soybean user in the world is China, followed by the US, while the EU ranks third. The data on the consumption of soybean by country are shown in Figure 2.

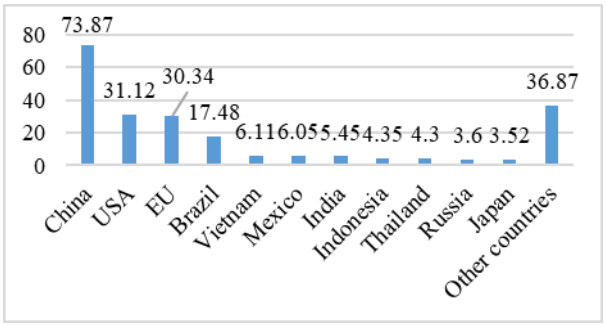

Fig. 2. Soybean consumption by countries in 2018, thousand tonnes
Source: Elaborated by authors based on [17].

The expansion of soybean production has caused many problems. Thus, the extension of the areas cultivated with soybean to millions of hectares, especially in countries such as

Brazil, Argentina and Paraguay, has led to the loss of considerable resources of forests, savanna and grasslands, to the destruction of communities, biodiversity and ecosystems, making a detrimental contribution on climate change. Today soybean plantations continue to endanger the primary and tropical forests of Amazonia, the Atlantic Forest and the Dry Forest of Chiquitano, the tropical savanna of Cerrado, etc. [23].

Genetically modified soybean requires large quantities of herbicides, thus affecting the quality of soil, surface water and groundwater. Implicitly, human and animal health problems are generated. The environmental problems were not the only ones that were caused by the extension of the cultivated areas with soybean. There were also major problems of human rights violations through forced land acquisition and even the murder of a large number of small farmers [2]. As a result, soybean production and trade, as well as related issues of the environment, indigenous peoples and rural workers have become an important element of political discourse in South America [13].

In EU countries, soybean provides 40% of the plant protein used in animal feed. However, 95% of the required quantity of soy is imported by them. In 2013-2015 the EU imported on average 36.1 million tonnes per year: 12.7 million tonnes for the production of soybean oil and flour and 18.5 million tonnes of soybean meal (the equivalent of 23.4 million tonnes of grain soybean). About 95% of the soy import is intended for animal feed. On the other hand, the EU represents one of the largest consumers of meat, with an annual consumption per capita of 68.6 kg (according to data of 2017). By 2030, it is expected to produce 47.5 million tonnes of meat per year, which will also involve increasing the amount of the soy required for animal feed. Under these conditions, the European Union's concern for stimulating the production of plant proteins is natural, determined both by increasing demand for the product and by such important circumstances, as the poor quality of imported soybean (most of which is produced from genetically modified seeds) as well as the adverse impact on the environment [15]. An important step in solving this problem is the European Soya Declaration signing by 14 countries in December 2017 [4]. The objective of increasing the production of leguminous crops for food and feed is examined in the context of concern for sustainable agriculture. At the same time, it is mentioned that, by focusing attention on supporting the growth of soybeans and other legumes, it will contribute to the achievement of two important objectives of the 2030 Agenda for Sustainable Development [22], namely: objective 2 "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" and objective 15 "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss".

The relevance of the concern for stimulating the production of soybean and other legumes is also argued for by contributing to the objective of the EU Sustainable Development Strategy adopted in 2001, which aims at increasing prosperity, improving the quality of life now and for future generations and capitalizing on the innovative potential of the economy in the environmental and social field.

The signatories of the declaration highlighted the following elements in supporting the stated objectives:

- developing sustainable production of soybean and other legumes in appropriate areas of Europe, taking into account the availability of resources;
- integrating the production of soybean and other legumes into well-planned crops rotations;
- ensuring the integrated protection of crops following the principle "as much as necessary and as little as possible", giving priority to the use of resistance of host plants and tolerant varieties;
- maintenance of traditional landscapes, landscape features and protection of biotopes with high natural value in agricultural landscapes;

- developing sustainable markets for soybean and other legumes in Europe that balance and respond to the needs of growers, processors, livestock breeders and consumers within the transparent value chains [4].

The actions taken by EU countries have led to the pattern of continuous growth trends in soybean production. Thus, according to the data of the European Commission [6], starting with 2012 the annual global production of soybean has been rising (Figure 3), noting a high growth rate especially in the period 2012-2014 (Figure 4). Even though the growth rate of annual global soybean production in the European Community slowed down after 2014, it is important that the volume of production continued to increase, which proves the effectiveness of the measures taken to support the production of soybean.

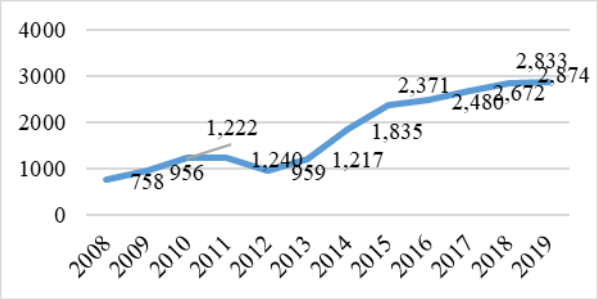

Fig.3. Evolution of soybean production in the EU between 2008-2019, million tonnes
Source: Elaborated by authors based on [6].

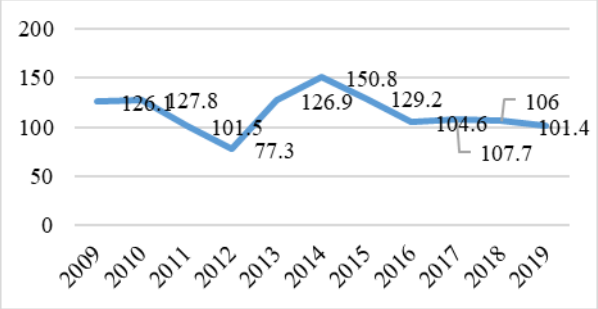

Fig.4. The growth rate of soybean production in EU countries between 2009-2019, %
Source: elaborated by authors based on [6].

At European level, the largest quantity of soy is produced in such countries as Ukraine, Russia, Italy and Serbia, followed by Romania, France, Hungary and Austria [14].

The Republic of Moldova is listed among the states that have adhered to the 2030 Agenda for Sustainable Development, assuming responsibility for the established sustainable development objectives [12]. At the same time, the data on the total areas cultivated with soybeans in the Republic of Moldova in the period 2008-2018 denote the absence of constant trends in their evolution (Figure 5). The largest area cultivated with soy in the analyzed period was recorded in 2015, but subsequently, it was reduced continuously, registering a level of only 28 thousand ha in 2018.

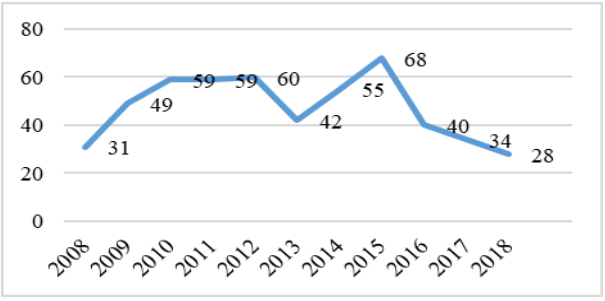

Fig.5. Evolution of the total area cultivated with soybean in the Republic of Moldova in the period 2008-2018, thousand ha
Source: Elaborated by authors based on [11].

The studies of the cultivation of the soybean in territorial profile indicate that most of the areas are located in the North region of the country, especially in Briceni, Edineț and Drochia districts. According to the data of 2017, 97% of the soybean plantations were concentrated in the respective area [16].

While soybean plantations were reduced during the investigated period, crop productivity had less alarming trends, the highest level of the indicator (21q/ha) being reached in 2014 and 2018 (Figure 6).

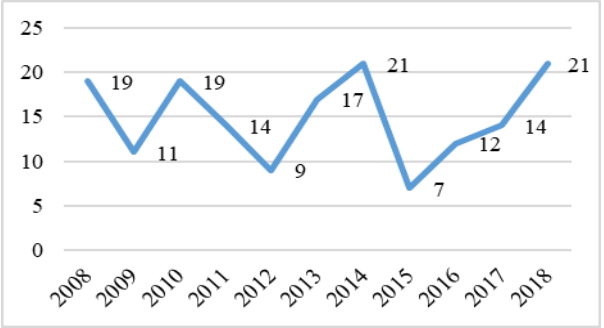

Fig. 6. Evolution of the average productivity of the soybean in the Republic of Moldova in the period 2008-2018, q/ha
Source: Elaborated by authors based on [11].

Even though the areas cultivated with soybean have reduced, increasing the productivity of the crop has ensured an increase of the global soybean production during the last 3 analyzed years (2016-2018, Figure 7). However, the level reached by the indicator in 2018 of 58 thousand tonnes is below the level of 2010, when the Republic of Moldova had a global harvest of 111 thousand tonnes of soy. An almost similar performance was obtained in 2014, 109 thousand tonnes of soy being produced. Thus we find that the volume of soybean production obtained in 2018 is 1.91 times lower than in 2010 and 1.87 times lower than in 2014.

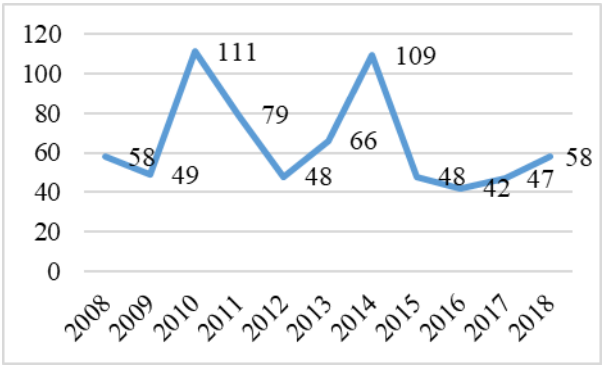

Fig. 7. Evolution of the global soybean harvest in the Republic of Moldova in the period 2008-2018, thousand tonnes
Source: Elaborated by authors based on [11].

The data related to export of soybean also show unstable trends. In the last decade, the largest quantity of exported soybean was registered in 2015 (69 thousand tonnes). Subsequently, there is a continuous decline in soybean exports. In 2018, 12.8 thousand tonnes were exported in the amount of $5.2 million [16], which is 56.2 thousand tonnes less than in 2015.

The processing of soybean in the Republic of Moldova is carried out by producing vegetable oil and soybean meal. Because of a whole series of technological and financial difficulties, in the Republic of Moldova the mechanical processing method is applied, based on the partial pressing of the oil through the screw press [16], while the chemical method is more efficient.

Estimating the evolution of soybean meal production, we also see fluctuating trends (Figure 8). At the same time, we can positively estimate the level reached in 2018, being higher than the indicators of previous examined years.

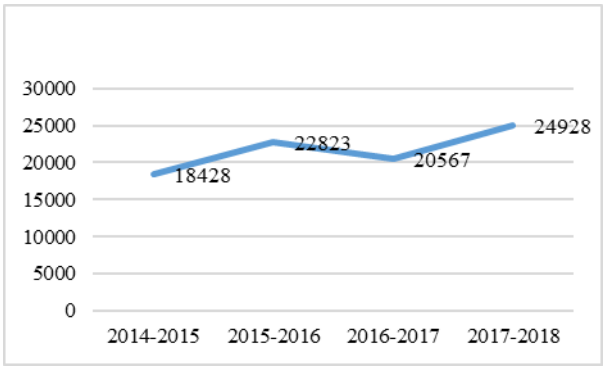

Fig. 8. Evolution of soybean meal production in the Republic of Moldova in the period 2014-2018, tonnes
Source: Elaborated by authors based on [16].

By generalizing the above, we deduce that in the evolution of the soybean cultivation and processing sector in the Republic of Moldova there are no visible and constant positive tendencies, a wide range of disturbing factors being identified:

- most of the necessary means of production are imported, and prices are constantly rising. As a result, costs are affected where only herbicides and seeds have a weight of over 44%;
- most of the producers face the problem of the absence of the storage spaces. As a result, they have to sell the production immediately after harvesting, at an unfavourable price;
- the access of the soybean to the elevators is limited, because the lots of soy brought to the elevators are too small and do not allow the optimum use of the processing capacity;
- there is lack of certified organic transport. As a result, cross-contamination of annual organic crops with conventional ones occurs during transportation;
- there is a reduction in the number of operators producing soybean meal under the pressure of increasing the import of genetically modified soybean meal, as well as reducing the VAT from 20% to 8% for cereal products (which was not accompanied by the reduction of the purchase price of the soybean and, respectively, diminished the profit of the processors) [16].

Based on these we find out that more active and effective measures are needed regarding the promotion of soybean culture among Moldovan producers, as well as the creation of a stimulating framework for the entire value chain. In this context, we can mention a whole series of factors that should facilitate the interest for the cultivation of the soybean:

I. Existence of favourable natural conditions for cultivation;

I. The growing need for quality soybeans, especially for the nutrition of humans and animals;

II. Recognizing the value of the crop as a remedy in solving environmental problems;

III. Efficiency of soybean cultivation.

According to the experts in the related field, the Republic of Moldova has natural soil and climate conditions, heat and light regimes favourable for cultivating the soybean, the only problem being the lack of precipitations especially in the central and southern areas.

On the other hand, at present in the Republic of Moldova there is a protein deficit of about 30-35%, the children and elderly population health being damaged. We also mention the growing need for soybean meal for the livestock sector which cannot be covered from internal resources. For example, total domestic consumption of soy in 2017 was double compared to 2014 and constituted 81.4 thousand tonnes. As a result, if in 2013 the Republic of Moldova imported 10.5 thousand tonnes of soybean meal, in 2017 the imported quantity constituted 39.5 thousand tonnes, while in 2018 34.5 thousand tonnes were imported. The largest source of imports is Romania (62%), followed by Ukraine (29.5%) and Brazil (8.5%). According to the importers' data, soybean meal purchased from Romania has its origin in Brazil or Argentina [16].

Last but not least, the issue of importing genetically modified soybean meal for animal and poultry feed should also be mentioned. According to ANSA's data, about 61% of the total volume of imported soybean meal contains genetically modified organisms [16]. In the absence of accurate data on the import of other genetically modified raw materials, it is difficult to accurately assess the adverse impact of the import of "food waste" on human health [18].

In the context of the above said, soy is mentioned by specialists as an optimal and unique culture, in particular due to the ability to synthesize an increased amount of protein in only 3-4 months. Thus, at a productivity of 2,000 kg per hectare, about 700 kg of crude protein and 400 kg of oil are obtained [5]. The orientation of the production towards export could ensure even higher results, the export prices being much higher than the domestic ones.

As mentioned above, soybean is also required as a culture with beneficial contributions in improving ecological problems, in particular through its role in remedying soil fertility problems. Regarding the soils of the Republic of Moldova, we find a continuous reduction of their humic state. Thus, the annual humus losses because of mineralization exceed the level of 700 kg/ha, and the total deficit, taking into account the erosion losses, is equal to 1,100 kg/year [21].

The lack of crop rotations capable of preserving soil fertility is mentioned as the main factor which conditions the establishment of a negative balance of the organic matter in the soil, along with erosion and the insufficiency of the local organic fertilizers. Under these conditions, leguminous and perennial crops are recommended by the specialists in order to conserve and improve the humic state of the soil [1].

Soybean also represents an efficient crop for agricultural producers. Thus, it is estimated that the cultivation of the soybean can bring profit starting with a productivity of 1 ton per ha [5], therefore, under the conditions of an effective management, it can guarantee the producers to obtain high economic performances.

The need to pay more attention to supporting and stimulating the production of genetically unmodified soybeans in the Republic of Moldova is also argued for through a wide range of strategic documents and, implicitly, strategic objectives, to which soybeans could make an essential contribution (Table 1).

Table 1. Strategic objectives that justify focusing efforts on stimulating the production of genetically unmodified varieties in the Republic of Moldova

The name of the strategic document	Objectives set, the achievement of which could be facilitated by the expansion of soybean production
National Development Strategy "Moldova 2030" (project) [10]	Specific objective 1. Increasing revenues from sustainable sources and mitigating economic inequalities; Specific objective 10. Ensuring the fundamental right to a healthy and safe environment.
National Strategy of Agricultural and Rural Development for the years 2014-2020 [8]	Specific objective 2.1. Supporting agricultural land and water management practices; Specific objective 2.2. Supporting environmentally friendly production technologies, environmentally friendly products, including biodiversity; Specific objective 6.3. Improving the quality of soils and the ecological reconstruction of degraded lands, affected by landslides and 100% agricultural protection strips, as well as sustainable management and protection of useful mineral resources.
Environmental Strategy for 2014-2023 [19]	Specific objective 2. Integrating the principles of environmental protection, sustainable development and green economic development, adapting to climate change in all sectors of the national economy; Specific objective 4. Reducing the negative impact of economic activity on the environment and improving measures to prevent environmental pollution; Specific objective 5. Creating the integrated monitoring and quality control system.
National Strategy of Public Health for 2014-2020 [9]	Specific objective 3. Ensuring the protection of health by streamlining the control of behavioural and environmental risk factors.
The Program for the Conservation and Increase of Soil Fertility for the years 2011-2020 [20]	The main objective 3. Stopping the active forms of degradation of the soil cover on an area of 877 thousand ha arable land by the end of 2020.

Source: Compiled based on [8, 9, 10, 19, 20].

It is obvious that the list of normative acts that, more or less, concerns environmental issues, population health, efficiency of agricultural production, etc. (thus justifying the inclusion of soybean in the area of interest of the decision makers of various levels) is not limited to those mentioned in Table 1. In particular, the draft of a relatively new document can be emphasized –National Development Strategy "Moldova 2030" - that connects the interests and priorities of the Republic of Moldova to international concerns for sustainable development [10]. Thus, within the pillar "Sustainable and inclusive economy" we distinguish the objective "Increasing revenues from sustainable sources and mitigating economic inequalities". As mentioned above, soybean is a crop capable of contributing to profit under the conditions of effective management. In the same document, within the pillar "Healthy environment" we identify the objective "Ensuring the fundamental right to a healthy and safe environment". The application of good agricultural practices by the soybean producers in the Republic of Moldova, in particular through the ecological argumentation of crop rotation, is an important remedy to diminish the negative effects on the environment [5].

CONCLUSIONS

Soybean production is an area of strategic significance; this being recognized by the European community. Despite this fact, in the Republic of Moldova there are no stable growth trends of soybean production and processing, due to a wide range of economic and technological obstacles.

The Republic of Moldova imposes itself through a vast series of strategic documents that support the interest in the respective crop and facilitate concrete measures to expand the production of the genetically unmodified soybean. At the same time, given the existence of adequate strategic visions, we can identify a series of actions that would facilitate their attainment:

- connecting the existing normative framework to the needs of the sector, by creating favourable conditions for the

production, processing, export of the related products;
- more active promotion of soybean culture among agricultural producers, with a special emphasis on its multiple benefits, as well as on the ability of the crop to ensure an efficient economic activity. Implicitly, it is necessary to identify more effective communication tools with the producers so as to ensure a greater information of them, together with consulting on various issues related to the cultivation technology;
- more active highlighting of the variety in the context of the measures regarding education for the sustainable development of different categories of audience: students, participants of the continuous training activities, etc.;
- ensuring an adequate curricular framework in vocational education, as well as including topics related to soybean cultivation and processing in vocational training programs, so as to ensure the acquisition of professional skills capable of contributing to the growth of the soybean production and processing sector.

REFERENCES

[1]Andrieș, A., 2011, Agrochemistry of nutrients. Fertility and soil ecology, Chisinau (Agrochimia elementelor nutritive. Fertilitatea și ecologia solului, Chișinău), 232 p.
[2]Arantxa, G., 2013, The soy mirage. The limits of corporate social responsibility: the case of the company Desarrollo Agrícola del Paraguay. https://oxfamilibrary.openrepository.com/bitstream/handle/10546/299687/rr-soy-mirage-corporate-social-responsibility-paraguay-290813-en.pdf?sequence=1&isAllowed=y Accessed on December 12th, 2019.
[3]Beciu, S., Dinu, T.A., Ladaru, R.G., 2013, Soybean production in Romania: Study case on consventional and former HT soybean producers, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 13(4):49-52.
[4]Common Declaration of Austria, Croatia, Finland, France, Germany, Greece, Hungary, Italy, Luxemburg, The Netherlands, Poland, Romania, Slovakia and Slovenia. European Soya Declaration - Enhancing soya and other legumes cultivation https://www.donausoja.org/fileadmin/user_upload/Activity/Media/European_Soya_signed_declaration.pdf Accessed December on 28th, 2019.
[5]Donau Soja, 2017, Handbook of good cultivation practices in the Republic of Moldova. Chisinau. (Manual al bunelor practici de cultivare a soii în Republica Moldova. Chișinău).
[6]European Commission. Oilseeds and protein crops statistics, https://ec.europa.eu/info/food-farming-fisheries/farming/facts-and-figures/markets/overviews/market-observatories/crops/oilseeds-and-protein-crops_en#production, Accessed on December 28th, 2019.
[7]Ionel, I., 2017, Romania's soybean market and coupled subsidies, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 17(1):249-252.
[8]National Strategy for Agricultural and Rural Development For the years 2014 - 2020, the Official Monitor of the Republic of Moldova no. 152 of 10.06.2014 (Strategia Națională de Dezvoltare Agricolă și Rurală Pentru Anii 2014 – 2020, Monitorul Oficial al Republicii Moldova nr.152 din 10.06.2014).
[9]National Strategy for Public Health for 2014-2020, Official Gazette of the Republic of Moldova no. 304-310 of 27.12.2013 (Strategia Națională de Sănătate Publică pentru anii 2014-2020, Monitorul Oficial al Republicii Moldova nr. 304-310 din 27.12.2013).
[10]National Development Strategy "Moldova 2030" - Project, (Strategia Națională de Dezvoltare „Moldova 2030”- Proiect), https://gov.md/sites/default/files/document/attachments/intr40_12_0.pdf, Accessed on December 26th, 2019.
[11]National Bureau of Statistics, Moldova, www.statistica.md, Accessed on January 4th, 2020.
[12]Nationalization of indicators for the Sustainable Development Goals (Naționalizarea indicatorilor pentru Obiectivele de Dezvoltare Durabilă), 2017, http://www.md.undp.org/content/dam/moldova/docs/Publications/Indicators_ONU_RO.pdf Accessed on January 06th, 2020.
[13]Predatory agribusiness likely to gain more power in Brazil election: report, 2018 https://news.mongabay.com/2018/09/predatory-agribusiness-likely-to-gain-more-power-in-brazil-election-report/, Accessed on December 29th, 2019.
[14]Soya Bean History – Donau Soja. https://www.donausoja.org/en/research/agriculture/soya-bean-history, Accessed on December 29th, 2019.
[15]Soy Alert, 2018, How to increase the EU’s plant protein production in a sustainable and agroecological way? https://www.foeeurope.org/sites/default/files/agriculture/2018/soyalert_report_fv_web.pdf Accessed on January 02nd, 2020.
[16]Soybean Culture from Moldova: Analysis of the Value Chain. Analytical study carried out within the project "Increasing the competitiveness of the agri-food sector by integrating it into the internal and global value chains, especially of the soybean culture sector" (Part I of the EU Program "Development of rural areas in the Republic of Moldova (DevRAM)" (Cultura de

Soia din Moldova: Analiza Lanțului Valoric. Studiu analitic efectuat în cadrul proiectului "Creșterea competitivității sectorului agroalimentar prin integrarea acestuia în lanțurile valorice interne și globale, în special a sectorului culturii de soia" (Partea I a Programului UE "Dezvoltarea zonelor rurale în Republica Moldova (DevRAM)").

[17]Soybean Bean Meal Infor Center https://www.soymeal.org/soy-meal-articles/world-soybean-production/, Accessed on January 2nd, 2020.

[18]Taran, A., 2015, Moldova is transformed into a food waste dump (Moldova este transformată într-o gunoiște a produselor alimentare), http://ecology.md/md/page/moldova-este-transformata-intr-o-gunoishte-a-produselor-alimentare, Accessed on January 4th, 2020.

[19]The environmental strategy for the years 2014-2023, the Official Monitor of the Republic of Moldova no. 104-109 of 06.05.2014 (Strategia de mediu pentru anii 2014-2023, Monitorul Oficial al Republicii Moldova nr. 104-109 din 06.05.2014).

[20]The soil fertility conservation and enhancement Program for 2011-2020 approved by Government Decision no. 626 of 20.08.2011, the Official Monitor of the Republic of Moldova no. 139-145 of 26.08.2011 (Programul de conservare și sporire a fertilității solurilor pentru anii 2011-2020 aprobat prin Hotărârea Guvernului nr. 626 din 20.08.2011, Monitorul Oficial al Republicii Moldova nr. 139-145 din 26.08.2011).

[21]The program for capitalization of new lands and for increasing soil fertility (part II Increasing soil fertility) approved by Government Decision no. 841 of 26.07.04, Official Monitor no. 138 of 13.08.04 (Programul de valorificare a terenurilor noi și de sporire a fertilității solurilor (partea a II-a Sporirea fertilității solurilor) aprobat prin Hotărârea Guvernului nr.841 din 26.07.04, Monitorul Oficial nr. 138 din 13.08.04).

[22]The 2030 Agenda for Sustainable Development, 2015, https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf , Accessed on January 3rd, 2020.

[23]The Growth of Soy. Impacts and Solutions. http://awsassets.panda.org/downloads/wwf_soy_report_final_feb_4_2014_1.pdf Accessed on January 3rd, 2020.

[24]Vozian, V., Avădănii, L., Iacobița, M., 2016, New varieties of pulses crops elaborated by the ICCC "Selection", Academos 1, p.72-75.(Soiuri noi de culturi leguminoase elaborate de ICCC „Selecția", Academos 1, p.72-75).

[25]UN launches 2016 International year of Pulses, celebrating benefits-legumes, https://news.un.org/en/story/2015/11/515012-un-launches-2016-international-year-pulses-celebrating-benefits-legumes, Accessed on January 4th, 2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

RATIONALIZATION OF THE ACTIVITY OF THE SECTORAL COMMITTEES FOR VOCATIONAL TRAINING AS A FACTOR OF INCREASING THE QUALITY OF PROFESSIONAL EDUCATION IN THE REPUBLIC OF MOLDOVA

Veronica PRISACARU[1], Alina CARADJA[2]

[1]Moldova State University, 60 Alexe Mateevici str., MD-2009, Chisinau, Republic of Moldova, Phone: mobile +373 69297575, Email: veronica.prisacaru@usm.md;
[2]State Agrarian University of Moldova, 44 Mircesti str., MD-2049, Chisinau, Republic of Moldova, Email: alina.caradja@mail.ru

Corresponding author: veronica.prisacaru@usm.md

Abstract

The purpose of the present paper is to elucidate the significance of the activity of the sectoral committees for vocational training in order to make the professional education`s offer interact with the labor market`s needs as well as of the problems related to the activity of the sectoral committees in the Republic of Moldova. In order to achieve the stated objective, the following research methods were used: synthesizing the theoretical approaches and good international practices in rationalizing the communication between the bidders and beneficiaries of the professional education`s offer; investigating the normative framework of the Republic of Moldova regarding the activity of the sectoral committees for vocational training; analyzing the results and problems related to the functioning of the sectoral committees in the Republic of Moldova; conducting an opinion survey of employers; formulating conclusions and reasoning. The authors' conclusions and recommendations refer to the directions for improving the activity of the sectoral committees for vocational training in the Republic of Moldova in order to enhance the effects of the interaction of the professional education system with the business environment.

Key words**:** *professional education, quality, Republic of Moldova, sectoral committees*

INTRODUCTION

Under the present conditions, characterized by the intensification of competition on the market of professional education services, the institutions that represent the system of initial and continuous professional education in the Republic of Moldova are increasingly confronted with the problem of the optimal adaptation of the educational offer to the demands of the labor market. The need for more effective interventions in this regard is also argued by the results of the numerous studies that denote the low degree of employer satisfaction with the quality of the product offered by the professional education system [2, 5, 21]. In this context, we will mention in particular the results of an opinion survey conducted in the period February-March 2019 on a sample of 310 respondents, being targeted three programs of continuous vocational training, ten programs of technical vocational education and ten programs of higher education. By examining the employers' appreciation of the quality of the specialists in the fields related to the researched programs (phytotechnics, horticulture, pedology and soil protection, agricultural crop production and animal husbandry, animal husbandry and veterinary medicine, technology of plant products) it was found that only one program (Agronomy, level 6 ECTS) obtained an average score of 4.7 points out of 5 maximum points. 13 programs obtained average marks within the limits of 3.6-4.5 points, 4 programs obtained average marks between 2.1-2 points, and two programs were rated with marks between 1.1-2 points. However, being asked their opinion on the skills to be improved, most of the respondents (over 70%) refused to make any proposals, invoking various reasons: from lack of time to lack of motivation for this effort [15]. Thus, based on the findings, we deduce that the problem of poor interaction

between initial and continuous professional education system and the business environment [14] still exists.

The significance of efficient communication with representatives of the business environment is argued by the fact that companies and organizations represent potential beneficiaries of the products offered by professional education institutions [6, 16, 22]. The product offered, which, in the specific case, is represented by the specialists trained in number and of an appropriate quality, will help balance the demand and the supply of skilled labor only if it meets the demands of the labor market, therefore of the concrete beneficiaries (employers). In this sense, it is clear that the objective of optimally adapting the offer of the professional education to the demands of the labor market in terms of quality and volume cannot be achieved without employers as consumers, making their contribution by enunciating these requirements. At the same time, we find out that, if professional education institutions are more active in initiating and maintaining dialogue with employers, being governed by medium-term interest (their image in the educational services market), those in the opposite camp are much more passive.

The lack of initiative and enthusiasm of the employers derives from the reduced awareness of the effects of communication with the institutions for the concrete enterprise, these obviously manifesting themselves not immediately, but in a larger time horizon, and encompassing aspects much larger than those in the area of interests of the concrete enterprise. In the context of the last reasoning, we can refer to the theory of human capital which promotes the idea that the benefits of education and training are ultimately manifested in higher labor productivity and higher wages [4, 12]. Thus it can be confirmed the assertion of Barrio-Garcia and Luque-Martinez that the more universities develop knowledge and learning, the more will be their contribution to collective intelligence and, consequently, the greater will be their success [3]. On the other hand, the "awakening" of employers' interest, their more active involvement in the dialogue with the educational offer providers represents an action that requires much greater efforts, than those that can be offered by the professional education institutions. In favor of the latter statement is the fact that the effects of education are not limited only to those that will be transposed, sooner or later, into concrete effects obtained by enterprises. The effects of education are much broader, manifesting at the societal level through its role in promoting democracy, sustainable growth, crime reduction, state welfare costs, etc. [11].

From the mentioned above, there are some logical solutions to the identified problems that can be exposed as follows:

- communication with employers must be transformed into a stable process, ensuring a continuous flow of useful information regarding the current and expected quality of professional education;
- communication must be interactive, each party participating equally, with proposals and feedback;
- communication with employers must be made aware of both parties as a tool to enhance their own performance, the key element being the competences offered by the educational institutions (as a performance indicator for the respective institutions) and the employees' productivity (as a performance indicator of the entities that reflects the skills used by employees).

The solutions proposed above can be implemented through conferring an organized character to the communication process between the educational service providers and the employers, through the creation of a legal organizational framework that would “discipline” the respective dialogue and turn it into a tool for synergy of the efforts of educational institutions and employers to optimally meet the demands of the labor market.

MATERIALS AND METHODS

The research was carried out by using the following methods: synthesizing the theoretical approaches and good international

practices in rationalizing the communication between the bidders and beneficiaries of the professional education; investigating the normative framework of the Republic of Moldova regarding the activity of the sectoral committees for vocational training; analyzing the results and problems related to the functioning of the sectoral committees for vocational training in the Republic of Moldova; conducting an opinion survey on a sample of 310 employers within the activities of the European Union project "Development of the Rural Areas of the Republic of Moldova" implemented by the Austrian Development Cooperation in partnership with the E.C. PRO DIDACTICA and Donau Soja; formulating conclusions and reasoning.

RESULTS AND DISCUSSIONS

At the international level, the concern for the optimal connection of the employees` competences to the needs of the sectors is a priority, being identified specially created bodies in this sense, which work with the direct and effective involvement of the employers. One of the relevant practices on this subject is that of the United Kingdom, where the Commission for Employment and Skills was created. The latter represented an organization supported by public funds that operated between 2008 and 2016. The basic purpose of the body was to provide guidance on skills issues and employment in the UK [19]. It represented a social partnership led by representatives of employers, unions, as well as volunteers. The strategic objectives of the respective body were:

- maximizing the effect of the policies regarding employment and skills as well as the incentives of the employer to sustain jobs and growth and ensure an internationally competitive skills base;
- developing the best market solutions by working with businesses so that leverage greater investment in skills;
- providing outstanding labor market intelligence in order to help businesses and people make the best choices for them [18].

The activity of the nominated body was a very broad one, involving guiding the elaboration of qualification standards, informing employers on various aspects related to human resources management, conducting and analyzing opinion polls of employers, organizing public consultations on various strategic aspects, etc. An essential aspect of the work of the UK Commission for Employment and Skills is total transparency, evidenced by the accessibility of the results of the activity to the general public through its web page, including by online posting of activity reports [20].

Even though the work of the UK Commission for Employment and Skills was suspended in 2016 (for financial reasons), at present we find that in the United Kingdom 25 Sectoral Competence Councils operate [10]. Among these we will refer in particular to Lantra - the Sector Skills Council responsible for agriculture, forestry, fish farming and veterinary activities. Being led by employers, Lantra has a number of important responsibilities, including:

- elaboration of occupational standards, qualifications and trades;
- skills management as an element of the Rural Development Program for six regions in England (this often involves making strategic decisions regarding training needs in the given branches);
- ensuring a formal mechanism for employment through several existing branch groups, including 24 forestry enterprises, 21 aquaculture enterprises, 17 fish and 13 veterinary units [18]. Having relevant information on the needs of the labor market, Lantra also offers vocational training in various fields with the conferral of related qualifications [8]. The huge contribution made by Lantra to the process of harmonizing vocational training in the fields concerned with the needs of the labor market is evidenced by the products of its activity, among which we can mention in particular the work "Agriculture, Forestry and Fishing: Sector Skills Assessment 2012" [18]. The latter is required not only as a valuable source of information for vocational training

providers, but also as a guide for applying the skills assessment tools in the sectors analyzed.
We cannot affirm that in the Republic of Moldova there is no awareness of the need to strengthen the collaboration with the external beneficiaries of the educational offer. National standards for accreditation of initial and continuing professional education programs require active communication with employers, starting from the design stage of each program. Existing quality management systems in professional education institutions provide for the use of communication with employers as a factor in enhancing the quality of activities performed. On the other hand, at national level, actions were taken to create a normative framework that would facilitate the adaptation of the educational offer to the needs of the labor market. Among these we can highlight in particular the adoption of the law on the sectoral committees for vocational training no. 244 of 23.11.2017 [9] which establishes the legal status and the way of organizing and functioning of the sectoral committees. "The mission of the sectoral committees is the development of social partnerships at the level of the economic branches in order to support the technical vocational education and the continuous training, as well as to correlate the vocational training content and quality with the demands of the labor market" [9]. Subsequently, at the request of the Ministry of Health, Labor and Social Protection and with the support of the International Labor Organization, the Guide on the establishment and functioning of the sectoral committees for vocational training was elaborated and published [13]. The mentioned document aims to increase the informational support regarding the mission, the attributions of the sectoral committees, as well as the instruments for their accomplishment. By examining the existing normative framework, we find out, however, that the main mission of the sectoral committees refers only to the technical vocational education (together with the continuous training), the higher education being omitted. In this context we can mention that the cooperation with the labor market, the optimal connection of the professional training to its needs cannot be ensured by emphasizing only on certain levels of professional education. The opinion survey of employers mentioned above [15] pointed out that employers are often reluctant to comment on the specific level of education of the required specialists (secondary, postsecondary or higher), important being the competences of the candidates. The investigation of the labor market and the transfer of its demands in the quality of the professional education's offer should logically be carried out integrally, thus creating premises for rationalizing the entire system of professional education, also by correlating the complex of competences on different levels. In this context we identify the need for inclusion of higher education in the area of the sectoral committees` attributions, thus amplifying positive effects of their activity and ensuring the increase of the quality of the entire initial and continuous professional education system, not only of the technical vocational and continuous education. By investigating the data on the functioning of the sectoral committees for vocational education in the Republic of Moldova, we can see that their number is increasing, being already covered such branches and fields, as transport and road infrastructure, constructions, agriculture and food industry, information and communication technology, light industry, trade, hotels and restaurants, financial intermediation and insurance, real estate transactions, etc. [7]. The tendency to increase the number of sectoral committees is based on the objective set by the Strategy for the development of technical vocational education for the years 2013-2020 [17] which foresees the creation of the sectoral committees in 12 areas of specialization by 2020. At the same time, according to the reflections made public on the quality of the activities carried out, we find out the existence of a series of problems in accomplishing the tasks assumed by the respective structures, such as:

- the absence of a clear vision regarding the connection of the interests of the business

environment with the educational programs at national level;
- the absence of continuous communication between sectoral committees and state institutions;
- the slow rhythm of actions to develop âpartnerships at local level, of the participation in the elaboration of public policies in the field of work etc. [7].

Deficiencies in the performance of the assumed tasks are acknowledged by the members of the respective committees. Thus, in the activity report of the sectoral committee for vocational education in agriculture and food industry for 2016, a whole series of unrealized objectives is mentioned [1], which denotes the low efficiency of the structure. Unfortunately, the problems in the activity of the sectoral committees continue to persist, this fact being confirmed in the workshop "Identification of constraints in the activity of the sectoral committees" held on 01.10.2019. The participants confirmed the problems mentioned above, but also a number of disruptive factors of the activity, such as:
- "passivity of the representatives of the business environment;
- lack of funding;
- shortcomings of the legal framework"[1].

Another problem identified in the functioning of the sectoral committees in the Republic of Moldova is the reduced transparency of the activities carried out. The last reasoning is argued by the fact that there are still no official web pages of all the created committees, and the existing ones often contain outdated information. In this context, there exists the need to take over the good practices of operating similar structures in the European space, which is imposed not only by the quality of performing tasks, but also by the operative publication of all the outcomes. Making a synthesis of the exposed information, we deduce that there are many factors with a direct and indirect influence on the quality of the functioning of the sectoral committees, these being represented in the tree of the problem (Figure 1). The medium-term and long-term consequences of the reduced functionality of the sectoral committees were also identified.

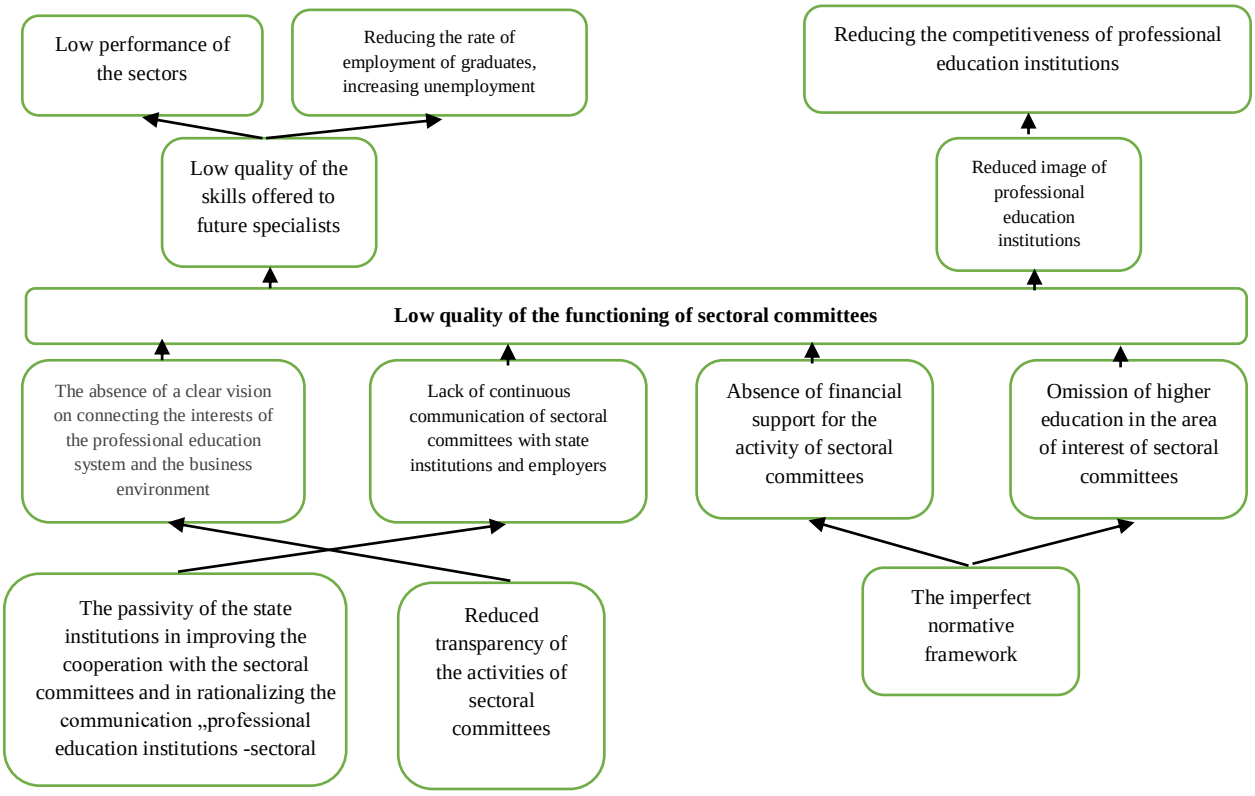

Fig.1. The problem tree of the low quality of the functioning of the sectoral committees for vocational education in the Republic of Moldova
Source: Elaborated by the authors.

The data summarized in Fig.1 on the causes and consequences of the functioning problems of the sectoral committees in the Republic of Moldova allow identifying the necessary activities to be undertaken in order to achieve the general objective of increasing the quality of the sectoral committees functioning, as well as of the expected positive consequences (Fig. 2).

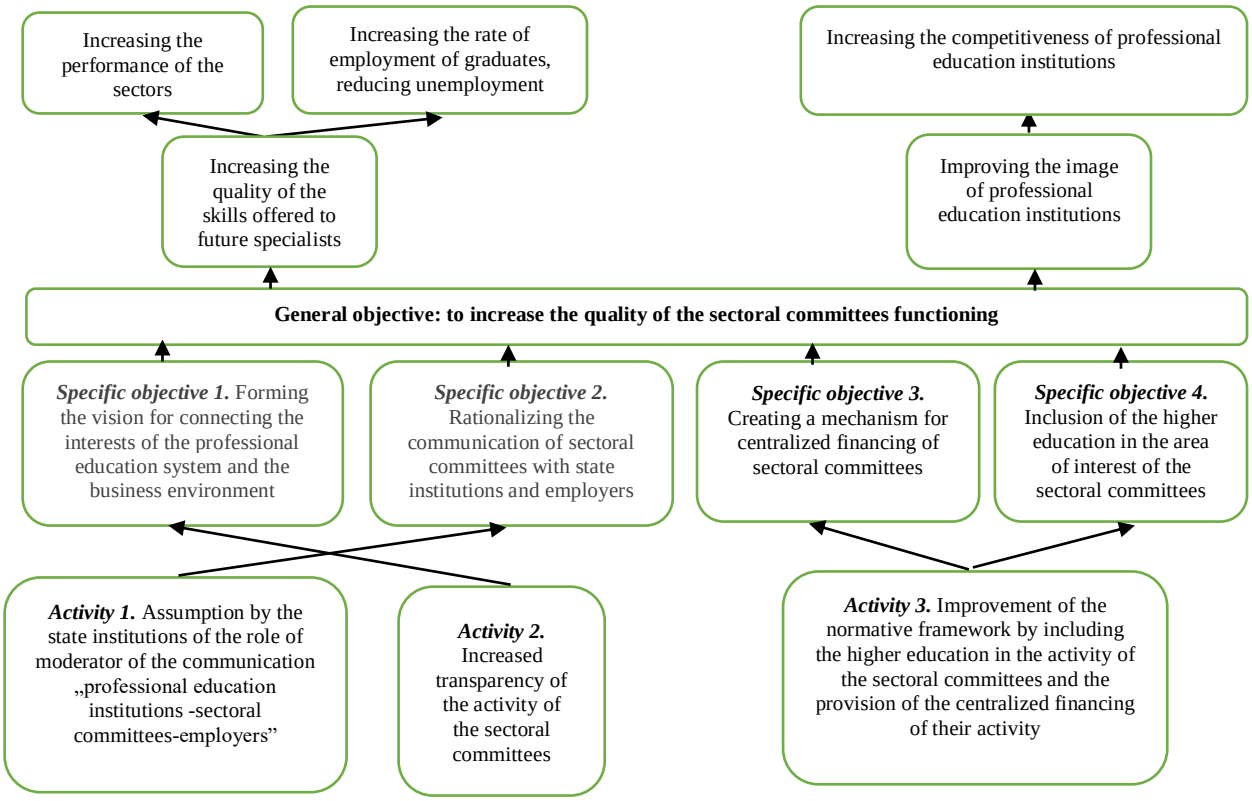

Fig.2. Specific objectives and activities proposed to increase the quality of the functioning of the sectoral committees for vocational education in the Republic of Moldova
Source: Elaborated by the authors.

Thus, as shown in Fig. 2, undertaking the recommended activities would bring medium-term advantages (increasing the quality of graduates` skills, improving the image of professional education institutions), and it will also have a positive long-term impact on the performance of sectors, labor market indicators, the sustainability of professional education institutions on the market of educational services.

CONCLUSIONS

In the Republic of Moldova, communication with employers is recognized as an important instrument in adapting the initial and continuous professional education to the needs of the labor market, being created the normative and organizational framework for its accomplishment. At the same time, we find deficiencies both in the existing normative framework and in the process of practical achievement of the objectives assumed by the created structures.

Based on the findings made, the following recommendations can be highlighted:

- improving the existing normative framework of the sectoral committees for vocational education by including higher education in their area of activity and creating an adequate financing mechanism;
-rationalizing the process of cooperation between sectoral committees and state institutions, including the assumption by the state institutions of the role of moderator in the communication "professional education institutions-sectoral committees-employers";
-ensuring greater transparency of the activities carried out by the sectoral committees for vocational education, promoting them more

actively in order to disseminate and optimize the results and to raise awareness of the labor market actors.

REFERENCES

[1]Activity report of the Sectoral Committee on Agriculture and Food Industry for 2016 (Raport de activitate a Comitetului sectorial în agricultură și industria alimentară pentru anul 2016). http://www.ipt.md/ro/cs-agricultura-page/item/418-raport-de-activitate-comitetului-sectorial-in-agricultura-si-industria-alimentara-pentru-anul-2016.Accessed on January 25th, 2020.

[2]Agency for Regional Development Center, 2016, Regional study. Workforce situation in the Central Region and the development needs of the vocational training system, Chisinau (Agenția pentru Dezvoltare Regională Centru, 2016, Studiu regional. Situația forței de muncă în Regiunea Centru și nevoile de dezvoltare ale sistemului de formare profesională, Chisinau). http://www.adrcentru.ro/Document_Files/ADStudiiRegionale/00002181/rmvmv_Studiu%20forta%20de%20munca%20si%20pregatirea%20profesionala.pdf. Accessed January 20th, 2020.

[3]Barrio-Garcia, S., Luque-Martinez, T., 2009, The value of client perception in university strategic planning: an empirical research study, Industry & Higher education, 2009, 23 (6):423-436.

[4]Becker, G.S., 1962, Investment in human capital: a theoretical analysis, Journal of political economy, 1962, 70 (5): 9-49.

[5]Buciuceanu-Vrabie, M., Gagauz, O., 2017, Young people on the labor market in the Republic of Moldova: skills and aspirations (Tinerii pe piața muncii din Republica Moldova: competențe și aspirații). https://www.undp.org/content/dam/moldova/docs/tineri_pe_piata_muncii_final.pdf . Accessed on January 21st, 2020.

[6]Kettunen, J., 2014, The Stakeholder Map in Higher Education, International Proceedings of Economics Development and Research, 2014, 78: 34-38, ISSN: 2010-4626, DOI: 10.7763/IPEDR.

[7]Labor Institute, sectoral committees for vocational training: opportunities and challenges at the beginning of the year (Institutul Muncii, Comitetele sectoriale pentru formare profesională: oportunități și provocări la început de an). https://institutulmuncii.md/2019/02/comitetele-sectoriale-pentru-formare-profesionala-oportunitati-si-provocari-la-inceput-de-an/. Accessed January 24th, 2020.

[8]Lantra, UK, https://www.lantra.co.uk/, Accessed on January 22nd, 2020.

[9]Law no. 244 of 23.11.2017 regarding the sectoral committees for vocational training, the Official Monitor no. 441-450 of 22.12.2017 (Lege nr. 244 din 23.11.2017 cu privire la comitetele sectoriale pentru formare profesională, Monitorul Oficial nr. 441-450 din 22.12.2017).

[10]List of Sector Skills Councils (SSCs). http://www.ssda.org.uk/list-of-sector-skills-councils.htm. Accessed on January 12th, 2020.

[11]McMahon, W., 2009, Higher Learning, Greater Good: The Private and Social Benefits of Higher Education, Baltimore, Maryland: Johns Hopkins University Press, 432 p.

[12]Mincer, J., 1962, On-the-job training: costs, returns and some implications, Journal of political economy, 1962, 70 (5): 50-79.

[13]Movileanu, R., Midari, V., 2018, Guide on the establishment and functioning of sectoral committees for vocational training (Ghidul privind constituirea și funcționarea comitetelor sectoriale pentru formare profesională). https://msmps.gov.md/sites/default/files/document/attachments/ghid_comitetele_sectorial_web.pdf. Accessed January 25th, 2020.

[14]Prisacaru, V., Caradja, A., 2017, Communication with business environment as a factor enhancing the impact of higher agricultural education on the sustainable rural development, Journal of Research on Trade, Management and Economic Development, 2017, 4 (2): 129-138.

[15]Prisacaru, V., Baltag, G., Sevciuc, T., 2019, Report on results of identifying the mid-term labour market demand for higher and vocational education in the area of: phytotechny, horticulture, pedology and soil protection, production of agricultural crops and livestock breeding, animal husbandry and veterinary medicine, products of plant origin technology, Chisinau, Educational Centre PRO DIDACTICA.

[16]Rowley, J., 1997, Beyond service quality dimensions in higher education and towards a service contact, Quality Assurance in Higher Education, 1997, 5 (1):7-14.

[17]Strategy for the development of vocational / technical education for the years 2013-2020 approved by the Government Decision no.97 of February 1, 2013, the Official Monitor no. 31-35 of 15-02-2013 (Strategia de dezvoltare a învăţământului vocaţional/tehnic pe anii 2013-2020 aprobată prin Hotărârea Guvernului nr.97 din 01 februarie 2013, Monitorul Oficial nr. 31-35 din 15-02-2013).

[18]UK Commission for Employment and Skills, 2012, Agriculture, Forestry and Fishing: Sector Skills Assessment 2012, Briefing Paper, October 2012. https://dera.ioe.ac.uk//15967/, Accessed on January 22nd, 2020.

[19]UK Commission for Employment and Skills, https://www.gov.uk/government/organisations/uk-commission-for-employment-and-skills, Accessed on January 22nd, 2020.

[20]UKCES Annual report and accounts 2016 to 2017. https://www.gov.uk/government/publications/ukces-annual-report-and-accounts-2016-to-2017. Accessed on January 22nd, 2020.

[21]USAID, 2017, Assessing the skills required of the workforce within the key value chains. APM project, High performance agriculture in Moldova. Chisinau (Evaluarea necesarului de competențe al forței de muncă în cadrul lanțurilor valorice cheie. Proiectul APM, Agricultura performantă în Moldova. Chisinau).
[22]Weaver, T., 1976, What is good of higher education? Higher Education Review, 1976, 8 (3):3-14.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

YIELD POTENTIAL AND STABILITY OF SOME SPRING BARLEY VARIETIES AND LINES

Florin Marian RUSSU[1], Ioana PORUMB[1], Camelia Ancuța URDA[1], Emanuela FILIP[1,2], Cristina STANCĂ-MOISE[3], Adina VARADI[1,2], Liliana VASILESCU[4], Eugen PETCU[4]
[1]Agricultural Research and Development Station A.R.D.S Turda, Romania, Emails: florin.russu@scdaturda.ro, ioanaporumb18@yahoo.com, cami1586@yahoo.com
[2]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania, Emails: emanuelafilip33@gmail.com, adina_presecan@yahoo.com
[3]University "Lucian Blaga" of Sibiu, Email: cristinamoise1@yahoo.com
[4]National Agricultural Research Development Institute Fundulea, Emails: liliana@ricic.ro, eugen_petcu12@yahoo.com

Corresponding author: ioanaporumb18@yahoo.com

Abstract

The experimental results were processed according to the polyfactorial experiences of type A x B x C where: A- was represented by the factor of locations with two graduations (Turda and Fundulea), B was the factor of year with three graduations (2016, 2017 and 2018) and C- factor genotypes with 25 graduations. Lines To 2027/10, To 2208/02 and the reselection of the Jubileu variety, are particularly noticeable in terms of average yield with relative increases compared to the control of 10, 9 and 5% respectively. The variation of the absolute productions was between 3683 kg/ha and 4862 kg/ha in Turda conditions and between 3265 kg/ha and 4143 kg/ha in Fundulea conditions. Following the use of the method proposed by Francis and Kannenberg (1978), the lines To 2027/10, To 2208/20, To 2167/01, To 2054/97, To 2095/01 and To 2013/99) which have a coefficient of variation below the average value and high output above average have proved to be production stable.

Key words: *spring barley, genotype, yield, stability, location*

INTRODUCTION

In our country, the spring barley meets very favourable conditions of culture in a quite restricted area (Bârsei Country, Sfântul Gheorghe and Târgul Secuiesc, Someșului Valley, Aries Valley, Mureș Valley, Criș Valley and the sub-Carpathian area of Moldova) a humid and cool climate. The dry and semi-dry areas of the country as well as the areas with light sandy soils are unfit for the culture of barley. In these less favourable areas, the production of barley is affected both quantitatively and qualitatively, an aspect which refers in particular to barley for beer. The most important quantitative reductions in barley yield occur when the grain filling phenomena occur longer periods with high temperatures, as a result of soil drought, reducing the period of accumulation of carbohydrates in grain, very common phenomena in most areas of the country [6]. The humid and cool climates positively mark the quality of barley for beer, as it favours the accumulation of starch in detriment of proteins [2, 3]. Yield capacity is determined by internal factors (genetic) and external factors (environmental conditions). According to Ceapoiu (1984), 56% of the total variance of a variety's production is affected by external conditions. This implies that 40-50% of the total variance would be genetically determined [1]. In some cases, the intrinsic genetic contribution to increasing production capacity has been associated with improved resistance to disease, fall or unfavourable environmental conditions. To prove their genetic contribution in this regard [7] performed an experiment with old and new varieties of wheat, which created artificial conditions for disease and fall prevention. Under these conditions, the production of new varieties exceeded the old varieties by about 2 tonnes per hectare, both at a high fertilisation level and at a reduced nitrogen fertilisation.

In determining the value of a cultivar, in addition to the yield potential, an important weight must have the stability of production. The lack of this trait can make a variety valuable only under certain, very specific

conditions. Unfortunately, ideal conditions do not exist because between years and localities, there are differences of climate and soil, the attack of diseases and pests and so on. The differences can be bigger or smaller, in any case, they exist. However, the need to appreciate the value of a variety must take into account the phenotypic stability [1].

Recent climate data analysis confirms the signals of increasing average annual temperatures to scientists. This is being felt more and more often in the established areas of spring barley culture. Furthermore, in many areas of the country, the years with dry autumn are more frequent, which directly contribute to the reduction of the areas sown with wheat, barley and oats. Given these considerations, the identification of genotypes with high ecological plasticity, capable of forming reasonable harvests from one year to the next or in less favourable geographical areas, becomes a new challenge for the ARDS Turda breeding team. These prerogatives could be materialized by testing the material (varieties and lines) under various pedoclimatic conditions or by using the hybridization works of genetically differentiated but also geographically differentiated parents. Thus, in a first stage we set out to test some lines and varieties of spring barley in an area where this crop does not meet favourable conditions, namely in the south of the country at NARDI Fundulea.

MATERIALS AND METHODS

The biological material that was the object of this experiment was represented by 25 lines and varieties of spring barley created at ARDS Turda (24) and ARDS Suceava (1), by the hybridization method followed by selection. For the field placement of the experiments the randomized blocks method was used in five replications. The sown area of the experimental plots was 14 m^2, being harvested only 10 m^2 according to the rules of experimental technique. In both areas, the same sowing rate of 550 germinated seeds/m^2 was used, the work being performed in the spring in the first instance, practical when in each location, the humidity of the land allowed this work to be carried out under optimal conditions. The experimental protocol provided for the use of identical doses of N mineral fertilizers in both locations (100 kg commercial product/ha). The fertilizer used was ammonium nitrate, applied in a single spray, spring after emergence. The experimental results were processed according to the polyfactorial experiences of type A x B x C in which: A- was represented by the factor of locations with two graduations (Turda and Fundulea), B- was the factor of year with three graduations (2016, 2017 and 2018) and factor C- genotypes with 25 graduations. The climatic data recorded in the three years in the two areas are presented in Table 1. The monthly distribution of rainfall over the three experimental years compared to the multiannual average reflects a significant variation. According to the data it could be said that the winter months are poorer in precipitation in the area of Turda compared to that of Fundulea. It can also be observed that in both areas, in March, there was excess rainfall, above the multiannual average of the area. The precipitations of April, the precipitations that have a remarkable impact on the tillering capacity and implicitly on the production, exceeded the multiannual average characteristic of each area. However, it should be noted that in 2018, the precipitation this month was below average in both locations, the most pronounced water deficit being recorded at Fundulea, an area where the precipitations of this month were almost completely absent. It could be mentioned further that this year continued with one more month of rainfall deficiency, a deficit that was more pronounced under the conditions at Fundulea. The evolution of precipitation from 2018 in the two areas showed a considerable impact on the yield potential of the studied variants. From the point of view of the temperatures it is possible to see the positive tendency of deviation of them in comparison with the multiannual average in almost all the months of the three years and in both areas.

Table 1. Rainfall and thermal regime, ARDS Turda and NARDI Fundulea (2016, 2017 and 2018)

	Turda						Fundulea					
months	**January**	**February**	**March**	**April**	**May**	**June**	**January**	**February**	**March**	**April**	**May**	**June**
Rainfall (mm)												
2016	25	23.8	47	62.2	90.4	123.2	53.3	10.3	54.9	73.7	81.2	43.7
2017	2.6	19.2	46.1	65.2	65.4	30.6	35.4	50.5	47.6	73.4	65.8	96.4
2018	16.7	33.4	40.9	26.2	56.8	98.3	36.0	58.6	40.6	2.4	34.0	120.6
multiannual average	21.8	18.8	23.6	45.9	68.6	84.8	34.5	31.7	37.1	44.6	61.5	74.1
Temperature (℃)												
2016	-2.8	4.6	5.9	12.4	14.3	19.8	-4.3	6.2	7.3	13.9	15.9	22.9
2017	-6.4	1.5	8.4	9.9	15.7	20.7	-5.5	-0.1	8.5	10.6	16.8	22.2
2018	0.2	-0.3	3.3	15.3	18.7	19.4	0.7	1.6	3.3	15.8	19.4	22.6
multiannual average	-3.4	-0.9	4.7	9.9	15	17.9	-2.3	-0.3	4.8	11.2	17.0	20.8

Primary data source: Turda and Fundulea weather station (longitude: 23° 47 '; latitude 46°35'; altitude 427 m).

RESULTS AND DISCUSSIONS

The experimental conditions (3 years x 2 locations) constituted a varied framework for the study of biological material, an assertion that emerges from the meanings of the sample values "F" corresponding to the years and locations, values that are statistically assured as being very significant (Table 2). Regarding the production potential of cultivars, from the analysis of the variance it can be noted the presence of yield differences, very significant between genotypes, differences that were not cancelled out by the variances of years and locations.

Table 2. ANOVA for grain yield at 25 spring barley genotypes in a multifactorial experience

The source of variability	**GL**	**s^2**	**F**
Year (A)	2	147560400	8790 ***
AxL	2	12654840	465 ***
Localities (L)	1	77775230	2856 ***
Genotype (C)	24	1461607	310 ***
AXC	48	364 373	77 ***
LxC	24	816 896	173 ***
AxLxC	48	330 572	70 ***
Error A	8		
Error L	12		
Error G	576		

Source: original, obtained through the statistical program.

According to the data presented in Table 3, it can be said that only in one year, the three conditions favourable for the crop of spring barley were met.

The year 2017 showed a positive impact on the capacity of expressing the production potential of the 25 variants, the yield differences from the control being very significant, the quantitative increase was 879 kg/ha. The smallest productions were registered in 2018, the differences from the control being smaller by 541 kg/ha, which represents very significant negative differences. In the context of climate change, the claims regarding the importance of the stability of crop yield are largely confirmed.

Table 3. The influence of the year factor on the average yield at 25 spring barley genotypes tested in two locations (Turda and Fundulea)

Years	Yield (kg / ha)	%	Difference	Significance
Average	3.961	100	0.00	Mt.
2016	3.622	92	-339	000
2017	4.841	122	879	***
2018	3.420	86	-541	000
DL (p 5%)	27			
DL (p 1%)	39			
DL (p 01%)	58			

Source: original, obtained through the statistical program.

Table 4. Influence of localities factor on average yield at 25 spring barley genotypes (2016, 2017 and 2018)

Places	Production kg/ha	%	Difference	Significance
Turda	4.283	100	0.00	Mt.
Fundulea	3.639	85	-644	000
DL (p 5%)	26			
DL (p 1%)	37			
DL (p 01%)	52			

Source: original, obtained through the statistical program.

The differences in yield between the two areas reflect the major involvement of the environment on the production potential of the 25 studied variants. Results shown in Table 4 are indicative in this respect, as the climatic conditions in the production Fundulea record a very significant decline compared to the control, represented by Turda. In choosing Turda as a control, it was considered that this area is very favourable to the barley culture, whereas if the average

control between the two areas were preferred, the discrepancy between them was less obvious. The average yield capacity of the 25 variants ranged from 3.510 to 4.389 kg/ha (Table 5). In an important part of the genotypes (8) there were higher productions than the control, the differences being very significant in seven variants and only significant in one variant, represented by the line To 2270/94. Of the seven genotypes lines can be seen in particular To 2027/10, To 2208/02 and the reselection of the Jubileu variety, with increases relative to the control 10, 9 and 5%. At the opposite pole are located seven genotypes, their productions registering very significant negative deviations compared to the control.

Table 5. Average yield at 25 spring barley genotypes (Turda and Fundulea)

Genotypes	Production kg / ha	%	Difference	Significance
Average (Mt.)	3.961	100	0.00	Mt.
Daciana	3.961	100	-0.47	-
Turdeana	3.983	100.6	22.27	-
Camomile	3.927	99.1	-33.77	-
Adina	3.885	98.1	-76.60	000
To 2270/94	3.998	100.9	36,67	*
To 2208/02	4.330	109.3	368.53	***
To 2330/98	4.088	103.2	127.13	***
To 2172/01	4.128	104.2	166.73	***
To 2168/01	4.114	103.9	153.07	***
To 2115/94	3.942	99.5	-19.03	-
To 2051/99	3.754	94.8	-206.67	000
To 2054/97	4.025	101.6	64,00	-
To 2013/99	4.013	101.3	51.97	-
To 2095/01	4.038	101.9	76.47	-
To 2149/99	3.510	88.6	-450.93	000
To 2017/93	3.559	89.8	-402.37	000
To 2014/99	3.855	97.3	-105.90	000
To 2247/01	3.773	99.4	-21.90	-
To 2167/01	4.237	107	276.33	***
To 2051/10	3.943	99.5	-18.23	-
To 2123/01	3.611	91.2	-350.50	000
To 2027/10	4.389	110.8	428.33	***
To 2170/01	3.973	100.3	11.63	-
To 2011/92	3.651	92.2	-309.87	000
Jubileu	4.174	105.4	213.10	***
DL (p 5%) 35; DL (p 1%) 46; DL (p 01%) 59				

Source: original, obtained through the statistical program.

The considerable fluctuations of the average yield from one locality to another but also the interannual ones, suggest the significant involvement of the environment in the formation of the spring barley crops. In all experimental years under the conditions at Fundulea, the barley yield were reduced to very significant negative differences compared to the control (Figure 1). The year in which the lowest productions were registered at Fundulea was the year 2018, in which the precipitations of April and May were well below the multiannual average.

Providing the rainfall and thermal necessities at a level that is as close as possible to the optimal one of the spring barley is a decisive factor in increasing yield. An eloquent example in this regard is the year 2017, a year in which in both areas the highest productions were obtained. The yield differences between those obtained this year and the other two were: 1.480 and 1.234 kg/ha under Turda conditions and 956 and 1.606 kg/ha under Fundulea conditions.

Also, based on the data presented in Fig. 1, it could be stated that in the years in which climatic conditions are met close to the necessity of the spring barley, even in the less favorable cultivation areas satisfactory yields are obtained. Thus, in 2017, when the area of Fundulea met near (humidity and thermal) conditions, the average production was higher than that obtained in Turda in 2016 and 2018.

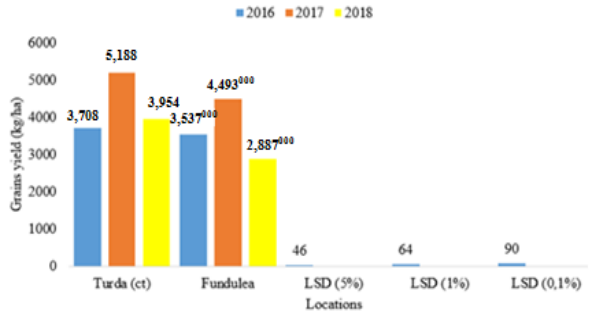

Fig.1. The influence of the interaction between localities and years on the average yield
Source: original, obtained through the Excel program.

Harvest is the result of the interaction between genotype and ecological environment or climate and is specific for each crop grown. In this sense, the production capacity of any cultivated genotype represents one of the essential and priority objectives for the process of genetic improvement of the new genotypes.

Studying the interaction between genotypes and localities (Table 6), it was found that there were differences regarding the contributions of these factors in achieving the average production per unit area. The variation of absolute yield was between 3,683 kg/ha and 4,862 kg/ha in Turda conditions and between 3,265 kg/ha and 4,143 kg/ha in Fundulea conditions.

In the conditions of the agroecosystem from Turda, the lines To 2027/10, To 2208/02 and Jubileu were located on the first three places, all with very significant differences from the average of the experiment. A two year field experiment (2013, 2014) conducted by Russu (2015) on 13 spring barley genotypes in the soil and climatic conditions from ARDS Turda demonstrated that the reselection from the Jubileu variety very significantly increased grain yield compared to the control [4]. In the less favourable climatic conditions from Fundulea, the top of the lines with the highest yields is made up of To 2208/02, To 2167/01 and To 2027/10. At the opposite end, the most important yield losses were recorded in To 2123/01 and To 2011/92. In 2019, Porumb et al. (2019) evaluated 66 spring barley genotypes in two different years (2016, 2017) and confirmed that Romaniţa, Daciana and Jubileu varieties as well as some perspective lines had the protein content between: 11.18% and 11.88% and and starch content of 55.48%. Based on these results, the studied genotypes are recomended to be used in the brewing industry [5].

By the fact that these lines have been statistically ensured and have recorded the highest yields in both locations, it can be seen the production stability, and at the same time the important contribution and role of the genotype in expressing its real potential.

The relative stability or constancy of genotype yield under the experimental conditions (years and localities) is generally illustrated by the values of the variants of genotype interactions with years and localities (Table 2). From these values it is clear that the analysed genotypes do not generally show a relatively constant behaviour in all the experimental conditions, they rather have a specific behaviour depending on the given conditions. This does not mean that from the analyzed cultivars cannot be identified forms that show an appreciable constancy of the yield under the experimental conditions.

In this case, for the assessment of the stability of production, we used the method proposed by Francis Kannenberg (1978), it is considered that genotypes which are relatively stable are those that have low values of coefficient of variation, while the genotypes with high values of the coefficient of variation are considered slightly stable.

The genotypes placed in quadrant I (Fig. 2) have a simultaneous genetic advantage, both for yield and for stability, recording a higher than average production and a coefficient of variation below the average value. The six genotypes listed in Figure 2 have a satisfactory overall adaptive capacity, producing considerable and constant yields under various environmental conditions. Also, the genotypes placed in quadrant II can be said to have above average productions and a good adaptive capacity but only under specific conditions.

Table 6. The influence of genotype x locality interaction (G x L) on the yield of the studied genotypes

Turda			Fundulea		
genotypes	**Yield kg/ha**	**difference**	**genotypes**	**Yield kg/ha**	**difference**
Average (Mt.)	4.283	0.00 Mt	**Average (Mt.)**	3.639	0.00 Mt
Daciana	3.952	-331.26 000	**Daciana**	3.969	130.33 ***
Turdeana	4.421	138.2 ***	**Turdeana**	3.545	-93.67 000
Romaniţa	4.264	-18.79	**Romaniţa**	3.590	-48.74
Adina	4.354	71.01 **	**Adina**	3.415	-224.21 000
To 2270/94	4.534	250.61 ***	**To 2270/94**	3.462	-65.27 000
To 2208/02	4.516	232.87 ***	**To 2208/02**	4.143	504.19 ***
To 2330/98	4.443	160.01 ***	**To 2330/98**	3.733	94.26 ***
To 2172/01	4.591	308.34 ***	**To 2172/01**	3.664	25,13
To 2168/01	4.163	-120.13 000	**To 2168/01**	4.065	426.26 ***
To 2115/94	4.314	30,74	**To 2115/94**	3.570	-68.81 00
To 2051/99	4.193	-89.99 000	**To 2051/99**	3.316	-323.34 000
To 2054/97	4.270	-13.06	**To 2054/97**	3.780	141.06 ***
To 2013/99	4.347	64.07 *	**To 2013/99**	3.679	39.86
To 2095/01	4.187	-95.66 000	**To 2095/01**	3.888	248.59 * ***
To 2149/99	3.683	-599.79 000	**To 2149/99**	3.337	-302.07 000
To 2017/93	3.763	-519.99 000	**To 2017/93**	3.354	-284.74 000
To 2014/99	4.445	161.94 ***	**To 2014/99**	3.265	-373.74 000
To 2247/01	3.829	-121.13 000	**To 2247/01**	3.716	77.33 **
To 2167/01	4.441	158.34 ***	**To 2167/01**	4.033	394.33 ***
To 2051/10	4.367	83.94 ***	**To 2051/10**	3.519	-120.41 000
To 2123/01	3.867	-416.19 000	**To 2123/01**	3.354	-284.81 000
To 2027/10	4.862	578.47 ***	**To 2027/10**	3.917	278.19 ***
To 2170/01	4.374	90.81 ***	**To 2170/01**	3.572	-67.54 00
To 2011/92	3.778	-505.53 000	**To 2011/92**	3.525	-114.21 000
Jubileu	4.785	502.14 ***	**Jubileu**	3.563	-75.94 00
DL (p 5%) 49; DL (p 1%) 65; DL (p 01%) 83					

Source:original.

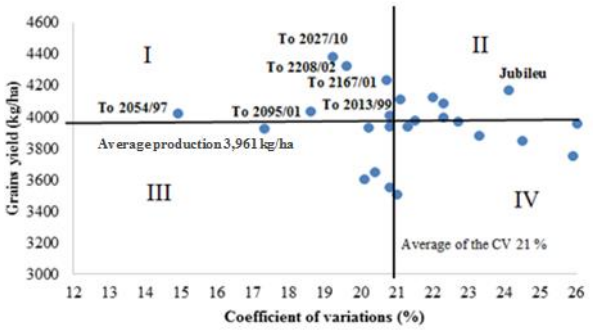

Fig .2. Stability of genotypes analysed according to the variation coefficient and the average yield kg/ha
Source:original, obtained through the Excel program.

CONCLUSIONS

The analysis of the genotypes under very different climatic conditions, allows to identify possible genotypes with a good general adaptation capacity. Thus the lines To 2027/10 and To 2208/02, show a high yield capacity and a good adaptability to the various environmental conditions. In addition to these lines can be mentioned the reselection of the Jubileu variety, which in favourable areas to the spring barley crop can produce high yields quantitatively.

REFERENCES

[1]Cristea, M., 2006, Classic şi modern în ameliorarea plantelor. Editura Academiei Române Bucureşti, (Classical and modern in plant improvement, Romanian Academy Publishing House), pp. 31-32.
[2]Leistrumaite, A, Paplauskiene, V., Masauskiene, A., Statkeviciute, G., 2008, Evaluation of spring barley Malting varieties for breeding programmes. Agronomijas Vestis. Latvian Journal of Agronomy, No: 11 LLU 2008.
[3]Muntean, L. S., 1993, Fitotehnie (Phytotechnics), Vol. I. Tipo Agronomia Cluj-Napoca, pp. 15-18.
[4]Porumb, I., Russu, F., Boanta, A., Filip, E., Tritean, N., Stanca-Moise, C., Muntean, L., 2019, Choosing the genitors - an important measure in making the breeding works better at the spring barley, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(1):471-476.
[5]Russu, F., 2015, Studiul unor cultivare de orz de primăvară cu două rânduri în system concurenţial şi neconcurenţial (Study of a set of varieties of spring barley two rows in competitive and non competitive system), Ph.D.Thesis, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca.
[6]Savin, R., Stone, P. J., Nicolas, E. M., Warslaw, I. F., 1997, Grain growth and malting quality of barley 1. Effects of heat stress and moderately high temperature. Aust. J. Agric. Res. 48: 625-634.
[7]Saulescu, N.N., 1980. Probleme de Genetică Teoretică şi Aplicată (Problems of Theoretical and Applied Genetics), Vol. XII, Chap.1, 11-43.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

LABOR FORCE UNDERUTILIZATION AS A SOCIAL AND ECONOMIC PROBLEM IN MOLDOVA

Olga SARBU[1], Liliana CIMPOIES[2]

[1]State Agrarian University of Moldova, 42 Mircesti St, Chisinau, Moldova Email: o.sarbu@uasm.md
[2]Academy of Economic Studies of Moldova, 61 B. Bodoni Blvd, Chisinau, Moldova, Email: liliana.cimpoies@gmail.com

Corresponding author: o.sarbu@uasm.md

Abstract

Human capital and labor are important factors for economic growth and social progress. Labor growth is one of the core components of economic growth. For any society, ensuring the fullest and most productive employment of the labor force is economic policy's major objective. Being a derivative market, the labor market fully reflects the national economy successes or failures. The instability of the economic indicators, the diminution of the population's standard of living and quality of life lead to a regress in the labor market. This situation is reflected in the dynamics of the employment indicators. The aim of this study is to analyze the underutilization of the labor force in the Republic of Moldova as a social and economic problem. This research is based on the analysis of the current legislative, normative acts in the Republic of Moldova. The analytical indicators calculations were made based on the data of the National Bureau of Statistics(NBS), National Agency for Labor Force Employment (NALFE). The study was carried out through a systemic approach, being applied the methods of quantitative and qualitative analysis, synthesis, systematic methods and static analysis.

Key words**:** *demographic situation, potential workforce, extended workforce, underutilization of workforce*

INTRODUCTION

Population employment and its quality depends on the level of vocational training. The economy is based on innovation and knowledge, thus, only a well-trained and skilled labor force can be competitive on the market [13]. The demographic decline in the Republic of Moldova derives from the negative evolution of the three components (birth rate, mortality, external migration) that determine the size and age structure of the population [14]. The decrease in the number of the population is a permanent phenomenon. It is caused by the decrease of the social-economic and living level, change of the individual and cultural values, external migration and population's aging. As a result, we face with a change in the structure of the population by age in favor of the older age groups, that represent a risk factor due to the increase of elderly person's share in the population's structure. The transformations in social and labor relations caused a change in the government's role in the field of employment from monopoly law in the use of labor to the free labor choice in the area, the sources of income, the voluntary choice to be a person able to work or not employed. Thus, the solution of the emerging problems that arise in this field requires a conceptual and scientific-methodological support and a more in-depth study [15]. There is a lot of research in the field, mostly descriptive, which does not reflect the impact of labor market determinants and their insufficient regulatory mechanism. Thus, this problem is actual for the Moldova, with an important practical significance. In this paper we analyze the level of involvement of the population able to work in the economic activity. The indicators used to characterize the potential of labor market are expressed in both absolute and relative size, which allows comparisons between markets, of same or different levels. The indicators expressed in absolute size are the following: the active population, the employed population and unemployed (the

unemployed active population)[13]. In relative size they are expressed through the activity rate, the employment rate and the unemployment rate.

The labor underutilization refers to differences between labor supply and demand, which is expressed by a need of unsatisfied employment among population.

Underemployed persons in relation to labor time are considered persons who meet the following criteria: they want and are available to work overtime; the hours actually worked in all activities are below the set limit.

According to some estimates, under the processes of economic globalization some changes will appear in the field of employment: a) increasing the level of initial training and adapting it to the labor market relations from the first years of training, will become an essential criteria for both the enterprises location, as well as for their ability to develop or adapt to transformations of the new production conditions and their markets; b) increasing the share of the elderly in active population (17.7% in 2017) which will intensify the pressure on the employed population; c) the principles of promoting the workers according to seniority will become inapplicable due to the active population aging in their full professional career; d) the distribution of the economic activity in the territory will become one of the essential aspects of the employment policy; f) the economic growth will guarantee a sufficient level of employment in each territorial unit. The policy of adapting the job offer to demand is of particular importance in employment. Policy instruments of adapting the supply of labor to demand can be divided into two groups: passive and active instruments [12]. Passive employment policy instruments include passive compensation expenses, such as: unemployment insurance, social assistance scheme for workers at the end of the statutory period of compensation. Initially, unemployment benefits were intended to offset income losses for a relatively short period. However, the prolongation of the duration of unemployment and the fact that an increasing number of workers, especially the elderly, cannot find a job, have reduced the amount and the duration of the compensation. The active tools of the policies to adapt the job offer to the demand are oriented to stimulate the integration of the newcomers into the labor market or the reintegration of the long-term unemployed [6]. The development of the labor market, to a large extent, depends on the economic situation of the country. It fully reflects the successes or failures that take place in the national economy. The Moldova's economy has faced a series of imbalances, changes, adjustments and readjustments, both structural and institutional, legislative, behavioral, aimed at creating and operating the new economic mechanism based on market relations, competition, increasing the competitiveness of the national economy etc [16]. At the same time, some disfunctions have been recorded as economic indicators fluctuations, decrease in living conditions and life quality as well as of the quality of human capital. The local labor market has undergone profound transformations generated by economic reforms, with direct influences on the quality of the human factor. In addition, social conditions caused the reduction of population, particularly active population and continued the ageing trend. Analyzing the structure of the active population by age groups, there are obvious trends of its aging.

MATERIALS AND METHODS

For the given research, the methodological reflections of the local and foreign scientists regarding the labor employment problem were analyzed. Also, statistical data on the labor force, from the Statistical Yearbook of the Republic of Moldova (2018) were examined. To measure labor force underutilization level in Moldova, the following indicators were calculated and analyzed: unemployment rate (LU1); the compound rate of underemployment in relation to time and unemployment (LU2); compound unemployment rate and potential workforce; (LU3) and the composite indicator of labor underutilization. (LU4) [8]. The investigation was carried out using the methods of

quantitative and qualitative analysis, synthesis, comparison and reasoning.

RESULTS AND DISCUSSIONS

The labor market is closely related to working population. To study these correlations we used indicators as: active population size, employed population, underemployed population, number of unemployed, inactive population.

The analysis of the active population during 2011-2018 has evolved differently, but recently an increase from 1,272.8 thousand people in 2016 to 1,290.7 in 2018 is observed. This fact contributed to the increase of employed population from 1,207.5 thousand people in 2016 to 1,252.2 in 2018 (Table 1). As a result, the number of unemployed decreased from 51.6 thousand people in 2016 to 38.4 in 2018.

Table 1. Evolution of the indicators regarding the relation of the working population with the labor market

	2011	2012	2013	2014	2015	2016	2017	2018
Active population, Thou. pers.	1,257.5	1,214.5	1,235.8	1,232.4	1,265.6	1,272.8	1,259.1	1,290.7
Employed population, Thou. pers.	1,173.5	1,146.8	1,172.8	1,184.9	1,203.6	1,219.5	1,207.5	1,252.2
Underemployed population, thousand persons	90.5	83.0	86.0	80.1	74.7	80.7	75.4	78.9
Unemployed, Thou. pers.	84.0	67.7	63.1	47.5	62.1	53.5	51.6	38.4
Inactive population, Thou. pers.	1,768.1	1,751.2	1,756.1	1,717.6	1,721.7	1,712.7	1,724.7	1,692,2
Including being in some reasons of inactivity:								
- searching for a job, but are not able to work	2.2	1.0	1.1	1.6	1.1	1.1	1.1	1.1
- does not search, is available to work	35.1	25.4	17.7	33.4	15.8	17.7	16.2	17.9
- want to work, but does not search for a job and is not available	5.7	4.1	3.2	10.2	6.9	13.0	12.4	9.6
- does not search for a job and is not available	1,396.8	1,388.1	1,392.3	1,355.6	1,372.5	1,361.9	1,345.8	1,358.7
- is working abroad	328.3	332.5	341.9	316.9	325.4	319.0	306.2	314.5

Source: based on data from National Bureau of Statistics.

Underemployed people are employed persons, who during some period of time would prefer to work overtime; the working time, at all the employments is below the set time limit of 40 hours; and is available to work overtime, if given the opportunity. The number of underemployed persons is 78.9 thousand, with a share of 6.2% from total employed persons. The number of people in this category decreased in 2018 by 6.5% compared to its level in 2016. Each eighth employed person (12.8%) stated that would prefer to change the situation in relation to the current workplace, because is not satisfied with the level of retribution (inadequate situation in relation to the income). Most of them (87 percent) desire a higher hourly wage. Their share of total employment accounted 11.1%, being slightly lower than the previous year (12.0%). Others are ready to work extra hours for a higher income [11].

The number of unemployed, according to the definition of the International Labor Office (ILO), is 51.6 thousand, with 3.2% lower than its level in 2016 (53.3 Thou. pers.).

Unemployment affects mostly men - 59.9% from total unemployed and mostly people living in urban areas - 64.7% [10].

In order to evaluate the level of underutilization of the workforce, it is necessary to analyze such indicators as "potential workforce" and "extended workforce".

The potential workforce includes all employed people who, during a short period of time, were neither employed nor unemployed and: carrying out "job search" activities, were "not available at the time", but they could become available in a short period of time or they were not carry out "job search activities", but they want to work and were "available at the moment" [8]. Extended workforce is defined as the sum of the workforce plus the potential workforce. (Table 2).

Table 2. Labor force indicators for 2011-2018

	2011	2012	2013	2014	2015	2016	2018	2019
Labor force, Thou. pers.	1,257.5	1,214.5	1,235.8	1,232.4	1,265.6	1,272.8	1,259.1	1,290.7
Potential labor force, Thou. pers.	35.1	37.4	26.4	18.8	16.8	17.7	16.2	17.9
Extended labor force, Thou. pers.	1,292.5	1,251.9	1,262.2	1,251.2	1,282.4	1,290.5	1,275.3	1,308.6

Source: based on data from National Bureau of Statistics.

According to the new international standard, starting with 2016, the characteristic of underutilization of the labor force is carried out by the following indicators [10]:

1.The unemployment rate:

$$\text{LU1} = \frac{unemployed}{labour\ force} * 100; (1)$$

2.The compound rate of underemployment in relation to time and unemployment:

$$\text{LU2} = \frac{underemployed\ persons + unemployed}{labour\ force} * 100; (2)$$

3.The compound rate of unemployment and potential labor force

$$\text{LU3} = \frac{potential\ labour\ force + employed\ persons}{expanded\ labour\ force} * 100; (3)$$

4.The composite indicator of underutilization of the labor force:

$$\text{LU4} = \frac{potential\ labour\ force + unemployed + underemployed\ persons}{expanded\ labour\ force} * 100; (4)$$

Labor underutilization indicators shows that the unemployment rate (LU1) registered a value of 4.1%, without significant changes compared to 2017 (4.1%) (Table 3). The unemployment rate was for men - 4.8%, and for women - 3.3%.

Table 3. Evolution of the determinants of participation in the economic activity of the working age population

	2011	2012	2013	2014	2015	2016	2017
Activity rate, %	42.3	40.7	41.4	41.2	42.4	42.6	43.3
Employment rate, %	39.4	38.4	39.3	39.6	40.3	40.8	42.0
Under-employment rate, %	7.7	7.2	7.3	6.8	6.2	6.6	6.2
Indicators of labor force underutilization							
Unemployment rate (LU1), %	6.7	5.6	5.1	3.9	4.9	4.2	4.1
The compound rate of under-employment and unemployment (LU2), %	13.9	12.4	12.1	10.4	10.8	10.5	10.1
The compound rate of unemployment and potential labor force (LU3), %	9.2	8.4	7.1	5.3	6.2	5.6	5.1
The composite indicator of underutilization of the labor force (LU4), %	16.2	15.0	13.9	11.7	12.0	11.8	11.0

Source: based on data from National Bureau of Statistics.

There are significant disparities between the average values: 5.7% in urban areas, compared to 2.7% in rural areas. Among young people (15-24 years) the unemployment rate was 11.8%. In the age category 15-29 years this indicator had the value of 8.1%, by region, we observe that they had a higher impact in Chisinau (rates LU1

and LU3), North area (rates LU2 and LU4) and Center area (rates LU2 and LU4).

Table 4. Evolution of the indicators regarding the level of participation of the working age population in the economic activity and the underutilization of the labor force by development regions in the Republic of Moldova, 2011-2016

	2011	2012	2013	2014	2015	2016
Chisinau Municipality						
Activity rate, %	54.2	54.0	53.3	51.4	51.3	49.7
Employment rate, %	49.2	49.6	50.0	48.5	47.8	46.9
Unemployment rate (LU1), %	9.3	8.2	6.3	6.0	7.0	5.7
The compound rate of underemployment and unemployment (LU2), %	12.8	11.8	9.4	9.1	11.3	9.5
The compound rate of unemployment and potential labor force (LU3), %	11.1	10.2	7.8	6.9	7.5	6.4
The composite indicator of underutilization of the labor force, (LU4), %	14.5	13.8	10.9	9.9	11.8	10.2
North Region						
Activity rate, %	39.0	38.7	39.6	40.8	44.4	44.9
Employment rate, %	37.0	36.9	38.0	39.9	42.4	43.1
Unemployment rate (LU1), %	5.2	4.6	3.9	2.4	4.5	4.0
The compound rate of underemployment and unemployment (LU2), %	15.3	14.2	12.9	10.0	10.3	12.3
The compound rate of unemployment and potential labor force (LU3), %	8.8	8.2	5.9	4.4	6.0	5.4
The composite indicator of underutilization of the labor force, (LU4), %	18.5	17.4	14.7	11.8	11.7	13.5
Center Region						
Activity rate, %	39.8	37.5	38.9	38.0	38.8	40.7
Employment rate, %	37.6	35.8	37.0	36.8	37.3	39.0
Unemployment rate (LU1), %	5.7	4.5	4.9	3.2	4.0	4.2
The compound rate of underemployment and unemployment (LU2), %	14.8	12.6	14.5	12.5	12.9	12.1
The compound rate of unemployment and potential labor force (LU3), %	7.8	7.4	6.8	4.4	5.4	5.7
The composite indicator of underutilization of the labor force, (LU4), %	16.7	15.3	16.3	13.6	14.2	13.5
South Region						
Activity rate, %	37.0	33.2	33.7	34.3	33.9	33.8
Employment rate, %	34.7	31.8	31.8	33.1	32.8	33.2
Unemployment rate (LU1), %	6.2	4.1	5.6	3.6	3.4	1.8
The compound rate of underemployment and unemployment (LU2), %	12.0	10.0	11.4	9.7	7.4	5.9
The compound rate of unemployment and potential labor force (LU3), %	8.9	6.9	8.3	5.6	5.3	4.3
The composite indicator of underutilization of the labor force, (LU4), %	14.5	12.7	14.0	11.5	9.3	8.4

Source: based on data from National Bureau of Statistics.

At the same time, in the South area were registered lower rates than the national average. According to the level of economic activity and employment, the rates of these indicators are different by region, in 2016 with decreasing trends in Chisinau compared to previous years, which includes a better involvement of the labor force in economic activities (Table 4).

If we refer to the impact expected by applying the indicators regarding the underutilization of the labor force, these will contribute to the decrease of the level of participation in the economic activity, of employment and unemployment rate, will allow to monitor more effectively the access to the paid work, as well as to the clear identification of the potential workforce (indicators LU2 and LU3). Besides the implementation of the indicators (standards) established by the International Labor Organization (ILO), the administrative data of the National Agency for Labor Force Employment (NALFE) is used. This data refers to the working

population in situation of unemployment, which also recommends some quantitative and qualitative characteristics of labor force potential [9].

Table 5. Characteristics of the indicators regarding unemployment registered by NALFE, including among young people

	2011	**2012**	**2013**	**2014**	**2015**	**2016**
Registered unemployment rate, %	3.6	2.8	1.9	1.7	2.1	2.1
Number of unemployed persons registered, persons	67,254	51,378	43,463	42,166	50,612	50,063
From which: - share of young people (16-29 years), %	35.8	35.2	35.6	33.6	32.3	31.0
Number of available places, units	28,250	35,049	37,530	41,536	42,345	44,612
Unemployed which found a job, %	20.14	30.29	38.47	38.81	33.2	35.2
Share of young people with a job, %	21.9	32.5	41.8	44.1	37.1	40.0
Young people graduates of vocational training, persons	1,630	1,828	1,822	2,037	2,089	1,960
From which: found a job compared to the trainings graduates, %	66.6	73.2	78.2	85.6	78.2	93.7
School graduates, persons	691	691	702	383	680	560
including: in % the share of those who found a job from those registered	22.1	27.5	35.5	75.5	31.9	65.5
Graduates of secondary vocational schools. persons	230	218	185	92	216	126
including: the share of those that found a job comparing to the registered ones. %	20.4	22.0	44.3	52.2	28.2	57.9
Graduates of specialized higher education institutions (colleges), persons	101	98	85	46	65	54
including: the share of those which found a job comparing to registered ones, %	25.7	40.8	57.5	65.2	49.2	44.4
Graduates of higher education institutions, persons	404	335	353	178	267	177
including: the share of those who found a job comparing to registered ones, %	26.0	47.8	41.6	53.9	37.4	41.2
Coefficient of labor force replacement (the ratio of employees / released)	1.008	0.990	1.032	1.030	0.950	0.972

Source: based on data from NALFE.

Almost one third of registered unemployed people are young people who require vocational training to be placed in the labor market (Table 5). One of the reasons for the underutilization of the labor force is the established working regime, particularly the incomplete regime (partial, temporary employment, etc.). The working regime with the most complete employment was registered in 2015-2016, when about 94.0% of the employed population worked a full day, and 6%, worked partially (part -time). Naturally, the situation of the working regime for the analyzed period was uneven and in 2011-2015 there is a tendency of increase in the share of employees with the weekly working regime 0-30 hours, in 2016 the share of employees with the working regime 40 hours and over 75.1% of the total number of employees.

The normal working time of the employees cannot exceed 40 hours per week according to art. 95-97 of the Labor Code of the Republic of Moldova [1]. For some categories of employees, depending on age, health status, working conditions or other circumstances, according to the labor legislation, and the individual employment contract, the reduced working time is established to: 24 hours for

employees aged 15 to 16, 35 hours for employees aged 16 to 18, as well as 35 hours for employees working in harmful working conditions according to the nomenclature approved by the Government, including for certain categories of employees whose work involves increased intellectual and psycho-emotional effort [5].

Table 6. Characteristics of the working regime of the employed population and of the employees (weight of the population with the respective working regime in% compared to the employed / total employee)

Week duration	2011	2012	2013	2014	2015	2016	2011	2012	2013	2014	2015	2016
	Employed population						**Employee**					
0-20 hours	7.7	8.0	8.4	8.3	9.0	8.5	7.5	8.1	8.6	8.7	9.6	8.9
21-30 hours	12.6	14.3	15.5	15.7	17.0	18.1	5.9	6.8	6.9	6.9	6.7	5.8
31-39 hours	12.1	11.6	12.2	14.3	15.2	14.8	8.0	7.3	7.9	9.4	11.9	10.1
40 hours	40.1	40.7	38.0	36.3	32.9	34.9	52.4	52.9	50.9	49.4	45.9	50.4
Over 41 hours	27.5	25.4	25.9	25.4	25.9	23.7	26.2	24.9	25.7	25.6	26.0	24.7
0-30 hours	20.3	22.3	23.9	24.0	26.0	26.6	13.4	14.9	15.5	15.6	16.3	14.7
Over 40 hours	67.6	66.1	63.9	61.7	58.8	58.6	78.6	77.8	76.6	75.0	71.9	75.1
	Employed population in urban area						**Employed population in rural area**					
0-20 hours	7.0	7.4	7.9	7.9	9.1	8.4	7.5	8.8	9.0	8.4	9.1	9.0
21-30 hours	5.9	8.0	7.6	7.1	8.2	8.2	18.7	20.1	22.5	22.9	24.6	26.4
31-39 hours	8.6	7.9	8.4	10.3	12.4	11.0	15.2	15.0	15.5	17.6	17.6	18.0
40 hours	52.7	52.6	51.1	49.6	43.1	47.2	28.7	29.4	26.3	25.4	23.9	24.6
Over 41 hours	25.8	24.1	25.0	25.1	27.2	25.2	29.9	26.2	26.7	25.7	24.8	22.0
0 – 30 hours	12.9	15.4	15.5	15.0	17.3	16.6	26.2	28.9	31.5	31.3	33.7	35.4
Over 40 hours	78.5	76.7	76.1	74.7	70.3	72.4	58.6	55.6	53.0	51.1	48.7	46.6

Source: based on data from National Bureau of Statistics.

A reduced working time or 30 hours per week was foreseen for 1st and 2nd degree disabilities, as well as the part-time day or part-week work, can be established by the agreement between the employee and the employer, considering some circumstances due to the state of health, childcare or care of a sick family member, according to the medical certificate. According to the legislation, the remuneration of the work of the aforementioned employees in these cases (article 97 of the Labor Code) is carried out in proportion to the time worked or according to the volume of the work done, without limiting the rights to the calculation of the seniority in work or the contribution period (except the cases provided for by the legislation in force), the duration of the annual rest leave or other work rights.

From the analysis of the work regime for 2016, it appears that only 75% of the employees with the complete work regime have the minimum wage guaranteed in full volume, and on the other hand - depending on the hours worked or about 25% of the employees have the regime of working up to 30 hours weekly (Table 6).

According to the Wage Law [8], a guaranteed minimum wage (12, 13) was approved calculated based on the average working time of 169 hours per month. Therefore, "part-time" working regime is a social problem, because the employees within this category and the members of their families, most

likely, fall into the category of vulnerable social groups, situated at "poverty risk" [6].

Table 7. Distribution of employees according to the salary size calculated annually for the month of September

Persons that received wage in the amount of	2013	2014	Persons which received wage	2015	2016 Total	Including in	
						Budgetary sector	Real sector
until la 900 MDL	0.5	0.2	until 1,000.0 MDL	0.2	0.1	0.01	0.10
900.1–1,200 MDL	6.2	4.4	1,000.01–1,500.0 MDL	6.7	4.3	12.67	0.42
1,200.1–1,600 MDL	16.2	7.6	1,500.01–2,000.0 MDL	13.4	6.0	12.87	2.77
1,600.1–2,000 MDL	11.2	15.7	2,000.01–2,500.0 MDL	11.8	16.4	8.49	20.13
2,000.1-3,000 MDL	20.8	20.0	2,500.01–3,000.0 MDL	10.8	10.7	8.56	11.64
3,000.1–4,000 MDL	16.5	16.5	3,000.01–4,000.0 MDL	16.5	16.2	13.30	17.51
4,000.1–5,000 MDL	11.6	13.1	4,000.01–5,000.0 MDL	13.4	13.8	14.43	13.52
5,000.1–6,000 MDL	6.7	8.5	5,000.01–6,000.0 MDL	9.9	10.6	13.88	9.10
over 6,000 MDL	10.3	14.1	6,000.01-7,000.0 MDL	6.0	7.2	8.09	6.75
			7,000.01–8,000.0 MDL	3.5	4.5	3.95	4.81
			8,000.01–10,000.0 MDL	3.4	4.4	2.34	5.37
			over 10,000.0 MDL	4.4	5.8	1.41	7.88
Average wage calculated in September for personnel who worked a whole month, MDL	3,552.1	3,981.0	Average wage calculated in September for personnel who worked a whole month. MDL	4,379.8	4,850.1	3,926,9	5,284,8
Minimum amount of existence of working population, MDL	1,710.0	1,726.8	Minimum amount of existence of working population. MDL	1,842.2	1,914.7		

Source: based on data from National Bureau of Statistics.

Thus, to evaluate the employment level, its characteristics, specificity and consequences in the field is needed. This problem should be "priority" of public authorities dealing with labor policies and of society next to unemployment, as a characteristic of not using the potential of the labor force, being formally employed under the conditions of the full time job, as well as to evaluate the demand and supply of labor force in the process of economic development.

From the analysis of the statistical data obtained from the annual research in the month of September, which includes the people who worked a full month full-time, it is observed that for September 2016, about 10% of employees and about 25% of employees in the budget sector have wages smaller than the minimum amount of existence of the working population (in 2013-2014 the share of employees whose salary was up to 2,000 MDL had a share of 34.1% and 27.9% respectively (Table 7).

Employed people that receive a salary equal or less that the existence minimum (1,600 MDL) registered a share of 22.9% in 2013 and 12.2% in 2014. In 2015, employed people that benefited from salaries level until 2,000 MDL had a share of 20.3%, which decreased in 2016 to 10.4%. In 2016, the share of persons that received a wage up to 2,000 MDL was of 25.6% for the people employed in budgetary sector, while 3.3% were employed in the real sector. The reason for the appearance of such a gap is related to the formation of the current retribution system. The wage amount received by people employed in the budgetary sector is based on minimum wage law, this amount constituted 1,000 MDL on October 1, 2014, being valid also during the period 2015-2016. Regarding the wage amount received in the real sector, it is based on the minimum wage and is reviewed by the Government according to the increase of labour productivity at national level and the consumer price index [7].

In 2015 was reviewed the minimum wage amount received in the real sector. That amount increased to 190 MDL or 11.25 MDL per hour [2]. Furthermore in 2016 the minimum wage amount for real sector is raised at 2,100 MDL or 12.43 MDL per hour [3]. The latest change in the monthly minimum wage occurs in 2017, its amount being of 2,380 MDL or 14.09 MDL per hour for a full working week of 169 hours [4].

According to the legislation, the amount of the tariff salary is different among sectors. Thus, the tariff salary for workers under first category in the budgetary sector is 2.4 times greater than the labour retribution in the real sector (Table 7).

Such a situation, when the salary has lost its role of labor motivation and reproducing the qualitative capacities (natural, intellectual, professional, etc.) of labor force, is main cause of phenomenon as labor migration, particularly among young people, as well as being in a state of economic inactivity, which contributes to the increase of the underutilization of the labor force.

CONCLUSIONS

The labor market represents an important place in the modern economic development.. Sustainable socio-economic development is impossible without an efficient and competitive labor market, and the change of this market takes place simultaneously with the development of other resources markets or with a driving force, such as human resources, the manpower, that in the long run has acquired a high qualification and financial independence.

In Moldova, the labor market, being a derivative of the economic development, has some particularities due to its formation was during the transition to the market economy it was affected by different forms of labor force involvement in economic activity and the efficiency of its use. The application of new indicators of underutilization of the working population gives the possibility to highlight the potential and extended workforce. At the same time, the lack of equitable systems of labor remuneration, the low wage level, the imperfect labor regime contributes to the exclusion of and labor force active part from the market and to labor migration abroad in search of better possibilities.

To improve the situation on the labor market, decrease underemployment, increase the efficient functionality and ensure the market competitiveness is needed:

-to develop a scientific mechanism to determine the labor force demand and supply;
-to establish and develop the Labor Market Observatory, the objective of which will contribute to the analysis of the economic and employment area, the elaboration of the labor market forecasts etc;
-to maintain and extend employment, ensuring the matching of labor supply and demand, applying different flexible forms of employment and incentives to active job search by the unemployed;
-to streamline the forms of development of the partnership and social dialogue in order to improve the situation on the labor market by correlating the interests of the social partners, protecting the labor rights, actively involving the social partners in the practical solution employment policies;
-to improve the legal and normative framework regarding labor retribution according to the experience of other countries, to determine the real cost of the workforce taking into account the advanced social standards.

REFERENCES

[1]Codul Muncii al Republicii Moldova, Legea nr.154-XV din 28 martie 2003. Monitorul Oficial al Republicii Moldova, 2003, nr.159-162, art. 648 (Labor Code of the Republic of Moldova, Law no. 154-XV of March 28, 2003. The Official Monitor of the Republic of Moldova, 2003, no. 159-162, art. 648).

[2]Hotărîre al Guvernului Republicii Moldova nr.219 din 29 aprilie 2015 „Cu privire la modificarea punctului 1 din Hotărîrea Guvernului nr.165 din 9 martie 2010". Monitorul Oficial al Republicii Moldova, 2015, nr.105-109, art.230 (Decision of the Government of the Republic of Moldova no.219 of April 29, 2015 "On the modification of point 1 of the Government Decision no.165 of March 9, 2010". Official Gazette of the Republic of Moldova, 2015, no. 105-109, art. 230).

[3]Hotărîrea Guvernului Republicii Moldova nr.488 din 20 aprilie 2016 „Cu privire la modificarea punctului 1 din Hotărîrea Guvernului nr.165 din 9 martie 2010". Monitorul Oficial al Republicii Moldova, 2016, nr.114-122, art. 544 (Government Decision of the Republic of Moldova no.488 of April 20, 2016 "On the modification of point 1 of the Government Decision no.165 of March 9, 2010". Official Gazette of the Republic of Moldova, 2016, no. 114-122, art. 544).

[4]Hotărîre a Guvernului Republicii Moldova nr.242 din 26 aprilie 2017 "Cu privire la modificarea punctului 1 din Hotărîrea Guvernului nr.165 din 9 martie 2010".

Monitorul Oficial al Republicii Moldova, 2017, nr.134-143, art.321 (Decision of the Government of the Republic of Moldova no. 242 of April 26, 2017 "On the modification of point 1 of the Government Decision no. 165 of March 9, 2010". Official Gazette of the Republic of Moldova, 2017, no. 134-143, art. 321).

[5]Hotărîre al Guvernului Republicii Moldova nr.1473 din 30 decembrie 2016 "Cu privire la aprobarea Strategiei naţionale privind ocuparea forţei de muncă pentru anii 2017–2021". Monitorul Oficial al Republicii Moldova, 2017, nr.109-118, art.272 (Decision of the Government of the Republic of Moldova No. 1473 of December 30, 2016 "On the approval of the National Strategy for employment for the years 2017-2021". Official Gazette of the Republic of Moldova, 2017, no. 109-118, art. 272).

[6]Iorga, A., Toma, E., Dobre, C., Muscănescu, A., 2014, Rural labor force size and structure analysis. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 14 (2), pp.169-172.

[7]Legea salarizării nr.847-XV din 14 februarie 2002. ÎMonitorul Oficial al Republicii Moldova, 2002, nr.50-52, art.336 (Salary Law no. 847-XV of February 14, 2002. Official Gazette of the Republic of Moldova, 2002, no. 50-52, art.336).

[8]Legea Republicii Moldova nr.355-XVI din 23 decembrie 2005 „Cu privire la sistemul de salarizare în sectorul bugetar". În: Monitorul Oficial al Republicii Moldova, 2006, nr.35-38, art.148(Law of the Republic of Moldova no. 355-XVI of December 23, 2005 "On the system of remuneration in the budgetary sector". In: Official Gazette of the Republic of Moldova, 2006, no.35-38, art.148).

[9]National Bureau of Statistics, 2017, Metodologia anchetei asupra forţei de muncă în gospodării (Methodology of the household labor force survey).

[10]National Bureau of Statistics (2019). Labour force in the Republic of Moldova. Employment and unemployment.

[11]National Bureau of Statistics, Labour underutilisation in the Republic of Moldova. https://statistica.gov.md/newsview.php?l=ro&idc=168&id=5208. Accessed on 01.02.2020.

[12]Rusali, M., 2015, Major developments of Romania's agricultural sector within EU 27 – comparisons post-accession. Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 15 (3):275-277.

[13]Sârbu, O., 2012, The reflection of rural population's occupational situation at its revenues and expenditures level. Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 12 (4):

[14]Sârbu, O., 2013, Economic and social aspects of the demographic ageing process in the Republic of Moldova. Scientific Papers Series Management, Economic Engineering in Agriculture and rural development, Vol. 13(1):353-360.

[15]Sârbu, O., 2013, Particularities of employment in rural areas of the Republic of Moldova. Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 13(1):361-370.

[16]Sârbu, O., Cimpoies, L., 2017, Poverty reduction in rural areas through agricultural development: evidence from Moldova. Journal "Agriculture and Forestry", 64(1), pp. 81-88.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ANALYSIS OF THE PADDY FARMERS' KNOWLEDGE ABOUT INTEGRATED WEED MANAGEMENT (IWM)

Iman SAYADMANSOUR, Mohammad Sadegh EBRAHIMI

Isfahan University of Technology, College of Agriculture, Department of Rural Development,
Emails: iman.sayadmansour@yahoo.com, ebrahimi_ms@iut.ac.ir

Corresponding author: ebrahimi_ms@iut.ac.ir

Abstract

In the recent years chemical control of weeds has become a dominant method of weed control. The heavy use of these chemicals has had a negative impact on the environment and human health. So this study tries to investigate the analysis paddy farmers' knowledge about integrated weed management (IWM) in Iran. The study was done by a descriptive-surveying method that including field and documentary data. The population of the study consisted of selected Dooreh - CHegeni farmers that cultivation wheat and rice together. Sample population was selected by using the Cochran formula (n=198). The main instrument used in this study was a questionnaire. The validity of research tool was obtained by the idea of experts and for reliability of questionnaires a pilot test was conducted. The Cronbach' Alpha coefficient of higher than 0.7 showed that research tool was reliable (learning style (0.818), economic characteristic (0.700) and social characteristic (0.723) respectively). The result of correlation analysis showed that the variables such as: belief in discussion with other farmers about sustainable weed management, the importance of dialogue and implement the recommendations of experts, quality and quantity of extension programs, attitude towards the impact of SWM (Sustainable Weed Management) on healthy crop production and farmers 'attitude toward the effects of this type of management on increasing production has a significant effect on farmers' awareness of integrated weed management in the field The results also showed that farmers' use of appropriate seed (weed-free) and farmers' appropriate attitude toward discussion with other farmers about integrated weed management in the field is the most important variable could be predicted the rice farmers' knowledge of IWM(Integrated Weed Management) in the field.

Key words**:** *integrated weed management (IWM), paddy farmers, knowledge management*

INTRODUCTION

Integrated weed management (IWM) is a new approach for cropping systems to weed management that relies on essential knowledge for its implementation and focuses on crop health and safe production in fields. It can be viewed as a series of interactions among several weed control components. It is inclusive, taking into account agronomy and social, economic, and environmental issues. In other words it is an interdisciplinary and multidisciplinary subject. Simply defined, IWM can be thought of as the ‘‘use of many little hammers” [19]. "The philosophy of sustainable agriculture is gaining ground in a world becoming acutely aware of finite fossil fuel resources and adverse impacts of agriculture and other industries on the environment. In spite of substantial advances in productivity through applications of fertilizers, pesticides, and irrigation, it is necessary to realize that inappropriate or excessive use of these inputs can have unexpected and undesirable effects on the environment, natural ecosystems, and the world's human inhabitants. Therefore, the concept of sustainable agriculture is to develop the systems that will provide for our needs without endangering the quality of life of future generations"[14]. Sustainable agriculture has raised as a major challenge of the 21st century to meet these complications and natural and human difficulties; that is, agriculture should be consumed less and be sustainable more [14]. In the present century, the most important concern in the international community is the detrimental impact of human activities on the world's natural resources and environment. Experience of recent decades of advanced agricultural technology activities has shown that such activities cause: erosion and destruction of soil, air pollution and water

loss, destruction of marine ecosystems, destruction of natural habitats for plants and animals and also the pest resistance against insecticide and pesticide [1]. Basically integrated weed management or sustainable weed management on the farm seeks to develop a systematic strategy for farmers to use less and less herbicides at the farm level. In this respect, several approaches can be emphasized in order to make the farm more sustainable. One of the most important is the creation of better knowledge and knowledge about the agricultural ecosystem for farmers. It is important for the farmer to change his or her current practices and practices in weed management and to assist in sustainable farm management by choosing more effective strategies such as using other weed control techniques. Integrated weed management emphasizes the proper use of all physical, agronomic, biological and chemical methods to reduce weed damage [21].

Rice (Oryza sativa L.) is now a staple food for a population of nearly 3 billion people worldwide. Roughly half of the world's population use rice as their main source of food. The amount and per capita consumption of rice in many countries, especially Asian countries, is higher than in other parts of the world [8]. In Iran, rice is, after wheat, the second major source of food for people. So that the Iranian basic goods it covers include wheat, rice, crude oil and raw sugar. In resent sutdied indicated the total 14,000 tonnes of agriculture pesticides were annually used in Iran. Herbicides constituted the largest volume (43%) [20]. Iran accepted the Basel convention 1992 and became a party to the Rotterdam Convention in 2004. The Plant Protection Organization, as a part of the Ministry of Jihad-e- Agriculture, established in 1967, has been in charge of programming pesticide usage strategies and securing the pesticide use based on international conventions. It has also been the authority responsible for supervising the import, production and distribution of pesticides; managing, supervising and legislating phytosanitary quarantine, and providing technical recommendations for both chemical and biological controls [8]. Considering chemical pesticide usage in Iran indicates the highest consumption of chemicals in the paddy fields. Since pesticides can pose serious threats to human health and the environment, therefore the paddy farmers' knowledge about integrated weed management is very important [9]. Research results in Iran and other underdeveloped countries show that this amount of paddy farmers' knowledge about integrated weed management is undesirable [3, 7, 10].

Literature review

Wilson et al (2009) studied the acceptance of integrated weed management by farmers. The results of their research showed that farmers have a good understanding of the need to adopt integrated weed management on the farm but do not apply this type of management. This failure may be due to a gap in farmers' understanding of the human role in weed dispersal, with no belief that this type of management can pose serious risks to the management of the farm, natural resources and environmental risk [21]. Sinzogan et al (2004) surveyed farmers' knowledge and perceptions of pest management in the field. They state that farmers obtain information on pest and disease management using informal networks and channels. The most common and most effective type of information acquisition has been the use of informal contacts with other farmers. The results of the study indicated that farmers do not have an understanding of the key concepts of pest control systems. However, they were keen to share their knowledge, insights, and practices in pest management [18].

Borkhani et al (2011) investigated the application of integrated pest management (IPM) practices of paddy farmers. The results revealed that strategies based on education can be an efficient approach, provided that farmers have direct access to quality training and The results also emphasize that variables such as: level of education of the farmer, the participation of the farmer in training and extension courses, amount of belief and attitude of the farmer about the effectiveness of integrated pest and disease management as

well as the level of income of the farmer can be the most important predictors to related the rate of application of integrated pest and disease management by rice farmers [2]. The result of Rejaul & Bakshi (2005) research found that It can be stated that there are as many variables as: farmers' participation in farm management activities, the participation of the farmer in training and extension courses, farmer's education level, farmer's age, farm comparisons and their involvement with local management. In contrast, variables such as: agricultural experience and poor health have a negative impact on the adoption of integrated pest and disease management by the farmer [15]. Pouratashi and Iravani (2012) studied the farmers' knowledge and perception of integrated pest management in Iran. The result of this reseach showed that the amount of agricultural pesticides consumed in Iranian farms is high and the farmers, although the farmers were to some extent aware of the side-effects of the excessive use of chemical fertilizers and pesticides, they still continued utilizing chemical inputs due to the shortage of knowledge of and little access to the alternative or sustainable techniques and facilities [13].

Fami et al. (2010) conducted a research with the objective to study the farmer's attitude on sustainable agriculture and its determinants. The results of study showed that Iranian farmers have a shortage of information about the appropriate spray time and use pesticides and herbicides . Also the result ahowed there is a positive correlation between literacy, participation in extension courses, farmer's knowledge about sustainable agriculture, level of use of sustainable agriculture methods, extensive contacts and job satisfaction and negative correlation between age, experience in agricultural activities and agrarian land with attitude toward sustainable agriculture [5]. Borkhani et al (2013) investigated the socio-economic factors affecting the adoption of integrated pest management innovations by rice farmers. The results of their research showed that socio-economic and institutional factors influence farmers' adoption decisions of IPM innovation. Also their results showed that variables such as: the extent of farmer participation in social activities and the presence of strong local leaders in the area can have a positive and significant impact on farmers' adoption decisions of integrated pest management innovations [2].

Kotile & Martin (2012) investigated the best practices for sustainable weed management in the field by farmers. The result showed that a majority of respondents use sustainable agricultural practices associated with weed control, and continued to show interest in learning about those practices they consider sustainable. Respondents are likely to get interested in learning about the practices they already use [9]. Jabbour et al (2014), in their research, they examined farmers' knowledge and perceptions of weed management. Their research results showed that farmers' knowledge and understanding of total seed density can be predicted. The result of this reseearch showed that the farmers used less seed densities, discussing more about weed management with other farmers, especially about the dangers of weeds, as well as the important benefits of weed-free management. They usually use the method of weed management practices, and learning from their own experience and extension workers. These farmers usually had more knowledge about weed management and also showed a greater understanding of the importance of using about integrated weed management (IWM)[6].

The result of Mortezaie et al (2017) showed Iranian farmers use more than 14,000 tonnes of agricultural pesticides annually on their farms. In Iran's agricultural fields, the most commonly used pesticides are: Herbicides constituted the largest volume about 6,000 tonnes annually (42%), followed by insecticides and acaricides about 5,000 annually (38%) and in the third place fungicides about 3,000 tonnes annually (20%) [11]. Integrated and sustainable weed management in Iranian farms can not only reduce the use of herbicides but also reduce the environmental risks.

Singh et al (2018) studied the Adoption of integrated weed management practices correlates with farmers profile characteristics. The result of this research showed that a positive and significant correlation between level of adoption of respondents on overall IWM practices with other variables such as: age, education, farm size, training, extension contact, mass media exposure, input availability and innovativeness were noticed [17].

MATERIALS AND METHODS

The purpose of this study was to analysis the paddy farmers' knowledge about integrated weed management (IWM). The study was carried out in 2014 in Dooreh-Chegeni County, located in the Lorestan province in Iran. The instrument used for the collection of the data was a questionnaire. The questionnaires designed for wheat producers who were living in the study area (N=1,650) [4].

Applying a multistage sampling technique, 198 farmers were randomly selected. Developments of the items in the questionnaire were based upon a comprehensive review of the literature, suggestions made by researchers in agricultural education and sociology, and the experience of the researchers. The respondents were asked to respond to statements regarding the knowledge about sustainable weed management in wheat for weed control. The statements were measured using a Likert-type scale (1-5) to indicate whether the respondents have knowledge about sustainable weed management in wheat. Descriptors for the scales were as follows: 1 = not at all, 2 = very little, 3 = sometimes, 4 = often and 5 = always for the knowledge scale [16].

The respondents also answered some questions on the demographic characteristics, including educational level, age and etc. In order to establish its content validity, the questionnaire was reviewed by the researchers. Clarity and the readability of the instrument were improved after the review. The reliability coefficient for the knowledge of sustainable weed management scale was 0.85, indicating a good level of reliability. The results of the Alpha coefficients (shown in Table 1) indicated that the selected scales were appropriate.

Table 1. Reliability Analysis (Alpha)

Scale Name	No. Of items	Alpha Value
Learning style	17	0.818
Economic characteristic	23	0.700
Social characteristic	12	0.723

Source: the result of this research.

Data were analyzed descriptively and inferentially using SPSS (Statistical Package for Social Science) for Windows, version 21. This procedure yielded percentages, means, and standard deviations, and The Spearman correlation procedure to determine whether there was a significant relationship between some of the demographic characteristics and the variables in the study. Also, in this study, used in the stepwise regression for data analysis.

RESULTS AND DISCUSSIONS

According to research result, more than 39% of the respondents were middle-aged. Also, age mean of the answers were about 45 years. The educational level of respondents was in primary school level. Literate and primary school farmers had the highest (59.6%) and only 4.5% of farmers have post high school educations (Fig 1).

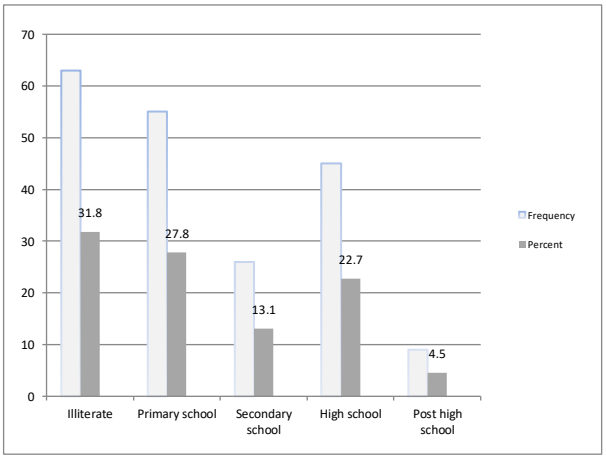

Fig.1. Distributional pattern of respondents' Educational level
Source: the result of this research.

Attention to Table 2, distributional pattern of respondents' agricultural work experience showed that farmers have about 18 year agricultural work experience.

Table 2. Distributional pattern of respondents' Agricultural work experience (years)

Agricultural work experience (years)	Frequency	Percent	Cumulative percent
10<	40	20	20
10-20	56	29	49
20-30	53	27	76
>30	49	24	100
Plural	198	100	-
Mean	18.44	-	-
Standard deviation	10.566	-	-
Minimum	2	-	-
Maximum	41	-	-

Source: the result of this research.

Results (Table 3) showed a few farmers (only 5.6 percent) had above 2 hectare cultivation paddy field. The main cultivation of respondents' was 0.65, ranging from 0.25 to 3 hectares.

Correlation analysis was used to analyze the relationship between the variables. Table 4 demonstrates a significant correlation between paddy farmers' knowledge about integrated weed management with independent variables. Spearman coefficient of correlation was used to determine the relationship between the independent variables and other variables.

Table 3. Distributional pattern of respondents' based on cultivation paddy field

Cultivation (hectare)	Frequency	Percent	Cumulative percent
1<	153	77.3	77.3
1-2	34	17.2	94.4
>2	11	5.6	100
Plural	198	100	-
Mean	0.65	-	-
Standard deviation	0.490	-	-
Minimum	3	-	-
Maximum	0.25	-	-

Source: the result of this research.

Based on the results, there is a positive and significant relationship at 95 percent level of confidence between the variable of paddy farmers' knowledge about integrated weed management with other independent variables such as: level of importance of dialogue and implement the recommendation of experts, quality and quantity of extension programs, attitude towards the effects of sustainable weed management in crop health and level of attitude towards the effects of sustainable weed management in increasing production in fields. In addition, there is a positive and significant relationship at the 99 percent level between a variety of belief in discussion with other farmers about weed management and knowledge of integrated weed management (Table 4).

Table 4. Relationship between the respondents' knowledge level and selected independent variables (Spearman's correlation)

Independent variables	Coefficient of Correlation	Level of significance
Belief in discussion with other farmers about sustainable weed management	0.272**	0.000
The importance of dialogue and implement the recommendations of experts	0.214*	0.002
Quality and quantity of extension programs	0.147*	0.039
Attitude towards the effects of sustainable weed management in crop health	0.148*	0.038
Attitude towards the effects of sustainable weed management in increasing production	0.167*	0.018

*Significant at 0.05 levels **Significant at 0.01 levels
Source: the result of this research.

Step by step multiple regression analysis was used to analyze the paddy farmers' knowledge of integrated weed management. In this method, the independent variables having a significant relationship with the dependent ones are entered into the equation to evaluate the each one`s role in the independent variable. Thus, the multiple stepwise regression method was used to evaluate the role of 6 independent variables having a significant relationship with the dependent farmers' knowledge in IWM one. Based on the regression results, as illustrated in table 5.

According to the results, in the first step, the percent of knowledge the use of pure seed (X1) with 0.195 coefficients of determination was taken into the analysis. At the second

steps, the amount familiar with using crop rotation was analyzed (X2). This variable specified about 6.5% of the changes related to the dependent variable.

Table 5. Step by step regression analysis of conformity of the level farmers' knowledge in IWM

Steps	R	R2
1	0.442	0.195
2	0.509	0.260
3	0.563	0.317
4	0.584	0.341
5	0.599	0.358
6	0.614	0.377

Source: the result of this research.

Table 6. Influential factors on conformity of the paddy farmers' knowledge about integrated weed management

Independent variables	Unstandardized coefficients		Standardize coefficients	Calculated T	Level of significance
	B	Std. Error	Beta		
Constant number	32.604	2.552	-	12.778	0.000
(X1)	2.505	0.395	0.371	6.338	0.000
(X2)	1.051	0.392	0.168	2.684	0.008
(X3)	1.394	0.418	0.197	3.331	0.001
(X4)	0.935	0.399	0.136	2.344	0.020
(X5)	1.143	0.468	0.151	2.439	0.016
(X6)	1.045	0.436	0.141	2.400	0.017

**P<0.01 *P<0.05
Source: the result of this research.

At the three steps, variables of belief in discussion with other farmers in the integrated weed management (X3) were analyzed. This variable specified 5.7% of the changes related to the dependent variable. At the fourth steps, variables of extension activities (Skilled farmers) (X4) were analyzed. This variable specified 2.4% of the changes related to the dependent variable. At the fifth steps, variables of amount familiar with using flooded (X5) was analyzed. This variable specified 1.7/% of the changes related to the dependent variable. At the sixth steps, variables of attitude towards the effects of sustainable weed management in increasing production (X6) were analyzed. This variable specified 1.9% of the changes related to the dependent variable. Regression of variables was led to a linear equation analyses of these total variables showed that they specify about 37.7% of the changes related to conformity of the paddy farmers' knowledge about integrated weed management in fields.

Analyzing β of the changes showed that knowledge the use of pure seed (X1) is the most influential variable. Other results are shown in tables (5) and (6).

According to the regression coefficient the regression line equation could be written as:

$$Y= 32.604 + 2.505\ X1+ 1.051\ X2+ 1.394\ X3+ 0.935\ X4+ 1.143\ X5+ 1.045\ X6$$

CONCLUSIONS

The findings of this study indicated that more than 39% of the respondents were middle-aged. Farmers have about 18 year agricultural work experience and a respondents' educational level illiterate and primary school farmers had the highest (59.6%). The result of correlation analyzed showed that there are positive and significant relationships between variables such as: belief in discussion with other farmers about sustainable weed management, the importance of dialogue and implement the recommendations of experts, quality and quantity of extension programs, attitude towards the effects of sustainable weed management in crop health and also attitude towards the effects of sustainable weed management in increasing production have positive significance effect. The results of regression analysis to predict the behavior of farmers accepting innovation of integrated weed management in the field show that variables such as: the amount of pure seed used by paddy farmers also believe that discussion with other farmers in integrated weed management can be influenced the farmers knowledge and awareness about IWM(integrated weed management). However, the results of the study emphasize that the extent of farmers' participation in training and extension activities and the use of extension activities can also help to develop a proper attitude towards the application of integrated weed management by rice farmers. the effects of integrated weed management in

increasing production in fields could explain the most variation in the extent of IWM practice application by paddy farmers. Therefore, it is recommended to use FFSs and extension workshops could be increasing the wheat producers' knowledge toward IWM practices. It seems the farmers like to view the tangible effects in integrated weed management your field by the increased of their paddy field production.

ACKNOWLEDGMENTS

This study was based on a research project financially supported by Isfahan University of Technology, Iran, which is highly appreciated.

REFERENCES

[1]AL-Subaiee, S. S., Yoder, E.P., Thomson J.S., 2005, Extension agents' perceptions of sustainable agriculture in the Riyadh Region of Saudi Arabia. Int. J. Agric. Extent. Educate. 12, 5-13.

[2]Borkhani F. R., Rezvanfar A., Fami H. SH. and Pouratashi M. 2013. Social Factors Influencing Adoption of Integrated Pest Management (IPM) Technologies by Paddy Farmers. Int. J. Agric. Manage. Develop. (IJAMAD), 3(3):211-218.

[3] Chizari, M., Ommani, A. R., Noorivandi, N. A. 2006,XAnalysis technical knowledge of farmers regarding dryland sustainable agriculture in Khuzestan province of Iran. International Symposium on Drylands Ecology and Human Security Perspectives, Policy Responses and Sustainable Development in the Arab Region, Challenges and Opportunities, Dubai.

[4]Ebrahimi, M. S., 2015, Agricultural development management. Isfahan. Amokhteh Publisher.

[5]Fami, H.SH., Asadi, A., Sadati, S. A., 2010, Farmer's Attitude on Sustainable Agriculture and its Determinants: A Case Study in Behbahan County of Iran. Res. J. Appl. Sci. Engineer. Technol. 2(5):422-427.

[6]Jabbour, R., Gallandt, E. R., Zwickle, S., Wilson, R., Doohan, D., 2014, Organic Farmer Knowledge and Perceptions are associated with On-Farm Weed Seed bank Densities in Northern New England. Weed Sci. 62(2), 338-349.

[7]Khalid, A. 2002. Assessing the long-term impact of IMP farmer field schools on farmer's knowledge, attitudes and practices: A case study from Gezira scheme, Sudan. International learning workshop on farmer field schools, Emerging issues and challenges, Yogyakarta, Indonesia. Oct. 21-25.

[8]Khush, G. S., 2004, Harnessing Science and Technology for Sustainable Rice-based Production System. In: Proceedings of FAO Rice Conference. International Rice Commission Newsletter.

[9]Kotile, G., Martin, R., 2008, Sustainable Agricultural Practices for Weed Management: Implications to Agricultural Extension Education. J. Sustainable Agric. 16, 31-51.

[10]Mancini, F., Van-Bruggen, A. H. C., Jiggins, J. L. E. 2006. Evaluating cotton integrated pest management (IPM) farmer field schools outcomes using sustainable livelihoods approach in India. Cambridge University Press. Agric. Journal, 43: 97-112.

[11]Mortezai, Z., Mosavi, S B., Baghestani, M A., Atoti, A. 2017. An assessment of agricultural pesticide use in Iran, 2012-2014. J Environ Health Sci Eng. 2017; 15: 10.

[12]Plant Protection Organization, 2005, Country report of Islamic Republic of Iran. Sub-regional workshop on the implementation of Stockholm Convention and synergies with other Chemicals related conventions, 21-24 February 2005, Cairo, Egypt.

[13]Pouratashi, M., Iravani, H., 2012, Farmers' Knowledge of Integrated Pest Management and Learning Style Preferences: Implications for Information Delivery. Int. J. Pest Manage. 58(4): 347-353.

[14]Rasul, G., Thapa, G.B., 2004, Sustainability of ecological and conventional agricultural systems in Bangladesh: An assessment based on environmental, economic and social perspectives. Agric. Systems. 79, 327–351.

[15]Rejaul, H., Bakshi, K., 2005, Pest Management, Productivity and Environment: A Comparative Study of IPM and Conventional Farmers of Northern Districts of Bangladesh. Pak. J. Soc. Sci. 3(8):1007-1014.

[16]Sayadmansoure, I., Ebrahihmi, M.S., 2017, Investigation of wheat producers' knowledge about sustainable weed management. Int. J. Sustainable Society. 9(2):165-177.

[17]Singh, P. K., Gharde, Y., Choudhary, V.K. 2018, Adoption of integrated weed management practices correlates withfarmers profile characteristics. Indian Journal of Weed Science 50(1): 69–71.

[18]Sinzogan, A. C., Van-Huis, A., Kossou, O. K., Jiggins, J., Vodouhe, S., 2004, Farmers' knowledge and perception of cotton pests and pest control practices in Benin: results of a diagnostic study. J. Life. Sci. 52, 285-303.

[19]Swanton, J., Mahoney, J., 2008, Integrated Weed Management: Knowledge-Based Weed Management Systems. Weed Sci. 56:168–172.

[20]United Nations Development Program, UNDP, 2005, Healthier rice for people, better livelihoods for farmers, safer environment for migratory birds in the Caspian region by farmer's field schools method, November 2005, Tehran.

[21]Wilson, R. S., Hooker, N., Tucker, M., LeJeune, J., Doohan, D., 2009, Targeting the farmer decision making process: A pathway to increased adoption of integrated weed management. Crop Prot. 28, 756–764.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

SOME ASPECTS CONCERNING THE ACCOUNTING FOR THE LANDS EXISTENCE AND MOVEMENT ON THE BALANCE SHEET OF THE ENTITY

Tatiana SEVCIUC, Veronica PRISACARU

Moldova State University, 60 Alexe Mateevici str., MD-2009, Chisinau, Republic of Moldova, Phone: mobile +373 69297575, Emails: sevciuctatiana@mail.ru, veronica.prisacaru@usm.md

Corresponding author: sevciuctatiana@mail.ru

Abstract

One of the most essential problems of accounting is the correct estimation of the patrimonial elements, which could have a major influence on the economic benefits of the entity. Value is a main, economic concept, for which there is no unanimous definition. The appearance and existence of value are determined by several attributes. The study of accounting for the existence and movement of lands is one of the most complex problems and the most debatable modern theories and practices. This investigation is focused on accounting aspects related to the lands movement on the balance sheet of the entity, taking into account the fact that they are part of tangible assets. Research involves a set of criteria and specific motivations of the decision-making process in choosing the optimal accounting variant, based on influencing factors of different intensities, in relation to the target of the action and the social-economic conditions existing in the society at a given time. This investigation was carried out using a wide range of methods. Preference was given to the method of the monographic study with the application of the elements of analysis, observation, selection, induction and deduction. The most relevant results are summarized in the conclusion that, in practical terms it may be useful (especially for companies with large and varied areas of their own land) to open separate files of land records. The files are opened for each plot of land separately (which was passed at the entries based on a separate document and represents a distinct object of record of the fixed assets), with consequent inclusion of all the information related to the change of value, of destination and of the qualitative characteristics of the lands in question.

Key words**:** *lands, value, accounting, purchase, price, fixed assets*

INTRODUCTION

The objective of this article is to present the accounting aspects related to the lands movement on the balance sheet of the entity, taking into account the fact that they are part of tangible assets, and, as a result, they are presented as assets of significant utility to all economic agents, because they are fertile and livelong and can serve as a support for the cultivation of annual and perennial plants, the construction of buildings with different destination, the construction of roads and others. We have started from studying the legislative and normative acts in the field that regulate the way of accounting for this object of records. The analysis was a qualitative one, which followed the concerns of some researchers in the field related to land accounting as well as in order to identify the optimal and correct solutions for accounting for lands movement and existence.

MATERIALS AND METHODS

The researches in the field were performed based on the generalization of the uncertainties conditioned by the way of accounting for lands existence and movement on the entity's balance sheet. The methodological support of the investigations is represented by the fundamental principles of accounting, the provisions of the National Accounting Standard "Tangible and intangible assets" [9], the Law on the lease in agriculture [7], NAS "Equity and debt" [10] and the publications of indigenous scholars. Preference was given to the method of the monographic study with the application of the elements of analysis, observation, selection, induction and deduction.

RESULTS AND DISCUSSIONS

As part of the tangible assets, lands (or plots of land) represent assets that:

•have a significant utility for all economic agents, due to their fertility and viability they can serve as support for the cultivation of annual and perennial plants, the construction of buildings with different destination, the construction of roads, etc. [4];

•possess a certain value (price) that varies according to many factors (location, arrangement, relief, creditworthiness, etc.) and is determined with authenticity only in the case of purchasing, selling or renting;

•do not have the actual cost, unlike buildings, agricultural machines and other fixed assets produced with own forces or purchased from third parties, they are not created by the employees, but they are, in fact, a gift of nature.

•represent a special type of agricultural real estate [7] that, by analogy with buildings, air power networks and other fixed assets, are solidly connected to the earth and cannot be moved into space (they cannot change their place) without causing considerable damage to their destination [1];

•physically (substantially) they are equivalent to the part of the terrestrial crust located at the level of the soil layer or at the bottom of the aquatic basins (ponds, lakes, etc.). Therefore the land should not be confused with the basements. The latter represent the part of the earth's crust located below the soil layer and the bottom of the water basins that extend to accessible depths for geological study and exploitation. The basements, as opposed to land, are the exclusive property of the state and cannot be privatized, sold or donated. The usefulness of the basements is determined by the presence of certain deposits, and of the lands (as mentioned above) - by their fertility and viability[6];

•in the case of rational exploitation (for example, by implementing soil cultivation, irrigation, fertilization, efficient agro technical soil tillage procedures, etc.) they have an unlimited duration of use and are not subject to physical or moral wear. Moreover, in prosperous households the useful properties of the land (for example, soil texture, humus weight, content of mobile active substances in the arable layer, etc.) not only do not degrade over time, but on the contrary, they can even improve. To obtain that it is necessary, first of all, to compensate by fertilizing the quantity of phosphorus, potassium and nitrogen extracted from the soil by the obtained harvest (including as by-products);

•bring together in a harmonious and natural way a varied nomenclature of solid, liquid and gaseous substances, microorganisms, organic residues and other constituent parts which, in the case of land use in the agricultural circuit, are expressed by a qualitative synthesis indicator called soil creditworthiness. The soil creditworthiness related to a certain land (with an area of, for example, 80 hectares) of a specific enterprise is established by specialists in the field of agro chemistry and soil science, with the extraction of samples according to typical schemes and their laboratory analysis, followed by generalizing the obtained results and comparing them with standardized parameters. Currently the average significance of soil quality in the Republic of Moldova is equal to 65 degrees-hectares. This indicator is widely used in cadastral calculations, in developing different forecasts and strategies, in leasing relationships, as well as in determining the size of the land tax.

The lands on the balance sheet of agricultural enterprises can be classified according to various criteria. Thus, depending on the presence of the vegetal cover, the agricultural land is divided into land with vegetation and land without vegetation. On the land with vegetation annual and perennial plants (both sown and planted, as well as of natural origin) grow regularly (permanently) or with some interruptions. According to article 36 of **the Land Code** no. 828 - XII of December 25, 1991 this type of land brings together arable areas (including lots on which greenhouses, solariums and seedlings are located), perennial plantations, meadows, pastures and streams. The plant products harvested from the lands in question (with the exception of the products collected from the young

perennial plantations) are evaluated at comparable prices and are included in the calculation of the global agricultural production for the respective financial year, which, in turn, served for a long time as the basis for completing rows 010, 011 and 014 of the form no. 6 - CAI "Main indicators of the company's activity"[6].

The amount of green mass consumed by domestic animals (especially cattle and sheep) on natural and improved (or cultural) pastures without prior harvest (i.e. grazing) is reflected in the calculation mentioned in row 5.6.4. The quantity of herbs (in quintals) is indicated in column 5 and is to be generalized based on the data from *the minutes of passing the pasture fodders to entries*. The total mass of these fodders is determined either by the agronomic method (that is, by mowing the grasses on typical sectors), or by the animal husbandry method (that is, by a special calculation). The second method is applied when each pasture is used by only one species of animals. In this case, on the verse of the primary document is indicated consecutively: the group of animals, the quantity of products (in kg) obtained during the grazing period, the need for nutritional units (in kg) in relation to a product unit, the total need for nutritional units (in quintals), the number of nutritional units (in quintals) administered to farm animals, the amount of nutritional units (in quintals) obtained by grazing by animals (this indicator is determined as the difference between the two previous indicators), the amount (in quintals) of grazed herbs (this indicator is determined by dividing the previous indicator by the nutritional value of freshly mowed grasses).

On the land without vegetation, no phyto technological products are obtained and no agro-technical (soil tillage) procedures are performed. According to the same article of **the Land Code**, this type of land brings together the surfaces on which the objects of the production infrastructure are located (warehouses, mechanized facades for temporary storage and conditioning of crops, repair workshops, etc.), animal husbandry farms (including fish farms), forest protection curtains for fields, internal roads and access routes to the work place and others [6].

The two types of land (with and without vegetation) differ not only in the way they are used, but also according to the maximum rates of land tax that is applied if the agricultural land has no cadastral index. For the lands with vegetation the quota concerned in relation to one hectare constitutes:

• 55 lei - for meadows and pastures;

• 110 lei - for any other categories of land.

At the same time, the taxation can be carried out depending on the soil creditworthiness. In this case, for the meadows and pastures the quota of 0.75 lei is applied for one degree-hectare and for the other categories of lands – the quota is twice higher.

For the land without vegetation that does not have an estimated value determined by the territorial cadastral authorities, some maximum rates of land tax are applied. According to annex no. 1 to **the Law for the implementation of Title VI of the Fiscal Code**, the size of the quotas in question varies depending on the location of the lands (in or out of town), the composition of the objectives located on them, the state of the land sectors (suitable for use or destroyed as a result of the production activity) etc. The following quotas are distinguished respectively: in the case of the land located in rural areas (villages, communes) and destined to agricultural enterprises - 10 lei per are; in the case of out-of-town land on which buildings and constructions are located - 350 lei per hectare, etc. [2].

Depending on the tax regime, taxable and non-taxable lands are distinguished. Most of the lands on the household's balance sheet is taxable and contributes directly or indirectly to obtaining agricultural products. They are taxed, as a rule, with land tax in accordance with the provisions of the legal act mentioned above.

The non-taxable land comprises:

•plots of land planted with young perennial plantations;

•surfaces used by the technological-experimental stations "Bălți", "Pașcani", "Codrul" and others for scientific purposes

(i.e. for the elaboration of new varieties or testing of modern technologies for soil tillage, conditioning or primary processing of the crop, etc.);

•perennial fruit bearing plantations that were destroyed or considerably damaged as a result of natural calamities. In this case, the tax exemption is granted by the representative authority of the local public administration, and the extent of the damage caused by the exceptional events is determined by a special commission whose structure and functioning mechanism are established by the Government.

Other criteria for land classification can be identified in the specialty literature. Thus, depending on the presence of the constructions and their destination the lands are delimited in:

• land with constructions;
• land with complex destination;
• land with no constructions [11].

In conclusion, it can be mentioned that the normative acts in force and some works of the indigenous economists operate with other names of the land types that are not characteristic for agricultural households and neglect obvious things. Thus, **the General plan of accounts** [5] provides for the notion of land with deposits, the same notion can be found in point 51 of the **NAS "Intangible and tangible fixed assets"** [9]. But this notion neglects the fact that the deposits (separately or in combination with other natural resources) are located not on land or inside it, but in the basement, which cannot be qualified as a tangible asset and cannot be accounted for by the businesses, as it represents a public heritage (a wealth of the whole nation). That is why it would be fairer to call these types of lands not lands with deposits, but lands under which there are basements with deposits; and not lands with natural resources (oil, natural gas, forests, etc.), but lands with forest areas (or forested lands) and lands under which there are basements with deposits.

Each land classification criterion has a certain applicative value and contributes to solving specific tasks. However, in our opinion, farms need other approaches to this subject, which, on the one hand, take into account the production profile and the particularities of rural enterprises, and on the other hand, avoid existing duplications and uncertainties. In this order of ideas it can be considered optimal (or primary) to delimit the land into three groups as follows:

• land used for agricultural purposes;
• land used for other purposes;
• unused land [3].

Thus, depending on the direction of the lands receipt, their entry cost is equal:

• in the case of the purchase against payment of the land plots for agricultural purpose owned by the state or by the administrative-territorial units - at the normative purchase price which is determined by multiplying the tariff indicated in position I of the annex to **the Law on the normative price and procedure of sale and purchase of land** no. 1308 of July 25, 1997 (with subsequent modifications and completions) [13] to the soil creditworthiness and to the surface of the purchased sector. Today the mentioned tariff is unique for all buyers and constitutes 621, 05 lei for one degree-hectare. The quantitative and qualitative parameters of the purchased land (or its cadastral characteristic) are indicated in the document issued by the Land and Land Relations Agency or by the town hall on whose territory the land in question is located. At the same time, if necessary, the normative purchase price (for example, in the amount of 217,367.50 lei of an agricultural land with the surface of 5 hectares and with the soil creditworthiness of 70 degrees-hectares) is supplemented with one-time related costs (broker's commissions for intermediation services; third party fees for verifying the existence of the sequester, pledge, mortgage and other restrictions regarding property management; land tax not paid by the seller; property valuation payment; notarial services payment; fee for legalizing property rights; means used for clearing shrubs, collecting and evacuating stones, boulders and industrial waste, land levelling, demolishing unnecessary buildings and / or buildings with trash transportation

and the obtained materials storing, etc.). If, in the process of preparing the purchased land for inclusion in the agricultural circuit, some goods are obtained that are of interest to the enterprise and have a certain consumption value (for example, firewood, monolithic or broken bricks, concrete slabs, etc.), they are estimated at the net realizable value and are attributed to the diminution of the entry cost of the land.

Discounts or other facilities in the case of the sale of the public lands are not provided for by the law mentioned above. Moreover, if the land plots are sold through competition or at an auction, their maximum price is not limited and depends exclusively on the payment capacity of the buyers. At the same time, the minimum price cannot be lower than the normative price of the land;

• in the case of purchase against payment of the private lands - at the free purchase price negotiated by the land owners (that is, the holders of the right of ownership, possession and land beneficiaries) and the interested buyers on behalf of the agricultural households. The minimum or maximum size of this price is not regulated by any domestic legal act. It depends exclusively on the honesty of the participants in the commercial transaction, being influenced at the same time by the market situation, the national currency stability, the inflation level and other economic and / or social factors.

In the case of the occurrence of one-time costs similar to those listed above, they are added to the free price of the land, thus increasing the entry cost of the purchased land. However, if the owner of the land (the seller) grants the buyer a commercial discount at the time of purchase, the discount in question is deducted from the price and from the entry cost of the land respectively. This one from the beginning is recorded at the free price diminished by the amount of the granted discount. The commercial discount granted later (for example, more than one month after the land transaction has been made) does not affect the entry cost. It is reflected in accordance with the provisions of point 48 of the **NAS "Equity and debt"** [10], to be attributed to the reduction (extinction) of the debts and the increase of the current income;

• in the case of the purchase of land and buildings (or constructions) on a parcel of land at a lump sum price (unique price)- at the current price (derived from the normative or free price) determined by calculation, in two stages, by the accounting apparatus. The first stage is the ratio between the common price (common for both types of real estate) and the total fair value of the purchased assess; it is established based on the information of the state statistical bodies and the bodies regulating prices formation or by an independent appraiser, starting from the convention that these goods were purchased separately (i.e. based on fractional prices indicated in a common document or in two different documents). Usually, this ratio is expressed by a coefficient that is less than 1. In the second stage the fair value of the purchased land is multiplied by the coefficient determined previously. The obtained product represents the entry cost of the plot of land concerned which is to be recorded in the composition of the non-depreciable tangible assets. The entry cost of the buildings (or constructions) located on the purchased land is determined the same way, but it is registered in the respective group of fixed assets or tangible fixed assets in execution.

From the above mentioned we can conclude that in the case of land operations, the directions of their entry are less varied than in the case of fixed means operations. Some of these directions are simply physically and geographically impossible (for example, land as the surface part of the earth's crust cannot be created on somebody's own or by the enterprise, even if there are daring opinions at this point), and other directions are not accepted by the legislative framework in force (for example, Article 4 (2) of **the Leasing Law** [8] prohibits the transfer of agricultural land into leasing, and Article 20 (4) of the **Leasing Law in agriculture** [7] does not allow the redemption of the leased land].

The entry cost of the land is determined for each sector that served as the object of a separate economic operation (purchase,

contribution, donation, etc.) and was accompanied by a separate primary document. In practice, this cost is definitively formed after the land has been brought to working condition (when it becomes suitable for use) and after the registration of the property right at the territorial cadastral body.

The lands, included in the enterprise's patrimony, are evaluated in Moldovan lei. If in the sale-purchase contract of the land the price is indicated in foreign currency (and this can occur when the seller of the land wants to protect himself from the negative effect of the spontaneous and significant variations of the exchange rates), and the payment will be made in the national currency, then the entry cost is also expressed in lei by recalculating the amount in foreign currency according to the official rate established by the National Bank of Moldova at the date of the beneficiary's entry into the possession of the real estate. In practice this date coincides, in fact, with the date of entry into force of the sale-purchase contract. Subsequently, as the debts are being paid from the pay office or by transfer, favourable and unfavourable amount differences can appear. The first type of difference is caused by the lowering of the national currency (when, for example, for one euro or one US dollar a larger number of lei is offered) and it is related to the financial expenses, and the second type is generated by the increase of the national currency (when, for example, for one euro or one US dollar a smaller number of lei is offered) and it is attributed to the same type of income. As a result, the differences in amount do not affect the entry cost of the land received from third parties.

After the initial recognition of the lands and their estimation at the entry cost, each company decides on its own how to continue to reflect the existence and movement of this type of estate - at the entry cost or at the reassessed value. The first indicator is based on real data from certain documents, it is simple and convincing and is in full accordance with the provisions of point 17 of the **NAS "Intangible and tangible fixed assets"** [9]. While the second indicator focuses on fair value (or market value), it requires a significant volume of calculations (information, selections, surveys, etc.) and must be reviewed (specified) periodically. The selected variant for subsequent land valuation is indicated in the entity's accounting policies and should not be changed arbitrarily (without sufficient arguments), as this may complicate the collection of data from financial statements by external users.

Unlike fixed assets, for the accounting of land movement there are currently no standardized primary documents elaborated by the Ministry of Finance or other central bodies empowered with such functions. At the same time, it is known that a good part of the bought plots of land, by analogy with some buildings, equipment, machines and other objects of long use with a unit value over 6,000 lei, cannot be exploited at once and logically they will be reflected in the composition of the tangible fixed assets in progress for a certain period of time. Therefore, in this case, a separate document is needed that would confirm the completion of the preparation works of these lots for use and their commissioning confirmed by a special commission, with the inclusion of the estate in the composition of the land. The minutes (receipt) of the receipt-delivery (movement) of the fixed assets (form no. MF-1), for example, can serve the basis for the elaboration of the form of such a document. The need to make documents for narrow use may also occur in other cases (for example, when the lands are reprocessed, their transfer from one group to another, the consolidation of land by voluntary exchange, the exclusion of land lots from the agricultural circuit as a result of soil erosion, the uncovering of the fertile soil layer to prepare mineral deposits for exploitation, etc.).

In addition, in practical terms it may be useful (especially for companies with large and varied areas of their own land) to open separate files of land records. The files are opened for each plot of land separately (which was passed at the entries based on a separate document and represents a distinct object of

record of the fixed assets), with consequent inclusion of all the information related to the change of value, of destination and of the qualitative characteristics of the lands in question.

The generalization of the information regarding the existence and the movement of the lands is made with the help of the asset account **122 "Lands"**. The debit reflects the entry of the real estate in question and the increase of its value as a result of some events (preparation for working conditions, adjustment, re-evaluation, etc.), and the credit reflects the exit of the given type of non-depreciable assets, the recording of the stocks obtained from the demolition of the unnecessary buildings located on the lands received from third parties, as well as other less frequent economic operations. The balance of the account is debited and represents the entry cost (or re-evaluated cost) of the parcels of land of the company at the end of the month, quarter or year [4]. In the balance sheet this balance is reflected by an ordinary amount in line 070 *"Lands"* in chapter 1 *"Fixed assets"*.

At the same time, it is necessary to make some clarifications. First of all, according to the **General plan of accounts** in the debit of account **122 "Lands"** there are compulsory reflected:

(a)all lump sum costs and payments related to the purchase of the land lots and bringing them into working condition. For comparison, it can be mentioned that in the case of future objects of fixed assets, the same costs and payments are accumulated in advance in account **121 "Tangible fixed assets in progress"**, which, in our opinion, is more methodologically correct ;

(b)all the parcels of land received from third parties, regardless of the size of the gap (several days, weeks, months or even years) between the date of taking over the lands and the date of putting them into operation. While, as mentioned above, in the case of fixed assets the existence of such a gap is inadmissible. In other words, the tangible fixed assets entered from the outside can be registered in the debit of the account **123 "Fixed assets"** only if the date of their entry coincides with the date of putting into operation. Otherwise, the assets in question are also reflected in the account **121 "Tangible assets in progress"**, which is in full accordance with the professional reasoning and the fundamental principles of accounting [12].

(c)according to **the General accounting plan** the following seven sub-accounts are foreseen in account **122 "Lands":**

- 1221 "Lands under preparation for pre-determined use";
- 1222 "Lands without constructions";
- 1223 "Lands with constructions";
- 1224 "Fields with deposits";
- 1225 "Lands with perennial plantations";
- 1226 "Lands received in economic management";
- 1227 "Other lands"[5].

Thus, in comparison with the situation that existed until 2013, four new sub-accounts (the first and last three) were added to the examined account. The other sub-accounts didn't change.

However, as it was mentioned above, such an approach is not one of the best and can be rejected by businesses. At the same time, the following circumstances may serve as additional arguments in favour of the given opinion:

(i)Article 36 of **the Land Code [**6] assigns to the agricultural land not only the lands with vegetation (sowing, orchards, pastures, meadows, etc.), but also the lands containing deposits, facades, repair shops , livestock farms and other real estate for agricultural purposes;

(ii)even the agricultural lands themselves, according to the same article, include plots of land on which various terrestrial constructions are located: greenhouses, wire trellises for vine, anti-hail systems in the orchards etc.;

(iii)the deposits of useful minerals are located not on land or inside it (that is, in the soil layer), but in the basement, which represents a

public heritage and is not subject to accounting.

Moreover, most agricultural households don't want to open some sub-accounts to the first-degree account mentioned above. The basic reason that is usually invoked is the reduced surface of own lands and the uncertain criteria for the classification of the plots of land.

The analytical records of the lands are kept according to their types, destinations, location, objects of assets records, sources of origin and other directions provided in the entity's accounting policies.

The following examples are given to strengthen the practical skills of the readers in the field of accounting for land operations.

Example 1. In the year 201N, due to its bad financial situation, the agricultural household "Prosperare" Ltd. sold against payment two separate plots of land to a legal person headquartered in Chisinau. The value base of the exited capital assets is equal to their entry cost and constitutes 110,000 lei. The land transaction in question brought to the enterprise an income of 90,000 lei which allowed it to successfully complete the autumn agricultural works (harvesting grapes, ploughing etc.). Other operations for the alienation of capital assets (land, shares, debt securities etc.) did not take place during this year in the household. It is worth mentioning that in the previous year capital losses were not recorded.

The following year, the same household sold the shares of a primary winemaking factory that had not paid dividends to any of its many investors for the last few years.

This operation generated expenses in the amount of 11,000 lei and brought in an income in the amount of only 6,000 lei, which constituted only 54.5% of the entry cost of the issued securities. The factory in question is an unaffiliated part of the household.

Until the end of 201N + 1 the company sold another plot.

The expenses incurred from this transaction (it is the entry cost of the land established by the calculation based on the accounting data) amounted to 120,000 lei, and the income obtained was150,000 lei. Other exits of capital assets were no longer recorded in 2015.

The above example results in the following economic facts, accounting formulas and records in annexes 1.2D and 1D of *the Income Tax Declaration* (VEN 12 form).

1)Settlement of the entry cost of the exited capital assets:

debit account **721 "Expenditures on fixed assets"** - in the amount of 110,000 lei (in 2014) and 131,000 lei (in 201N + 1), credit account **122 "Lands**" - in the amount of 110,000 lei (in 2014) and of 120,000 lei (in the year 201N + 1),

credit account **141 "Long-term financial investments in non-distressed parties"** - in the amount of 11,000 lei (in the year 201N + 1).

2)Reflection of the income from the sale of capital assets:

debit account **234 "Other current receivables**" - in the amount of 90,000 lei (in 2014) and 156,000 lei (11,000 lei + 120,000 lei) (in the year 201N + 1), credit account **621 "Revenue from operations with fixed assets"** - in the amount of 90,000 lei (in 2014) and 156,000 lei (in 201N + 1).

Example 2. In February 201N the agricultural household "Plai" Ltd. leased 3 distinct plots of arable land (A, B and C) which are component parts of a previously divisible land in the share capital of the enterprise brought by one of the founders. Until this month, all the 3 new tenants were registered as unemployed at the territorial office of the labour force and received benefits, and then they lost a source of existence. There were concluded typical lease agreements for a period of 5 years with the concerned persons, the agreements were registered at the territorial cadastral office. As the tenants have agronomic studies and they have previously activated as average managers or specialists in various households for a long time, an

additional clause was included in the agreements which stipulated their material liability for diminishing the fertility of the soil and the way of determining the damage caused to the lessor.

The data related to the leased land parcels, the size of the lease payments and the results recorded by the tenants during the 5 years of activity are presented in Table 1.

Table 1. Data related to the operations of leasing land parcels for agricultural use

Indicator	Parcel A	Parcel B	Parcel C
A	1	2	3
The entry cost determined by calculation, lei	10,000	15,000	20,000
Area, hectares	2	3	4
Soil credit worthiness, degrees-hectares including			
-at the beginning of the lease term	65	62	67
-at the end of the lease term	62	62	68
Minimum amount of lease payment in force majeure the ecase, lei including			
-for the whole parcel	1,614.73	2,310.31	3,328.83
-for one hectare	807.36	770.10	832.21
The share of the value of the global harvest that is payable to the lessor as a monetary ayment,%	20	20	20
The average annual value of the global crop according to local market prices, lei	50,000	69,000	112, 000

Source: Elaborated by authors based on case studies from the practice of agricultural entities.

On the leased land plots there were cultivated early varieties of potatoes, peppers, donuts and eggplants, i.e. vegetables with a high added value.

During the lease term, the climatic conditions were, in fact, favourable, that is why the lease payment was cashed in the initially negotiated proportion.

According to the provisions of the concluded contracts, the household incurred the following costs during the considered period:

a)annual payment by transfer of the land tax according to the maximum quotas stipulated in annex no. 1 to **the Law on the implementation of Title VI of the Fiscal Code** [2];

b)advance cash payment by the holder of the services related to the contracts registration, the elaboration of the geometric plans and the obtaining of the copies of the cadastral plan of the divisible land to which the plots of land transmitted for rent belong - in a total amount of 2,500 lei;

c)payment by transfer for the services of a specialized enterprise for the determination of soil creditworthiness at the beginning and at the end of the lease term - in the amount of 24,000 lei;

d)annual payment by transfer for the services of a holder of the entrepreneur patent related to the experimental determination (by field measurements) of the size of the biological harvest (until its manual or mechanized harvesting) - in the amount of 2,000 lei.

The lease payment was paid into the cash register of the entity by all leaseholders on due date and in full size. In addition, a complaint was filed in relation to the reduction of soil quality on the plot of land A. The respective tenant acknowledged the complaint and until the end of the concerned year recovered the damage in the cash register. The following economic facts, calculations and accounting formulas result from the data of the example above.

1.Reflecting the entry cost of the plots of arable land transmitted for lease:

debit account **122 "Lands"** - in the amount of 45,000 lei (10,000 + 15,000 + 20,000),

credit account **122 "Lands"** - in the amount of 45,000 lei (10,000 + 15,000 + 20,000).

Note. It is recommended to open an additional sub-account for the leased land.

2.Reflection of the costs incurred by the lessor for the calculation of the land tax for the parcels of land transmitted in the lease:

debit account **711 "Cost of sales"** - in the annual amount of 876 lei during the lease term, credit account **534 "Debts to the budget"** - in the annual amount of 876 lei during the lease term.

Note. The above amount was determined in the following way: (1.5 lei × 65 degrees-hectares × 2 ha) + (1.5 lei × 62 degrees-hectares × 3 ha) + (1.5 lei × 67 degrees-hectares × 4 ha) = 195 lei + 279 lei + 402 lei = 876 lei.

At the same time, if the concerned plots of land were used in the agricultural circuit of the owner, the amount of the land tax would be attributed to the administrative expenses. It should also be borne in mind that according to article 16 paragraph (3) of **the Leasing Law in agriculture** the land tax is calculated and paid by the tenant, except the cases when the contract assigns this obligation to the lessor [7].

3.Land tax transfer to the budget: debit account **534 "Debts to the budget"** - in the annual amount of 876 lei during the lease term, credit account **242 "Current accounts in national currency"** - in the annual amount of 876 lei during the lease term.

4.Advance payment by the holder for the services provided by the territorial cadastral office related to the transmission of the land parcels for rent: debit account **711 "Cost of sales"** - in the amount of 2,500 lei, credit account **226 "Staff receivables"** - in the amount of 2,500 lei.

Note. The above accounting formula is preceded by another formula as follows: debit account **226 "Staff receivables"**, credit account **241 "Cash"**. At the same time, the payment order shall indicate the destination of the advance and its term of use.

5.Reflection of the costs incurred by the lessor when determining the soil creditworthiness at the beginning and the end of the lease term:

debit account **711 "Cost of sales"** - in the amount of 12,000 lei in each year of 2014 and 2018, credit account **521 "Current commercial debts"** - in the amount of 12,000 lei in each year of 2014 and 2018.

6.Payment of the services related to the determination of soil creditworthiness by transferring cash from the current account into national currency: debit account **521 "Current commercial debts"** - in the amount of 12,000 lei in each year of 2014 and 2018, credit account **242 "Current accounts in national currency"** - in the amount of 12,000 lei in each year of 2014 and 2018.

7.Reflecting the costs incurred by the lessor in determining the size of the biological harvest:

debit account **711 "Cost of sales"** - in the annual amount of 2000 lei during the lease term, credit account **544 "Other current debts"** - in the annual amount of 2,000 lei during the lease term.

Note. The need for such an action is conditioned by the fact that the majority of the tenants intentionally reduce the data on the collected harvest, and the surplus of the undocumented products is sold to different natural or legal persons (even at a price lower than the market price), with the appropriation of the earned cash. Determining the biological (potential) harvest before the beginning of mass harvesting of plant products doesn't allow the tenants to act that way.

8.Payment by transfer of the services related to the determination of the size of the biological harvest: debit account **544 "Other current debts"** - in the annual amount of 2,000 lei during the lease term, credit account **242 "Current accounts in national currency"** - in the annual amount of 2,000 lei during the lease term.

9.Calculation of the lease payment in the amount of 20% of the annual average value of the global harvest obtained by the tenants:

debit account **231 "Receivables regarding the revenues from the use of the entity's assets by the third parties "** - in the annual amount of 46,200 lei during the lease term,

credit account **611 "Sales revenue"** - in the annual amount of 46,200 lei during the entire lease term.

10.Cash receipt in the account of repayment of the tenants' receivables:debit account **241 "Cash"** - in the annual amount of 46,200 lei during the lease term, credit account **231 "Receivables regarding the revenues from the use of the entity's assets by third parties** " - in the annual amount of 46,200 lei during the lease term.

11.Reflection of the submitted and acknowledged complaint to recover the damage caused by the decrease of the soil creditworthiness on the plot of land A:

debit account **234 "Other current receivables"** - in the amount of 3726.30 lei,

credit account **611 "Sales revenue"** - in the amount of 3,726.30 lei.

Note. The above amount was determined by multiplying the number of degrees-hectares by which the fertility of the soil was reduced at the tariff for calculating the normative price of the land indicated in position I of the annex to **the Law on the normative price and the way of selling-buying the land** and at the surface of the land plot concerned. In other words, 3,726.30 lei = (65 - 62) × 621.05 × 2.

12.Cash receipt in cash at the settlement of the complaint submitted and recognized by the tenant: debit account **241 "Cash"** - in the amount of 3,726.30 lei, credit account **234 "Other current receivables"** - in the amount of 3,726.30 lei.

13.Reflection of the entry cost of the plots of arable land returned by the tenants on the basis of the act of surrendering-taking over the leased agricultural land: debit account **122 "Lands"** - in the amount of 45,000 lei (10,000 + 15,000 + 20,000), credit account **122 "Lands"** - in the amount of 45,000 lei (10,000 + 15,000 + 20,000).

Note. As a result, the additional sub-account for the land parcels submitted for lease is closed.

CONCLUSIONS

According to its economic nature and to the generated consequences leasing of agricultural land is a part of the operational lease category. Although the lease term is imposing (up to 30 years, with the possibility of unlimited subsequent extension based on a common agreement of the parties), the repurchase of the leased land is prohibited by law. During the lease term the tenant has only the right of possession, and the right of owner belongs to the lessor. Therefore, both the transfer of the land for rent and the return of the land by the users are recorded through internal accounting formulas within a synthetic account;

-The revenues obtained from land leasing represent incomes derived from leases, and they, in turn, are included in the composition of the revenues from sales;

-In accordance with the principle of matching the incomes and expenses, the incomes obtained from land leasing shall correspond only to the costs related to the lease agreements on the concerned real estate. In other words, if, under ordinary conditions, some expenses (for example, land tax paid by the landowner) are considered as administrative expenses, then under lease conditions they will be considered as component parts of the cost of sales. Of course, such accounting treatment of the costs conditioned by land lease does not change the profit of the company nor its fiscal obligations. That is why it is methodologically and professionally reasoned. In addition, authentic information about the profitability of leasing operations is ensured systemically. Thus, in the example above, the costs of the enterprise conditioned by land leasing amounted to 40,880 lei, and the incomes obtained – to 234,726.30 lei. These data correspond to a gross profit of 193,846.30 lei and to an extremely high profitability of 474.2%.

For comparison, it can be mentioned that in practice the profitability of obtaining the absolute majority of plant and animal products in agricultural enterprises is much lower and it rarely exceeds several tens of per cent. Unfortunately, the results of land lease are not valuable, which is explained, firstly, by the lack of operational and permanent control by the lessor, and secondly, by the frequent cases of fraud committed by both parties.

REFERENCES

[1]Civil code of the Republic of Moldova. Chisinau: S.A. Book, 2002. 892 p.
[2]Fiscal code no. 1163-XII of April 24, 1997. In: The Official Monitor of the Republic of Moldova. 2007 (subsequently amended and supplemented).
[3]Frecauteanu, A., Stahovschi, A., 2007, Financial accounting at the enterprises of the agri-food complex. Ch.: SAUM Editorial Center, 2007. 353 pp.
[4]Frecauteanu, A., Stahovschi, A., Chislaru, A., 2009, Accounting of liabilities and expenses for enterprises in the production sphere. Ch.: SAUM Editorial Center, 286 pp.
[5]General plan of accounts, 2013, The Official Monitor of the Republic of Moldova no. 233-237.2.
[6]Land code no. 828 of December 25, 1991. In: The Official Monitor of the Republic of Moldova. 2001, no. 107, art. 817 (republished, amended and supplemented).
[7]Leasing Law in agriculture: no. 198 - XV of May 5, 2003. In: The Official Monitor of the Republic of Moldova. 2003, no. 163-166, art. 650.
[8]Leasing Law: no. 59-XVI of April 28, 2005.
[9]National Accounting Standard "Intangible and tangible fixed assets". In: The Official Monitor of the Republic of Moldova no. 233-237, s. 1533, from 20.10.2013.
[10]National Accounting Standard "Equity and debt". In: The Official Monitor of the Republic of Moldova no. 233-237, s. 1533, from 20.10.2013.
[11]Nederita, A. et. al., 2003, Financial accounting. Ch. ACAP, 640 pp.
[12]Nederita, A., 2007, The correspondence of the accounting accounts according to the provisions of N.A.S and the Fiscal Code. - Chisinau: Accounting and auditing, 2007. 640 p.
[13]The Law on the normative price and the way of selling and buying land: no. 1308 of July 25, 1997.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

RISK MANAGEMENT TOOLS AND STRATEGIES USED BY THE BULGARIAN GRAIN PRODUCERS

Pavel SHEYTANOV

University of National and World Economy, 1700, Students Town, Sofia, Bulgaria, Phone: +359 897979751, Email: p_sheitanov@yahoo.com

Corresponding author: p_sheitanov@yahoo.com

Abstract

Risk management is an essential part of the farm management process. Nowadays every farm has to pay a special attention to the risk management in order to make the right investments and limit the losses. The grain sector is well developed in Bulgaria and has a great contribution to the gross added value from all agricultural products. This study aims to examine the tools and strategies that are used by the Bulgarian grain producers to reduce the risk in their farms. As a result, the most used tools and combinations of instruments for managing the risk are examined, as well as the connections between the different tools and strategies.

Key words**:** *agriculture, grain, risk, instruments, Bulgaria*

INTRODUCTION

The process of risk management can be defined as a specific system which is responsible for the effectiveness of identifying and mitigating the threads (risks) and the consequences of their occurrence. The main reason for every farmer to take actions related to managing the risks are the potential financial losses [4]. An essential part of risk management is the decision to choose the appropriate risk management tools and strategies to protect the farm from bankruptcy as a result of a variety of unfortunate events [5]. The risk management process consists of five steps [1]. The first one is to identify the risk itself and its nature. The second step is to analyze the risk, which involves establishing the likelihood of occurrence and determining the magnitude of possible consequences, as well as the correlation between the occurrence frequency and the magnitude of losses. The next step is to assess the different risk management strategies that are relevant to the particular farm. It is followed by choosing the most suitable and effective strategy. The last step of the process is to control and monitor the selected strategies. According to [3] and [6] risk management strategies are divided in three main categories, taking in consideration the results from [9] and [10]:

-Risk prevention - risk prevention strategies are in place prior to the occurrence of the risk event, with the aim of reducing the likelihood of the appearance of the risk;
-Risk mitigation - as with risk prevention, these strategies are undertaken prior to the occurrence of the risk event, but their purpose is to reduce the potential negative impact on the farm;
-Coping with risk - The aim of these strategies is to mitigate the impact of the risk once it has already occurred.
Each of the strategies includes various compounds of tools for managing the risk (Table 1).

Table 1. Strategies and tools for risk management

Level/Strategy	Farm-level	Market level
Risk prevention	-Diversification -Risk avoidance -Maintaining liquid assets -Best practices	-Staff training
Risk mitigation	-Informal cooperation -Sharing technical equipment	-Vertical integration -Using derivatives -Production contracts -Insurance
Coping with risk	-Other employment -Mutual assistance -Seasonal migration -Cost reduction Borrowing money	-Sale of assets -Income diversification -Using bank loans

Source: Kirechev, D. (2013), Siegel, P. and Alwang, J., (1999).

MATERIALS AND METHODS

The first part of the paper is based on a research of theoretical review on the authors working in the field of risk management in agriculture. In order to make classification of the usage of the risk management tools, data with the grain producers' preferences needs to be collected.

One of the most popular methods for gathering behavior information is by survey and there are four main methods to reach the target respondents [8]:

-Face-to-face interview
-Telephonic interview
-Mail questions
-Internet questions

In this case the preferred method was the face-to-face interview.

The survey was held in 2018 as part of a scientific project [2] that is focused on the integrated approach of the risk management process in agriculture. The presented analysis is part of the dissemination of PhD thesis as well. Based on the mentioned theory and the presented risk management tools in Table 1, each of the respondents was asked which of the instruments they had used during the last season. The farmers were asked to answer closed-ended questions only with "yes" or "no" whether they used any of the risk management tools. The instruments themselves are divided into two categories: on a farm and market level.

RESULTS AND DISCUSSIONS

The survey that was conducted aimed to cover farms that are harvesting 5% or more of the total area under wheat for the prior year (2017). As a result, 35 grain producers harvesting wheat from Bulgaria were interviewed and the needed data regarding the variety of risk management tools and strategies they had applied was collected. Below the results of the following analysis are presented and they are divided into two categories.

Usage of tools for risk management on farm-level

Fig. 1 is presenting the usage of farm-level instruments by the surveyed grain producers.

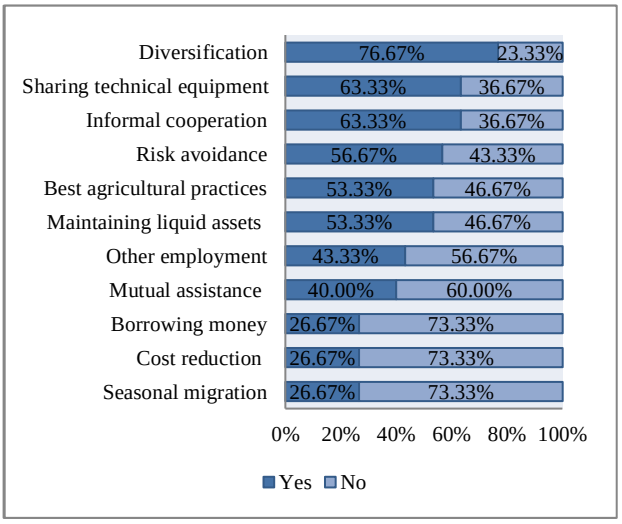

Fig. 1. Usage of different tools for risk management on farm-level
Source: Own calculation.

The results from the survey indicate that the most used risk management tool during 2017 among grain producers is diversification. Diversification is said to be applied by 76.7% of the surveyed farmers as the main risk prevention tool. Also, as part of the risk prevention strategy, used by more than half of the respondents, are the avoidance of risk, best agricultural practices and maintaining liquid assets (56.67%, 53.33%, 53.3% respectively). As a result, the risk prevention strategy becomes the most used method among survey respondents.

The second most common strategy is risk mitigation, which includes tools as sharing technical equipment, warehouses and informal cooperation. Both of these tools are used by 63% of the respondents, which qualifies them as the most used tools after the diversification one. Tools that are part of coping with risk strategy are the least applied methods by farmers, used by less than half of them.

It was also analyzed the usage of a combination of two different tools. The results for the farm-level tools are presented in Table 2.

The two most used pairs of risk management tools are diversification with informal cooperation and informal cooperation with sharing technical equipment.

Table 2. Usage of different combinations of tools for risk management on farm-level

	Tool / Tool	1. Diversification	2. Informal cooperation	3. Sharing technical equipment	4. Risk avoidance	5. Maintaining liquid assets	6.Best agricultural practices	7. Other employment	8. Mutual assistance	9. Seasonal migration	10. Cost reduction	11. Borrowing money
1.	Diversification	100%										
2.	Informal cooperation	50.0%	100%									
3.	Sharing technical equipment	46.7%	50.0%	100%								
4.	Risk avoidance	43.3%	33.3%	33.3%	100%							
5.	Maintaining liquid assets	43.3%	30.0%	26.7%	43.3%	100%						
6.	Best agricultural practices	40.0%	40.0%	33.3%	36.7%	40.0%	100%					
7.	Other employment	33.3%	40.0%	33.3%	16.7%	13.3%	23.3%	100%				
8.	Mutual assistance	30.0%	20.0%	16.7%	26.7%	33.3%	30.0%	13.3%	100%			
9.	Seasonal migration	20.0%	10.0%	20.0%	13.3%	13.3%	6.7%	10.0%	3.3%	100%		
10.	Cost reduction	20.0%	16.7%	13.3%	26.7%	26.7%	20.0%	6.7%	23.3%	0%	100%	
11.	Borrowing money	20.0%	16.7%	13.3%	26.7%	26.7%	20.0%	6.7%	23.3%	0%	26.7%	100%

Source: Own calculation.

Other commonly used combinations of two different instruments at the farm-level are: best agricultural practices with maintaining liquid assets; informal cooperation with the employment in other sectors of the economy; maintaining liquid assets with avoiding the exposure to risk. The surveyed farmers find that the usage of seasonal migration is incompatible with cost reduction and borrowing money from friends and neighbours. Also, only 13% of the farmers have other employment and maintain liquid assets at the same time. On the other hand, 92% of the farmers who have other employment outside of agriculture use informal cooperation with other farmers as a risk mitigation tool. During the analysis were made additional calculations on how much of the farmers using one specific tool are using the rest of the tools as well. The tables with the calculations are not shown in this paper but some of the results are mentioned.

This comes from their side employment and the limited time they have to fulfill all their farm-related obligations.

The relationship between the sharing some of the technical equipment and inventories tool among farmers and the mutual assistance tool can be described as average, meaning that 42% of the respondents who are relying on mutual assistance tend to share their equipment and inventory with other farmers. On the contrarily, only 26% of the farmers who share their equipment use mutual assistance as a tool. This can be explained to some extent by the fact that the farmers who share their machines and inventory in some cases have a written or oral agreement with the other farmer. It is also possible for them to share the costs of purchasing and maintaining the machines. Thus, farmers who seek help from their colleagues to mitigate the consequences of risky events are more likely to do so accidentally and without negotiation.

All of the farmers who said that they were using the cost reduction as a tool also indicated that they borrowed money from friends or others and are accounting for almost 27% of all respondents. The same portion of respondents indicates that they have used risk avoidance and maintain liquid assets. In this case, 87.5% of them also used assistance from other farmers (mutual

assistance) to cope with the effects of risk events.

Usage of tools for risk management on market level

The same analysis was made for the market level tools (Fig. 2) where the results show that the most popular tool used by 70% of the respondents is the bank credit. The second and fourth most used tools are the sale of assets (63.33%) and income diversification (53.33%). The usage of those three instruments forms the strategy for coping with the risk as the most preferred strategy on market level by the Bulgarian grain producers.

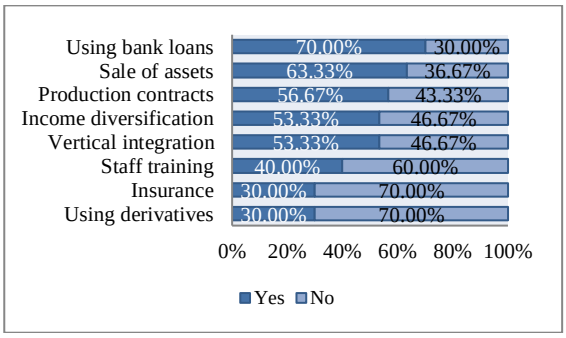

Fig. 2. Usage of different tools for risk management on market level

Source: Own calculation.

The tools from the second most used strategy for mitigating the risk on market level are as follows: production contract (56.67%), vertical integration (53.33%), insurance (30%) and the usage of derivatives (30%). The staff training, which is part of the strategy for preventing the risk, is used by 40% of the farmers.

In Table 3 are presented the combinations of different tools on market level, which are used together at the same time by the farmers. As most used combinations were pointed the usage of bank loans with sales of assets (46.7%) and using bank loans with income diversification (43.3%). While the least used pairs of tools are the insurance with using derivatives (3.3%) and sale of assets with using derivatives (6.7%).

Most of the farmers (67%) who are using bank loans are selling some of their assets as well, while only 29% of those same farmers (who are using bank loans) tend to use derivatives. Also, 77.8% of the farmers who insured their crops are using production contracts.

Table 3. Usage of different combinations of tools for risk management on market level

	Tool / Tool	1. Staff training	2. Vertical integration	3. Using derivatives	4. Production contracts	5. 3 Insurance	6. Sale of assets	7. Income diversification	8. Using bank loans
1.	Staff training	100%							
2.	Vertical integration	20.0%	100%						
3.	Using derivatives	10.0%	16.7%	100%					
4.	Production contracts	26.7%	36.7%	16.7%	100%				
5.	Insurance	16.7%	13.3%	3.3%	23.3%	100%			
6.	Sale of assets	26.7%	33.3%	6.7%	36.7%	23.3%	100%		
7.	Income diversification	20.0%	40.0%	10.0%	33.3%	13.3%	36.7%	100%	
8.	Using bank loans	30.0%	43.3%	20.0%	40.0%	23.3%	46.7%	43.3%	100%

Source: Own calculation.

By analyzing the relation between the tools at farm and market levels, it can be concluded that everyone who uses insurance as a risk management tool, also diversifies their production. Besides that, 92% of the farmers who invest in providing a proper training programme for their employees also use diversification as a tool for risk management. Furthermore, well-established is that 88% of people who borrow money from friends and acquaintances also take out loans from banks.

CONCLUSIONS

After examining the usage of the different risk management tools, it was found that no single farm utilizes all the available tools. However, the surveyed grain producers were familiar

with all of the mentioned tools and had some basic knowledge about them.

The most popular strategies turned out to be different on farm and market level. The surveyed farmers are tending to use risk management tools from the risk prevention strategy on farm-level, while on market level they prefer to use the tools for coping with the risk. The most used instrument on farm and market level are the diversification and the bank loans respectively.

Although insurance is mentioned as one of the most popular and effective instrument in different risk management studies, in this survey the results show that is one of the least used tools from the Bulgarian grain producers.

The process of risk management describes farm decisions on how they should deal or face various risks if they occur. Based on the research it can be concluded that all of the surveyed grain producers are using different risk management toolkits and strategy mixes to fit the specific needs of their farm.

REFERENCES

[1]Hardaker, J., Huirne, R., Anderson, J., 1997, Coping with Risk in Agriculture, Cab International, Wallingford, United Kingdom, pp. 23-37.
[2]Harizanova-Bartos, H., Stoyanova, Z, Petkova, I, Metodiev, N. Sheytanov, P., Dimitrova, A., 2018, Scientific research project NID, NI 16/2018, Integrated risk management approach in the agricultural sector, Sofia: UNWE.
[3]Holzmann, R., Jorgensen, S., 2000, Social Risk Management: A New Conceptual Framework for Social Protection and Beyond, The World Bank, SP Discussion Paper No. 0006.
[4]Just, R., 1975, Risk aversion under profit maximization, American Journal of Agricultural economics, 57(2): 347-352.
[5]Kaen, F., 2005, Risk Management, Corporate Governance and the Modern Corporation, in Risk Management: Challenge and Opportunity, Edited by Frenkel, M., Hommel, U., Rudolf, M., Springer, 2nd edition, pp. 423-436.
[6]Kirechev, D., 2013, Managing production risk in agriculture. Management and sustainable development, 3, pp. 81-87.
[7]OECD, 2009, Managing Risk in Agriculture: A Holistic Approach. Paris: OECD.
[8]Roopa, S., Rani, M., 2017, Questionnaire Designing for a Survey, The Journal of Indian Orthodontic Society, October - December 2012, 46(4): 273-277.
[9]Siegel, P., Alwang, J., 1999, An Asset-based Approach to Social Risk Management – A Conceptual Framework, Social Protection Discussion Paper No. 9926, The World Bank (Washington, D.C.), pp. 17-20.
[10]The World Bank, 1999, Dynamic Risk Management and the Poor – Developing a Social Protection Strategy for Africa, Main report.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

METHODOLOGY OF ZONING APPLICATION FOR AGRICULTURAL CROPS CULTIVATION ON THE BASIS OF SPACE IMAGERY

Mykhailo STUPEN[1], Nazar STUPEN[2], Zoriana RYZHOK[1], Ruslana TARATULA[1]

[1]Lviv National Agrarian University, Ukraine, 1, V. Velykoho str., Lviv Region, 80381, Ukraine, Phones: +38 032 22 42 961, +38 093 94 32 302, +38 067 90 01 076; E-mails: zemdek@ukr.net, zoryana.rizhock@gmail.com, ruslana.78@ukr.net
[2]Lviv Polytechnic National University, Ukraine, 6, Karpinskogo str., Lviv, Lviv region, 79000, Ukraine, Phone: +38 067 37 06 682, E-mail: nazstupen@gmail.com

Corresponding author: zoryana.rizhock@gmail.com

Abstract

One has carried out the monitoring of rapeseed cultivation on the example of land-use area of 69.7 hectares, located on the territory of Busk district of Lviv region outside the settlement Baluchyn according to the artificial satellite Sentinel-2. One has identified the state of its sowing, which is characterized by the maximum value of the NDVI vegetation index on July 1, 2019, and indicates the developed vegetation for harvesting. Areas with high, medium and low rapeseed vegetation are displayed using the numerical taxonomy method of optical brightness based on the analysis of multispectral land-use scan data in the Crop Monitoring geo-information system. One has done biological yielding capacity prediction using obtained values of vegetation index NDVI, NDRE, MSAVI and RECI in each zone of land use, which indicates the sparse vegetation of rapeseed with low yield and therefore requires the application of additional organic and mineral fertilizers in the low vegetation area with an average of 41 hectares per the research object. The obtained results of the use of geo-information technologies according to space monitoring data are proposed to be applied for the estimation of the state of sowing, yielding capacity prediction, the performance of agrarian and technical operations at all stages of agricultural development.

Key words: *geo-information systems, space monitoring, remote sensing of lands, zoning, vegetation index, yielding capacity, land use, agricultural crops cultivation*

INTRODUCTION

To begin with, the monitoring of the state of crop cultivation due to modern conditions without the remote methods and GIS application is impossible. Considering the development of current GIS technologies, space multispectral scanning, high resolution of global positioning systems, new opportunities are emerging to monitor the quality of the crops.

V. Dankevych and Ye. Dankevych [1], V. Liulchyk, O. Kachanovskyi and S. Bulakevych [6], A. Soloviova [7], N. Stupen, M. Stupen, and O. Stupen [9], V. Zatserkovnyi [10] researched the application of GIS technology in agricultural production management in their scientific works. However, one has not fully used the issues of soil mapping based on phyto-indication and other methods of remote sensing, so they should be considered as a promising direction for further investigations in the field of remote sensing.

Due to the proper level of information support for space imagery in agriculture, we have made proposals for the application of zoning techniques for monitoring and classification of crop production using Crop Monitoring geoinformation software [2], where one has done an appropriate assessment of crop convergence status by thematic raster results of the vegetation index based on Sentinel-2 artificial satellite data.

MATERIALS AND METHODS

One has applied the method of zoning of the territory by values of the thematic raster of the vegetation index of the estimation of the state of agricultural crops cultivation due to the taxonomic method. Its essence lies in the fact that one determines the values of the characteristic X_{ij} by n indicators for the

territory of the research object. We take these indices as coordinates in n-dimensional space and determine for each pair of units taxonomic distances [10]:

$$d_{ij} = \sqrt{\sum_{j=1}^{n}(X_{ij} - X_{kj})^2} \quad (1).$$

Conducting zoning, one has used high-resolution space imagery obtained from the Sentinel-2 artificial satellite for detailed observation over a long time. The satellite allows optical and near-infrared imaging implementing a slit image capturing approach, thereby obtaining images with high measurement and imaging-visibility properties by providing NDVI, NDRE, MSAVI, RECI, vegetative indices with a resolution of 10, 20, 30 and 60 m regularly every ten days, masks of acreage – once a month and maps of land use – twice a season [6].

RESULTS AND DISCUSSIONS

We have carried out the study on the example of land use area of 69.7 hectares, located on the territory of Busk district of Lviv region outside the settlement Baluchyn. The area of land use is contrasting according to the structure of the soil cover, and thus differs from each other by the results of the NDVI vegetation index on the space image over a small period of time (Fig. 1 and 2).

Fig. 1. The image of the NDVI vegetation index for land use on July 1, 2019.
Source: on the basis of data [2].

Considering satellite imagery, as of July 1 and 3, 2019, we observe a significant difference in the values of the NDVI vegetation index for the research object, which is detected automatically using Crop Monitoring geo-information software [2]. The result of the study is the identification of the sowing state of rapeseed cultivation, which is characterized by the maximum NDVI value as of July 1, 2019, as one can see from the raster image in Fig. 1, and indicates the developed vegetation for harvesting according to space imagery.

Fig. 2. The image of the NDVI vegetation index for land use on July 3, 2019.
Source: on the basis of data [2].

Next, we opt for the contrast field areas considering the light tone on the space image for conducting zoning using the method of the numerical taxonomy of optical brightness. An algorithm for applying zoning to construct a raster image of a field was created based on the analysis of multispectral scan data in the Crop Monitoring geoinformation system [2]. As a result of their automated calculation, we determine the optical brightness intervals as taxa, on the basis of which the areas of rapeseed cultivation in the land use area are reflected. For instance, we show the zoning image of rapeseed cultivation according to the NDVI index value (Fig. 3). It is a quantitative indicator of the amount of photosynthetic active biomass used to estimate the state of vegetation [6].

Fig. 3. Land use zoning for rapeseed cultivation according to the NDVI Vegetation Index on July 1, 2019
Source: on the basis of data [2].

Further automatic image tracing according to NDRE data allows estimating the area of land use with high vegetation of rapeseed cultivation (Fig. 4). Normalized Difference Red Edge allows better studying later rapeseed harvests because it is more sensitive to leaf chlorophyll content, nitrogen uptake, reflecting changes in other mineral fertilizers, and provides a better estimate of vegetation state than the Normalized Difference Vegetation Index [5].

Fig. 4. Land use zoning for rapeseed cultivation according to the NDRE data on July 1, 2019
Source: on the basis of data [5].

The automated character of the data processing of the space image, the use of the mathematical and statistical zoning apparatus improves the accuracy of determining the vegetation zones of cultivation of a certain agricultural crop in comparison with the traditional method of large-scale soil survey and their mapping. Fig. 4 shows the zoning of land use for the cultivation of rapeseed according to the MSAVI vegetation index on July 1, 2019. Unlike other vegetation indices, it considers atmospheric natural phenomena during long-term monitoring [3].

Fig. 4. Land use zoning for rapeseed cultivation according to the MSAVI data on July 1, 2019
Source: on the basis of data [6].

The cartogram of the brightness of the land use zoning image carries direct information on the values of the RECI vegetation index in each pixel in Fig. 5, which determines the content of chlorophyll in plants in a stress state and indicates whether the plant is healthy [3].

Fig. 5. Land use zoning for rapeseed cultivation according to the RECI data on July 1, 2019
Source: on the basis of data [2].

One has pointed out three zones with high, medium and low vegetation of plants in accordance with the zoning results of land use in the cultivation of rapeseed using remote sensing data in the geo-information system Crop Monitoring [2]. However, their area is diverse according to the vegetation index NDVI, NDRE, MSAVI, and RECI. Close in structure is the area of land use zoning by NDRE and MSAVI values, and similar is the NDVI and RECI indices (Table 1). It indicates the peculiarities of their application to optimize crop cultivation.

Table 1. Land use zoning for rapeseed cultivation according to the NDVI Vegetation Index on July 1, 2019

Vegetation Index	Area					
	High vegetation		Medium vegetation Zone 2		Low vegetation	
	ha	%	ha	%	ha	%
NDVI	33.3	47.7	17.6	25.2	18.8	27.0
NDRE	4.7	6.6	33.1	47.5	32.0	45.9
MSAVI	2.7	3.8	24.6	35.3	42.4	60.9
RECI	28.6	41.0	18.9	27.1	22.2	31.9

Source: on the basis of data [2].

Based on the obtained values of the vegetative index NDVI, NDRE, MSAVI, and RECI according to the data of remote sensing in each land use area on July 1, 2019, the estimated rapeseed yielding capacity which is lower than the statistical one 34.2 c/ha for the location area of the research object [4]. One can observe from Table 2 that the yielding capacity from the whole land area will be 1.7 times lower compared to the agricultural one in the amount of 2,383.7 c in the area of 69.7 ha. Taking into consideration the analysis of rapeseed cultivation in the studied area of the field (69.7 hectares), we observe that the maximum biological (predicted) yielding capacity can be 1,382.1 according to the results of the vegetative index NDVI, and the minimum one – 965.0 t based on MSAVI data. It is definitely that the sparse vegetation of low-yielding rapeseed sowing is on the land plot, and accordingly, it requires the application of additional organic and mineral fertilizers in the low vegetation area [8] with an average of 41 hectares per the research object.

Table 2. The predicted yielding capacity of rapeseed according to vegetation index data for land use on July 1, 2019.

Area	Vegetation index value				The predicted yielding capacity of rapeseed according to vegetation index data, c/ha				The statistical yielding capacity of rapeseed in the research area, c/ha	The yielding capacity of rapeseed for sowing area of the researched land use, c				
										predicted				statistical
	NDVI	NDRE	MSAVI	RECI	NDVI	NDRE	MSAVI	RECI		NDVI	NDRE	MSAVI	RECI	without taking into account the vegetation index data
High vegetation	0.74	0.58	0.63	0.63	25.31	19.8	21.5	21.5	34.2	842.8	93.1	58.1	614.9	
Medium vegetation Zone 2	0.58	0.53	0.53	0.53	17.1	18.1	18.1	18.1		300.3	598.4	445.1	341.5	
Low vegetation	0.37	0.37	0.32	0.26	12.7	12.7	10.9	8.9		239.0	406.0	461.8	197.5	
For sowing area of land use 69.7 ha										1,382.1	1,097.5	965.0	1,153.9	2,383.7

Source: on the basis of data [2, 4].

CONCLUSIONS

As a result of the conducted research, an algorithm of modern soil zoning was formed due to the transition to quantitative estimation of the cultivation state of crops, using the creation of electronic soil maps based on thematic raster vegetation index applying geo-information technologies. The developed crop cultivation zoning model will significantly reduce the time spent on fieldwork by diagnosing and mapping soils, which presents qualitative information for the purposes of soil monitoring, effective land use, soil protection, and fertility enhancement.

Zoning using geo-information systems based on multispectral space scanning data allows the creation of electronic mapping of crop growth and development indices, as well as their yielding capacity on certain fields within space imagery with accurate geographical reference.

REFERENCES

[1] Dankevych, V., Dankevych, Ye, 2019, Monitoring of Agricultural Crops using Remote Sensing Systems. Economics OF Agro-Industrial Complex, 8:27.

[2]Earth Observing System, 2019, Crop Monitoring. https://eos.com/eos-crop-monitoring/, Accessed on 18.12.2019.

[3]GISLAB, 2019, Vegetation Indices, https://gis-lab.info/qa/vi.html, Accessed on 19.12.2019.

[4]Main Statistical Office in Lviv Region, 2019, Agriculture, Forestry and Fishing Industries. http://database.ukrcensus.gov.ua/statbank_lviv/Database/04SILGOSP/databasetree_uk.asp, Accessed on 20.12.2019.

[5]MicaSense, 2019, What is NDRE? https://www.micasense.com/what-is-ndre, Accessed on 19.12.2019.

[6]Liulchyk, V., Kachanovskyi, O., Bulakevych, S., 2017, Application of Geo-information Systems in Current Land Management. Ukrainian Journal of Applied Economics. 2 (2): 129-137.

[7]Soloviov, A., 2013, GIS-technology as a Management Tool for Agrarian Production Systems. Business Navigator, 3: 169-175.

[8]Stupen, N., Bohira, M., Stupen, O., Ryzhok Z., 2019, Prospects of the Application of European Practice on Efficient Agricultural Lands Use in Ukraine. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(3): 563-569.

[9]Stupen, N., Stupen, M., Stupen, O., 2018, Electronic Agricultural Maps Formation on the basis of GIS and Earth Remote Sensing. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18(4): 347-353.

[10]Zatserkovnyi, V., Tishaiev, I., Virshylo, I., Demydov, V., 2016, Geo-information Systems in Earth Sciences: monograph, Nizhyn, 510 p.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

METHODICAL FEATURES OF THE DETERMINATION OF LAND SUITABILITY FOR CONDUCTING AGRICULTURAL PRODUCTION

Roman STUPEN, Oksana CHERECHON, Oksana STUPEN, Myroslava SMOLIARCHUK

Lviv National Agrarian University, Ukraine, 1, V. Velykoho str., Lviv Region, 80381, Ukraine, Phones: + 38 067 33 27 875, + 38 032 22 42 961; E-mails: romomas@ukr.net, okcherechon@gmail.com, oksanashufryn@ukr.net, murosya_s@ukr.net

Corresponding author: oksanashufryn@ukr.net

Abstract

One has researched the method of classification of the suitability of arable lands for the cultivation of basic agricultural crops. One has presented the classification of lands by suitability on the example of the landmass of limited liability company "Luhy", located on the territory of Velyki Hlibovychi village council of Peremyshliany district of Lviv region *on the basis of detailed analysis of materials of soil surveys. The mapping of the ecological suitability of the land is presented and scientific recommendations for cultivation and cultivation of crops in crop rotation for the object of study for ecological use in the system of intra-land management are offered.*

Key words**:** *ecological suitability of land, cultivation of crops, suitability classes of arable lands, in-farm land management*

INTRODUCTION

An excessive production load on agricultural lands has recently led to an increase in negative processes. Among them, in addition to erosion, the threatening state of neglecting the issues of the ecological suitability of lands for the cultivation of certain crops, in particular, is an unjustified increase of such crops as rapeseed, sunflower and others which deplete soils.

The scholars Ye. Butenko [2], N. Voitovych [11], P. Kazmir and L. Kazmir [4], N. Stupen [8], A. Tretiak [9; 10] consider the environmental assessment of the territory, firstly, as suitability for intensive use; secondly, as an assessment of fertility factors in this territory. It involves the analysis of the territory in the context of compliance of factors with the basic requirements of plants. When external conditions do not comply with the requirements of the plants, then there is the issue about the inappropriateness of the territory for the certain plant or the necessity to adapt the conditions to the plants or, conversely, the plants to environmental conditions.

Assessing the territory as a place of cultivation of plants, and considering their demand for natural factors, as well as the range of fluctuations of the demand and natural conditions on which the productivity of plants depends, we make conclusions that the degree of suitability of the territory for crops, and on the necessary measures for their improvement [1].

MATERIALS AND METHODS

We have applied the method of ecological and economic classification of the suitability of lands for growing basic agricultural crops to carry out the study [9; 10]. The study of the classification of arable land suitability is based on the indicator of the cost recovery of the partial economic evaluation of arable land, which reflects the yielding capacity of the certain crop and the cost of obtaining it, as well as soil valuation data [9]. Considering the calculations and indicators of the partial economic evaluation of arable land and soil valuation, arable lands or landownership lands are divided into three groups and five classes of suitability within the land assessment area [10].

The first group includes arable lands, which provides a level of cost recovery for growing basic crops over 1.30.

The second group includes undeveloped and poorly washed arable lands, which do not provide cost recovery for intensive crops growing (mainly sugar beets, corn for grain and others at the level of 1.30 and above).

The third group unites the middle-washed and heavily-washed arable lands. As a rule, when growing intensive crops on them, the level of cost recovery will be below 1.30 (Fig. 1). The data of such classification of arable land is used for optimization of the structure of lands and acreage, development of projects of agricultural land management of the territory of agricultural enterprises and solving other issues on the organization of rational use and land protection [7].

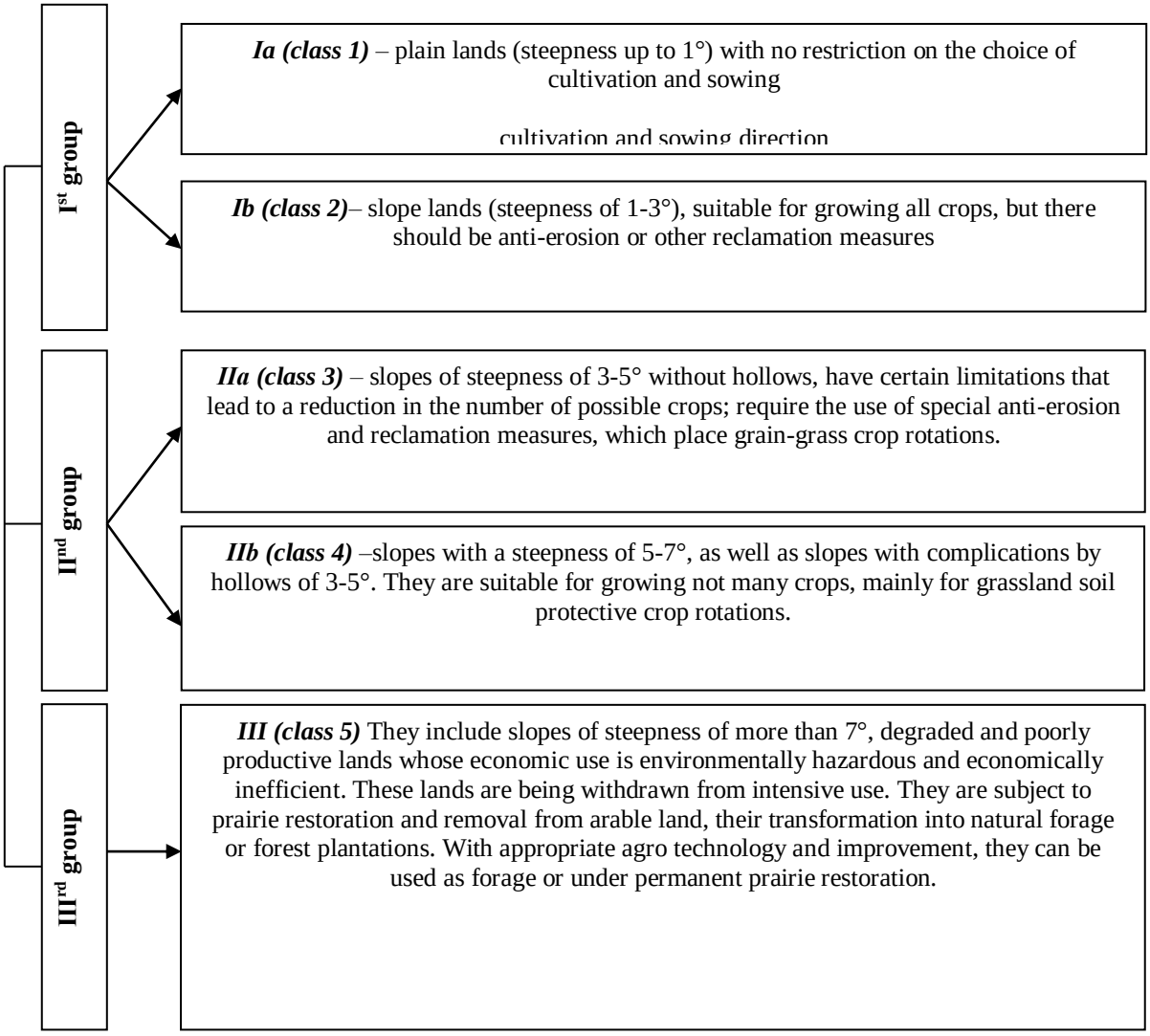

Fig. 1. Groups and classes of suitability of arable lands.
Source: on the basis of data [9, 10].

RESULTS AND DISCUSSIONS

One carries out the classification of the suitability of lands to facilitate understanding by landowners and other land users of soil maps for their practical application. This fact allows having broader generalizations based on soil potential and land use restrictions.

The object of the study is the land arrays of "Luhy" Limited Liability Company located on the territory of Velyki Hlibovychi village council of Peremyshliany district of Lviv region. The territory of this farm belongs to the Forest-Steppe Natural-Agricultural Zone, Forest-Steppe Western Natural-Agricultural Province, Dnister-Western Buh district. The average monthly air temperature during the year varies from - 7-8 to +20°-21° depending on the location of the farm. The absolute minimum and maximum of the air

temperature were -32 and + 37°. Annual precipitation varies from 400 to 560 mm [5].
On the farm, the main economic activity is mixed agriculture, where crops such as rapeseed, barley, wheat, and soybeans are grown. The average yielding capacity of rapeseed is 25.4 c/ha, barley – 47.9-59.3 c/ha and wheat within 56.3-61.2 c/ha respectively. Considering the agro-technical measures for cultivation of appropriate crops in the farm, one should determine the suitability of the land tracts for their cultivation in crop rotation, performing the selection of varieties of crops taking into account the stability, competitiveness against weeds, diseases or pests by optimizing soil cultivation system, fertilization, setting deadlines and ways of sowing, harvesting [3].
Land plots have been allocated to substantiate the suitability of landmasses for their cultivation in the farm. Their detailed analysis is given in Table 1.

Table 1. Analysis of land plots

№	Total area, ha	Agro-production groups of soils		
		code	name	area, ha
1	1.2557	45g	dark gray podzolic soils and black soils with podzolic gleysolic light-loamy ones	1.0922
		51d	dark gray podzolic soils, degraded soils, and podzolic black soils and medium-loamy, heavily washed degraded ones	0.1635
2	1.2592	45g	dark gray podzolic soils and podzolic gleysolic light-loamy black soils	1.2592
3	0.1718	49g	dark gray podzolic and degraded soils and podzolic black soils and gleysolic light-loamy lightly-washed degraded ones	0.1718
4	0.7859	45g	dark gray podzolic soils and podzolic gleysolic light-loamy black soils	0.2390
		51d	dark gray podzolic soils, degraded soils, and podzolic black soils and medium-loamy, medium washed degraded ones	0.5469
5	0.7501	45g	dark gray podzolic soils and podzolic gleysolic light-loamy black soils	0.7501
Total		4.2227		

Source: on the basis of data [6].

One used a large-scale soil survey of Velyki Hlibovychi village council of 1992 to analyze the soil cover of the selected land plots. As we see in Table 1, the land plots are represented mainly by dark gray podzolic soils and black soils with podzolic gleysolic light-loamy ones (code 45g) [6]. The depth of the humus profile in them is determined at the level of 80-100 cm, where the humus content is 4-5% [5].
Having analyzed the location of soils on the investigated land plots, we can state that the cartograms of the arrays of the ecological suitability of the lands are proposed as a scientific prerequisite for their ecological use.
One has shown the territorial location of groups of arrays of ecologically suitable lands in Figure 2, by way of qualitative localized background or hatching, depending on the intensity of land use. Taking into account the above-mentioned information, one can observe that the lands of the first group of ecological suitability arrays are shown in red, the second group – orange, the third group – yellow, the fourth group – mustard and the fifth one – green.
Table 2 presents the explication of land plots according to suitability classes.

Table 2. Explication of land plots according to suitability classes.

№	Area, ha	Agro group code / Suitability class		
		45g	49g	51d
1	1.2557	1.0922 / I		0.1635 / III
2	1.2592	1.2592 / I		
3	0.1718		0.1718 / II	
4	0.7859	0.2390 / II		0.5469 / IV, V
5	0.7501	0.7501 / I		
Total	4.2227	3.3405	0.1718	1.7104

Source: it is done by the author on the basis of data [6].

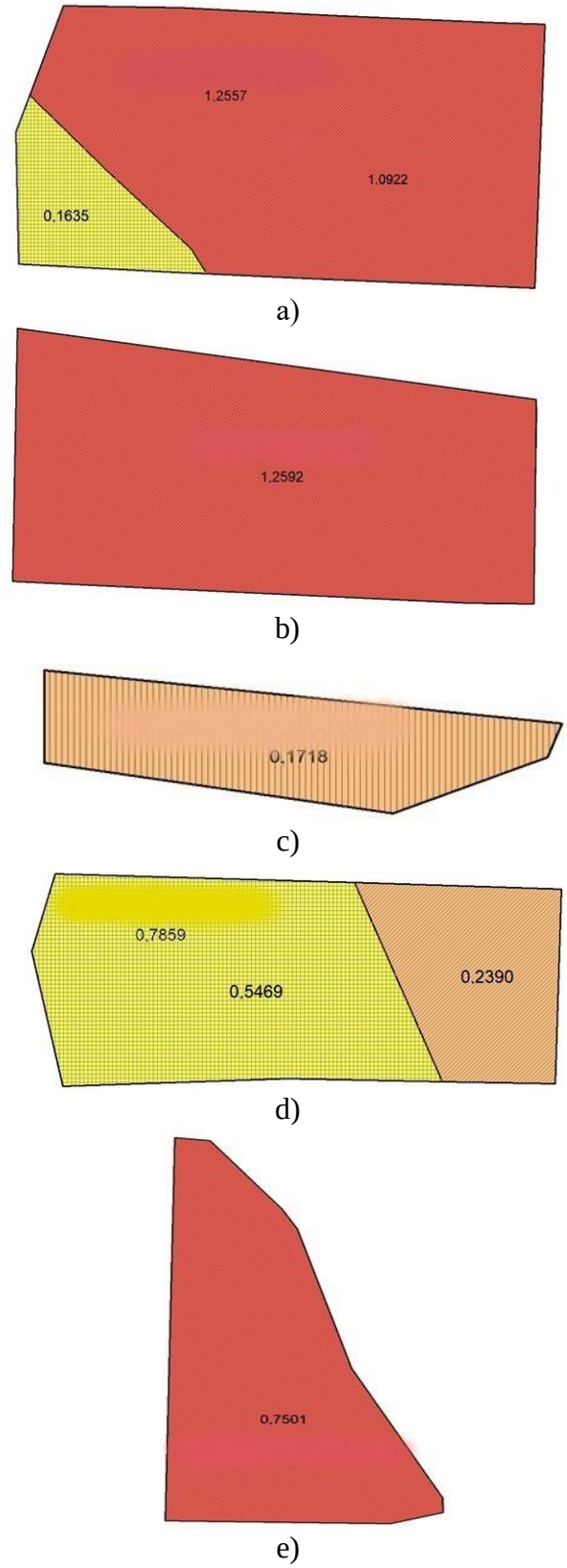

Fig. 2. The cartogram of environmental suitability chart of land plot, the area of a) 1.2557 hectares; b) 1.2592 ha; c) 0.1718 ha; d) 0.7859 ha; e) 0.7501 ha.
Source: on the basis of data [6].

Table 2 shows that the largest area of the investigated lands is agro group 45g – 3.3405 ha. These are the undisturbed soils that belong to the 1st and 2nd technological groups, and they are mainly included in the first class of suitability, where it is possible to grow all regional crops including row ones by intensive technologies. However, a small part of them – 0.2390 hectares is included in the second class of suitability, where it is obligatory to cultivate and sow across or at an acceptable angle to the slope. One also includes parts of land plots, adjacent to the highly washed soils, that is they are on slopes 3-5˚ in the second class (Fig. 2c), 2d). We suggest to include soils of agro group of 49g, with an area of 0.1718 to the second class of suitability, as these are lightly washed soils located on the slopes of 3-5˚. A small area of 0.1635 hectares on the land plot of agro group 51e - highly washed soils can be included in the third class of land suitability (Fig. 2a). The land plot, the main area of which is 0.5469 ha, is occupied by highly washed soils (code 51e) is shown in Fig. 2d).

CONCLUSIONS

In the farm we offer two land use options, namely:

Ist option – withdrawal from intensive cultivation and prairie restoration (the 5th class of suitability) for the lease period;

IInd option – considering that it is a leased land share - for limited use (the 4th class of suitability) with the introduction of grassland soil protective crop rotation (on slopes 5-7 °, where heavily washed soils predominate).

The location on such lands of cultivated crops is excluded. In grassland crop rotations the proportion of perennial grasses will be from 40-50 to 80%.

The conducted research on the example of an agricultural enterprise allows to more reasonably solving the problem of organization of crop rotations, as an essential part in the system of agricultural land management.

REFERENCES

[1] An analysis of the suitability of arable lands, 2019, The classification of arable lands by the suitability of soils for crop production. Characteristics of the criteria by which agricultural groups of soils are carried out: genetic convergence of soils, degree of negative processes, https://knowledge.allbest.ru, Accessed on 01.12.2019.
[2]Butenko, Ye., 2012, Ecological and economic assessment of agricultural land use due to market conditions: monograph, Kyiv, 158 p.
[3]Institute of Agriculture of the Carpathian region of National Academy of Agrarian Sciences of Ukraine, 2019, Features of Growing Winter Crops Technologies for the 2019 Harvest (Autumn Works): Recommendations, Obroshyno, 48 p.
[4]Kazmir, P., Kazmir, L., 2007, Land management design: organization of lands and crop rotation and landscaping of crop rotation: a lecture course, Lviv, 97p.
[5]Martyn, A., Osypchuk, S., Chumachenko, O., 2015, Natural and Agricultural Zoning of Ukraine: Monograph, Kyiv, 328 p.
[6]Polupan, M., 2005, Classification of Soils of Ukraine, Kyiv, 300 p.
[7]Stupen, M., Stupen, R., Ryzhok, Z., Stupen, O., 2019, Methodological foundations of the organization and protection of lands in the context of the balanced nature use. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(1): 565-571.
[8]Stupen, N., Bohira, M., Stupen, O., Ryzhok, Z., 2019, Prospects of the application of European practice on efficient agricultural lands use in Ukraine. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(3): 563-569.
[9]Tretiak, A., Druhak, V., Leonets, V., Tretiak, R., Hunko L., 2019, Methodological recommendations of ecological and landscape land management of agricultural enterprises, Kyiv, 92 p.
[10]Tretiak, A., Tretiak, R., Shkvar, M., 2011, Guidelines for environmental stability assessment of agricultural landscapes and agricultural land use, Kyiv, 15 p.
[11]Voitovych, N., 2015, Ecological aspects of valuation of arable lands, Scientific Bulletin of Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies, 3 (63): 377-380.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

AGRICULTURAL GROWTH RESPONSE TO HUMAN CAPITAL DEVELOPMENT IN NIGERIA

Udeme Henrietta UKPE[1], Jacintha Nkeiruka EZE[1], Fani Raoul Choumbou DJOMO[2], Chinwe Prisca OSAYI[1]

[1]Federal University Wukari, Faculty of Agriculture and Life Sciences, Department of Agricultural Economics and Extension, P. M. B. 1020, Wukari, Taraba State, Nigeria; Emails: ukpe@fuwukari.edu.ng, ezejacintha4@gmail.com, chinwepriscaigbelina@yahoo.com
[2]University of Buea, Faculty of Agriculture and Veterinary Medicine, Department of Agricultural Economics and Agribusiness, P.O. BOX 63 Buea, South West Region, Cameroon, Email: raoulfani@gmail.com

Corresponding author: ukpe@fuwukari.edu.ng

Abstract

This study evaluated agricultural growth response to human capital development in Nigeria. Annual time series data covering a period of 1993-2017 were utilized to analyse the objectives. The result shows that recurrent expenditure on education contributed above 10% and capital expenditure on education contributed above 2% to agricultural growth in the long run. Primary school enrolment contributed above 20% and tertiary institution enrolment contributed above 1% to agricultural growth in the short run. The impulse response result shows that agricultural growth responded negatively capital expenditure on education but responded significantly to recurrent expenditure. There was minimal response of agricultural growth to both capital and recurrent expenditures on health. It was therefore recommended that capital expenditures on education and health be increased and channelled appropriately.

Key words**:** *human capital, education, health, agricultural growth*

INTRODUCTION

The role of agriculture cannot be overemphasized in economic development, particularly in the developing economies of all regions as it constitutes about one-third of GDP. In addition to ensuring food and nutritional security, it serves as the major source of rural employment and backbone of rural economies. Yet, in Africa as a whole, growth in this sector has been sluggish in recent years. Improving this growth rate is an item of increasing concern for both governments and international organizations [1]. In countries where agriculture accounts for majority of the employment their citizens increased growth in agricultural incomes is essential to facilitate growth in the overall economy since the goods and services have the ability to generate overall GDP growth from agriculture including the non-farm sectors. This ability and the comparative advantage in reducing poverty vary among the different countries [3].

According to [10] "The concept of human capital refers to the abilities and skills of human resources of a country, while human capital development refers to the process of acquiring and increasing the number of persons who have the skills, education and experience that are critical for economic growth and development of a country's economy". [2] posited that human capital refers to the human factor in the production process consisting of the combined knowledge, skills and abilities of the workforce employed to carry out the various activities required to generate income. Development of human activities, however, requires a holistic participation from the government, the private sector and the research institutions. It is no doubt that the government is actively promoting human development activities by providing funds and infrastructures [11]. With increasing globalisation, attention is being drawn towards human capital development because

of the productivity of the job market due to the recent recession in the various economies of the world. Developed nations emphasize on human capital development by devoting necessary time and efforts and for the developing countries to develop, emphasis should be more on human capital development towards accelerating the economic growth as this will project them into the international arena [6]. Thus human capital development is not limited to education and health. In Nigeria, Human capital is produced mainly in the education and health sectors. In providing the necessary resources, both physical and human using public resources, the government in the process develops human capital [9]. The objectives of this study were to: ascertain the contributions of human capital development indicators to agricultural growth in Nigeria; and analyse the response of agricultural growth to human capital development agricultural growth in Nigeria.

MATERIALS AND METHODS

The study was conducted in Nigeria. Federal Republic of Nigeria is located in West Africa between latitude 9.0820° N and longitude 8.6753° E. Nigeria has a total land area of 909,890sqkm. The projected population of Nigeria in 2019 is 196,056,444 from the 2006 population census of 140,431,790 using the annual growth rate of 2.6% [8]. Nigeria's human capital development has remained weak due to underinvestment in it. The country has been ranked 152 out of 157 by World Bank in the human capital index [12].

Data for this study were obtained entirely from secondary sources. Annual time serial data covering the period of 1993 to 2017 for growth in agricultural production, the expenditure of government on education and health were obtained from various issues of the Central Bank of Nigeria Statistical Bulletin while primary school enrolment, secondary school enrolment and tertiary enrolment were obtained from Nigeria Bureau of statistics. Data collected were analysed using variance decomposition and impulse response analyses.

The variance of any given dependent variable (Y_t) in response to the orthogonal shocks to it can be thought of as the variance of the errors in forecasting it using equation (1) because without the shocks we would forecast the variable to remain unchanged.

$$Y_t = Z_0 e_t + Z_1 e_{t-1} + Z_2 e_{t-2} + \cdots +$$

$$Z_n e_{t-n} + Y_0 \qquad (1)$$

The vector of one step ahead forecast errors is given by $Z_0 e_t$ [4].

The OLS model used to estimate the AR(p_n) model which are the basis for the conventional impulse response estimation was specified as:

$$\text{LnAG} = \alpha_0 + \alpha_1 \text{LnPRY} + \alpha_2 \text{LnSEC} + \alpha_3 \text{LnTER} + \alpha_4 \text{LnREDU} + \alpha_5 \text{LnCEDU} + \alpha_6 \text{LnRHLT} + \alpha_7 \text{LnCHLT} + \alpha_8 \text{LnL} + u \qquad (2)$$

where:
AG = Agricultural Growth
PRIM = Primary School enrolment
SEC = Secondary School Enrolment
TER = Tertiary School Enrolment
REDU = Recurrent Expenditure on Education
CEDU = Capital Expenditure on Education
RHLT = Recurrent Expenditure on Health
CHLT = Capital Expenditure on Health
L = Labour force
α = coefficients to be estimated and their a-priori signs indicate that all the coefficients are positively related to AG
u = the random error, with mean zero and constant variance.

RESULTS AND DISCUSSIONS

Contributions of human capital development indicators to agricultural growth in Nigeria

Employing a 10 year forecasting horizon, the forecasting error variance decomposition determines the proportion of the movement in the time series that are due to the shocks in their own series as opposed to shocks in other

variables. The result on Table 1 reveals that in the first year, agricultural growth accounted for 100% changes in itself, 38.56% in the fifth year and 35.43% in the tenth year. Focusing on the impact on agricultural growth, the estimated decompositions suggest that capital expenditure on education explain only between 0% and 4.45% of future variation in agricultural growth over the forecast horizon. Recurrent expenditure on health and secondary school enrolment accounted for less than1% throughout the period. This might be as a result of constant industrial actions by medical personnel due to poor working conditions and non-availability of modern health facilities.

Result further shows that shocks to the recurrent expenditure on education had the second highest influence on agricultural growth throughout the period of analysis as it increased steadily and significantly overtime. Labour, primary school enrolment and tertiary institution enrolment contribution to agricultural growth dropped from 1.82%, 20.53% and 2.9% in the short run period to 1.76%, 19.17%, and 2.86% respectively in the long run period. The contributions of capital expenditure on education and recurrent expenditure on education to agricultural growth increased from 1.41% and 33.28% in the short run period to 4.45% and33.93% in the long run period respectively.

Response of agricultural growth to human capital development agricultural growth in Nigeria

The impulse response functions are based on a moving average of the VAR model and the dynamic responses of one variable to another are evaluated. Figure 1 presents the impulse response of agricultural growth to capital expenditures on health and education; recurrent expenditures on education and health; primary school, secondary school and tertiary institution enrolment and labour.

The red dotted lines represent a two deviation band around the point estimates while the point estimates of the impulse response functions are plotted on solid line. If the bands cross zero, point estimates are considered to be significant. The result on the graphs shows that a simple deviation in capital expenditure on health will positively affect agricultural growth. Agricultural growth follows a positive path after a deviation in capital expenditure on health, recurrent expenditure on education and health, primary school and tertiary institution enrolment and labour. Agricultural growth response to capital expenditure on education, secondary school enrolment is negative at the beginning before becoming positive later.

This result agrees with [5] who found that agricultural production responds positively to human capital in Nigeria because of the positive coefficient of human capital development (proxied by total government expenditures on social and community services) which was statistically significant at 1%. Therefore as human capital development increases; agricultural output also increases. It makes intuitive sense, in that as farmers get equipped with innovation information generated from research and development, it helps to boost their productivity.

Table 1. Variance decomposition

Period		LNAGRIC			LNLABOU					
	SE	OUTPUT	LNCEDU	LNCHLT	R	LNPRY	LNREDU	LNRHLT	LNSEC	LNTER
1	1.058898	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	1.716211	77.17599	0.288681	0.088025	3.997446	17.17665	0.356235	0.063100	0.045055	0.808821
3	2.252232	54.81012	1.668387	0.244278	2.689857	21.94117	15.78889	0.046951	0.646963	2.163388
4	2.634496	43.29717	1.402106	0.187088	2.051370	21.51585	27.59032	0.613705	0.577272	2.765116
5	2.820654	38.56763	1.405027	0.172675	1.827692	20.53212	33.28865	0.767403	0.537157	2.901640
6	2.892774	36.86408	2.206878	0.190998	1.771562	19.95408	34.72079	0.834751	0.519903	2.936961
7	2.921834	36.16906	3.196018	0.305727	1.785974	19.60448	34.67619	0.821138	0.521411	2.920002
8	2.937445	35.80619	3.922526	0.508573	1.777765	19.39879	34.35177	0.812436	0.526777	2.895168
9	2.948010	35.57664	4.293210	0.774457	1.765934	19.26200	34.10689	0.806755	0.539020	2.875089
10	2.956005	35.42863	4.449605	1.035153	1.759150	19.17497	33.93137	0.806488	0.554206	2.860426

Source: Eviews data analysis output, 2019.

Also it corroborates [9] findings that human capital positively affects economic growth using education component of human capital. [7] study findings show that education is an

imperative HCD indicator, which has a significant influence on the growth of TFP of the agriculture sector as education indicated a positive influence on the growth of total factor productivity.

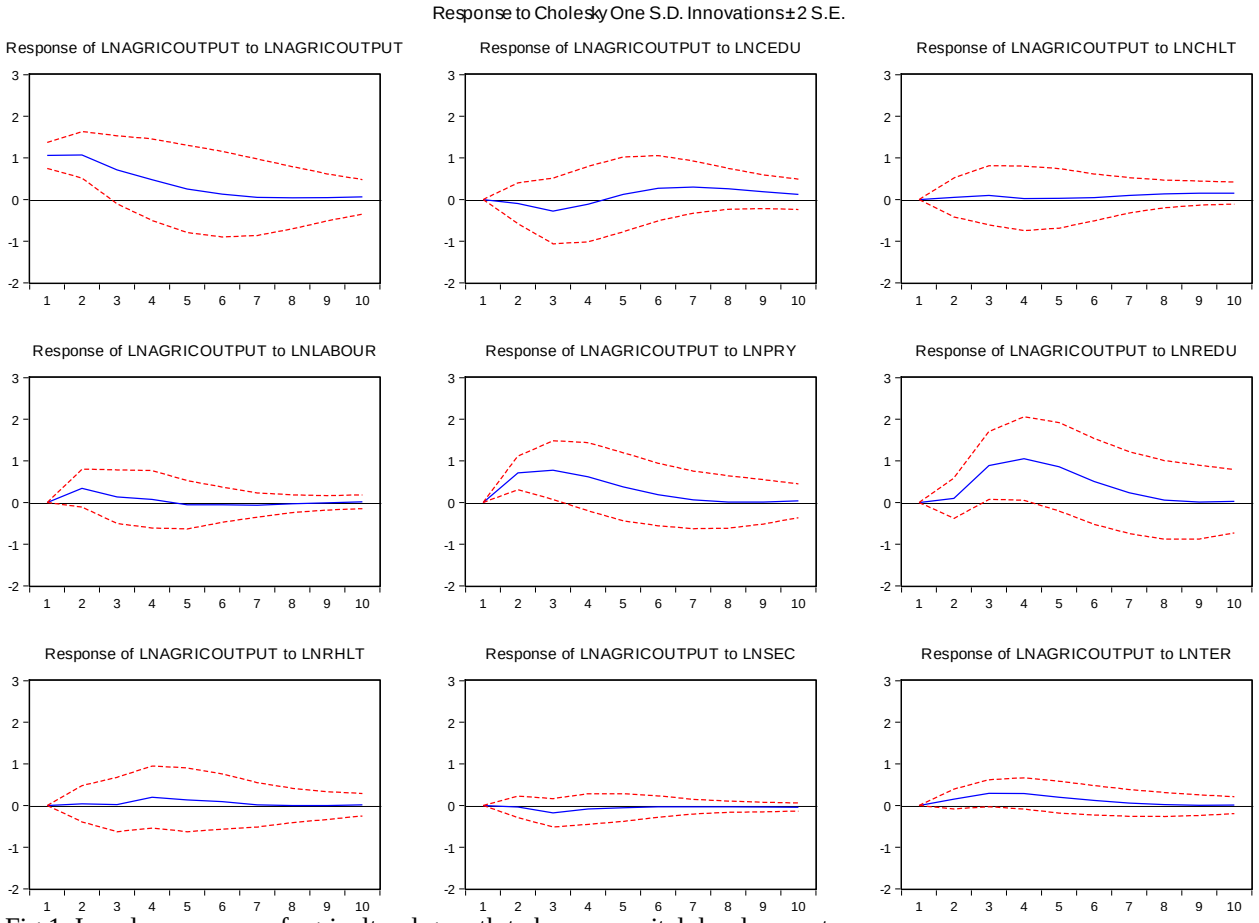

Fig 1. Impulse response of agricultural growth to human capital development
Source: Eviews data analysis output, 2019.

CONCLUSIONS

The contribution of human capital development to agricultural growth and response of agricultural growth to human capital development was evaluated in this study using time series data spanning a period of 25 years (1993-2017). It were capital and recurrent expenditures on education, primary school enrolment to agricultural growth, tertiary institution enrolment and labour contributed significantly to agricultural growth in the long and short run. The response of agricultural growth to capital expenditure on education and secondary school enrolment in the short run was negative but positive in the long run. There was significant response of agricultural growth to recurrent expenditure on education; primary school enrolment and tertiary institution enrolment while the response to capital and recurrent expenditures on health were minimal.

REFERENCES

[1]DFID, 2015, Growth and Poverty Reduction: The Role of Agriculture. A DFID policy paper Department for International Development, London.
[2]Ejere, S. I., 2011, Human Capital Formation as Catalyst for National Development: Nigeria in Perspective, International Business and Management, 2(2):98-104.
[3]FAO, 2012, The State of Food Insecurity in the World. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Food and Agriculture Organization FAO, Rome, Italy.
[4]Floyd, J. E., 2005, Vector Autoregression Analysis: Estimation and Interpretation. Lecture note prepared for University of Toronto on September 19, 2005.

[5]Kifordu, F. C., 2015, The Effect of Human Capital Development on Agricultural Production in Nigeria. A research project submitted to the Department of Economics, Faculty of Social Science, Madonna University, Okija, Anambra State. 67pp.
[6]Matthew, A. O., 2011, Human Capital Investment and Economics Growth in Nigeria: The Role of Education and Health, Knowledge Management, Information Management, Learning Management, Knowledge Management, Information Management, 14: 266 -277.
[7]Muguna, B. K., 2015, The Contribution of Human Capital Development on Agricultural Land-Use Intensification: Analysis Using Mwea Irrigation Scheme Data. Research project submitted for partial fulfillment of requirements of the award of Master of Arts in Economics of the University of Nairobi.
[8]National Bureau of Statistics 2010, Annual Abstract of Statistics, federal Republic of Nigeria, 611pp. https://ww w.nigerianstat.gov.ng/download/71Accessed on the 22nd of January, 2019
[9]Ogujiuba, K., 2013, The Impact of Human Capital Formation on Economic Growth in Nigeria, Journal of Economics, 4(2): 121-132
[10]Okojie, A., 2005, Management of Risk and Default in Agricultural Lending, in: Ijere M and Okorie A. (Eds.), Readings in Agricultural Finance Lagos, Longman Nigeria Plc
[11]Shapira, P., Youtie, J., Yogeesvaran, K. and ZakiahJafaar, 2006, Knowledge economy measurement: Methods, results and insights from the Malaysian knowledge content study, Research Policy, 35(10): 1522-1537.
[12]World Bank 2018, The World Bank is helping to fight poverty and improve living standards for the people of Nigeria with more than 130 IBRD loans and IDA credits since 1958. https://www.worldbank.org/en/country/nigeria/overview, Accessed on 27th December, 2018.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

RESEARCHES REGARDING THE INCREASE AND MODERNIZATION OF THE MEAT PROCESSING CAPACITIES BY USING THE FUNDS OFFERED THROUGH THE NATIONAL RURAL DEVELOPMENT PROGRAM IN THE NORTH WEST DEVELOPMENT REGION

Daniel Valeriu ULIU[1], Marius VLADU[2]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, 011464, Bucharest, Romania, Phone: +40766287579, E-mail: daniel_uliu@icloud.com
[2]University of Craiova, Faculty of Agronomy, Department of Agricultural and Forestry Technology, 19 "Libertăţii" Street, Craiova 200583, Dolj County, Romania, Phone: +40744870085, E-mail: mariusvladu@yahoo.fr

Corresponding author: daniel_uliu@icloud.com

Abstract

To implement the Common Agricultural Policy (CAP) in the Member States, the European Agricultural Fund for Rural Development (EAFRD) was created by the European Union. The EAFRD finances the National Rural Development Program (PNDR), which in order to reach the priority objectives of Romania decides the financing lines. The National Program for Rural Development deals with the provision of non-reimbursable funds from the Government of Romania and the European Union for the development of rural areas in Romania. The increase and modernization of the meat processing capacities through the use of the funds offered by NRDP have as an objective the increase of the added value of the agricultural products of animal origin (meat processing). Sub-measure 4.2 ("Support for investment in the processing / marketing and / or development of agricultural products") is concerned with the modernization and creation of processing units and the introduction of new technologies in this field. The purpose of this paper is to analyze the situation of investments in meat processing units in the North-West Development Region of Romania, between 2015-2018, where 9 projects were financed (eligible value of 24,413,529 euros), representing 22% of the total, of 42 projects financed at national level (eligible value of 98,084,071 euros), by sub-measure 4.2, of the National Rural Development Program 2014-2020. From the correlation of the amounts invested (eligible value) from the counties of this area with the value of the total agricultural production (the live weight of the animals destined for slaughter), it follows that the projects were done randomly, independently of the animal agricultural production.

Key words**:** *eligible value, processing meat, financing, project, measure, live weight.*

INTRODUCTION

The European Union, through the Common Agricultural Policy, offers a complex system of rural development interventions and increased flexibility, allowing, with the help of the rural development plan, the design of a financial package according to the national specific, based on the principle of subsidiarity [3].

The aim of the CAP is to support the rural areas of the EU and to face the many economic and social challenges by developing their own rural development programs based on European mechanisms [4].

Adjustments to European Union standards have led to substantial disappearances of investments in meat processing. These factors make companies more vulnerable to bankruptcy [2].

After the date of accession to the European Union, some financial support can be used through the use of structural funds and all the best available techniques suggested by the EU will be implemented to modernize the meat industry [5].

The simulations show that a grant scheme can promote compliance and can contribute to a modernization of the industry in the exporting country, but its marginal efficiency is diminished [8].

Subsidies for investments should increase the economic results of the supported companies and increase their competitiveness [9].

The import of unprocessed meat is increasing, also the consumption of meat per capita is

increasing, but also the companies in the field of meat processing are increasing [11].
Export support and its promotion represent a very good method for sustainable development, also for Romania's economic development and integration into the complex system of international relations [1]. A study conducted in Poland shows that for the development of meat companies, cooperation with scientific research and development institutions and investments in human capital must be achieved [10]. Also, the production of raw materials (pork, beef, sheep and goat meat, poultry meat) influences investments in meat processing units. Domestic pig production must be sufficient to cover domestic consumption, pig farmers must be supported to increase their production. In case the farmers are not supported, the imports from the western countries will increase, due to their overproduction.[7]. Following the analysis of pork production trends, a forecast was made between 2015-2020, which resulted in a decrease in pork production at EU level and an increase in pork production in Romania [6].

MATERIALS AND METHODS

In this article, a study was conducted on the production of animals intended for slaughter (cattle, pigs, sheep and goats, poultry) and investments in meat processing units carried out by sub-measure 4.2 of the National Rural Development Program, between 2015-2018. The North-West Region of Romania was analyzed (Bihor, Bistrița-Năsăud, Cluj, Maramureș, Satu-Mare, Sălaj counties) where the number of projects and the amounts invested in the meat processing units were investigated, but also the potential their development regarding the production of animals intended for slaughter. From the selection reports published by the Agency for Financing Rural Investments, the data regarding the financing of the projects were taken.
The situation of the production of animals destined for slaughter took from the database of the National Institute of Statistics.
In order to highlight the correlations between animal agricultural production – the live weight of the animals for slaughter (x) and the number of projects (y) and animal agricultural production – the live weight of the animals for slaughter (x) and the total eligible value (y) the following equation was used:
- *the equation for the correlation coefficient*:

$$r = \frac{\sum (x_i - \overline{X})(y_i - \overline{Y})}{\sqrt{\left(\sum (x_i - \overline{X})^2\right)\left(\sum (y_i - \overline{Y})^2\right)}},$$

where:
$\overline{X}$ and $\overline{Y}$ - are the averages for samples, average (matrix1) and average (matrix2).
In the analysis, the values of the correlation coefficient (r) and of the coefficient of determination will be presented (R^2).

RESULTS AND DISCUSSIONS

In the North West region of Romania, 9 projects were financed, representing a percentage of 22% of the total of 42 projects from all over Romania, through sub-measure 4.2 of the PNDR 2014-2020, in the meat processing units in 2015 -2018. (Table 1).
In Cluj county there were 5 funded projects, in Satu-Mare county there were 2 funded projects, and in Bihor county 2 funded projects, while in Bistrita-Nasaud, Maramures and Salaj counties there was no funded project (Table 1).

Table 1. Number of projects funded in the North-West Region, between 2015-2018

Year	County						Total	National Total
	Bihor	Bistrița Năsăud	Cluj	Maramureș	Satu-Mare	Sălaj		
2015	0	0	0	0	1	0	**1**	**4**
2016	0	0	0	0	0	0	**0**	**8**
2017	2	0	2	0	0	0	**4**	**18**
2018	0	0	3	0	1	0	**4**	**12**
Total	**2**	**0**	**5**	**0**	**2**	**0**	**9**	**42**

Source: Own calculation.

The total amount invested (the eligible value) at national level in the meat processing units, in the period 2015-2018, by submeasure 4.2 of the National Rural Development Program 2014-2020 is 98,084,071 euros, while in the North-West Region were invested 22,413,529 euros (eligible value), representing 23% of the total amount at national level (Table 2).
The eligible value from Cluj county is 13,290,386 euros, and the public value is 6,658,938 euros, being the county with the most funded projects and the highest amount invested by this measure. In Bihor county we have an eligible value of 5,616,143 euros and a public value of 2,807,958 euros, and in Satu-Mare county we have an eligible value of 3,507,000 euros and a public value of 2,342,000 euros. In Bistrita-Nasaud, Maramures and Salaj counties there were no projects financed by this measure (Table 2).

Table 2.The value of the projects financed in the North-West Region, between 2015-2018 [€]

Year	Value [€]	Bihor		Bistrița - Năsăud		Cluj		Maramureș		Satu-Mare		Sălaj		Total Eligible Value	Total Public Value	Total National Eligible Value	Total National Eligible Value
2015	Eligible	-		-		-		-		650,000		-		**650,000**		2,185,556	
	Public		-		-		-		-		325,000		-		**325,000**		1,092,778
2016	Eligible	-		-		-		-		-		-		-		27,066,427	
	Public		-		-		-		-		-		-		-		12,439,399
2017	Eligible	5,616,143		-		3,999,790		-		-		-		**9,615,933**		41,183,117	
	Public		2,807,958		-		1,999,896		-		-		-		**4,807,854**		18,969,048
2018	Eligible	-		-		9,290,596		-		2,857,000		-		**12,147,596**		27,648,971	
	Public		-		-		4,659,042		-		1,999,000		-		**6,658,042**		15,589,513
Total	**Eligible**	**5,616,143**		-		**13,290,386**		-		**3,507,000**		-		**22,413,529**		**98,084,071**	
	Public		**2,807,958**		-		**6,658,938**		-		**2,342,000**		-		**11,790,896**		**48,090,738**

Source: Own calculation.

The live weight of the cattle destined for slaughter, in the North-West Region was increasing during the analyzed period, in 2015 there were registered 25,227 tonnes live weight, and in 2018 the value reached 30,237 tonnes live weight. The live weight of the pigs intended for slaughter was increasing, in 2015 there were 67,172 tons live weight, and in 2018 the value reached 74,274 tons, in the North West Region. And in the case of sheep and goats there were increases, in 2015 there were 12,707 tons live weight, and in 2018 there were 14,256 tons live weight. The live weight of the birds destined for slaughter was 49,241 tons live weight in 2015, and in 2018 it reached 64,029 tons live weight (Table 3).

Table 3. Animal agricultural production – live weight of the animals for slaughter – cattle, pigs, sheep and goats, poultry

Animal product categories	Development region and counties	Measure Units	Years			
			2015	**2016**	**2017**	**2018**
Cattle	Bihor	Tonnes live weight	2329	4501	5538	6941
	Bistrița-Năsăud		7617	7998	6754	6288
	Cluj		3787	4756	5700	5551
	Maramureș		5674	6335	4656	5882
	Satu-Mare		3479	3606	2840	3459
	Sălaj		2341	2347	2006	2115
	North-West Region		**25,227**	**29,543**	**27,494**	**30,237**
Pigs	Bihor	Tonnes live weight	16,961	31,208	26,861	24,096
	Bistrița-Năsăud		8678	9046	9175	8922
	Cluj		10,071	10,040	10,314	8538
	Maramureș		10,299	10,215	10,593	10,397
	Satu-Mare		12,115	11,944	13,087	14,464
	Sălaj		9048	9323	9767	7857
	North-West Region		**67,172**	**81,779**	**79,797**	**74,274**
Sheep and goats	Bihor	Tonnes live weight	2183	2239	2371	2866
	Bistrița-Năsăud		2246	2382	2186	2489
	Cluj		2590	3103	2877	3734
	Maramureș		1535	1613	1528	1590
	Satu-Mare		1605	1764	1610	1544
	Sălaj		2548	1891	1848	2034
	North-West Region		**12,707**	**12,992**	**12,420**	**14,256**
Poultry	Bihor	Tonnes live weight	15,483	20,702	24,741	22,862
	Bistrița-Năsăud		1441	1634	2123	1826
	Cluj		8597	7355	14,435	15,457
	Maramureș		1410	1285	1920	1672
	Satu-Mare		20,396	16,231	16,488	20,532
	Sălaj		1914	1694	1555	1676
	North-West Region		**49,241**	**48,901**	**61,262**	**64,029**

Source: http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table, Accessed on Dec.10, 2019.

The total live weight of animals intended for slaughter (cattle, pigs, sheep and goats, poultry), in the period 2015-2018, in the counties in the North-West Region was as follows: in Bihor county 211,788 tonnes live weight, Bistrița-Năsăud county 80,805 tonnes live weight, Cluj county 116,905 tonnes live weight, Maramures county 76,604 tonnes live weight, in Satu-Mare county 145,164 tonnes

live weight, and in Salaj county 59,964 tonnes live weight (Table 4).

Table 4. Live weight of the animals for slaughter – cattle, pigs, sheep and goats, poultry – in 2015-2018

Animal product categories	Bihor	Bistrița-Năsăud	Cluj	Maramureș	Satu-Mare	Sălaj
	Tonnes live weight	Tonnes live weight	Tonnes live weight	Tonnes live weight	Tonnes live weight	Tonnes live weight
Cattle	19,309	28,657	19,794	22,547	13,384	8809
Pigs	99,126	35,821	38,963	41,504	51,610	35,995
Sheep and goats	9659	9303	12,304	6266	6523	8321
Poultry	83,788	7024	45,844	6287	73,647	6839
Total live weight of the animals for slaughter	**211,882**	**80,805**	**116,905**	**76,604**	**145,164**	**59,964**

Source: Own calculation.

Table 5. Development region and counties, total live weight of the animals for slaughter, the number of projects, the total eligible value

Development region and counties	Total live weight of the animals for slaughter	The number of projects	The total eligible value [€]
Bihor	211,882	2	5,616,143
Bistrița-Năsăud	80,805	0	0
Cluj	116,905	5	13,290,386
Maramureș	76,604	0	0
Satu-Mare	145,164	2	3,507,000
Sălaj	59,964	0	0
North-West Region	**691,324**	**9**	**22,413,529**

Source: Own calculation.

Between animal agricultural production – the live weight of the animals for slaughter and the number of projects there is a correlation coefficient of 0.22, respectively a reduced dependence on the two variables. The correlation coefficient R2 has the following values: 0.56, 0.57, 0.99, 1.00 for polynomial functions of degree 2, 3, 4 and 5 (Fig.1).

It turns out that there is a correlation between the two variables, but no mathematical model can be recommended for use, so the number of projects in each county of the North West Region does not depend on the animals intended for cutting in each county, the projects being accessed randomly.

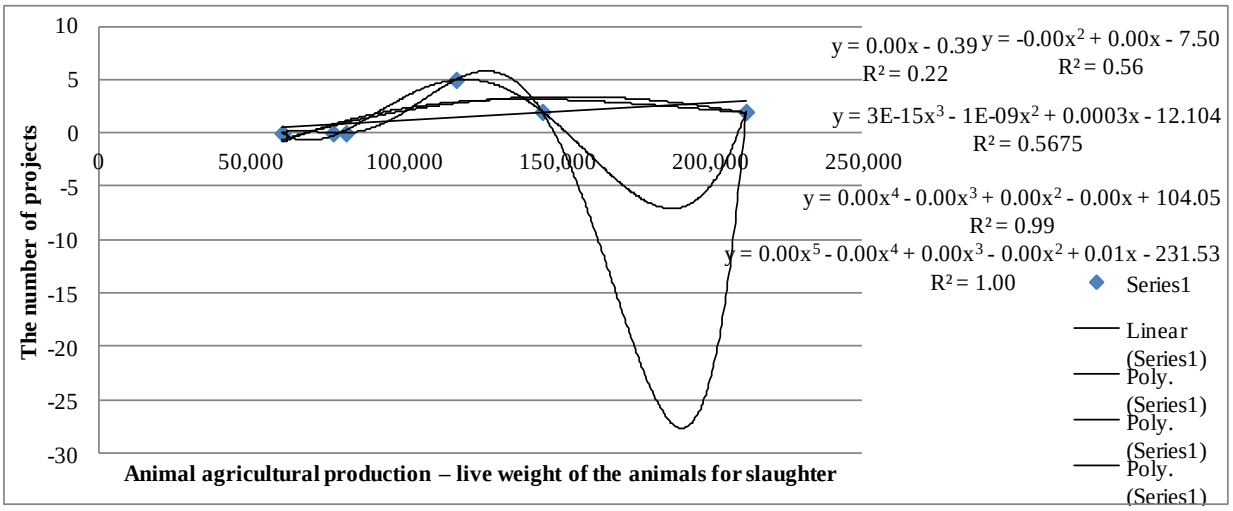

Fig. 1. Correlation Between animal agricultural production – the live weight of the animals for slaughter and the number of projects
Source: Own design.

Between animal agricultural production – live weight of the animals for slaughter and the total eligible value there is a correlation coefficient of 0.21, respectively a reduced dependence on the two variables.

The correlation coefficient R2 has the following values: 0.44, 0.48, 0.99, 1.00 for polynomial functions of degree 2, 3, 4 and 5 (Fig. 2).

It turns out that there is a correlation between the two variables, but no mathematical model can be recommended for use, so the eligible value invested by sub-measure 4.2 from each county of the North West Region does not depend on the animals destined for cutting in each county, the projects being accessed randomly.

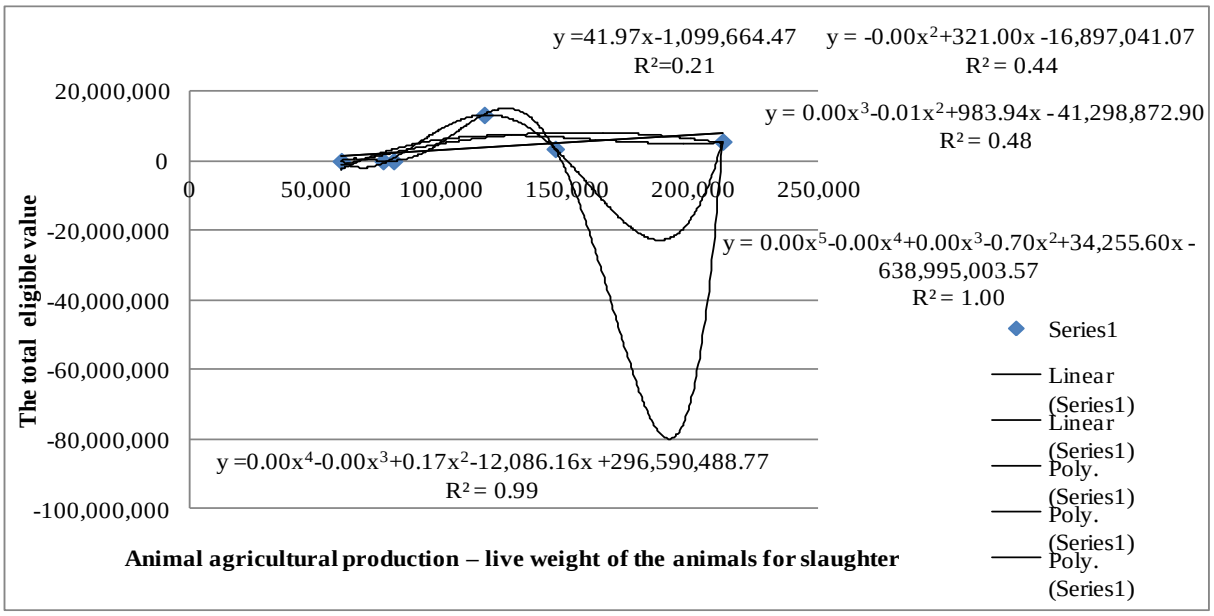

Fig. 2. Correlation between animal agricultural production – the live weight of the animals for slaughter and the total eligible value
Source: Own design.

CONCLUSIONS

In the North West region of Romania, 9 projects were financed, representing a percentage of 22% of the total of 42 projects from all over Romania, through sub-measure 4.2 of the PNDR 2014-2020, in the meat processing units in 2015 -2018.

In the period 2015-2018, 22,413,529 euros (eligible value) were invested in the North-West Region of Romania, representing 23% of the total amount invested (eligible value) at national level of 98,084,071 euros, through sub-measure 4.2 of the 2014-2020 NRDP. From the correlation of the amounts invested (the eligible value) from the counties of this area with the value of the total animal production (live weight of the animals destined for slaughter), it follows that the projects were randomized, independently of the animal agricultural production (the live weight of the animals destined for slaughter).

REFERENCES

[1]Alecu, I. N., Stefan, P., Cretu, R.C., Cutas, C., 2016, Proposals Concerning the Promotion Strategy of Food Products in Foreign Markets. Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development 16(1):31–37.

[2]Boratynska, K.,2012, Predicting Bankruptcy of Selected Companies from The Polish Meat Sector, Economic Science for Rural Development: Rural Business and Finance: 1. Rural Business Economics and Administration, 2. Finance and Taxes, Pp. 170–75.

[3]Comanescu, I. S., Foris, D., Foris, T., 2019, Dimensions of the Funding Programmes for Sustainable Rural Development, Economic Science for Rural Development 2019, Pp. 44–51.

[4]Michalcewicz-Kaniowska, M., Zajdel, M.,2019, Rural Development in European Union Policy, Economic Science for Rural Development 2019, Pp. 140–146.

[5]Pisula, A., Urban R., 2004, Adaptation process of Polish meat industry to EU standards. Medycyna Weterynaryjna 60(5):473–477.

[6]Popescu Agatha, 2015, Research on the Pork Production Trend in the EU-28, the CEECs and Romania, Proceedings of 25th IBIMA Conference Innovation Vision 2020: from Regional Development Sustainability to Global Economic Growth, Amsterdam, The Netherlands, May 7-8, 2015, pp.1407-1422

[7]Popescu Agatha, 2016, Research on Concentration of Pork Production in Romania. Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development 16(1):405–410.

[8]Rau, M. L., van Tongeren, F., 2007, Modeling Differentiated Quality Standards in the Agri-Food Sector: The Case of Meat Trade in the Enlarged EU. Agricultural Economics 37(2–3):305–15.

[9]Spicka, J., Naglova, Z., Gurtler, M., 2017, "Effects of the Investment Support in the Czech Meat Processing Industry. Agricultural Economics 63(8): 356–369.

[10]Szybiga, K., Krzysztof P., 2009, Competitiveness and Innovativeness of Meat Industry Plants, Zywnosc-Nauka Technologia Jakosc, 16(3):84–94.
[11]Uliu, D.V., Vladu M., 2019, Studies on Meat Sources to Cover Processing, Consumption and Trade Needs. Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development, 19(4):361–66.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

INNOVATIVE-INVESTMENT DEVELOPMENT OF AGRICULTURE IN THE CONDITIONS OF FORMATION OF THE EXPORT-ORIENTED ECONOMIC SECTOR: SYSTEM APPROACH

Marianna VASILCHENKO[1], Ivan SANDU[2]

[1]Institute of Agrarian Problems of the Russian Academy of Sciences, 94, Moskovskaya St., 410012, Saratov, Russia, Phone: +78452263179, Fax:+78452264768, Mobile phones: +79172036930, :+79873093797, Emails: mari.vasi4lenko@yandex.ru
[2]Federal State Budgetary Scientific Institution "Federal Research Center of Agrarian Economy and Social Development of Rural Areas - All-Russian Research Institute of Agricultural Economics, 35, kor.2 sh. Khoroshevskoe, Moscow, 123007, Phone: +7499195-60-16, Mobile:+79032382618, Email: anna_gu@mail.ru

Corresponding author: mari.vasi4lenko@yandex.ru

Abstract

Creating a highly productive export-oriented agricultural sector of the economy and increasing the efficiency of agricultural production in agriculture is possible on the basis of stimulating innovation and investment. The purpose of this study is to assess the impact of investment resources on the activation of innovative processes on the example of the livestock industry and to develop recommendations for increasing the innovation and investment activity of agriculture in the context of the formation of an export-oriented economy. The author's paradigm of increasing innovation and investment activity in the agricultural sector of the economy is formed on the basis of the concept of NIS, diffusion of innovations, as well as theories of structural transformation of the economy. As a result of the analysis and evaluation of the innovation and investment development of agriculture, tendencies have been identified for increasing innovative activity and the imbalance between the existing innovative potential and the effectiveness of its use. Differentiation of regions by the level of provision with investments in fixed assets in agriculture was carried out, interregional differences were revealed. The developed author's methodology for assessing the level of innovation of the livestock industry in the Russian regions will allow us to formulate approaches to improving the structural investment policy. The practical significance of the results of the study is to develop a scheme for the development of organizational and economic support for increasing innovation activity in the context of the formation of an export-oriented agricultural sector of the economy.

Key words**:** *innovation and investment development, agriculture, export-oriented agrarian economy, organizational and economic support, state support*

INTRODUCTION

In solving the problems of creating a highly productive export-oriented agrarian sector of the Russian economy, the most important role belongs to the development of innovation and investment activity and its orientation towards the introduction of advanced scientific and technological achievements aimed at updating the technical, technological, organizational base of agricultural production and obtaining competitive high-tech products.

In the Address of the President of the Russian Federation to the Federal Assembly dated 03/01/2018, the main national development goals of Russia were formulated. Among them were named Russia's entry into the five largest economies of the world, as well as the excess of world average economic growth rates. The head of state set a goal to increase the share of investment in fixed assets in GDP to 25% by 2024. It was emphasized that at present it does not exceed 21% in the structure of GDP. An increase of this indicator by only 4% by 2024 will lead to a significant change in the structure of expenditures in the country's economy [21]. An increase in the share of investments indicates a significant change in the structure of expenditures in the economy: an increase in the savings rate of the population, an increase in investment activity for modernization and technological renewal. The Message notes

that over the past five years, the index of physical volume of investments in fixed assets in the agro-industrial complex amounted to only 3.3%, which is insufficient for the country's economic growth. In accordance with the Decree of the President of the Russian Federation dated May 7, 2018 No. 204 «On National Goals and Strategic Tasks of the Development of the Russian Federation for the Period until 2024« [11], which the Ministry of Industry and Trade of Russia developed the Passport of the National project «International Cooperation and Export» [26].

One of the components of the Passport is the federal project «Export of agricultural products». In accordance with the latter, it is planned to increase the export of agricultural products by 2 times by 2024 compared to 2018. This is possible only by increasing the export of commodity stock with high added value, which, of course, should be based on an innovative approach to further strategic development of production.

The emphasis is on the fact that it is possible to intensify innovation and investment processes provided that production efficiency in the agricultural sector is increased, measures are taken to increase its stability, improve the pricing policy in the agro-industrial complex, develop competitive relations between agricultural producers in resolving issues of their lending, and also radically change state financial policy in the agro-industrial complex [14].

The formation of the author's paradigm of increasing innovation and investment activity in order to accelerate the formation of the export-oriented agricultural sector of the economy is described by the concept of National Innovation Systems of NIS and the diffusion of innovations.

The developers of the NIS concept include K. Freeman, B.-A. Lundvall and R. Nelson, who are supporters of the views of J. Schumpeter and F. Hayek. The main theoretical and methodological views are reduced to such postulates as knowledge as a factor of economic growth, the development of NIS is due to the diffusion of innovations; the institutional component of any economic system determines and regulates the rate of diffusion of innovations, as well as the creation, implementation and commercialization of new knowledge in time and space, enhancing the spillover effects of their spread.

Freeman suggests to understand by «National Innovation system, NIS» the unification of public and private sector institutions into a single network, whose joint activity is focused on the development, modification, import and further dissemination of new technologies [20].

At the same time, Lundvall considers NIS, its elements and the links formed between them [19]. These elements and the relationships between them should be in active interaction in production processes, distribution processes, as well as when using knowledge that is useful for the economy. Nelson believes that knowledge can be recognized as useful only when it is possible to put them into practice in order to ensure the maximum degree of effectiveness. According to Nelson, NIS is a system of national institutions, on the level of joint interaction of which depends on the level of effectiveness of innovative companies. He defines the NIS as a system of national institutions collaborating together, and the degree of effectiveness of the activities of national companies in the field of innovation depends on the level of such interaction. Patel and Pavit suggested that the institutes included in the NIS structure are endowed with their own structural units that contribute to the activation of the innovation process, as well as the necessary competencies that allow to identify the main directions of technical knowledge, as well as determine their speed [27]. Metcalf defines NIS as “a set of different institutions that individually and in cooperation contribute to the development and transfer of technologies and provide a framework for the formation of public policies that affect innovation processes. NIS is a system of different interconnected institutions that produce, store and transmit knowledge, skills and human-created products used in the development of new technologies ”[22].

Improving the efficiency of using the innovative potential of innovative systems in the agricultural sector is associated with the creation, implementation, distribution and commercialization of innovations, taking into account the needs of the regions and the specific features of agricultural production, the adaptation of foreign digital systems and the growth of integration interaction between educational, scientific, industrial and implementation units [12].

Aker J [1], Al-Hassan, R., Egyir, I, Abakah, J. [2] consider the development of the innovative potential of developing countries, in which agricultural growth rates, on the one hand, are ahead of the world due to favorable climatic conditions, on the other hand, they are slowing down due to undeveloped infrastructure, the complexity of investment policies, insufficiently developed mechanisms of state support at the regional level, and the low level of digitalization of agricultural production.

Allaire G., Boyer, R Barbier E., Reardon T. [7] are devoted to the study of global economic trends and their influence on increasing the efficiency of the innovative potential of the agro-industrial complex. Bush L., Bain C. [8]. In these works, the analysis of the main directions of network interaction and the transfer of knowledge and technologies is carried out. The contribution of innovation to improving the efficiency of production processes in agribusiness is presented in Autor D.H. [6], Dixie G. Jayaraman, N. [15], Gandhi R., Veetaraghavan R., Toyama K. [16]. Dasgupta S., Mamingi N. [10], Oliver, Y., Robertson, M., Wong, M. [24]. Consideration of adaptation options for advanced scientific and technological achievements in agriculture at the federal, regional and enterprise levels is reflected in the studies of Rios L.D., Srivastava L., Chaddad F., Reardon T. [17], Humphrey J., Schmitz H. [18].

The analysis of foreign and domestic literature allowed us to distinguish two trajectories of research on the innovative development of the agro-industrial complex. Foreign researchers are guided by a technology leadership strategy and positive experience in the formation of cluster structures by developed countries, where the focus is mainly on the scientific and technological development of large companies, agricultural holdings, multinational corporations that are suppliers of high-tech products to the agribusiness of other countries.

Russian scientists are guided by the priority role of the state in the development of the scientific and intellectual potential of the agro-industrial complex, the application of a targeted program approach to the development of the high-tech agrarian sector of the economy and agriculture in the regions, the formation of a systemic innovation process with increased interest of agribusiness at all stages of the chain, provided with investment and infrastructural support at all levels of the hierarchy [23].

In domestic and foreign literature, there are various approaches to the essence of investment and innovation in agriculture.

The innovative development of various levels of the hierarchy of the national economy, including agriculture and agriculture, is reflected in the writings of Sandu I.S., Altukhov A.I., Ushacheva I.G., Nechaeva V.I., Tatarkina A.I., Lazovsky V. .V., Semenova E.I.

According to Altukhov, A.I. it is necessary to develop a methodology for the multifunctionality and multiplicativity of agricultural production, ensuring the level of profitability of the agricultural sector of the economy required by modern realities, and transforming it into a knowledge-based and high-tech sector [3]. The need for economic modernization in the transition to an innovative development model is justified in the works of Tatarkin A.I. The author characterizes modernization as a contradictory, protracted and high-cost process of changing the social structure, the dominant mode of production, to a more efficient and demanded [35].

In the context of the formation of an export-oriented agricultural sector of the economy, the transformation of the agricultural sector of

the economy into a high-tech and high-tech business is associated with the construction of the institute of an innovative system in the agricultural sector, generating scientific and technological achievements and ensuring their implementation, distribution and commercialization in the production process [33].

The basis of such systems, in our opinion, are innovation and technology centers, business incubators, technology parks, the functioning of which is aimed at accelerating the transfer of developments to production, the development of high-tech types of products [32].

According to Ushachev I.G. improving the efficiency of innovative processes in agriculture is impossible without institutional changes: the formation of vertically integrated cooperative associations and the creation of national cooperative structures; the revitalization of sectoral and functional unions in the development of agricultural production and the formation of territorial agro-industrial clusters [36].

Thus, the dominant role in creating a model of export-oriented agrarian economy belongs to building links between science, government and local self-government, agribusiness and innovative units within the framework of the implementation of innovative agricultural policy. These horizontal and vertical relationships are aimed at creating a favorable innovative environment for the development of regional innovative agricultural systems [28].

At the same time, economies that successfully form regional innovative agricultural systems are more intensively transforming into innovative ones. In their turn, the regions where the formation of innovative agricultural systems is constrained by administrative, bureaucratic, and infrastructure barriers are characterized by a slowdown in the rate of innovative development [13].

An integrated approach to the development of the agricultural economy determines the content of the modern model of scientific and technological policy aimed at creating an export-oriented agricultural sector in the context of the transition to Industry 4.0. The scientific substantiation of the need to intensify the integration interaction of the subjects of the innovation process in the agro-industrial complex is based on the theory of I. Schumpeter and M. Porter. In the era of the digital transformation of the economy and export orientation, the regional investment and innovation policy and the resources for its implementation must be balanced in all sectors of the innovation chain.

Investigation of investment processes is based on Keynesian and neoclassical theories of economic growth (the theory of the investment multiplier by J. M. Keynes, the theory of economic growth by R. Harrod-Domar, and the Solow theory). In recent decades, Paul Romer's theory of endogenous economic growth has been widely developed, according to which knowledge, innovation and investment in human capital are the most important factors in economic growth. The increase in economic growth is mainly due to the support of education, the provision of subsidies for research and development, as well as the creation of incentives for the introduction of innovations. Unlike previous theories that highlight technological innovation as the main source of economic growth, Romer's theory emphasizes the priority of knowledge in long-term economic development, and the development of new technologies is associated with economic decisions and market conditions.

The level of provision with investment resources is the most important condition for economic growth and increased competition in the agricultural sector, as it is an incentive to activate the process of innovative structural transformation. The most common theories of structural transformations are: the theory of dynamic development of E. Domar, the theory of structural changes of J. Schumpeter, the institutional theory of structural transformations of D. North, the theory of "three-phase development" X. Chenery, A. Straut. The first of them justifies the mandatory import of capital and softening the conditions for attracting it for economically underdeveloped countries against the

background of a deficit of both real savings and financial resources. The theory of X. Chenery, A. Strauta, called the "three-phase development theory" of the economies of underdeveloped countries, calls the cause of structural transformation the influence of a number of factors, among which capital accumulation is considered the most important. In this case, the "three-phase development" of the state is understood as the period of maximum use by the economy of investments to equalize the average propensity to save, as well as the investment rate; a period accompanied by a lack of investment resources, which requires an inflow of capital from outside; the period of economic growth due to import substitution and increasing exports, which determines the process of structural transformation of the economy [9].

As a result, the restructuring of the economy becomes a consequence of the redistribution of investment resources [4]. The growth of innovation development efficiency indicators necessitates the establishment of mutual relations at the regional level of innovation and investment processes, while it is necessary that the attraction of investments goes along the entire chain of innovations. An optimal strategy is characterized by the reflection of measures aimed at increasing the rating of the region, the application of institutional measures aimed at implementing an innovation policy, improving the distribution of productive forces in the territories, as well as taking other relevant measures [34]. The important role of the latest investment and innovation tools, models and mechanisms aimed at increasing the competitiveness of the agricultural sector, as well as increasing export potential, is noted by Russian scientists, while in order to solve the issues of increasing the activity of economic entities in the field of innovation, it is necessary to develop a focused agricultural innovation policy, which should identify tasks and mechanisms that take into account previously defined priorities [37]. Harmonization of politics at the federal and regional levels is the key to the implementation of the task [31]. At the same time, the mechanism of state support for innovative reproduction in the countryside must be built in such a way that it directly stimulates the process of changing technological patterns. All of the above indicates the need to improve investment policy, its main directions in this case are measures to stimulate investment attraction in priority agricultural sub-sectors [25].

The purpose of this study is to assess the impact of investment resources on the activation of innovative processes on the example of animal husbandry and to develop recommendations for increasing the innovative activity of agriculture in the context of the formation of an export-oriented economy.

MATERIALS AND METHODS

The studies are based on the study and synthesis of statistical data on innovative activities in the agro-industrial complex and agriculture and scientific approaches to the activation of innovative and investment activities. When conducting research, empirical methods such as measurement, generalization, comparison, analysis were used.

The issues of developing methodological approaches to assessing the level of innovative development both in the economy as a whole and in agriculture are devoted to the works of various foreign and domestic researchers [29]. Systems for assessing the level of innovation activity are distinguished by their goals, factors, results, principles of formation and mechanism for the implementation of innovations. According to a rating compiled by the Organization for Economic Cooperation and Development (OECD), an innovative agricultural system consists of three groups of determinants: a knowledge system of the agricultural sector of the economy, research and development, education, society and consumers. On the basis of foreign assessment systems Agricultural Scienceand Technology Indicators ASTI for the Russian agricultural sector, it is possible to consider this type of

indicator as an investment in the creation of knowledge in relation to agriculture based on the criterion of the effectiveness of scientific research in agriculture. In the agricultural sector of the economy of foreign countries, there are institutes of innovative development, such as marketing research agencies, the development of their results and the spread of innovation on the basis of organizations that provide consulting services to ministries of agriculture, as well as "technological valleys" and innovation clusters at agricultural universities.

In world practice, the evaluation of the results of the development of innovations in the production processes of enterprises is reflected in statistical forms of accounting. In Russia, innovation statistics are mainly conducted in high-tech sectors of the economy. However, in recent years there has been a favorable trend in the collection and systematization of data on innovation and in the agricultural sector. On the basis of order No. 563 of August 30, 2017, the Federal State Statistics Service approved a new edition of the quarterly federal statistical monitoring form No. 4-innovation, “Information on the Organization's Innovation Activities,” Since 2018, enterprises operating in agriculture are required to fill it out. This new edition was developed by Rosstat taking into account international recommendations in the field of statistical measurement of innovation. This form updates the information on technological innovations completed in the last 3 years in agriculture.

The work will develop methodological approaches to assessing the diffusion of innovations at the regional level using the example of the livestock industry based on the calculation of production innovation criteria. Empirically, groups of regions will be identified that are described by different levels of investment in fixed assets in agriculture. The study puts forward a hypothesis about the impact of investment on accelerating innovation processes in agriculture.

RESULTS AND DISCUSSIONS

In the current conditions of the development of the agro-industrial complex, of particular interest are the problems of increasing innovative activity in the agricultural sector of the economy, assessing trends and prospects for improving the organizational and economic mechanism for managing innovative agricultural systems in Russian regions.

Current agricultural development trends put pressure and create new challenges for the agricultural sector in accordance with the requirements of the future. These trends are associated with an increase in food demand amid a global demographic upswing, a decrease in agricultural production in the face of adverse climatic and geographical factors. According to the analysis of world trends of continuous population growth, which suffers from hunger and lack of full access to food in recent years, the number of hungry people has reached 821 million. increasing this unfavorable trend by 17 million people. In addition, agriculture as a whole is inferior to other sectors of the economy due to the long turnover of capital and high risks, which necessitates its state support. Russian agriculture is characterized by a wide variety of technological modes, high spatial heterogeneity, asymmetry of economic and social status. The volume of state support for agriculture in Russia is inferior to the level of world leading countries, which will subsequently lead to a technological lag of the Russian agricultural sector from the indicators of developed countries by such criteria as the availability of agricultural machinery, elite seeds, mineral fertilizers and other types of effective innovations. The need for innovation in the agricultural sector of the Russian economy is also associated with increased competition as a result of globalization processes in the global economy, economic sanctions, the need to invest new funds, higher prices for advanced production technologies and equipment, a lack of competencies in managerial and production personnel in the context of structural

transformation of the economy. These challenges are both an incentive and a barrier to the formation of an export-oriented economy on an innovative basis. Actual problems of improving the efficiency of innovative processes based on the development of the scientific potential of the agricultural sector are related to the creation, implementation, distribution and commercialization of innovations, taking into account geographical and environmental factors affecting crop production and animal husbandry, adaptation of foreign digital technologies, increasing integration activity between education and science , agribusiness and implementation structures, taking into account the needs of the regions in the implementation of targeted innovations.

The innovation and investment component is the most important determinant of the strategic development of the national economy at the macro, meso and micro levels and is considered in the work as an effective way to reduce the time lag during the transition to the next technological structure.

Beginning in 1995, Russian agriculture has been characterized by fluctuations in production indicators both in crop production and in animal husbandry (Fig. 1).

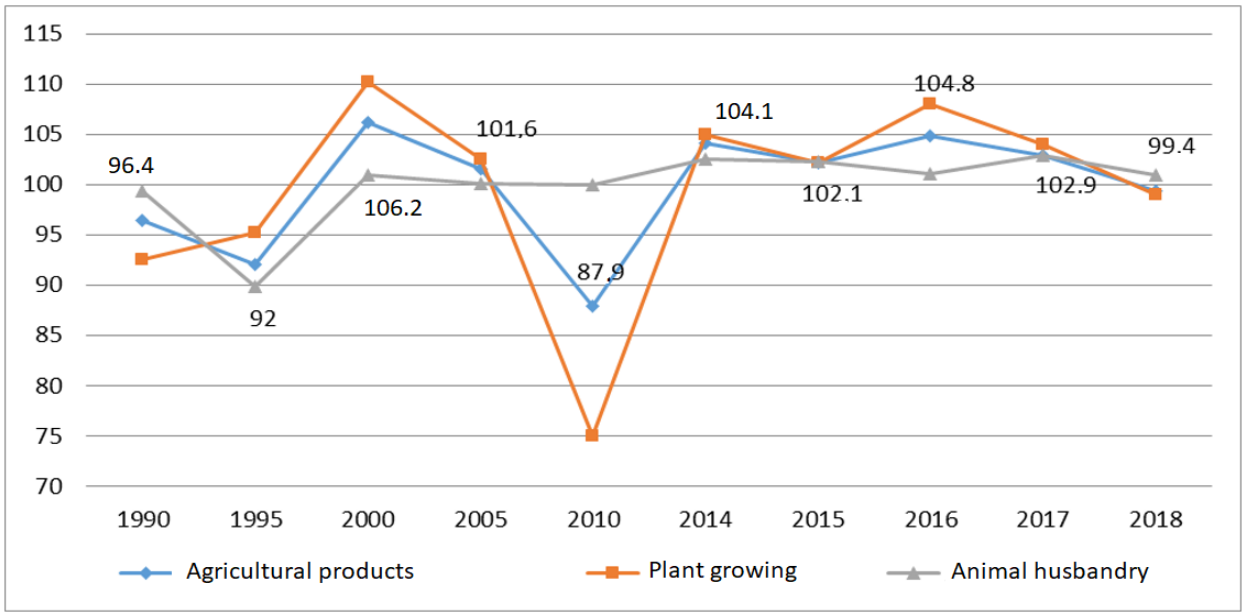

Fig. 1. Indices of agricultural production in the Russian Federation (in comparable prices, % of the previous year)
Source: Own determination.

In 2018, agriculture in Russia is characterized by an increase in the agricultural production index, an increase in the number of orders for equipment of domestic producers.

With its high scientific potential, agriculture is currently demonstrating growth in a stagnant economy and is the engine of economic growth, creating the necessary jobs and gross value added. However, in Russia there is an insufficiently stable trend of investment inflow into agriculture. In addition, the general deficit of domestic and foreign investment in agriculture is associated with a high degree of risks specific to this sector, as well as insufficient information from potential investors on the state of the agricultural innovation climate. In Table 1, there are presented some proposed indicators for assessing the effectiveness of the functioning of the innovative potential of agriculture in dynamics.

Figure 1 shows that the innovative potential of agriculture remains low, and significant disparities are observed between the various sectors of the agro-industrial complex, despite the increase in costs of technological innovations.

The development of the innovative potential of agriculture needs the development of

effective mechanisms to stimulate innovative activity in the agricultural sector [5].

As a result of the analysis, we can identify trends in investment and innovation that are characteristic of agriculture. In the field of investment, there has been a slight increase in investment activity of Russian and foreign investors, improvement of the structure and sources of investment, structural changes in investment policy due to inert state regulation of the agricultural sector of the economy, insufficiently developed regulatory framework for regulating investment processes.

Table 1. Dynamics of indicators for assessing the innovative potential of agricultural systems, RF, 2013–2018

Indicators	2013	2014	2015	2016	2017	2018
Amount of state support funds under the State program for agricultural development and regulation of markets for agricultural products, raw materials and food, million rubles.	260,960	262,122	254,982	295,928	257,529	…
Investments in fixed assets aimed at the development of agriculture, billion rubles.	516	510	505	511	434	…
Expenditures on technological innovations of agricultural enterprises, million rubles.	29,974	25,864	25,023	23,963	23,976	…
The share of costs for technological innovations in the total volume of goods shipped, works performed, and services provided by agricultural enterprises, %	0.57	0.55	0.53	0.54	0.55	…
Created varieties and hybrids of agricultural crops	298	293	287	266	295	238
Breeding forms of animals, birds, fish and insects	4	9	7	4	3	1
Developed new and improved technologies	301	295	273	247	224	210
Developed vaccines, diagnostics, and biopreparations	59	47	36	36	27	15
New names of food products have been developed	364	392	214	192	188	172
Received patents for inventions and selection achievements	755	751	649	710	730	745
Published books and monographs	589	571	566	585	610	630
Published articles, thousand units.	13.9	13.5	13.6	14.5	13.4	15.9
Including in peer-reviewed journals	5.7	5.9	6.0	7.5	7.9	8.5
In foreign publications	0.71	0.82	1.0	0.92	0.87	1.04

Source: Rosstat data.

The innovation sphere is characterized by a slow build-up of implementation activities based on advanced scientific and technological achievements, a concentration of new developments in the production sphere, and a poor supply of innovative personnel.

An important structural problem in the use of investments in agriculture is the imbalance in their distribution and concentration. It is necessary to improve the current investment policy at the level of the constituent entities of the Russian Federation, in particular, to stimulate the influx of investments into priority agricultural sub-sectors.

The agro-industrial complex of the Russian regions is characterized by spatial heterogeneity and pronounced interregional asymmetry in terms of the level of provision with investments in fixed assets (Table 2).

In 2018, the Central Federal District of Russia accounted for 43.6% of the total investment in fixed assets aimed at the development of agriculture; the share of the Volga Federal District - 17.2% (Figure 2). By regions, the share of investments in fixed assets in agriculture in the total investment is also characterized by fluctuations [30].

The highest level of investment activity can be traced in the republics of Crimea and Sakha (Yakutia), the Kemerovo region, with more than 90% of organizations investing in fixed assets. The lowest values of investment activity are typical for regions such as the

Republic of Ingushetia - 29% of organizations invest in fixed assets; The Republic of Dagestan (37%), the Republic of Altai (48%). Analysis and assessment of the relationship between the level of security of investments in fixed assets of agriculture and the diffusion of innovations were carried out on the basis of the sub-sectors of livestock and pig farming.

Table 2. Dynamics of investments in fixed assets aimed at the development of agriculture, by federal districts of Russia

	2016		2017		2018	
	million rubles	%	million rubles	%	million rubles	%
RF	363,685.3	100	374,722.4	100	423,194.4	100
Central District	169,094.8	46.4	163,084.0	43.5	184,504.1	43.6
Northwest Federal District	15,633.5	4.3	18,651.1	5.0	24,374.3	5.8
Southern Federal District	42,707.5	11.7	44,601.0	11.9	57,726.0	13.6
North Caucasian Federal District	21,000.3	5.8	21,675.8	5.8	19,416.7	4.6
Volga Federal District	67,495.8	18.5	66,577.8	17.8	72,639.6	17.2
Ural federal district	14,713.6	4.1	17,772.9	4.7	21,045.0	5.0
Siberian Federal District	25,020.6	6.8	29,412.2	7.8	31,563.9	7.5
Far Eastern Federal District	9,019.1	2.4	12,947.6	3.5	11,924.7	2.7

Source: Rosstat data.

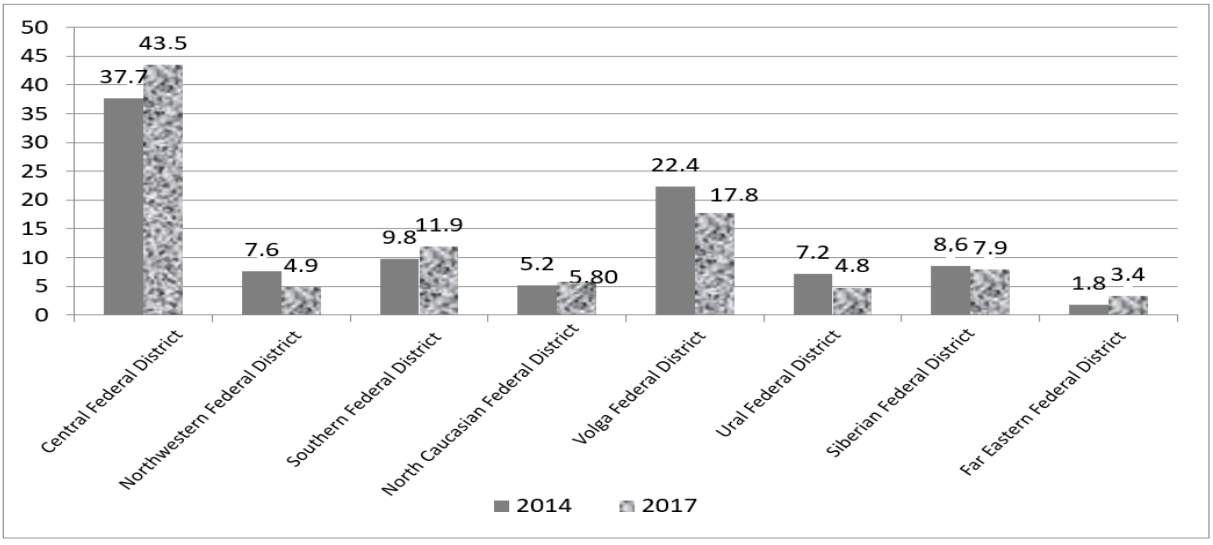

Fig. 2. Distribution of investments in fixed assets aimed at the development of agriculture in the federal districts, in% of the volume of investments in fixed assets for agriculture in the Russian Federation
Source: Own determination.

The rationale for the selection of these sub-sectors is explained by the fact that in recent years, due to the processes of modernization and technical re-equipment taking place in these sub-sectors, the processes of disseminating advanced scientific and technological achievements and innovations have been most actively implemented. According to official statistics, in 2017, the commissioning of agricultural capacities for cattle amounted to 275.1 thousand cattle places (an increase compared to 2014 by 2.3 times); for pigs - 1,335.2 thousand cattle places (an increase of 1.7 times compared with 2014).

To carry out calculations in the study, an information array was used, including 71 regions of the Russian Federation. The regional typology criterion was determined by the indicator «Investments in fixed assets per 1,000 rubles. gross agricultural output». In order to increase the reliability of calculations and to exclude the incompatibility of information on individual indicators of the presented population, the Magadan Region and the Jewish Autonomous Region were excluded from the sample; Moscow, St. Petersburg, Sevastopol, as well as the Republic of Crimea. This indicator characterizes the capital intensity and allows us to characterize the sufficiency of investment resources for the implementation of innovative processes. The first group included regions with a capital intensity of up to 100 rubles. 42 regions); in the second - with an indicator of 100 to 200 rubles. (21 regions; in the third, with an indicator of over 200 rubles (8 regions). The average value for the groups is: the first group is 53.5 rubles (which is significantly lower than the average Russian level of 91.1 rubles); the second group is 143.4 rubles; the third group - 402.3 rubles (a significant excess of the average Russian level). According to the results of the calculations, it can be seen that if we take the average Russian indicator as a threshold level (91.1 rubles per 1,000 rubles of gross output), the obtained typological groups of regions can be described as a group with a minimal insufficient level investments, the second group of regions as sufficient and the third group as ultra-high. An example of the leading regions from the third typological group are the Arkhangelsk (740.8 rubles) and Murmansk (4,657 rubles) regions. In addition, a special feature of the third group is investment in agriculture compared with the total investment (6.9%), while the average Russian value of this indicator is at around 3.6%.

To identify the degree of correlation between the level of capital intensity and innovative activity in animal husbandry, private indicators of innovative production of cattle, pigs and milk were used.

Table 3. Indicators of investment, gross output and productivity of certain types of livestock products by groups of regions of Russia

	Groups of regions on the basis of «Investments in fixed assets per 1000 rubles. gross agricultural output», rubles		
	1st group, up to 100 rubles	2nd group, from 100 to 200 rubles	3rd group, over 200 rubles
The number of regions, units	42	21	8
Investments in fixed assets aimed at the development of agriculture, million rubles	181,526.4	227,408.6	62,473.8
Gross agricultural output, million rubles	3,390,197	1,586,369	155,287
Capital intensity of production, rubles	53.4	143.4	402.3
The share of investment in agriculture in the total investment,%	4.1	4.4	6.9
Milk yield in agricultural organizations per cow, kg	4,922	6,126	7,900
The threshold level of milk yield, kg	10,000	10,000	10,000
The innovation rate of milk production, share	0.49	0.61	0.79
The average daily gain of cattle in agricultural organizations	473	618	567
The threshold level of the average daily gain of cattle	800	800	800
The coefficient of innovative production of cattle meat, share	0.59	0.77	0.71
The average daily gain of pigs in agricultural organizations	437	502	533
The threshold level of the average daily gain of cattle	850	850	850
The coefficient of innovation in the production of pig meat, share	0.51	0.59	0.63

Source: Own determination.

These indicators were obtained by standardization as the ratio of animal productivity to its threshold level, which can be achieved with the efficient use of production resources in conjunction with innovations being introduced into sub-sectors. The innovation coefficient is calculated as the ratio of actual productivity indicators to the threshold level (Table 3, Fig.3).

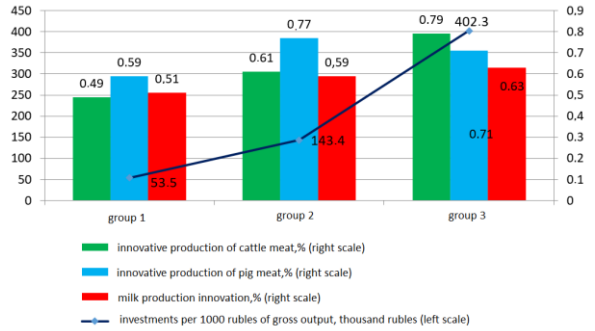

Fig. 3. The impact of agricultural capital intensity on the innovation of livestock production by groups of regions of the Russian Federation in 2018.
Source: Own determination.

Thus, the results of the study confirmed the hypothesis about the impact of investments on the innovative development of agriculture on the example of livestock industries.

The developed author's methodology for assessing the level of innovation of the livestock industry in the regions of Russia will allow us to formulate approaches to improving the structural investment policy.

In conditions of insufficient budgetary funds, the issue of determining the optimal level of investment necessary to intensify the processes of creation, implementation, distribution and commercialization of innovations and the effectiveness of the state innovation and investment policy, which will be disclosed in further research by the authors, is relevant.

One of the most important areas for the development of innovation and investment processes and increasing the activity of medium-sized milk producers in regions with low agroclimatic potential is the possibility of buying machinery and equipment with a high level of innovativeness of production processes. The strengthening of the innovative vector of regional investment support predetermines the need to stimulate the acquisition by agricultural producers of such innovative resources as machinery and equipment with a high innovative component.

It should also be noted such a direction of increasing innovation and investment activity as improving the systems of guarantee and collateral. So, in the Novosibirsk region, a guarantee fund provides guarantees of up to 70% of a loan under agricultural loan agreements to agricultural producers in the form of consumer cooperatives, small and medium enterprises, and peasant (farmer) farms.

The study proposes a scheme for the development of organizational and economic conditions for increasing innovative activity in agriculture (Fig. 4).

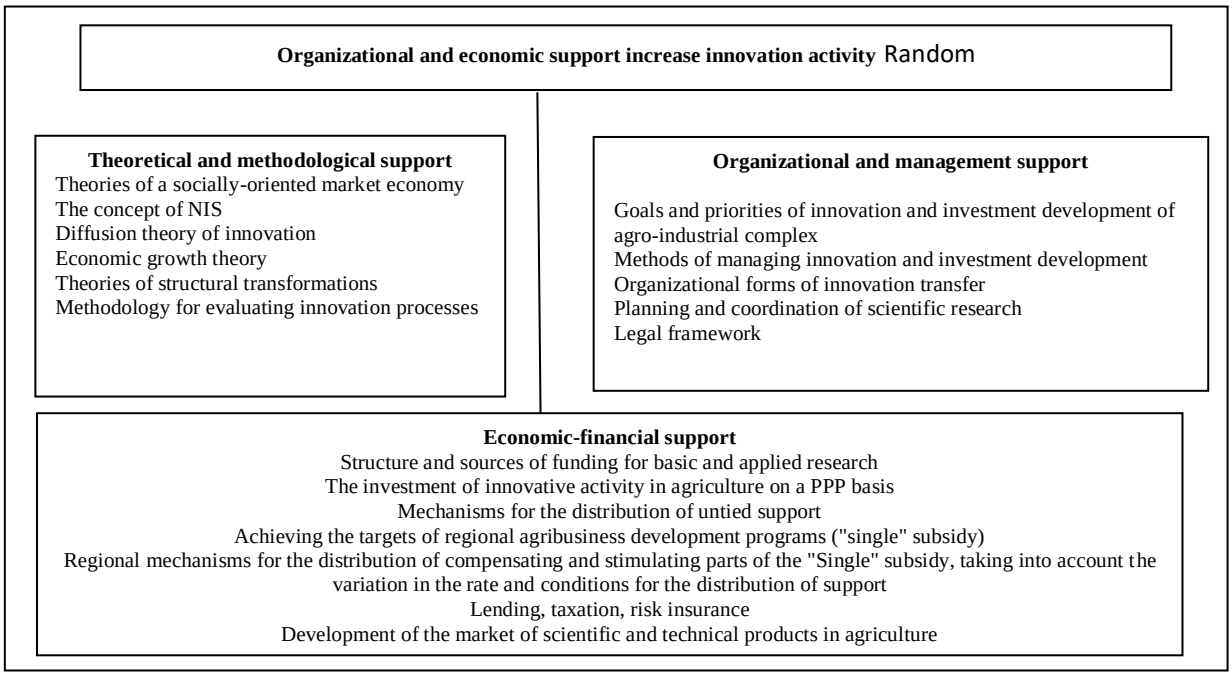

Fig. 4. The development scheme of organizational and economic support for increasing innovative susceptibility in agriculture in the context of the formation of an export-oriented agricultural sector of the economy
Source: Own determination.

The formation of a model of export-oriented agrarian economy by increasing the efficiency of agricultural production can be achieved with a comprehensive approach to solving legislative, regulatory, organizational and economic issues of the development of innovative processes. In fig. Figure 1 shows the development of organizational and economic support for increasing innovation activity in the context of the formation of an export-oriented agricultural sector of the economy, in which the theoretical, methodological, organizational and managerial, economic and financial blocks are highlighted.

The development of theoretical and methodological provisions of the organizational and economic mechanism is implemented through the adaptation and improvement of a number of theories as applied to ongoing innovative processes, as well as the construction of a methodology for evaluating innovative systems with the identification of principles, approaches, determinants, constraining and accelerating factors, the development of an algorithm and model for evaluating the effectiveness of individual innovations, industries, regions and justification of the optimal level of investment injections for the activation of innovative processes in accordance with industry requirements and conditions for the plurality of regional diffusion of innovation.

Improving the organizational and economic support of innovative processes consists in developing management methods for various forms of integration of scientific, educational, industrial, innovative structures, development of planning and coordination of fundamental and applied research, harmonization of federal and regional state policies in stimulating innovative activity.

Improving economic and financial support consists in researching the most optimal set of sources, forms and methods of targeted financing of agricultural enterprises, including by adjusting approaches to providing unrelated support and developing regional mechanisms for the distribution of compensating and stimulating parts of the "Single" subsidy, taking into account varying rates and conditions distribution support.

CONCLUSIONS

It is proved that the growth of agricultural production and the creation of an export-oriented agrarian economy are inextricably linked with the intensification of investment activity. The development of theoretical and methodological provisions for investing in innovation is described by the concept of National Innovation Systems NIS and the diffusion of innovations. It is proved that increasing the efficiency of using the innovative potential of agricultural systems is associated with an increase in the degree of communicative interaction between the institutions of the innovation system: educational, scientific, industrial and innovative units. In the context of the formation of an export-oriented agricultural sector of the economy and the transition to high-tech agricultural production, it is advisable to build an institute of an innovation system in the agro-industrial complex, generating scientific and technological achievements and ensuring their creation, implementation, distribution and commercialization in the production process as innovative technological centers, business - incubators, technology parks.

It was substantiated by calculation that the actors forming institutional ties are more intensively transforming into innovation and vice versa - regions where the formation of innovative agricultural systems is constrained by administrative, bureaucratic, and infrastructure barriers, characterized by a slowdown in the rate of innovative development.

The paper assesses the impact of investment resources on the activation of innovative processes on the example of animal husbandry and develops recommendations to increase the innovation and investment activity of regional agricultural systems in the context of the formation of an export-oriented economy. The regions were differentiated by the level of provision with investments in

fixed assets in agriculture, interregional differences were revealed, and the hypothesis of the existence of a connection between investments and the ongoing diffusion of innovations was proved.

The formation of a model of export-oriented agrarian economy by increasing the efficiency of agricultural production can be achieved with a comprehensive approach to solving legislative, regulatory, organizational and economic issues of the development of innovative processes.

The improvement of innovation and investment policy is proposed on the basis of the introduction of the organizational and economic mechanism, in which the theoretical and methodological, organizational and managerial, economic and financial support are highlighted.

Thus, improving the innovation and investment activity of regional systems based on the proposed estimated and forecasting methodological tools and improving the organizational and economic mechanism to stimulate innovation activity will increase the efficiency of agricultural production in order to create an export-oriented agricultural sector of the economy.

ACKNOWLEDGEMENTS

The reported study was funded by the Russian Foundation for Basic Research according to the research project №20-010-00979 A « Influence of investment resources of regional agricultural systems on increasing export potential in the conditions of innovative structural transformation».

REFERENCES

[1]Aker, J., 2011, Dial «A» for Agriculture: Using ICTs for Agricultural Extension in Developing Countries. Agricultural Economics. 42(6):631-47.

[2]Al-Hassan, R., Egyir, I., Abakah, J., 2013, Farm household level impacts of information communication technology (ICT)-based agricultural market information in Ghana. Journal of Development and Agricultural Economics 5.4: 161-167.

[3]Altukhov, A. I., 2014, The main problems of agricultural development and ways to solve them. Bulletin of the Kursk state agricultural Academy. No. 2. pp. 2-6.

[4]Andryushchenko, S.A., Vasilchenko, M.Ya., Derunova, E.A., Rubtsova, V.N, Sharikova I.N., 2018, Modeling of Structural and Institutional Factors of Development in Regions Unfavorable for Agriculture. The Journal of Social Sciences Research. №3. pp.40-43.

[5]Andryushchenko, S.A., Potapov, A.P., Vasilchenko, M.Ya., Trifonova, E.N., Derunova, E.A., 2019, Instruments of state regulation of agri-food systems of regions unfavourable for agricultural production. Asia Life Sciences. №1. pp.77-97.

[6]Autor, D. H., 2015, Why are there still so many jobs? The history and future of workplace automation. Journal of Economic Perspectives. 29. 3:3-30.

[7]Barrett, C., Barbier, E., Reardon, T., 2001, Agro-industrialization, Globalization and International Development: The Environmental Implications. Environment and Development Economics. 6. 419-433.

[8]Busch, L., Bain, C., 2004, New! Improved? The Transformation of the Global Agrifood System. Rural Sociology. 69 (3). 321-346.

[9]Chenery, H. B., 1975, The structuralist approach to development policy // American association Papers and Proceedings. № 65. pp. 310–316.

[10]Dasgupta, S., Mamingi, N., Meisner, C., 2001, Pesticide Use in Brazil in the Era of Agro-industrialization and Globalization. Environment and Development Economics. 6 (4). 459-482.

[11]Decree of the President of the Russian Federation No. 204 of may 7, 2018 «National goals and strategic objectives for the development of the Russian Federation for the period up to 2024» (may 8, 2018) // https://www.garant.ru/products/ipo/prime/doc/71837200/, Accessed on February 02, 2020.

[12]Derunova, E., Andryushenko, S., Gerchikova, E., Firsova, A., Derunov, V., 2018, Monitoring of innovative activities effectiveness in agriculture. Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development, Vol. 18(3): 89-100.

[13]Derunova, E.A., Ustinova, N.V., Derunov, V.A., Semenov, A.S., 2016, Modeling of diversification of market as a basis for sustainable economic growth. Economic and Social Changes: Facts, Trends, Forecast, No. 6, pp. 91-109.

[14]Derunova, E.A. Kireeva, N. A., Prushchak, O. V., 2019, Inclusive development of the agri-food system as a driver for sustainable growth in the region's economy. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.19 (3):165-174.

[15]Dixie, G., Jayaraman, N., 2011, Strengthening agricultural marketing with ICT. The World Bank/ InfoDev'ARD, ICT in agriculture: connecting smallholders to knowledge, networks, and institutions. Module 9, pp.205- 237.

[16]Gandhi, R, Veeraraghavan R, Toyama K, Ramprasad V., 2009, Digital Green: Participatory Video and Mediated Instruction for Agricultural Extension. Information Technologies & International Development, Vol.5 (1):1-15.

[17]Henson, S.J., Reardon, T., 2005, Private Agrifood Standards: Implications for Food Policy and the Agrifood System. Food Policy, 30 (3), 241-253.
[18]Humphrey, J., Schmitz, H., 2001, Governance in Global Value Chains. IDS Bulletin, 32 (3), 19-29.
[19]Lundvall, B.A.,1992, National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning. Pinter Publishers, London.
[20]Menshikov, S. M., Klimenko L. A. Christopher Freeman, 2014, Long waves in the economy: When society changes its skin. Moscow: Lenand, pp. 208-214.
[21]Message of the President of the Russian Federation to the Federal Assembly dated 01.03.2018, http://www.consultant.ru/document/cons_doc_LAW_291976/, Accessed on February 02, 2020.
[22]Metcalfe, S., 1995, The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives. Stoneman P. (ed.) Handbook of the Economics of Innovation and Technological Change. Oxford: Blackwell Publishers, pp.409-512.
[23]Nechaev, V.I., Mikhayushkin, P.V., Altukhov, A.I., 2017, Formation of a cross-border agro-industrial cluster of EAEU countries for deep processing of grain. Strategy for the development of the agricultural sector of the economy: problems and solutions. Collective monograph. Krasnodar: Enlightenment-South, 703 p.
[24]Oliver, Y., Robertson, M., Wong, M., 2010, Integrating farmer knowledge, precision agriculture tools, and crop simulation modelling to evaluate management options for poor-performing patches in cropping fields// European Journal of Agronomy, 32(1), 40-50.
[25]Paptsov, A.G., Nechaev, V.I., Mikhailushkin, P.V., 2019, Towards to a single innovation space on the agrarian sector of the member states of the Eurasian economic union: a case study. Entrepreneurship and sustainability issues. T.7. №1. pp. 637-648.
[26]Passport of the Federal project «Export of agricultural products "(UTV. minutes of the meeting of the project Committee of the national project "international cooperation and export" dated December 14, 2018 # 5) // http://mcx.ru/upload/iblock/013/013f266cee8d39bce5ca867381ff0da1.pdf, Accessed on February 02, 2020
[27]Patel, P., Pavitt, K., 1994, The Nature and Economic Importance of National Innovation Systems. STI Review. No 14. pp. 9-32.
[28]Popescu, A., 2014, Research on profit variation depending on marketed milk and production cost in dairy farming, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 14(2):223-230.
[29]Popescu, A., 2018, Main aspects regarding the contribution of domestic trade to the development of Romania's economy in the period 2008-2017, Scientific Papers Series Management, Economic Engineering in culture and Rural Development Vol. 18(4): 250-259.
[30]Region of Russia. Socio-economic indicators. 2019: P32 Stat. sat. Rosstat. Moscow, 2019. 1204 p. https://www.gks.ru/storage/mediabank/Region_Pokaz_2019.pdf, Accessed on February 02, 2020.
[31]Sandu, I., Krutikov, V., 2019, Harmonization of regional and Federal policies in the context of foreign economic challenges. Economics of agriculture in Russia. No. 5. pp. 11-16.
[32]Sandu, I.S., Glagolev, S.N., Doshanova, A.I., Troshin, A.S., Lomachenko, S.N.,2015 Formation features of higher school innovation model in modern conditions. International Business Management. T. 9. № 6. pp. 1102-1107.
[33]Sandu, I.S., Veselovsky, M.Y., Semyonova, E.I., Fedotov, A.V., Doshchanova, A.I., 2015, Methodological aspects of social and economic efficiency of the regional activities. Journal of Advanced Research in Law and Economics. T. 6. №3. pp. 650-659.
[34]Stroeva O. A., 2010, Investment and innovation strategy of transition of the regional economic system to the mode of sustainable economic growth. Vestnik Orelgiet, No. 1(11). pp. 101-106.
[35]Tatarkin, A.I., Tatarkin, D.A., 2011, Innovative mission of modernization of the social order as a need for sustainable development of Russia., Economy of the region. No. 2. pp. 25-37.
[36]Ushachev, I. G., 2017, Strategic directions of sustainable socio-economic development of the Russian agro-industrial complex/Report at the international scientific and practical conference "Russian Agricultural sector: development strategy" MEF-2017, March 30, 2017, http://vniiesh.ru/news/Doklady_vystuplenija/20801.html, Accessed on 02.02.2020.
[37]Ushachev, I. G., Kolesnikov, A.V., Chekalin, V. S., 2019, Development of innovations - the most important component of the agrarian policy of Russia. Agro-industrial complex: economics, management. No. 5. pp. 22-31.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

STUDIES ON THE INFLUENCE OF CLIMATE CONDITIONS ON THE QUALITY OF *MERLOT* WINES

Valerica Luminita VISAN[1], Radiana Maria TAMBA-BEREHOIU[1], Nicolae Ciprian POPA[2], Silvana Mihaela DANAILA-GUIDEA[1], Ricuta DOBRINOIU[1] Diana GROPOSILA-CONSTANTINESCU[1]

[1]University of Agriculture and Veterinary Medicine Bucharest, Faculty of Biotechnologies, Mărăşti Bvd, no. 59, zip code 011464, Bucharest, Romania, tel. +40721135314, l_visan@yahoo.com, radianatamba@yahoo.com; silvana.danaila@yahoo.com; ricuta_dobrinoiu@yahoo.com; d_gconst@yahoo.com
[2]Farinsan SA, Gradistea village, Giurgiu district, Romania, cipnpopa@yahoo.com

Corresponding author: l_visan@yahoo.com

Abstract

To highlight the influence of the climatic conditions of the harvest year on the main biochemical parameters, and therefore on the quality of the red wines obtained from the Merlot variety, 4 wines obtained in the Dealu Mare region were analyzed, in 2013, 2014, 2015 and 2016. The climate of the studied years presented differences in temperature and precipitation, leading to different accumulations of sugars and phenolic compounds; climatic conditions also had an influence on the other quality parameters of the wines. The biochemistry analysis of the wines aimed: alcoholic strength (vol% alcohol), total acidity (g/L tartaric acid), volatile acidity (g/L acetic acid), total and reduced dry extract (g/L), glycerol content (g/L), the content in total and free SO_2 (mg/L). The influence of climatic conditions on the chromatic characteristics of Merlot wines was highlighted by spectrophotometric analysis of the total content of polyphenols (A280), the total content of tannins (g/L), including tannin structure (gelatin index, HCl index and ethanol index, %), content in anthocyanins (mg/L) and coloring intensity.

Key words**:** *Merlot variety, the influence of the climatic conditions, polyphenols, anthocyanins*

INTRODUCTION

The quality of the wines represents a complex system, in which are involved numerous factors [16]. The most important of these are: environmental factors (Eco pedoclimatic factors of the wine-growing area, annual climate), biological factors (grape variety, rootstock) and human factors (culture technology, winemaking techniques) [4, 22]. Of these factors, the annual climate can vary within quite large limits, significantly influencing the quality of the harvest and implicitly the quality of the obtained wine [9, 24]. Thus, the annual climatic factors can be particularly favorable and then we can talk about an exceptional year, which will lead to the expression of the maximum potential of the varieties and therefore to obtaining high quality wines [17, 24]. On the contrary, they can be very weak years for the viticulture, the adverse climatic conditions having repercussions on the quality of grape harvested and wine.

Description of the Merlot vine variety

Merlot is a French grape variety, originating from the Medoc peninsula, part of the renowned Bordeaux wine region [5, 22]. Here, it was cultivated long before the invasion of phylloxera and together with other varieties such as *Cabernet Sauvignon*, *Cabernet Franc* and *Malbec*, is part of the current assortment of the Malbec region. In the Bordeaux region, the *Merlot* variety occupies about 58% of the area cultivated with vine plantations, with Appellations Saint-Emilion and Pomerol [5].

In our country, the *Merlot* variety was brought to the end of the 19th century, as a result of the recovery action of the Romanian viticulture, the "exterminated" viticulture (as in fact all of Europe's) by phylloxera [18, 21].

Although, from a qualitative point of view, *Merlot* wine more rarely equals *Cabernet*

Sauvignon wine, the variety has started to be grown on larger areas due to grape production, much higher than the production of *Cabernet Sauvignon* [19, 21, 22]. The two varieties, with their common ancestor, are cultivated worldwide (but especially in Europe), somewhat in tandem, leading to the obtaining of high quality, elegant red wines that complement each other in blends [5]. If *Cabernet Sauvignon* wine is a stronger, full-bodied wine, with a higher tannin content and a wide aroma, *Merlot* is a delicate wine, with a color intensity and a lower acidity than *Cabernet* [2]. The *Merlot* wine has a discrete, fine fruitiness, reminiscent of raspberries and cherries, but may have, depending on the Eco pedoclimatic conditions a wider aromatic palette (strawberries and fresh raspberries, red currants, cherries, plums) [6, 8].

Merlot wine behaves very well in blends, especially with *Cabernet Sauvignon*, where the complexity of *Cabernet* complements the delicate and sweet aromas of *Merlot*. Blends are often made with other wines, such as *Syrah* or *Cabernet franc* [22]. The aroma and texture of *Merlot* wine, as well as *Cabernet's*, differs depending on the climatic conditions of the wine area as well as the year of harvest [11]. Thus, in areas with warmer climate, or in the years with higher temperatures during the ripening of the grapes, the *Merlot* wine becomes slightly more corpulent, with stronger, distinct aromas [5].

*Agrobiologically characteristics of the Merlot variety***.** *Merlot* variety has medium and high vigor, medium fertility, slightly variable and average productivity. Production reaches about 10 t/ha, higher yields recorded on clay-limestone soils [12]. The variety's resistance to frost is low, so it is recommended that the location of the vineyard plantation with *Merlot* take into account the cold currents in winter. The *Merlot* variety is also sensitive to drought [22]. The sensitivity of the variety also manifests during flowering, the flowers can easily abort if the temperatures are lower [12]. Also, the variety is sensitive to the **v**ineyard physio paths, called "honey" phenomena [12].

In our country, the *Merlot* variety is cultivated on an area of about 1200 ha in several wine-growing areas: Oltenia and Hills of Muntenia (in all the wine centers of Dealu Mare vineyard; in Samburesti vineyard, and in Drăgășani vineyard), Crisana and Maramures (Minis), the Hills of Moldova (Cotesti), Dobrogea Hills (Murfatlar) etc [15]. Although, the *Merlot* variety can lead to obtaining high quality wines, sought both in Europe as well as internationally side, its sensitivity requires careful zoning and establishment of plantations, in areas that allow it to reach the maximum potential of the variety.

The climatic conditions (temperature, luminosity, precipitation) determine a variation of the potential of the variety, intervening both on the production and on the quality of the wine.

MATERIALS AND METHODS

In order to highlight the influence of climatic conditions on the quality of *Merlot* wines, 4 wines were analyzed obtained in the Dealu Mare region from the 2013, 2014, 2015 and 2016 harvest. The basic physico-chemical parameters were analyzed: alcoholic strength, total acidity, volatile acidity, total dry extract, reduced extract and glycerol. Based analyzes were performed by standard methods [23]: refractometric method for determining the amount of sugar in grapes (with digital refractometer for the measurement of percentages Brix, HI96801); Schoorl method for determining reducing sugars in wines (g/L sugars); distillation method, for alcoholic strength (vol% alcohol); titrimetric method for total acidity (g/L acid tartric); distillation method with the distiller *Saunier Cazenave* (by entrainment volatile acids, followed by their titration in distillate in the presence of an indicator) for acidity volatile (g/L acid acetic); densimetric method, variant Tabarié for total dry extract (g/L) and volumetric method for glycerol (g/L) [23].

As for the specific analyzes, the polyphenolic composition of wines was judged by the content in total polyphenols, tannins and anthocyanins [3]. Analyzes have been carried

out in the wine by UV-VIS spectrometry techniques [7, 10].

Total content of polyphenols have been determined by TPI technique, using A_{280}. Total polyphenols index (TPI) is determined by multiplying the value of the absorbance by the dilution factor (TPI = A_{280} x DF) [21].

Tannins (g/L) have been determined by the Ribereau-Gayon method and tannins structure after Glories method, based on the following indicators: gelatin index (for astringent tannins %); HCl index (for condensed tannins, %); ethanol index (for the macromolecular associations tannins-polysaccharides, %). These indicators was determined by spectrophotometric method at λ = 280 nm [11]. The anthocyanins (mg/L) were determined by the Ribereau-Gayon method through the pH difference [21]. Color intensity was determined by summing the optical densities of the wine at the wavelengths: λ=420 nm, λ=520 nm and λ=620 nm.

RESULTS AND DISCUSSIONS

The basic chemical parameters of the wines were analyzed by the methods described in the previous chapter, the results of the analyzes being shown in Table 1.

Table 1. Basic chemical parameters of *Merlot* musts and wines

Wines	Chemical parameters of *Merlot*									
	tthe content of musts in sugars (g/L)	alcoholic strength of wines (vol % alcohol)	residual sugars of wines (g/L)	total acidity (g/L tartaric acid)	volatile acidity (mg/L CH_3COOH)	total dry extract (g/L)	reduced extract (g/L)	glycerol (g/L)	total SO_2 (mg/L)	free SO_2 (mg/L)
M_{2013}	228.4	13.0	4	6.18	0.3	29.8	25.8	9.4	165	35
M_{2014}	212.5	12.2	3.5	6.48	0.42	26.4	22.9	8.0	108	40
M_{2015}	235.5	13.6	3.3	5.42	0.61	30.9	27.6	9.7	155	30
M_{2016}	220.5	12.5	4.2	5.65	0.47	28.6	24.4	8.5	180	48

Source: Author's results.

Thus, the climatic conditions of the harvest years 2013, 2014, 2015 and 2016 led to variations in the accumulation of sugars in grapes, variations that were not, however, very significant. We note the year 2015 in which the favorable climatic factors led to the highest concentrations of sugars in grapes (Fig. 1).

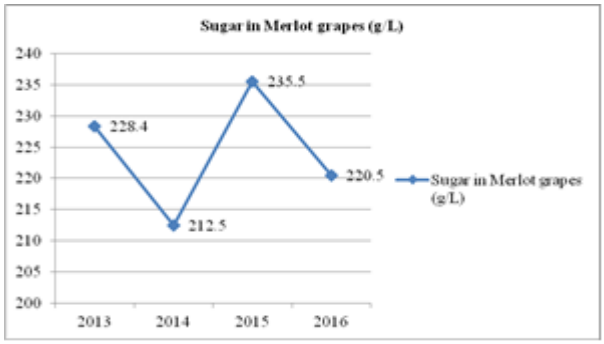

Fig. 1. Variation of sugar accumulation in *Merlot* grapes during the study years
Source: Author's results.

The alcoholic strength of the wines, obtained after the complete alcoholic fermentation of the musts also registered variations, from 12.2 vol% to 13.6 vol% alcohol.

The variations were significant but in all cases the wines registered the alcoholic strength necessary for their classification in the DOCC wine category, produced in the area of origin, within the Dealu Mare region (Fig.2).

The amount of residual sugars obtained from the alcoholic fermentation allowed the wines to be classified in the category of dry wine.

The total acidity of the wines registered normal values; however, in 2014 the high value of the total acidity produced a slight imbalance of the wine (Fig.2).

The total dry extract also, recorded variations, the favorable climatic conditions of 2015 leading to high values of this parameter in *Merlot* wine (Fig.3).

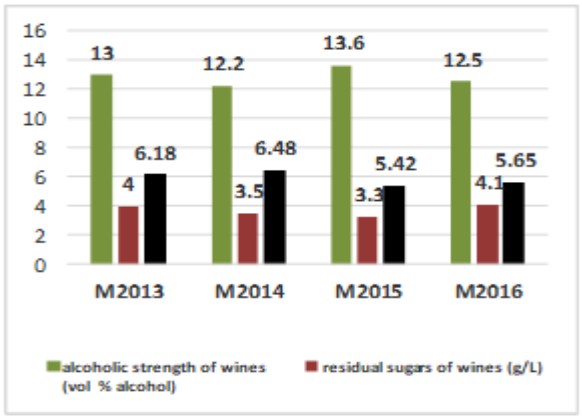

Fig.2 The alcoholic strength, total acidity and residual sugars of wines
Source: Author's results.

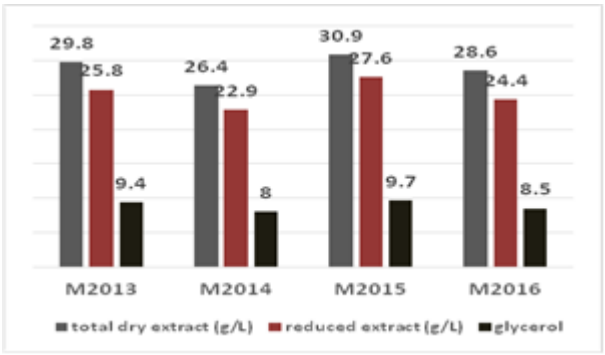

Fig.3 Content of wines in dry extract, reduced extract and glycerol
Source: Author's results.

Glycerol, the compound considered to be the most important by-product of alcoholic fermentation, contributes to the formation of dry extract, but also to the retention and revelation of wine aromas [14, 20]. Finally, glycerol influences the organoleptic qualities of the wine and therefore its quality. The amount of glycerol varied in tandem with the alcohol concentration of the wines, *Merlot* wine 2015 being characterized by the highest amount of glycerol (Fig.3).

In addition to the described parameters, the volatile acidity of the wines obtained during the 4 years of study was analyzed (Table 1). In most wines, the value of volatile acidity was below 0.5 g/L acetic acid. *Merlot* wine 2015 registered a slightly increased value of this very important parameter for the health and therefore the quality of the wine. The higher amount of volatile acids in the wine obtained this year may be a consequence of the high sugar concentration of the grapes-raw material. Also, in Table 1 are shown the SO_2 values, totally and freely, the most important exogenous substance for the stability of the wines, which also intervenes in many transformations suffered by the wine compounds. Both total and free SO_2 are within normal limits.

The polyphenolic composition of the analyzed *Merlot* wines was assessed by the total polyphenols content, the tannin content, the tannin structure of the wines, as well as by the anthocyanin content [13].

Regarding the total polyphenols content, *Merlot* wine is characterized by an average polyphenols content, compared to the other quality red wines: *Cabernet Sauvignon*, *Pinot noir*, *Feteasca neagra*. From the analysis of the results one can observe the influence of the climatic conditions and on the polyphenolic content of the wines (Fig.4).

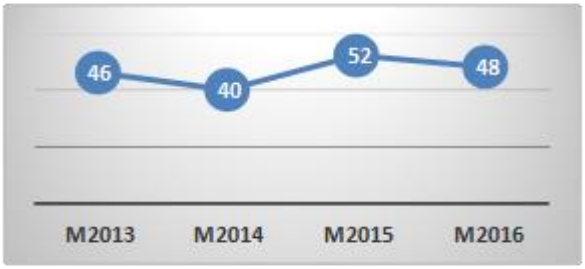

Fig.4. Variation of total polyphenols content (A_{280}) in *Merlot* wines
Source: Author's results.

Thus, in 2015 large accumulations of sugars were accompanied by higher accumulations of phenolic compounds, compared to the other years of study.

The tannin content was higher in the *Merlot* wine obtained in 2016, followed by the Merlot wines 2013 and 2015 (Fig.5).

Fig.5.Variation of the content in tannins (g/L) in *Merlot* wines
Source: Author's results.

The tannin structure of the varieties is a characteristic of them, the black grape varieties being characterized by a different content of tannins with astringent properties (Gelatin index), condensed tannins (HCl index) or macromolecular associations of tannins and polysaccharides (Ethanol index) [1, 25].
Merlot variety is characterized by a higher content of condensed tannins; percentage of condensed tannins was between 6.5% and 9% (Fig.6).

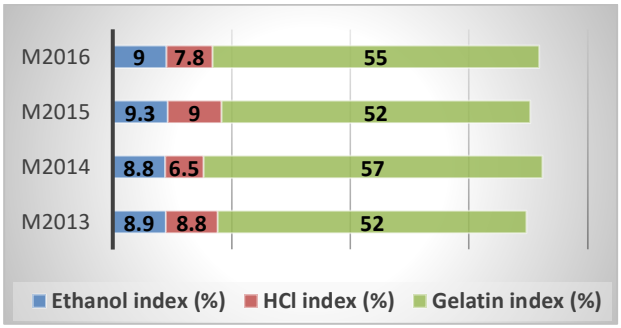

Fig.6. Structure of tannins in *Merlot* wines
Source: Author's results.

In terms of anthocyanin content, the highest accumulations were recorded in 2015. Large quantities of anthocyanins also accumulated in 2013 (Fig.7).

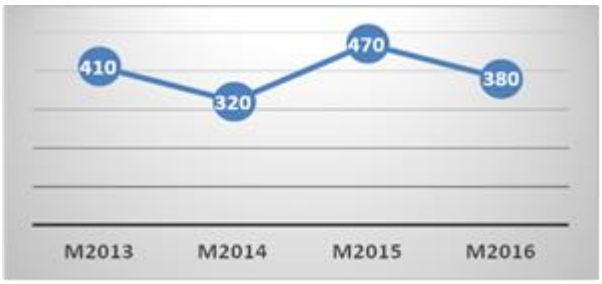

Fig.7. Variation of anthocyanin content (g/L) in *Merlot* wines
Source: Author's results.

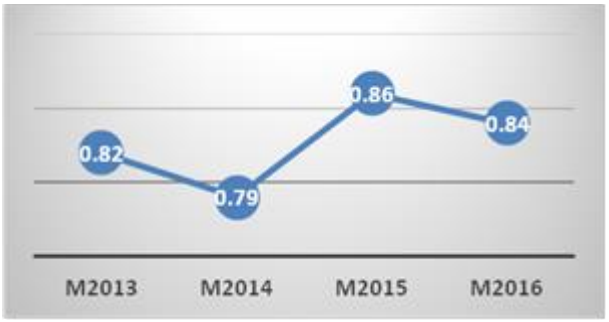

Fig.8. Color intensity (IC) in *Merlot* wines
Source: Author's results.

In 2015 the *Merlot* wines had a particularly pleasant, rich and heavy red-ruby color, with a value of 0.860 of the coloring intensity (Fig.8).

CONCLUSIONS

Merlot variety is sensitive to winter injury. Budbreak is fairly early and is thus susceptible to frost in the spring. The grapes are susceptible to diseases, especially to gray rot. Thus, the annual climatic conditions can influence the quality of *Merlot* wines.
The years 2013, 2014, 2015 and 2016 were different years in terms of climate, which led to variations in the composition and quality of the wines.
The analysis of the main biochemical parameters revealed the influence of the climate on the accumulation of sugars and, therefore, on the alcoholic strength, the content in dry extract, in glycerol, as well as on the chromatic characteristics of the wines.
In 2015 there were the highest accumulations of sugars but also the largest accumulations of phenolic compounds, including anthocyanins. The *Merlot* wine obtained this year was the most appreciated at the tasting, being a very well balanced wine, with an elegant red-ruby color, with the fresh aroma of raspberries and plums.

REFERENCES

[1]Cheynier, V., Prieur, C., Guyot, S., Rigaud, J., Moutounet, M., 1997, The structures of tannins in grapes and wines and their interactions with proteins, Wine: nutritional and therapeutic benefits,81-93.
[2]Christin, P.A., Junod, O, 2004, La chimie du vin, Futura Sciences, Dossier Chimie, 5-41.
[3]Clifford, M., 2000, Anthocyanins – nature, occurrence and dietary burden, Journal of the Science of Food and Agriculture, Vol 80 (7), pp. 1063-1072.
[4]Cotea, D.V.,1985, Tratat de Oenologie (Oenology Treatise), Vol.I, Ceres Publishing House, Bucharest, pp.28-35.
[5]Cotea, D.V., Grigorescu, C., Barbu, N.N., Cotea, V.V, 2000, Podgoriile si vinurile Romaniei, (Romania's vineyards and wines), Romanian Academy Publishing House, Bucharest, pp.102-108.
[6]Cotea, V.V., Cotea, D.V., 2006, Tehnologii de producere a vinurilor (Technologies for producing wines), Romanian Academy Publishing House, Bucharest, pp.133-137.

[7]Dallas, C., 1994, Effect of SO_2 on the extraction of anthocyanins, Vitis 33, pp. 42-51.
[8]Deloire, A., 2010, Les Potentialites Aromatiques du raisin: Influence des Itineraires Culturaux, Revue francaise d'Oenologie, 224, pp. 6.
[9]Fleet, G. H., 2002, Wine microbiology and biotechnology, Harwood Academic Publishers, Switzerland, pp.410-415.
[10]Giusti, M, Wrolstad, R.E., 2001, Characterization and Measurement of Anthocyanins by UV-Visible Spectroscopy. Current Protocols in Food Analytical Chemistry.
[11]Glories, Y., 1984, La couler des vins rouges, Connaisance Vigne Vin, 18, pp. 253-271.
[12]Indreas, A., Visan, L., 2001. Principalele soiuri de struguri de vin cultivate in Romania (The main grapes cultivars cultivated in Romania), Ceres Publishing House, Bucharest, pp.14-16.
[13]Kontek, A., Kontek, A., 2008. Compuşi fenolici din struguri, must şi vin. Proprietăţi şi influenţa lor asupra calităţii vinurilor. (Phenolic compounds from grapes, must and wine. Properties and their influence on wine quality), Wine&Spirit Club. Year III, No. 21.
[14]Moreno-Arribas, V., Polo, C., 2009, Wine Chemistry and Biochemistry. Ed. Springer, pp.20-25.
[15]Macici, M., 1996, Vinurie Romaniei (Romania's wines), Alcor Edimpex Publishing House, pp.80-89.
[16]Morlat, R., 1997, Terroir d'Anjou, Buletin O.I.V., 797, pp. 567-591.
[17]Navarre, C., 2010. L'œnologie (7e ed.), Ed, Lavoisier, pp.280-300.
[18]Oprea, A., 2000, Viticultura (Viticulture), Ceres Publishing House, Bucharest, pp.27-35.
[19]Oslobeanu, M., Macici, M., Georgescu, M., Stoian, V., 1991, Zonarea soiurilor de vita de vie in Romania (Zoning of vine varieties in Romania), Ceres Publishing House, Bucharest, pp.115-118.
[20]Popa, A., Popa, D., Dragomir, F., 2004, Microbiologie Oenologică (Oenological Microbiology). Universitaria Publishing House, Craiova, pp.48-52.
[21]Ribereau-Gayon, J., Peynaud, E., Sudraud, P., 1972, Dosage des anthocyanes dans les vins rouges. Sciences et Techniques du Vin, 1, pp. 497-499.
[22]Stoian, V., 2001, Marea carte a degustarii vinurilor (The great book of wine tasting), Artprint Publishing House, Bucharest, pp. 291-292.
[23]Tardea, C., 1980, Metode de analiză şi control tehnologic al vinurilor (Methods of analysis and technological control of wines), Ceres Publishing House, Bucharest, pp. 87-105.
[24]Visan, L., 2015, Biotehnologii fermentative. Biochimia şi biotehnologia vinului (Fermented biotechnologies. Biochemistry and biotechnology of wine, Invel-Multimedia Publishing House, Bucharest, pp.11-14.
[25]Vivas, N., 2007, Les composés phénoliques et l'élaboration des vins rouges, Bordeaux, Editions Féret, pp.330-335.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE MANAGEMENT OF SOILS FROM VITICULTURAL PLANTATIONS

Diana Elena VIZITIU[1], Lucian DINCĂ[2], Alina DONICI[3], Viorica ENACHE[4]

[1]National Research and Development Institute for Biotechnology in Horticulture Stefanesti Arges, Stefanesti City, 37 Bucureşti-Piteşti Road, Ştefăneşti, Argeş, 117715, România, Phone: 0248266808, Fax: 0248.266838, Email: vizitiud@yahoo.com
[2]"Marin Dracea" National Research and Development Institute in Forestry, 128 Eroilor Boulevard, Voluntari, Ilfov, 13 Cloşca Street, Braşov 500035, Romania, Phone/Fax: 0268.419936 Email: dinka.lucian@gmail.com
[3]USAMV Bucharest-Didactic Research and Development Station for Viticulture and Pomiculture, Pietroasa Istrita, Pietroasele City, 65 Principal Street, Buzau District, 127470, Phone/Fax: 0238512318 Email: donicialina79@gmail.com
[4]Bujoru Research and Development Station for Viticultural and Winemaking, 65 G-ral Eremia Grigorescu Street, Târgu Bujor, Galaţi, 805200, Phone/Fax: 0236340642, Email: enacheviorica57@gmail.com

Corresponding author: vizitiud@yahoo.com

Abstract

Wine plants are cultivated on different types of soils with different degrees of fertility, from sandy ones up to clay ones. Consequently, the technology for maintaining viticulture plantations must improve their fertility state and the soil's productivity. The large number of works and the repeated crossings with tractors and viticulture equipment in vineyards negatively influences the soil's characteristics: structure degradation, surface and depth compaction, the decrease of humus content, reduction of biological activity, that can finally led to a decrease of the soil's natural fertility. In this paper are presented different solutions for: preventing soil erosion; capitalization of viticulture fields in the conditions of applying a sustainable viticulture, remaking the water-air percentage and improving the soil's biological activity.

Key words**:** *management, soil, grassing, grapevine, mulching*

INTRODUCTION

Through their specificity, viticulture plantations occupy for a long time the fields, so that their emplacement is especially done on soils that are improper for other cultures. This includes fields under erosion (field slopes higher than 10%) that cause a permanent deterioration action of the soil's physical-chemical properties with a final result – a weak infiltration of precipitations in soils and a a water supply in the soil much diminished over time.
The climatic changes from the last period have led to a randomized distribution of precipitations with frequent torrential rains framed by long drought periods [4, 5, 16, 17]. Related to the effects of erosional processes and to the reduced capacity of the affected soil's regeneration, it is much more important to apply soil erosion prevention measures than to fight against them [3, 6, 7, 13,18].
Soil erosion is a physical process that occurs at the soil's surface or in its depth that transports by water or wind important soil masses together with their fertility at distances that can sometimes reach thousands of kilometers [1, 2, 8, 12, 14]. Often, soil erosion aggravates soil properties and definitely contributes to decreasing their productions. The loss of the fertile layer from the soil's surface is unequalled and sometimes irreversible, with high financial restoration efforts.
The grapevine's needs towards water are mostly satisfied from precipitations left over in the superior soil layers. Phreatic waters can also have a part only if they are not too deep.

A lack of precipitations and their inadequate distribution in the vegetation phase can create critical periods for grapevines from a physiological point of view that is later reflected in the production of grapes [16].

MATERIALS AND METHODS

The present paper presents different solutions for: preventing soil erosion; capitalization of viticulture fields by applying a long-lasting viticulture; remaking the water-air percentage and improving the soil's biological activity. These solutions are the results of studies realized at Research and Development Station for Viticulture and Winemaking (SCDVV) Bujoru and National Institute for Research and Development for Biotechnology in Horticulture (INCDBH) Stefanesti.

The observations were realized during 2012-2018 at SCDVV Bujoru where three experimental parcels were created: green fertilizer plants were used for the 10% slope inclination; the 18-20% field slope has large terraces with 5-6 rows of grapevine fertilized at soil with composted grape marc, barn manure; the field slope larger than 20% has narrow terraces with 1-2 rows of grapevines fertilized at soil with composted grape marc and barn manure. The observations and tests referred to: determining the soil's hydro physic indexes; soil content in NPK, humus and PH; the mobility of nutritive elements from soil; the dynamic of soil humidity on the 0-100 cm profile; recording the grapevine's behavior during the vegetation phase; the content of microorganism/1g sol; the soil's biological activity; monitoring climatic factors; controlling useful entomofauna and establishing the biologic reserve of pathogen factors.

For INCDBH Stefanesti, the studies were realized during 2012-2018 and consisted in applying more systems for maintaining the soil: permanent soil natural grassing (obtained by leaving the strip between the rows with the weeds that grow spontaneously); artificial grassing in strips with *Trifolium repens* var. silvestris (10 kg/ha) (obtained by grassing the area between the rows); artificial grassing in strips with *Lotus corniculatus*, Bull variety (18 kg/ha) (obtained by grassing the area between the rows); black field (conventional non-organic system).

RESULTS AND DISCUSSIONS

Solutions for preventing soil erosion

- Orienting grapevine rows on the level curves;
- Realizing ridges on slopes with gentle and uniform inclination in order to retain water;
- Creating coast channels with evacuation outlets for pluvial waters;
- Creating terraces with embankments from stone or cement walls;
- Maintaining the optimal level of organic matter in soil and ensuring its biodiversity [15];
- Ploughing on the level curves in slopes;
- Natural or artificial grassing, total or only for the intervals between the grapevine rows. This can be done by seeding gramineae and/or leguminous species (*Lolium perene, Poa pratensis, Agrostis stolonifera, Festuca rubra, Bromus inermis* Leyss. - Orfeu, *Trifolim pratense, Trifolium repens*);
- Creating bands with forest species on slope fields (cherry, locust, honey locust, cherry plum, walnut, hazelnut, blackthorn, oak, holm and others).

Solutions for capitalizing viticulture fields in the condition of applying a long-lasting viticulture [9]

- For fields with a slope <10%: using green fertilizer plants (a borceate made of 120 kg/ha vetch and 60 kg/ha oat), planted in early spring from two to two intervals (end of March-beginning of April) and mowed when are in blooms (June). After mowing, it remains as mulch on the soil's surface until it dries being then incorporated in the soil with the disk or milling machine. This process stimulates the soil's microbiological activity. In addition, it has a similar effect with applying a large quantity of barn manure. In comparison with barn manure, green fertilizer offers a plus of nitrogen and a minus of phosphor and potassium. Green fertilizers improve the mobility of nutritive elements in the soil-plant system. By incorporating them

under the furrow, the nutritive elements are fixed by humus and are no longer lost.
- For fields with a slope of 18-20% large terraces can be realized with 5-6 rows of grapevine, fertilized at soil with composted grape marc, barn manure and foliar fertilizer based on the phenophase moment and necessity.
- For fields with a slope >20%, situated in narrow terraces with 1-2 rows of grapevine, soil fertilization with composted grape marc (4.5 to/ha) / barn manure (15-20 to/ha) is also recommended. Foliar fertilizers can also be applied based on the phenophase and necessity (NPK 2:1:0 for sprout growing and NPK 0:1:1 for grapes ripeness). Foliar fertilization is recommended simultaneously with phytosanitary treatments in order to reduce the number of aggregates passages and for avoiding soil compactation.
- Reducing soil compactation by limiting the crossings with the tractor by using phytosanitary products that combat simultaneously more pathogen agents and pests.
- Realizing the superficial soil maintenance works by applying a reduced number of works and profound soil aeration.
- Avoiding soil works when it has a high humidity in order to prevent the compaction and to maintain/increase the soil water infiltration.
- Supplementing the nutritive input in viticulture plantations by using grass mowed as mulch, by applying foliar fertilizers and using a composted grape marc. This contributes to increasing the plants' longevity and to decreasing secondary effects caused by some climatic factors (prolonged drought, high temperatures, attack of different phyto-pathogen agents).

Solutions for restoring water-air percentage and for improving the soil's biological activity:

- Soil scarification preferably when it has a medium humidity of 50% IUA (active humidity interval). The recommended depth is of 55-60 cm so that it creates optimum conditions for depth water soil penetration.
- Applying agro-phyto-technical methods for preventing hydric stress: annual depth aeration - in order to ensure a maximum interception of precipitations, realizing a harrowing in April with mobilizing the soil at 5-8 cm (in order to level the plow, to reduce water evaporation and to favor soil surface heating); avoiding soil yielding by realizing spring ploughing at an optimum soil humidity level; realizing superficial soil maintenance works without turning over the furrows, in order to reduce soil water evaporation at a minimum during scarce rainy periods; if during the winter the sum of precipitations presents a pronounced scarcity, the spring ploughing must be replaces with soil aeration at the depth of 12-16 cm, without turning over the furrow.
- Partial mulching on the interval of grapevines with composted marc mulch (Fig. 1) in a minimum 10 cm depth layer; maintaining the grapevine row through post-emergent weed killing (applying two weed killings with products based on glyphosate in a dosage of 3-5 l/ha), and by limiting the rod load at 18 eye/but/m^2. This method capitalizes precipitation waters and limits its evaporation from soil.

Fig. 1 Mulching with composted marc
Source: [10,11].

- Total mulching with vegetal remains (straw, chopped strings etc.) in intervals and on rows with a depth of 10 cm that is redone from two to two years; fertilization with N, P, K in optimum dosage by limiting the rod loading at

18 eye/but/m^2 (Fig. 2). Mulching as soil maintenance method is also benefic in heat periods when the vegetal cover causes a lower temperature of the soil's superficial horizons in comparison with maintaining the soil as black field or through herbicides. Using the mulch or organic materials such as straws or vegetal remain for ensuring a physical barrier on the soil's surface.

Fig. 2 Mulching with vegetal remains
Source: [10,11].

- Applying adequate viticulture works for burying vegetal remains and accelerating their decomposition.
- Maintaining the soil through minimum tillage - Fig. 3 (autumn ploughing, deep mechanic hoeing in spring, total post emergent weed killing, 2-3 herbicidation).

Fig. 3 Minimum tillage
Source: [10,11].

- Temporary grassing – sowing species such as oatmeal, pea, clover, birdsfoot trefoil, lupine, soya, vetch etc (Fig. 4).

- Maintaining the natural grassing soil (Fig. 5) in order to regulate water content, to increase the organic matter content and to reduce erosion processes.

Fig. 4. Temporary grassing
Source: [9].

Fig. 5 Natural permanent grassing after mowing
Source:[15].

CONCLUSIONS

Reducing soil erosion as well as favoring water soil infiltration and preventing surface water leakage can be achieved by executing different works at the soil's level. In order to practice a safe viticulture that takes into account its effects on the environment as well as the consumers' safety, certain grapes production systems must be applied. As a consequence, the technologies for cultivating

grapevines must be remodeled and optimized in order to streamline natural resources. Thus, a long-lasting viticulture involves the proper application of soil works in order to avoid soil degradation by compaction (the least number of crossings by viticulture equipment); the use of organic fertilizers such as bran manure and green fertilizers; the application of the chemical fertilizers in small quantities for completing the necessary of grapevine plants.

The water and air content influence soil heating through the water/air percentage due to specific heath and their different thermic conductibility. The temperature is high in a dry soil, while a humid soil has a low temperature as water heaths harder due to the high caloric capacity.

The soil's water-air percentage as well as thermic regime can be optimized by applying soil works based on the area's microclimate where the viticulture plantation exists.

REFERENCES

[1]Alt, K., Osborn, C.T., Colacicco, D., 1989, Soil erosion: What effect on agricultural productivity? No. 556, p.1-6 Agriculture & Economics Reports from USDA's Economic Research Service. United State Department of Agriculture.

[2]Berca, M., 2008, Integrated management of plant nutrition (Managementul integrat al nutriţiei plantelor). Ceres Publishing House, Bucharest, p.195.

[3]Constandache, C., Dinca L., Tudose, N.C., Panaitescu C., 2018, Protecting surface water resources through silvicultural methods. International symposium "The environment and the industry", SIMI 2018, Proceedings book Section Pollution Assessment & Management Systems, pp. 276-284. http://dspace.incdecoind.ro/bitstream/123456789/1250/1/fp33.pdf, Accessed on 12.12.2019.

[4]Croitoru, A.-E., Piticar, A., Burada, C., 2015, Changes in precipitation extremes in Romania. Quaternary International. 1-11. https://www.academia.edu/16469085/Changes_in_precipitation_extremes_in_Romania, Accessed on 12.12.2019

[5]Dincă, L., D., Vizitiu, D. E., Donici, A., Popa, L., Murariu, G., 2018, The health dynamic of forest and vinicultural ecosystems from Romania during the last two decades in the context of current climatic changes. International Scientific Conference on Earth and Geosciences-Vienna, Green Scientific Sessions, Vol. 18, Issue 1.5, p.789-796, doi: 10.5593/sgem2018/1.5.

[6]Dincă, L., Buciumeanu, E.-C., Vizitiu, D. E., Enache, V., Cociorva, D., 2018, Main regulations and standards concerning the protection of forests and vinicultural plantations from Romania, with a special focus on improving the effects caused by climatic changes. International Scientific Conference on Earth and Geosciences-Vienna Green Scientific Sessions, Vol.18, Issue 1.5, pag. 719-726. DOI: 10.5593/sgem2018/1.5.

[7]Dincă, L., Achim, F., 2019, The management of forests situated on fields susceptible to landslides and erosion from the Southern Carpathians. Scientific papers series Management, Economic Engineering in Agriculture and Rural Development, 19(3):183-188.

[8]Dincă, L., Badea, O., Guiman, G., Bragă, C., Crișan, V., Greavu, V., Murariu, G., Georgescu, L., 2018, Monitoring of soil moisture in Long-Term Ecological Research (LTER) sites of Romanian Carpathians. Annals of Forest Research, 61(2): 171-188.

[9]Enache, V., Donici, A., Simion, C., Tabaranu, G., 2008, Capitalizing on the vineyards of the hilly area of Moldova under the conditions of applying a sustainable agriculture, Galaţi Academic Publishing House, (Valorificarea terenurilor viticole din zona colinară a Moldovei în condiţiile aplicării unei agriculturi durabile, Editura Academică Galaţi), pp.248-252.

[10]Enache, V., Donici, A., 2014, Research on minimizing the disruptive effect of climate change on viticulture by applying adapted technologies, Scientific Papers Horticulture Series, (Lucrări Ştiintifice Seria Horticultură), Iaşi, Vol. 57(2), pp.169-174.

[11]Enache, V., Donici, A., 2015, The adaptation to climate change a grapevine technologies, Scientific Works Horticulture Series, (Lucrări Ştiintifice Seria Horticultură), Iaşi, Vol. 58(2), pp.111-116.

[12]Lal, R., 2017, Soil Erosion Research Methods, Chapter 1: Soil erosion by wind and water: problems and prospects. In Soil erosion research methods, eBook, Routledge, New York, p.1-10.

[13]Marumoto, T., Hayakawa, S., Ezaki, T., Yamamoto, K., Okabe, H., 1997, Function of a mulching sheet for reforestation and the prevention of soil erosion. Journal of Agricultural Meteorology, 52(5), 613-616.

[14]Onet, A., Dincă, L.C., Grenni, P., Laslo, V., Teusdea, A.C., Vasile, L. D., Enescu, E. R., Crisan V.E., 2019, Biological indicators for evaluating soil quality improvement in a soil degraded by erosion processes. Journal of Soils and Sediments, 19(5), 2393-2404.

[15]Tomoiagă, L., Ficiu, L., Tăbăranu, G., Zaldea, G., Vizitiu, D., 2018, Eco-efficient solutions favorable to the conservation and reconstruction of biodiversity in vineyards and orchards. Good practice guide. (Soluții ecoeficiente favorabile conservării și reconstrucției biodiversității în fermele viticole și pomicole. Ghid de bune practici). Publishing house Blaj, p.68.

[16]Vizitiu, D. E., Dincă, L., Enache, V., Donici, A., Popa, L., Cociorva, D., Murariu, G., 2018, Identifying and describing the main climatic and stress factors that are affecting forest and vinicultural ecosystems, International Symposium "The Environment and the Industry", SIMI, 20th to 21st September 2018 Bucharest, Romania, 232-241,

http://dspace.incdecoind.ro/bitstream/123456789/1261/1/fp28.pdf, Accessed on 13.12.2019.
[17]Vizitiu, D. E., Dincă, L., Enache, V., Donici, A., Radomir, A.-M., 2019, Solutions to obtain the high quality viticultural production in the context of climate change. International Symposium "The Environment and the Industry", SIMI 2019, Proceeding book, pag. 229-237. DOI: http://doi.org/10.21698/simi.2019.fp30.
[18]Zuazo, V.H.D., Pleguezuelo, C.R.R., 2009, Soil-erosion and runoff prevention by plant covers: a review. In Sustainable agriculture (2008) 28: 65, 0Springer, Dordrecht, https://www.agronomy-journal.org/component/citedby/?task=crossref&doi=10.1051%2Fagro%3A2007062&mb=, Accessed on 07.01.2020.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

STUDENTS' ATTITUDE ON ENTREPRENEURSHIP IN HIGHER AGRICULTURAL ENGINEERING EDUCATION

Ionela Mituko VLAD[1], Elena TOMA[1,2], Adrian GAVRUȚĂ[3]

[1]University of Agricultural Sciences and Veterinary Medicine Bucharest, 59 Marasti, District 1, 11464, Bucharest, Romania, Emails: bmitsouko@yahoo.fr, elenatoma2001@yahoo.com
[2]National Institute for Research and Development in Informatics – ICI Bucharest, 8-10 Averescu Blvd., 011455, Bucharest, Romania, Email: elena.toma@ici.ro
[3]Banat's University of Agricultural Sciences and Veterinary Medicine „King Michael I of Romania" from Timişoara, 119 Calea Aradului, Timisoara, 300645, Romania, Email: adrian_k31@yahoo.com

Corresponding author: elenatoma2001@yahoo.com

Abstract

In the last decade, the Romanian agronomic engineering universities focused on the promotion of entrepreneurship among the students, by including entrepreneurial competences in curricula or by promoting entrepreneurial support activities. To develop more educational instruments in this field, we considered that the main challenge is to assess the entrepreneurship interest and needs of the students. In this context, the present paper aims to reveal the attitude of agricultural engineering students toward the implication in the development of their own business and to emphasize the role of formal education in their necessary skills development. The research is based on a survey conducted among students in final years of studies from a Romanian agronomic higher education institution and consisted in 215 questionnaires. Our approach has taken into consideration the differences among the students linked to their age, gender, place of residence, the potential employment and family environment. The main findings of our study have indicated that the students from agronomic engineering field have basically a positive attitude toward entrepreneurship and meanwhile they are very aware of the challenges related to the development of new businesses.

Key words**:** *entrepreneurship, entrepreneurial approaches, students' attitude, agronomic engineering*

INTRODUCTION

In the last two decades, the entrepreneurial education became very important due to its acknowledge role in speeding up countries economic growth [15]. Thus, the entrepreneurial interest of the students became also very important for the higher education stake holders in their process to adapt curriculum to the market needs. There are several studies which are trying to identify the factors which influence the decision behavior of students related to entrepreneurship and their conclusions are very relevant: entrepreneurship education contributes to the increase of student awareness about the subject and influence the entrepreneurial projects of the students [14], [8], [3], [16]; an entrepreneurial family background influences positively the entrepreneurial plans [2]; male students pointed out a clearer intention to start a business [13]; the change in the employment status can stimulate individual entrepreneurial activity [6]; the students from technical fields (like agricultural engineering) have a lower interest toward entrepreneurship than the students from faculties of economic studies [7] etc. We have found also some papers which are focusing on agricultural education (agronomic, agricultural engineering, etc.) and pointed out the factors influencing the entrepreneurial projects among their students, like: entrepreneurial education, family support, perceived behavioral control, etc. [12]; education support, personality traits and skills [9]; the need to gain independence [1] etc. However, almost all the studies mentioned that the entrepreneurial courses didn't have impacts on students' intention towards entrepreneurship. "Entrepreneurship education does not teach students to pursue an

entrepreneurial career, but to apply what they learned to their future jobs" [4].

This topic was approached intensely also in Romania in the last years due to the fact that entrepreneurship became a theme of interest for Romanian higher education, many universities including in their curriculum different disciplines adapted to develop entrepreneurship competencies. A research performed in Romania on engineering students (from Petru Maior University of Tirgu Mures) revealed that there are some important factors which influence positively the entrepreneurial intentions: students' entrepreneurial family background and entrepreneurial personality traits [5]. Also, there are studies which make a sketch of an engineer student with entrepreneurship skill: "persons which are determined to be independent … with ability to work in the multidisciplinary teams and which have the capacity to communicate the own ideas … these persons have the capability to take the risk …. to feel the business opportunity, to take the initiative … and to make decisions based on limited information", "persons who are passionate about what they are doing and who have a deeply knowledge in different areas of the life sciences and which are able to coordinate multidisciplinary teams", etc. [10][11].

By following this direction of research, our research aimed to respond to the following questions: what is the level of interest towards entrepreneurship in agronomic studying field? What are the factors which differentiate the students regarding this interest? What are the premises to motivate them? What are in their opinion the success factors and challenges in the process of development of a business?

MATERIALS AND METHODS

This research aimed to analyse the entrepreneurial interests of Romanian students from agronomic field of studies. Our research is based on the results obtained from 215 questionnaires completed by students from University of Agronomic Sciences and Veterinary Medicine of Bucharest (3rd and 4th year of studies) during academic year 2018-2019. The results were processed by SPSS, with descriptive statistic methods. Frequencies table (Table 1) indicates that in our database of respondents we have 53.5% women (from which 60% reside in urban areas and only 29.6% are employed) and 46.5% men (from which 64% reside in urban areas and 37.0% are employed). If we look more in detail by residence area, we observe that the majority of the questioned students come from cities (61.9%) but the percent of employability is higher for students which reside in rural areas (37.8%).

Table 1. Main characteristics of respondents

Variable	Categories	Frequency	Percent (%)
Gender	Woman	115	53.5
	- urban areas	69	60.0
	- rural areas	46	40.0
	- employed*	34	29.6
	- unemployed*	81	70.4
	Man	100	46.5
	- urban areas	64	64.0
	- rural areas	36	36.0
	- employed*	37	37.0
	- unemployed*	63	63.0
Residence area	Urban	133	61.9
	- gender (man)	64	48.1
	- gender (woman)	69	51.9
	- employed*	40	30.1
	- unemployed*	93	69.9
	Rural	82	38.1
	- gender (man)	36	43.9
	- gender (woman)	46	56.1
	- employed*	31	37.8
	- unemployed*	51	62.2
Total		215	100

Source: own data SPSS.

*55 students didn't declare the employability status (25.6%)

Our questionnaire aimed to collect information on the students' interest and view regarding entrepreneurial activities. In order to obtain all this information, we inquired eleven questions out of which, five dichotomous questions (with Yes/No answers) and four multiple-choice questions. For the last questions we converted responses also by using multiple dichotomies (dummy yes/no variables). Starting from these questions we computed the following multiple response set of variables (Table 2):

-*Entrepreneurship interest* (the own interest to start a business);

-*Business start premises* (what are the reasons that would determine the respondent to start a business);

Table 2. Annual variation coefficient

Variable	Primary variables (Dichotomy group tabulated at value 1 (yes))
Entrepreneurship interest	Q.1/Is in this period the entrepreneurship a concern for you? Q.9/If someone you know would give you $ 50,000 gift to spend, would you invest them in a business? (other alternatives: home, cars, vacations, personal goods etc.) Q.10/ If you would have the opportunity, would you be willing to invest time and money to participate in an entrepreneurship course?
Business field	Q.11.1/If you would have the opportunity to set up a business, in which domain will you invest? - Agriculture and related activities Q.11.2/If you would have the opportunity to set up a business in which domain will you invest? - Tourism and restaurants (other food processing and delivery activities) Q.11.3/ If you would have the opportunity to set up a business in which domain will you invest? - Others (IT, services, etc.)
Business start premises	Q.2.1/Which are the reasons that would cause you to start your own business? Financial independence Q.2.2/Which are the reasons that would cause you to start your own business? Independence in time organization Q.2.3/Which are the reasons that would cause you to start your own business? I consider it the kind of activity I find myself in
Business success	Q.8.1/ Which of the following aspects do you consider the most important for the success of a business? - Motivation Q.8.2/ Which of the following aspects do you consider the most important for the success of a business? - Education Q.8.3/ Which of the following aspects do you consider the most important for the success of a business? - Money Q.8.4/Which of the following aspects do you consider the most important for the success of a business? – Friends
Business challenges	Q.6.1/Which is the biggest problem that you consider in the current entrepreneurial environment in Romania? - The accessibility of financial fundsQ.6.2/ Which is the biggest problem that you consider in the current entrepreneurial environment in Romania? - Barriers to entry into new markets Q.6.3/ Which is the biggest problem that you consider in the current entrepreneurial environment in Romania? - Bureaucratic aspects Q.6.4/ Which is the biggest problem that you consider in the current entrepreneurial environment in Romania? - Identifying a sustainable business

Source: own data SPSS.

-*Business field* (if the respondent has the opportunity to open a business, in which domain would invest);
-*Business success* (which are the most important elements to assure the success in business);
-*Business challenges* (which are the elements that can impede the success of a business).
In addition, we tested: the willing to collaborate within an entrepreneurial organizations (Q.4), the main sources needed to finance their potential business (Q.5), if they have a firm business model in their family (Q.3), if they want to learn more about entrepreneurship (Q.10) and which is the time frame to develop a sustainable business in their opinion (Q.7).
Further, we computed the frequency tables and the interest variables were approached by gender, residence place, status of employment and familial environment. Also, for the questions which present the entrepreneurship interest we computed a new variable "Interest" for counting the persons who responded by 'yes' to all three questions (the answers related with interest were: Inexistent = 0; Low = 1; Medium = 2; High = 3). Additionally, we applied a crossed analysis (crosstabs) and the Pearson chi (chi-square) test to investigate if there are statistically significant differences in entrepreneurial attitude between the observed and the expected frequencies of variable sets based on the mentioned categories of classification.

RESULTS AND DISCUSSIONS

The assessment of the interest towards entrepreneurship of students took into consideration two aspects: 1) what is the level of intention and availability to start a business?; 2) why to start a business, how (what I need?) and what problems could I encounter? The first question was approached from three point of views: the degree of preoccupation in the present towards entrepreneurship (Q.1); the availability to start a business in the immediate future (prioritization) (Q.9); the field of business considered with potential by students (Q.11). The second question was approached through the assessment of three elements: premises to start a business (Q.2), factors needed for success in a business (Q.8) and factors which can impede the development of a new business (Q.6).

Overall attitude of students toward entrepreneurship

Entrepreneurship is a major concern only for 40.9% of students from agronomic field of studies (Table 3). However, if they could receive a certain amount of money in the immediate future, almost 48% of them will chose to invest in a business and 14% are undecided, so the interest is higher if exists some kind of external funding. However, overall, if we measure interest toward entrepreneurship through the chose methodology mentioned above, only 26.8% declare that they think to open a business, 31,4% declare that 'maybe' will open a business if they receive money from external sources and around 42% declare that they want to learn about entrepreneurship.

Table 3. Multiple response variables frequencies

Variable	Categories	Total		Yes (%)
		Responses	Percent of cases (%)	
Entrepreneurship interest	Q.1	88	26.8	40.9 (2.8% N/R*)
	Q.9	103	31.4	47.9 (14% N/R)
	Q.10	137	41.8	63.7 (0.5% N/R)
	Total	328	100.0	-
Business field	Q.11.1	43	25.6	20.0 (20.9% N/R)
	Q.11.2	64	38.1	29.8 (20.9% N/R)
	Q.11.3	61	36.3	28.4 (20.9% N/R)
	Total	168	100.0	-
Business start premises	Q.2.1	166	57.0	77,2 (0% N/R)
	Q.2.2	90	30.9	41,9 (0% N/R)
	Q.2.3	35	12.0	16,3 (0% N/R)
	Total	291	100.0	-
Business success	Q.8.1	136	32.6	63,3 (1,9% N/R)
	Q.8.2	89	21.3	41,4 (1.9% N/R)
	Q.8.3	167	40.0	77,7 (1.9% N/R)
	Q.8.4	25	6.0	11,6 (1.9% N/R)
	Total	417	100.0	-
Business challenges	Q.6.1	76	29.8	35,3 (0% N/R)
	Q.6.2	83	32.5	38,6 (0% N/R)
	Q.6.3	65	25.5	30,2 (0% N/R)
	Q.6.4	31	12.2	14,4 (0% N/R)
	Total	255	100.0	-

Source: own data SPSS.

Related with the field of business, we observed that only 25.6% of the students want to start a business in agriculture. Actually, from their responses we saw that 38.1% want to open a restaurant or a hotel/rural touristic accommodation household and around 36.3% want to open a business in another field (like auto services, IT services, etc.). The main reasons to start a business are financial (57.0%) and time (30.9%) independence, only 11,6% from respondents identifying their self as potential entrepreneur. In the students' opinion, related to the success and impediments in developing a business are:

-the most important factors to start a business and to be successful are money (40,0%) and motivation (32.6%), not knowledge or connections. We have to take in consideration that 46,5% affirm that they will start a business only if they will have their own money (family, friends, etc.) and only 25.6% would resort to loans next to their own sources (Q.5).

-Also, over 80% of them are aware that to develop a sustainable business you need at least 1-2 years (40,9% of them indicated over 2 years) (Q.7). So, having this in their mind, is not a surprise that the main factors of success are money and motivation. However, we want to point out that even if only 41.4% from the students selected education as important factor for success (21.3% of total responses related with success), our assessment showed that almost 64% from them are willing to invest time and money to participate in an entrepreneurship course.

the biggest challenge to develop a business in Romania is the competitivity of the market (the barriers to enter the market - 32.5%), followed very closely by the lack of means of financing (29.8%).

Factors influencing the interest towards entrepreneurship

In this part we investigated the variables from Entrepreneurial interest set (Q.1, Q.9 and Q.10) by gender, residence place, status of employment and family environment (Table 4). In this way we tried to see if there are significant statistical differences in responses by these criteria by applying descriptive analysis and Pearson Chi-Square test.

The interest to open and develop a business is higher for men than for women, almost half of men declared that entrepreneurship is a current concern. Also, almost 60% of the male students (compared with only 41% of the female students) are willing to start a business in the near future if they will have funds. Regarding the desire to improve their knowledge in the field, almost 64% from the students (both genders) are willing to participate in a specialized course. The Chi-square test didn't reveal significant differences by gender for the selected questions.

Table 4. Entrepreneurship interest assessment

		Q.1/Is entrepreneurship a concern for you right now?				Q.9/If someone you know would give you a $ 50,000 gift to spend, would you invest them in a business? (other alternatives: home, cars, vacations, personal goods etc.)				Q.10/If you had the opportunity, would you be willing to invest time and money to participate in an entrepreneurship course?			
		No	Yes	N/R	Total	No	Yes	N/R	Total	No	Yes	N/R	Total
Total	No	121	88	6	215	82	103	30	215	77	137	1	215
	%	56.3	40.9	2.8	100.0	38.1	47.9	14.0	100.0	35.8	63.7	0.5	100.0
GENDER (*W – Woman, M – Man*)													
W	No	72	40	3	115	49	47	19	115	41	73	1	115
	%	62.6	34.8	2.6	100.0	42.6	40.9	16.5	100.0	35.7	63.5	0.9	100.0
M	No	49	48	3	100	33	56	11	100	36	64	0	100
	%	49.0	48.0	3.0	100.0	33.0	56.0	11.0	100.0	36.0	64.0	0.0	100.0
W	%	59.5	45.5	50.0	53.5	59.8	45.6	63.3	53.5	53.2	53.3	100.0	53.5
M	%	40.5	54.5	50.0	46.5	40.2	54.4	36.7	46.5	46.8	46.7	0.0	46.5
Pearson Chi-Square Test		Chi-square 4.072 df 2 / Sig. 0.131				Chi-square 5.02 df 2 / Sig. 0.081				Chi-square 0.874 df 2 / Sig. 0.646			
PLACE OF RESIDENCE (*U – Urban, R – Rural*)													
U	No	79	51	3	133	55	61	17	133	47	85	1	133
	%	59.4	38.3	2.3	100.0	41.4	45.9	12.8	100.0	35.3	63.9	.8	100.0
R	No	42	37	3	82	27	42	13	82	30	52	0	82
	%	51.2	45.1	3.7	100.0	32.9	51.2	15.9	100.0	36.6	63.4	0.0	100.0
U	%	65.3	58.0	50.0	61.9	67.1	59.2	56.7	61.9	61.0	62.0	100.0	61.9
R	%	34.7	42.0	50.0	38.1	32.9	40.8	43.3	38.1	39.0	38.0	0.0	38.1
Pearson Chi-Square Test		Chi-square 1.530 df 2 / Sig. 0.465				Chi-square 1.591 df 2 / Sig. 0.451				Chi-square 0.641 df 2 /Sig. 0.726			
Employment status													
No	No	65	24	0	89	39	46	4	89	39	49	1	89
	%	73.0	27.0	0.0	100.0	43.8	51.7	4.5	100.0	43.8	55.1	1.1	100.0
Yes	No	35	35	1	71	31	35	5	71	21	50	0	71
	%	49.3	49.3	1.4	100.0	43.7	49.3	7.0	100.0	29.6	70.4	0.0	100.0
N/R	No	21	29	5	55	12	22	21	55	17	38	0	55
	%	38.2	52.7	9.1	100.0	21.8	40.0	38.2	100.0	30.9	69.1	0.0	100.0
No	%	53.7	27.3	0.0	41.4	47.6	44.7	13.3	41.4	50.6	35.8	100.0	41.4
Yes	%	28.9	39.8	16.7	33.0	37.8	34.0	16.7	33.0	27.3	36.5	0.0	33.0
N/R	%	17.4	33.0	83.3	25.6	14.6	21.4	70.0	25.6	22.1	27.7	0.0	25.6
Pearson Chi-Square Test		Chi-square 26.372 df 4 / Sig. 0.000				Chi-square 37.449 df 4 / Sig. 0.000				Chi-square 5.947 df 4 / Sig. 0.203			
FAMILY ENTREPRENEURIAL ENVIRONMENT													
No	No	72	29	0	101	44	51	6	101	48	52	1	101
	%	71.3	28.7	0.0	100.0	43.6	50.5	5.9	100.0	47.5	51.5	1.0	100.0
Yes	No	49	59	5	113	38	52	23	113	29	84	0	113
	%	43.4	52.2	4.4	100.0	33.6	46.0	20.4	100.0	25.7	74.3	0.0	100.0
N/R	No	0	0	1	1	0	0	1	1	0	1	0	1
	%	0.0	0.0	100.0	100.0	0.0	0.0	100.0	100.0	0.0	100.0	0.0	100.0
No	%	59.5	33.0	0.0	47.0	53.7	49.5	20.0	47.0	62.3	38.0	100.0	47.0
Yes	%	40.5	67.0	83.3	52.6	46.3	50.5	76.7	52.6	37.7	61.3	0.0	52.6
N/R	%	0.0	0.0	16.7	0.5	0.0	0.0	3.3	0.5	0.0	0.7	0.0	0.5
Pearson Chi-Square Test		Chi-square 53.322 df 4 / Sig. 0.000				Chi-square 15.739 df 4 / Sig. 0.003				Chi-square 13.183 df 4 / Sig. 0.010			

Source: own data SPSS.

*Question Q.3: Do you have personally or anyone else in the family, your own business?

The situation is similar if we look at the interest by place of residence. The differences between the answers of students from urban and rural areas are not statistically significant (p value > 0.5). However, the frequencies analysis allows us to conclude that among rural students exists a slightly higher preoccupation in this domain (with around 6-7% more than for students from urban areas).

If by gender and place of residence there aren't so many differences, when we take in consideration the employment status or entrepreneurial family environment the situation changes. Chi-square test results revealed a significant difference between: the students which are employed and the ones which are not in relation with questions Q.1 and Q.9; the students who have a firm business model in their family and the ones who are not related to all the questions connected with entrepreneurial interest.

So, what we may observe is that when students get a job, their vision on life changes. Half of the students that are employed are thinking to open their own business and if they receive somehow money they are disposed to invest immediately and also, over 70% of them are willing to invest time and money to learn how to do it.

The situation is similar if we group the students based on their entrepreneurial family environment. Around 52% of the students who grow up in an entrepreneurial environment are thinking to open their own business, 46% are willing to do it the near future and almost 75% want to learn how to be an entrepreneur.

The level of interest towards entrepreneurship of students

In the final part of our paper we computed a new variable (Interest) which comprises all the positive answers given by students to the questions related with the assessment of interest towards entrepreneurship. We established this interest on four levels, from inexistent to high, such in Table 5.

Table 5. Level of interest – descriptive statistics

		Interest*				
		Inexistent	Low	Medium	High	Total
Total	No	40	58	81	36	215
	%	18.6	27.0	37.7	16.7	100.0
GENDER						
Women	No	23	39	38	15	115
	%	20.0	33.9	33.0	13.0	100.0
Men	No	17	19	43	21	100
	%	17.0	19.0	43.0	21.0	100.0
Pearson Chi-Square Test		Chi-square 8.098 / df 3 / Sig. 0.044				
PLACE OF RESIDENCE						
Urban	No	29	35	45	24	133
	%	21.8	26.3	33.8	18.0	100.
Rural	No	11	23	36	12	82
	%	13.4	28.0	43.9	14.6	100.
Pearson Chi-Square Test		Chi-square 3.693 / df 3 / Sig. 0.297				
EMPLOYEE						
Unemployed	No	26	21	28	14	89
	%	29.2	23.6	31.5	15.7	100.0
Employed	No	6	22	31	12	71
	%	8.5	31.0	43.7	16.9	100.0
Pearson Chi-Square Test		Chi-square 12.398 / df 6 / Sig. 0.054				
FAMILY ENTREPRENEURIAL ENVIRONMENT						
Non-Entrepreneurial	No	27	30	30	14	101
	%	26.7	29.7	29.7	13.9	100.0
Entrepreneurial	No	13	27	51	22	113
	%	11.5	23.9	45.1	19.5	100.0
Pearson Chi-Square Test		Chi-square 8.098/ df 3 / Sig. 0.044				

Source: own data SPSS.

The assessment of interest at students' level revealed that only 16.7% are very interested to develop their own business (these are generally men, students from urban areas and students with an entrepreneurial background) and 37.7% obtained a medium score. However, overall, we can affirm that almost

55% of them have a positive standing towards entrepreneurship.

The Pearson Chi-Square test confirmed that are significant differences in dataset by gender, the family entrepreneurial environment and, in extremis, by employment. This statistical test allowed us to assess the interest towards entrepreneurial activities and to validate our findings. Meanwhile, if for place of residence we do not have high difference (50-60% of students have a positive attitude), for the other categories we may conclude the following (Fig. 1):

-men have a higher degree of acceptance of entrepreneurship activities, around 64% compared with only 46% of women;

-the majority of students which came from rural areas (58.5 %) want to develop a business, of which, 20% want to set up a business in agriculture and around 30% in tourism and restaurants (including rural accommodation establishments). We consider that this situation is due to the fact that almost 60% of them own a business in their family linked to these activities;

-based on their employment status, 60% of employed students will prefer an activity which can offer them financial independence and more time. Regarding the students which don't have a job, only 47% of them have in interest towards entrepreneurship. Actually, in this category we have the highest percent of the persons with no interest howsoever to develop a business (almost 30%);

-if they have a raw model in their life (they or someone from the family have a business) the interest to have and develop an entrepreneurial activity is higher. For example, 64% from the students which lived in an entrepreneurial familial environment show a medium and high interest towards entrepreneurship compared with only 44% in the category of the students which don't have this kind of environment.

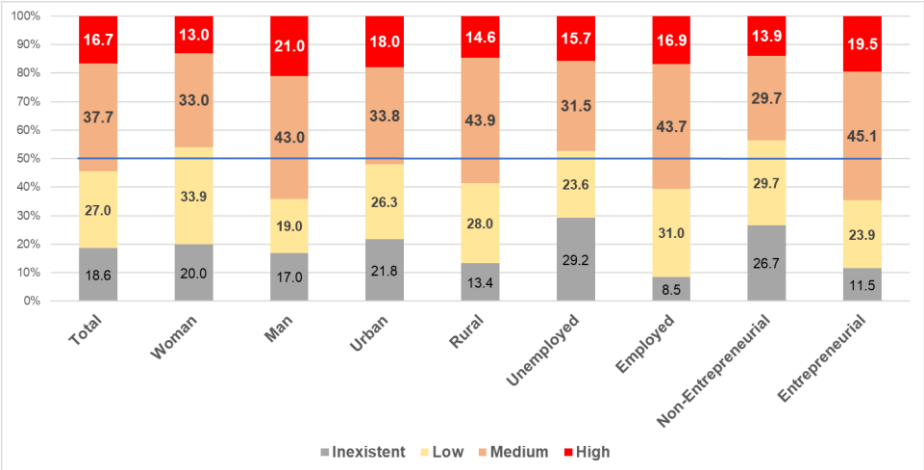

Fig.1. Level of interest by factors (%)
Source: Own design and calculation.

CONCLUSIONS

The aim of this research was to find the extent of entrepreneurship interest of Romanian engineering students from University of Agronomic Sciences and Veterinary Medicine of Bucharest. Results showed that only 55% of the respondents have a certain interest towards developing a business. We want to point out that only 16.7% were very interested in this subject (this are in general men, students from urban areas or students with an entrepreneurial background in their family).

All the 215 students included in the research were from the last years of studies which means that they learned about entrepreneurship along many disciplines inside curricula, but it's obvious that there are many other factors which influence their decisions. Actually, out findings complete other studies in the field from Romania which showed that "students' participation in

entrepreneurship education does not influence significantly their entrepreneurial intentions" [5]. In this way, we can say that the university curriculum only contributes to the formation of basic competencies and abilities but don't motivate the students "to do".

In the light of this findings, the recent national initiative to create and implement, at universities' level, organizations to promote entrepreneurship among students (student entrepreneurship societies) may improve the situation and foster entrepreneurship among students, including the ones from agricultural engineering fields. In 2019 this societies provided classes on different subjects like business management or entrepreneurial skills development, supported start-up exhibitions and presentations of successful entrepreneurs, organized thematic workshops and workgroups, etc. By taking these elements into account we plan to continue this research more in depth to see if this kind of institutional support, next to the university curricula, has a real impact on the growth of the interest of students towards entrepreneurship.

REFERENCES

[1]Barba-Sánchez, V., Atienza-Sahuquillo, C., 2018, Entrepreneurial intention among engineering students: The role of entrepreneurship education. European Research on Management and Business Economics, 24(1), 53-61.

[2]Bosma, N., Hessels, J., Schutjens, V., Van Praag, M., Verheul, I., 2012, Entrepreneurship and role models. Journal of Economic Psychology, 33(2), 410-424.

[3]Cera, E., Furxhiu, N., 2017, Factors which Influence Students Entrepreneurship Intentions: The Role of Education Programs, Subjective Norms and Perceived Behavioral Control. Journal of Educational and Social Research, 7(1), 173-179.

[4]Chen, S. C., Hsiao, H. C., Chang, J. C., Chou, C. M., Chen, C. P., Shen, C. H., 2015, Can the entrepreneurship course improve the entrepreneurial intentions of students?. International Entrepreneurship and Management Journal, 11(3), 557-569.

[5]Herman, E., 2019, Entrepreneurial Intention among Engineering Students and Its Main Determinants. Procedia Manufacturing, 32, 318-324.

[6]Lans, T., Gulikers, J., Batterink, M., 2010, Moving beyond traditional measures of entrepreneurial intentions in a study among life-sciences students in the Netherlands. Research in Post-Compulsory Education, 15(3), 259-274.

[7]NIRAS Consultants, FORA and ECON Pöyry, Survey of Entrepreneurship Education in Higher Education in Europe, 2008, https://ec.europa.eu/, Accessed on Dec.20, 2019.

[8]Potishuk, V., Kratzer, J., 2017, Factors affecting entrepreneurial intentions and entrepreneurial attitudes in higher education. Journal of Entrepreneurship Education.

[9]Pouratashi, M., 2015, Entrepreneurial intentions of agricultural students: Levels and determinants. The Journal of Agricultural Education and Extension, 21(5), 467-477.

[10]Radu, N., Chirvase, A. A., Babeanu, N., Popa, O., 2015, Educational management in the field of life sciences-key competences needed to start and develop the innovative SME's. Scientific Papers Series Management, Economic Engineering in Agriculture And Rural Development, 15(2), 297-300.

[11]Radu, N., Chirvase, A. A., Babeanu, N., Begea, M., 2019, Entrepreneurship in the field of life sciences: the personal skills needed to start an innovative SME. Scientific Papers Series-Management, Economic Engineering in Agriculture and Rural Development, 19(2), 375-379.

[12]Sher, A., Adil, S. A., Mushtaq, K., Ali, A., Hussain, M., 2017, An investigation of entrepreneurial intentions of agricultural students. Pakistan Journal of Agricultural Sciences, 54(4), 941-945.

[13]Sieger, P., Fueglistaller, U., Zellweger, T., 2016, Student Entrepreneurship 2016: Insights From 50 Countries. St. Gallen/Bern: KMU-HSG/IMU. International GUESSS Report, 2(3).

[14]Souitaris, V., Zerbinati, S., Al-Laham, A., 2007, Do entrepreneurship programmes raise entrepreneurial intention of science and engineering students? The effect of learning, inspiration and resources. Journal of Business venturing, 22(4), 566-591.

[15]Sultan, M. F., Maqsood, A., Student, K. A. S. B., Shrif, H. M., 2016, Impact of entrepreneurial education on students entrepreneurial intentions. KASBIT Business Journals (KBJ), 9(1), 131-153.

[16]Sun, H., Lo, C. T., Liang, B., Wong, Y. L. B., 2017, The impact of entrepreneurial education on entrepreneurial intention of engineering students in Hong Kong. Management Decision.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ECONOMIC ASPECTS OF THE DEVELOPMENT OF THE "DIGITAL AGRICULTURE" SYSTEM

Igor Leonidovich VOROTNIKOV, Nadezhda Viktorovna UKOLOVA, Sergey Vladimirovich MONAKHOV, Juliya Anatolyevna SHIKHANOVA, Vasily Voldemarovich NEYFELD

Saratov State Agrarian University, Teatralnaya square, 1, Saratov, 410012, Russia, Emails: igor_leon_vorotnikov@bk.ru, 812637@mail.ru, 184605@inbox.ru, 648096@mail.ru, 214283@inbox.ru

Corresponding author: igor_leon_vorotnikov@bk.ru

Abstract

In the article, the authors are revealing the features of the transition to a new type of farming. The possibilities of modern agriculture, use of smart technologies for agriculture, development of highly intelligent agriculture, features of the use of artificial intelligence in agriculture, use of the Internet, namely FoodNet, active use of GIS technologies, improvement of logistics systems, and banking services for farmers and agriculture producers are being examined on the ground of digital technology. The conclusion is being made concerning the need for the active development of the digital agriculture system.

Key words**:** *development economics, digital agriculture, GIS technologies, smart agriculture*

INTRODUCTION

Agriculture is one of the most promising areas of application of digital technologies and an opportunity to develop a digital economy. Being a key sector of the economies of many developing countries, agriculture provides significant growth in the global economy. Modern agriculture is characterized by a high share of the use of new technologies, both in the production process and in the service infrastructure. The use of new digital technologies is possible thanks to the active development and technological modernization of the agricultural production process. Now it is difficult to imagine new means of production used in agriculture without the presence of highly intelligent devices that minimize costs in the production process, as well as contribute to improving the efficiency of the production process.

MATERIALS AND METHODS

The study used various methods of economic science. The main research method was the dialectic method. The theoretical basis of the study was the work of scientists of the world and Russian science [1, 2, 3, 4, 8, 12, 13, 14, 15, 16, 17, 18, 20, 21], devoted to the use of digital technologies in various sectors of the economy, adaptation of these technologies to modern agriculture. The methodological basis of the study was the analysis of normative legal acts [5, 6, 9, 10, 11] and reports of state executive authorities, state programs, statistical data [7, 19], monographs, articles and scientific works.

RESULTS AND DISCUSSIONS

The active use of digital technologies in agriculture forms a new segment of agriculture, which, in our opinion, should be separated from the others and given the name of "digital agriculture".

"Digital agriculture" is the technological basis of agriculture of the future, its constituent element provides for the creation of highly efficient agriculture that can meet the growing needs of the population through the more economical use of limited resources, effective control of the expenditure of funds allocated for the implementation of the production process, and the use of the system control of the production process immediately from the

start of production to its delivery consumer-screw.

Modern agriculture is in the stage of active use of digital technologies [7]. This stage of development is largely based on the use of robotics and artificial intelligence, paving the way for an autonomous decision-making system and performing operations without human intervention [13]. At the same time, modern agriculture is becoming increasingly capital intensive. Agricultural production requires high costs for the purchase of modern high-performance machinery, equipment, software. Many medium-size and small enterprises face difficulties in solving the problems of investing financial resources for the development of agricultural production on a fundamentally new technological basis. And already in the short term they will be forced to leave the industry or carry out a comprehensive modernization of production, taking into account the availability of modern production systems.

Digitalization of agriculture involves an active investment policy in terms of IT technology, consulting, as well as data processing. All this is possible on the basis of the construction of large holding companies incorporating relevant structural units, as well as free financial resources. Another aspect of digitalization should be the active participation of the state in stimulating the development and use of digital technologies in this industry. The mechanism of interaction between state structures and private business is presented in Figure 1.

One of the directions of using digital technologies in agriculture is the creation of a modern infrastructure based on the use of digital technologies. Thus, the active use of GIS-technologies in the formation of digital agriculture is promising, especially in connection with changes in climatic conditions [18], as well as the development of the GeoFarmer system in connection with its successful testing in West and East Africa, as well as in Latin America [8]. The geographic information system in agriculture is a single centralized database in which you can collect, store, process, analyze and compare any information necessary for making management decisions, including cartographic data and data on any objects placed on the corresponding maps.

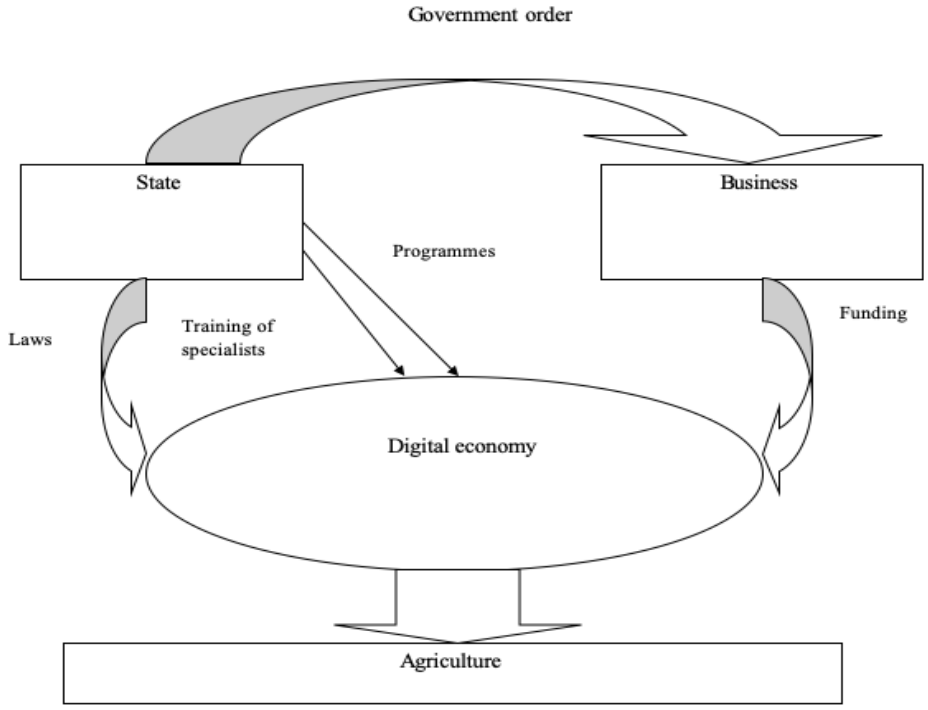

Fig. 1. The mechanism of interaction between the state and business in the process of development of the digital economy in agriculture
Source: compiled by authors.

The main advantage of this system is the ability to control the relevance of information by various methods, including from space and using unmanned aerial vehicles, the interaction of which with the global system should be automatic. This is an obvious advantage of introducing this system into agricultural management bodies, as it allows constant monitoring of the actual state of the industry and improves the quality of forecasts and recommendations on the development of business entities or individual regions as a whole.

Creating smart agriculture is a key task for the economies of many developing countries. For example, in China it has been the strategic goal of creating a new agricultural industry of the future since 2009 [20]. Russia's agriculture is also actively changing towards the development of highly intelligent agriculture, the active use of digital technologies [13]. The basis for creating smart agriculture is the ability to control all production processes, minimize costs, reduce environmental damage, improve the quality of manufactured products. The process of digitalization of production processes is most actively observed in large agricultural companies, such as RosAgro Group of Companies, EkoNiva Group of Companies, etc. Of course, the possibilities of small forms of managing using new technologies are very limited. To this end, government agencies should provide support to small farms and individual entrepreneurs engaged in modern agribusiness by providing soft loans, leasing modern equipment, and creating the appropriate infrastructure.

In the global economy, a new segment of the Internet, FoodNet, is actively developing, as one of the platforms for placing products on the Internet, which ensures the rapid promotion of products from the manufacturer to the consumer, as well as monitoring the promotion of products at all stages of the product life cycle. Active development of FoodNet allows both producers and consumers to receive additional benefits. To manufacturers in the form of increasing the speed of product sales and minimizing transaction and other costs. And the consumer to buy products at lower prices with high quality products.

Modern digital technologies significantly reduce the costs associated with logistics, which is especially important for countries with large territories. So, the growth in farm size and new branches mean that logistics is becoming even more complex [3].

In the banking sector, commercial banks are also actively developing and applying digital technologies in lending to agricultural producers of both legal entities and individuals. For example, new digital technologies are already actively used in bank lending and customer service. Leading banks, both Russian and foreign, create entire divisions whose work is aimed at the development and subsequent implementation of these technologies, as well as their further technical support. The main emphasis in the development of digital technologies in the banking sector is made on the formation of a unified identification system: using biometric technologies, the development of a digital communication system: on the basis of modern communication platforms, improving the digital transaction service and digital settlement service, as well as using a big data analytics system to build predictive and reference models and more.

Digital platforms provide agricultural producers with access to the provision and efficient use of limited financial resources. The experience of their successful application is most clearly shown in the study by C. Agyekumhene and others [1].

Modern agriculture in Russia is a high-tech industry that actively uses modern digital technologies, digital logistics systems, digital infrastructure and equipment that use GPS / GLONAS and related software. Russian companies such as LLC Infobis [19] are actively introducing online control services and accounting work in agribusiness. These services can reduce costs and reduce losses during the implementation of technological operations, significantly increase the level of profitability, simplify the management process and increase labor productivity.

The objectives of the development of the digital economy in the agricultural sector are: to increase investment in 2024 to 8.9 trillion rubles, increasing revenue from the sale of expert products for the perspective of 2025 to $ 45 billion, creating, scheduling and accumulating information resources to create end-to-end chains from agricultural production to consumption with full integration into related sectors of the digital economy [9].

The current and future indicators of the effectiveness of the development of the digital economy in domestic agriculture are shown in Figure 2.

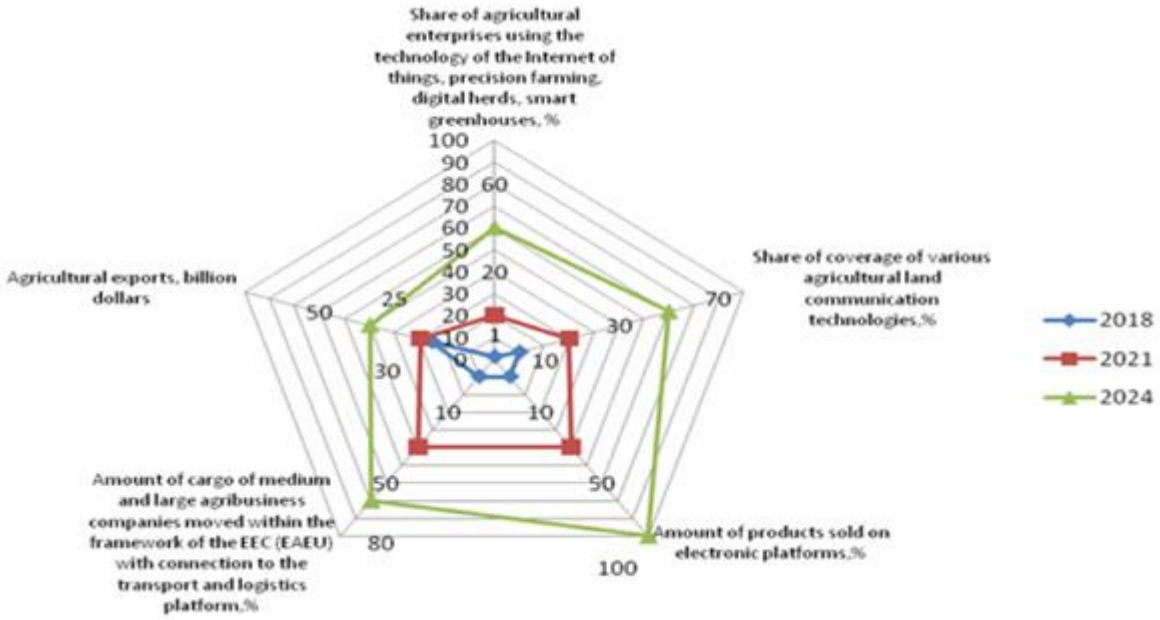

Fig. 2. Indicators of the application of the digital economy in agriculture of Russia
Source: compiled by the authors on the basis of data [9].

Regional projects of the digital economy in Russia, such as "Normative regulation of the digital environment", "Information security", "Personnel for the digital economy", "Digital public administration", "Information infrastructure", "Digital technologies" provide for financing in the amount of 0.2 billion rubles and suggest a decrease in the share of purchased and rented foreign software to 10%, an increase in the number of university graduates in IT areas, providing grant support for regional projects to introduce domestic products, services and platform solutions created on the basis of end-to-end digital technologies.

The degree of economic development significantly affects the level of agricultural development. If earlier it was believed that agriculture was the basis of the economies of developing countries [15], then with the possibility of using new technologies and the active role of large multinational companies, it becomes possible to shift emphasis in the development of highly efficient agriculture.

The development of economic thought at the present stage is mediated by a number of features caused by the progressive pace of development of social production, the introduction of information and telecommunication technologies, which has a direct impact on the formation of the categories under consideration. The mechanism of forming information flows in the digital economy of the agricultural sector is a system of interconnected and interdependent economic regulators operating on a single methodological basis.

Despite the large number of advantages in creating a digital agriculture system, some authors have expressed concern about the imperfection of the digital technologies used, their vulnerability, and the safety of

information [3]. However, successful experience in the use of digital technologies in resource conservation issues in Africa and Latin America contributes to the expansion and active use of these technologies [8].

In addition, the leading agrarian countries of the world economy are also actively developing the digital economy, which is confirmed by research by G.W. Norton and others [15] and Fan TongKe and others [20].

Professor I.S. Sandu [17] in his scientific work on digitalization of agriculture, he pays attention to the fact that Russian farmers use elements of the digital economy in limited quantities due to lack of financial resources. In his opinion, it is necessary to expand the scope of the digital economy through public investment, as well as the formation of various cooperative associations.

Professor P.I. Ogorodnikov [16] in his studies on the transition of agriculture to the digital economy emphasizes the need for more thorough training of specialists in information and communication services for agricultural production.

The study by V. Korostelev [12] pays attention to the use of digital technologies in the agricultural risk insurance system. In his opinion, it is necessary to use satellite monitoring technology in the agricultural risk insurance system. They found that accounting for remote sensing of land during examination procedures is an important step towards improving the methodology for assessing agricultural risks.

In the study, P.B. Akmarov, M.Kh. Gazetdinov, O.P. Knyazeva [2] substantiates the need for the development of information technologies in the agricultural sector of the economy, as the main factor in ensuring the country's food security and the competitiveness factor of domestic agricultural products.

Professor E.A. Bubenok [4] conducts research on the possibility of using artificial intelligence in a digital platform as a driver for the innovative development of breakthrough technologies for the development of domestic agribusiness.

According to N.V. Ukolova and N.A. Novikova [21] digitalization opens up opportunities for gaining new knowledge, broadening one's horizons, mastering new professions and advanced training. And they proposed a model: man - digital economy - knowledge - development, which is designed to become the basis of the modern model of economic development of the Russian Federation. In the study by N.I. Kuznetsov and others [14] the need to create a single information space and the application of effective information technologies in agriculture are proved.

CONCLUSIONS

In conclusion of the economic study, it is necessary to draw the following conclusions.

The development of the "digital agriculture" system will improve the efficiency of modern agriculture. It should be noted the high potential of modern digital technologies to optimize costs and improve the quality of planning, budgeting in improving the efficiency of agriculture.

The use of digital technologies in modern agriculture will contribute to the development of production of environmentally friendly products, reduce environmental pollution from agricultural production, reduce the anthropogenic impact of production on the environment, help minimize resource costs in the process of agricultural production, increase the efficiency of agricultural production, and increase competitiveness and sustainable development.

The results of digitization of agriculture will be the creation of a common information space, improving the quality and efficiency of management decision-making through the use of modern analytical methods of research, promotion of state support for domestic agricultural producers, optimum satisfaction of transforming the needs of users of information resources, increase the reliability of indicators of development of agricultural production, reduction of response time to possible threats to the sustainable development of agriculture, the further

improvement of the technical, organizational and methodological basis of effective use of information technology.

REFERENCES

[1]Agyekumhene, C., de Vries, J.R., van Paassen, A., Macnaghten, P., Schut, M., Bregt, A., 2018, Digital platforms for smallholder credit access: The mediation of trust for cooperation in maize value chain financing. NJAS - Wageningen Journal of Life Sciences, 86-87: 77-88. DOI: https://doi.org/10.1016/j.njas.2018.06.001, Accessed on 04.02.2020.

[2]Akmarov, P.B., Gazetdinov, M.Kh., Knyazeva, O.P., 2019, State and basic directions of digital economy development in agriculture of Russia. Bulletin of Kazan State Agrarian University, 14(1(52)): 107-112.

[3]Bernhardt, H., Mederle, M., Treiber, M., Worz, S., 2018, Aspects of digization in agricultural logistics in Germany. Scientific papers-series e-land reclamation earth observation & surveying environmental engineering, 7: 215-220.

[4]Bubenok, E.A., 2019, Artificial intelligence in a digital platform as a driver of innovative development of breakthrough development technologies of domestic agriculture. Bulletin of the Moscow International Higher School of Business MIRBIS, 1(17): 90-95.

[5]Decree of the Government of the Russian Federation of 08.25.2017 N 996 "On approval of the Federal scientific and technical program for the development of agriculture for 2017 - 2025". http://www.consultant.ru/document/cons_doc_LAW_223631/, Accessed on 04.02.2020.

[6]Decree of the President of the Russian Federation of 05.09.2017 No. 203 “On the Strategy for the Development of the Information Society in the Russian Federation for 2017 - 2030”.

[7]Digital Farming: what does it really mean? https://www.cema-agri.org/images/publications/position-papers/CEMA_Digital_Farming_-_Agriculture_4.0__13_02_2017_0.pdf, Accessed on 04.02.2020.

[8]Eitzinger, A., Cock, J., Atzmanstorfer, K., Binder, CR., Laderach, P., Bonilla-Findji, O., Bartling, M., Mwongera, C., Zurita, L., Jarvis, A., 2019, GeoFarmer: A monitoring and feedback system for agricultural development projects. Computers and electronics in agriculture, 158: 109-121. DOI: https://doi.org/10.1016/j.compag.2019.01.049, Accessed on 04.02.2020.

[9]Explanatory note to the proposal on the implementation of the new direction of the program “Digital Economy of the Russian Federation”. https://iotas.ru/files/documents/%D0%9F%D0%BE%D1%8F%D1%81%D0%BD%D0%B8%D1%82.%D0%B7%D0%B0%D0%BF%D0%B8%D1%81%D0%BA%D0%B0%20eAGRO%20fin%20000.pdf, Accessed on 04.02.2020.

[10]Federal Law "On Science and the State Scientific and Technical Policy" of 08.23.1996 N 127-FL. http://www.consultant.ru/document/cons_doc_LAW_11507/, Accessed on 04.02.2020.

[11]Federal Law of June 28, 2014 N 172-FL "On strategic planning in the Russian Federation". http://base.garant.ru/70684666/#ixzz4uQGu3xWG, Accessed on 04.02.2020.

[12]Korostelev, V.G., Kadomtseva, M.E., 2018, Use of digital technologies in the system of insurance of agricultural risks. Economic safety and quality, 3(32): 12-17.

[13]Korotchenya, V., 2018, Russia and agriculture 4.0. Economics of agriculture of Russia, 6: 98-103.

[14]Kuznetsov, N.I., Milovanov, A.N., Shikhanova, Yu.A., Pototskaya, L.N., Monakhov, S.V., 2019, Scientific bases of digital economic development in agriculture of Russia. Bulletin of the Saratov State Socio-Economic University, 3(77): 125-129.

[15]Norton, G.W., Alwang, J., 1993, Introduction to economics of agricultural development. Virginia Polytechnic Institute and State University, Blacksburg, VA, USA.

[16]Ogorodnikov, P.I., Klyushin, D.I., Matveeva, O.B., 2018, Interaction of innovative and digital economies - the basic factor of successful development of agriculture. Notes of the scientist, 8(33): 84-90.

[17]Sandu, I., Ryzhenkova, N., Afonina, V., Doschanova, A., 2018, Digitization as an instrument of innovative development of the agriculture. AIC: economy, management, 8: 12-18.

[18]Shen, S., Basist, A., Howard, A., 2010, Structure of a digital agriculture system and agricultural risks due to climate changes. Agriculture and Agricultural Science Procedia, 1: 42-51. DOI: https://doi.org/10.1016/j.aaspro.2010.09.006, Accessed on 04.02.2020.

[19]The official website of the company "Infobis". http://infobis.ru, Accessed on 04.02.2020.

[20]TongKe, F., 2013, Smart Agriculture Based on Cloud Computing and IOT. Journal of Convergence Information Technology (JCIT), 8(2).

[21]Ukolova, N.V., Novikova, N.A., 2019, Role of human potential in the digital economy. Bulletin of the Altai Academy of Economics and Law, 1-2: 166-173.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 1, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

DEVELOPMENT OF THE WALNUT SECTOR IN THE REPUBLIC OF MOLDOVA

Andrei ZBANCA[1], Ghenadie NEGRIUTU[1], Ludmila DOBROVOLSCHI[1], Inga GHERASIM[2]

[1]The State Agricultural University of Moldova, 44 Mircesti str, 2049, Chisinau, Republic of Moldova, Phone: +373 22 432 432, Fax: +373 22 312 276, E-mail: andzbanca@yahoo.com, ghenadie.negritu@gmail.com, liuda.dob@mail.ru.
[2]Riscani Agro-industrial College P.E., 37 Trandafirilor str. t. Riscani, d. Riscani, MD-5601, Phone: +373 256 28 701, Fax: +373 256 28 741, E-mail: colegiulriscani@gmail.com

Corresponding author: andzbanca@yahoo.com

Abstract

The development of international trade with agri-food products imposes new requirements for increasing the economic efficiency for agricultural production. Currently, there is an increased interest among the entrepreneurs oriented towards the development of the walnut sector, which offers a high profitability and, based on these considerations, it is an important source for the small farmers to increase the income in the rural localities. The purpose of the research is to analyze the current state of development of the walnut sector in the Republic of Moldova and to forecast the development prospects for the coming years.

Key words**:** *value chain, strategy, export and import of nuts, profitability, sector development*

INTRODUCTION

The modernization of the walnut production sector in the Republic of Moldova into a competitive and efficient one requires considerable investment and adequate support from the state and donors. The diversification of production and production for export in the case of the walnut sector is a potential source of income generated from bringing currency into the country and increasing profits in rural areas.
The purpose of the research consisted in systematizing the information from the walnut sector and the current state of its development in the Republic of Moldova, as well as forecasting its prospects for sustainable development for the coming years.

MATERIALS AND METHODS

The research carried out was based on the following sources of analysis: world data from the walnut industry and from the Republic of Moldova, as well as specialized literature in the field. Other sources are information collected from actors in the value chains of the walnut production trade and sectoral information of agricultural producers.
The methodology used in the analysis of the walnut sector consisted of the use of statistical and calculation data of the current and future development of the given sector elaborated by the group of authors.

RESULTS AND DISCUSSIONS

The marketing of walnuts is much more advantageous and this is explained by the fact of the increased interest in international markets and the deficit of walnut kernel. In the case of walnuts in the Republic of Moldova, the traditional export market is the EU, but it is exported stable in the east as well. The EU market will remain a core customer and continue to be, but other new markets in Asia should not be neglected, for trade diversification and for creating added value in the marketing of nuts.
The global walnut market is estimated at approx. 2.5 billion dollars, and Moldova is an important player in international trade, exporting walnuts in the value of 100-130 million dollars annually.

The walnut sector place the Republic of Moldova among the main producing states in the world. The volume of world nut production is over 2 million tons, and the trend is constantly increasing in line with the continuous increase in consumption.

Table 1. Analysis of the world production of the walnut crops. The dynamics of the production of the walnut crops worldwide, in terms of quantity (tons) and structural (%).

Specification	Years								Average per 2015-2017 / Average per 2012-2014, %	Average structure, %
	2012	2013	2014	Average per years 2012-2014	2015	2016	2017	Average per years 2015-2017		
China	720,000	780,000	900,000	800,000	1,000,000	1,060,000	1,000,000	1,020,000	127.5	48.4
United States	450,871	446,335	518,003	471,736	549,754	622,329	589,670	587,251	124.5	28.1
Chile	53,000	60,000	81,634	64,878	80,000	117,000	120,000	105,667	162.9	4.5
European Union	110,000	110,000	107,900	109,300	117,928	116,670	115,000	116,533	106.6	6.0
Ukraine	96,940	115,790	102,740	105,157	115,080	108,000	113,000	112,027	106.5	5.8
Turkey	85,000	75,000	40,000	66,667	60,000	63,000	58,000	60,333	90.5	3.4
India	36,000	43,000	35,000	38,000	33,000	32,000	35,000	33,333	87.7	1.9
Others	31,000	30,800	40,500	34,100	37,500	39,500	39,000	38,667	113.4	1.9
Total	**1,582,811**	**1,660,925**	**1,825,777**	**1,689,838**	**1,993,262**	**2,158,499**	**2,069,670**	**2,073,810**	**122.7**	**100.0**

Source: Foreign Agricultural Service/USDA.

The volume of production in the period 2015-2017 increased by 22.7% compared to the period of 2012-2014, which shows a rapid growth. In the structure of walnut production, worldwide, China is the country with the highest share - 48.4%, followed by the United States with 28.1%.

Other important countries in the field of walnut production are the European Union (6%), Ukraine (5.8%) and Chile (4.5%). The volume of world walnut consumption is over 2.06 million tons, and the trend is steadily increasing in consumption, as this product is accepted as a healthy and beneficial food.

Table 2. Progress of consumption of walnut production worldwide, tons

Specification	Years								Average per 2015-2017 / Average per 2012-2014, %	Average structure, %
	2012	2013	2014	Average per years 2012-2014	2015	2016	2017	Average per years 2015-2017		
China	812,200	854,300	956,400	874,300	1,075,200	1,089,600	1,050,000	1,071,600	122.6	52.3
European Union	230,200	262,100	278,500	256,933	310,228	355,670	360,000	341,966	133.1	16.1
Turkey	117,500	115,100	101,100	111,233	142,500	159,200	163,000	154,900	139.3	7.2
United States	154,266	154,922	140,532	149,907	134,543	190,778	150,451	158,591	105.8	8.3
India	24,900	26,400	32,700	28,000	43,400	46,200	54,000	47,867	171.0	2.0
Japan	27,700	29,000	38,000	31,567	40,400	46,000	50,000	45,467	144.0	2.1
Ukraine	38,940	40,590	43,140	40,890	39,380	51,600	38,100	43,027	105.2	2.3
South Korea	28,200	29,100	33,900	30,400	30,500	32,100	35,000	32,533	107.0	1.7
Saudi Arabia	8,100	17,100	14,300	13,167	15,100	32,600	30,000	25,900	196.7	1.1
Canada	20,700	22,200	17,900	20,267	24,000	25,300	26,500	25,267	124.7	1.2
Others	106,700	107,800	102,941	105,814	116,050	100,068	108,050	108,056	102.1	5.8
Total	**1,569,406**	**1,658,612**	**1,759,413**	**1,662,477**	**1,971,301**	**2,129,116**	**2,065,101**	**2,055,173**	**123.6**	**100.0**

Source: Foreign Agricultural Service/USDA.

In the structure of world walnut consumption, China is the country with the highest consumption - 52.3%, followed by the European Union with 16.1%. Other important countries in the consumption of walnuts are the United States of America (8.3%) and Turkey (7.2%).

The volume of world export during the period 2015-2017 increased by 31% compared to the period 2012-2014, indicating the increased interest in this production. In the structure of the world walnut export the United States of America is the country with the largest export 62.6%, followed by Chile with 13.1%. Other important countries in the field of walnut export are Ukraine (10.6%) and Moldova (5%).

The volume of world walnut imports amounts to about 700 thousand tons, and the trend is growing at a rather rapid rate.

In the structure of the world walnut import, the European Union is with the highest weight - 33.5%, followed by China with 12.9%.

Table 3. Dynamics of world export of walnut production for 2012-2017 (tons)

Specification	Years								Average per 2015-2017 / Average per 2012-2014, %	Average structure, %
	2012	2013	2014	Average per years 2012-2014	2015	2016	2017	Average per years 2015-2017		
United States	310,329	313,471	364,101	329,300	445,781	460,101	475,000	460,294	139.8	62.6
Chile	50,500	57,400	76,800	61,567	78,500	115,000	118,000	103,833	168.7	13.1
Ukraine	58,000	75,200	59,600	64,267	75,800	56,100	75,000	68,967	107.3	10.6
Moldova	25,100	27,100	36,800	29,667	34,100	34,000	34,000	34,033	114.7	5.0
China	16,100	16,700	14,500	15,767	8,300	19,000	20,000	15,767	100.0	2.5
European Union	15,000	24,700	16,500	18,733	18,300	13,500	15,000	15,600	83.3	2.7
Turkey	9,600	12,000	8,000	9,867	6,500	7,600	8,000	7,367	74.7	1.4
Others	18,700	19,200	13,600	17,167	11,300	9,000	9,500	9,933	57.9	2.1
Total	**503,329**	**545,771**	**589,901**	**546,334**	**678,581**	**714,301**	**754,500**	**715,794**	**131.0**	**100.0**

Source: Foreign Agricultural Service/USDA

Table 4. Dynamics of the import of walnut production worldwide, tons

Specification	Years								Average per 2015-2017 / Average per 2012-2014, %	Average structure, %
	2012	2013	2014	Average per years 2012-2014	2015	2016	2017	Average per years 2015-2017		
European Union	140,200	171,800	187,100	166,367	215,600	252,500	260,000	242,700	145.9	33.5
Turkey	42,100	52,100	68,100	54,100	90,500	105,100	110,000	101,867	188.3	12.8
China	108,300	91,000	70,900	90,067	83,500	48,600	70,000	67,367	74.8	12.9
Japan	27,700	29,000	38,000	31,567	40,400	46,000	50,000	45,467	144.0	6.3
South Korea	28,200	29,100	33,900	30,400	30,500	32,100	35,000	32,533	107.0	5.2
India	200	600	10,400	3,733	14,300	23,200	30,000	22,500	602.7	2.2
Saudi Arabia	8,100	17,100	14,300	13,167	15,100	32,600	30,000	25,900	196.7	3.2
Canada	20,800	22,600	22,600	22,000	24,500	25,800	27,000	25,767	117.1	3.9
Iraq	11,200	13,700	11,900	12,267	19,500	19,100	20,000	19,533	159.2	2.6
United States	10,885	15,417	27,402	17,901	13,931	20,210	20,000	18,047	100.8	2.9
Israel	9,600	9,600	10,700	9,967	13,000	13,400	14,000	13,467	135.1	1.9
Australia	10,600	12,200	12,400	11,733	11,200	11,600	13,000	11,933	101.7	1.9
Mexico	7,400	6,300	9,600	7,767	13,800	9,200	10,000	11,000	141.6	1.5
Brazil	8,000	8,300	7,100	7,800	8,200	9,000	9,500	8,900	114.1	1.4
Taiwan	7,300	6,400	8,300	7,333	8,900	8,000	9,000	8,633	117.7	1.3
Others	51,000	49,100	38,500	46,200	39,800	25,925	29,550	31,758	68.7	6.4
Total	**491,585**	**534,317**	**571,202**	**532,368**	**642,731**	**682,335**	**737,050**	**687,372**	**129.1**	**100.0**

Source: Foreign Agricultural Service/USDA.

Other important countries in the import of walnuts are Turkey (12.8%) and Japan (6.3%). The volume of walnut imports during the period 2015-2017 increased by 29.1%, compared to the period 2012-2014.

Under the conditions of the market economy, agricultural entrepreneurs must analyze in detail the procedure of starting the business in order to determine correctly the way of implementing the business and the volume of investments.

For the players in the value chain of the walnut sector, it is important, if the selected technology allows ensuring **quality, productivity and competitive price.** Only the quality and high productivity of the walnut crops at a surface unit will allow us to compete and enter the production in the strategic markets for marketing walnuts.

An important aspect when planting walnut orchards - we need to know the development of the walnut sector in the republic for the last years, and this dynamic analysis is presented in Table 5.

The analysis of the dynamics of the development of the walnut production sector in the Republic of Moldova allows us to state that in the last years,2014-2018, the growth rates are fast, due to the fact that the area has doubled (yielding orchards has increased

considerably) and respectively the volume of production has increased by 73 %, which is motivated by the increased interest and existence of the marketplace (Table 6).

Table 5. Dynamics of the development of the walnut production sector in the Republic of Moldova, 2010-2018

Specification Indicators	MU	Years										Growth 2019/ 2010, %
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Fruit orchards, nuts and fruit shrubs - total												
Surface - total	mii ha	116.30	119.20	119.80	122.50	122.30	135.56	134.53	135.47	139.50	140.13	120.5
Surface yielding	mii ha	94.20	94.20	95.00	90.20	89.90	110.36	110.12	113.00	114.70	114.21	121.2
Production volume	**mii tone**	**322.34**	**379.10**	**380.40**	**419.50**	**497.30**	**485.48**	**595.69**	**667.20**	**850.20**	**805.87**	**250.0**
Average harvest	t/ha	3.42	4.02	4.00	4.65	5.53	4.40	5.41	5.72	7.41	7.06	206.2
Nut crops												
Surface - total	mii ha	9.40	11.30	12.30	14.00	24.20	25.22	27.19	29.00	30.80	31.20	331.9
Surface yielding	mii ha	4.10	4.60	5.00	6.10	14.30	15.01	15.76	17.70	18.90	19.50	475.6
Production volume	**mii tone**	**11.58**	**14.00**	**9.10**	**12.50**	**13.10**	**11.04**	**13.83**	**18.50**	**20.20**	**20.00**	**172.7**
Average harvest	t/ha	2.79	2.99	1.77	2.06	0.88	0.70	0.84	0.94	0.96	1.03	36.8

Source: National Bureau of Statistics.

Table 6. Dynamics of planting new surfaces with walnuts in the Republic of Moldova, 2013-2019, (ha)

Years	Walnuts	Hazelnut	Almond	Total	Structure, %
2013	530.9	-	42.5	573.3	7.8
2014	1,042.0	85.7	8.0	1,135.7	15.4
2015	940.0	75.0	24.0	1,039.0	14.1
2016	1,193.0	104.0	17.0	1,314.0	17.8
2017	689.0	200.0	36.0	925.0	12.5
2018	705.5	144.0	31.5	880.9	11.9
2019	1,148.0	331.8	32.3	1,512.1	20.5
Total, ha	**6,248.3**	**940.5**	**191.2**	**7,380.0**	**100.0**
Structure, %	**84.7**	**12.7**	**2.6**	**100.0**	

Source: Agency for Intervention and Payments for Agriculture.

On average, annually, over 700-1,000 hectares of nuts are planted in the Republic of Moldova (the largest areas of orchards are planted with walnuts crops), which is suitable for the sustainable development of the sector and to satisfy the international demand, which is always growing.

Important for entrepreneurs who intend to plant nut orchards, it is that they have to find clear answers to the following questions (nobody can offer practical solutions, and to wait when the orchards will come into fruition - the period is extremely high and the investments are the same):

(1)What is the correct and efficient planting scheme for different areas and different kinds of walnuts:

(2)What is the need for pollination in orchards and how many percentages (to be compatible and to coincide in time);

(3)Irrigation is required or not, as it is an important factor in ensuring the expected harvest;

(4)What are the risks of frosts in winter and loss of harvest caused by late spring frosts;

(5)How can we ensure quality when growing walnuts, when we have rains that affect the quality and color of the kernel in autumn.

Sectoral recommendations for the sustainable development of the walnut sector in the Republic of Moldova:

(a)Selection and experimental establishment of pollinators for basic varieties in commercial orchards (pollinator occupying no more than 5% of trees) are indispensable.

(b)In the genetic improvement programs, as well as the temporary introduction and testing of valuable varieties from other cultivation areas, similar to the agro climatic ones in our country, genotypes with a long biological resting period, overlapping flowering periods with the local assortment are recommended, a high potential for fruiting both from the terminal and lateral buds, especially from the type of protandric flowering.

(c)Given the local traditions of domestic spread and cultivation, etc., the walnut, with the presence of a large biodiversity (based on the secular propagation by seeds), remains an important crop, from a strategic point of view, for ensuring the organic production system.

Every year, in the Republic of Moldova, 3-4 thousand tons of walnuts are imported, that is 11.4% of the total quantity of imported fruits. These are subsequently shelled and sold on the domestic market or redirected for export. Walnuts imported from France are peeled in Moldova, because labor is much cheaper and then exported to France unpeeled.

Table 7. Trade balance in the walnut trade of the Republic of Moldova (years 2005-2018, USD)

Specification	Years			Structure, % (average in 2005-2015)	Years			Structure, % (average in 2016-2018)	Deviations, % (average in 2016-2018/ average in 2005-2015)
	2005	2010	2015		2016	2017	2018		
Import of walnut production									
Fruits and nuts	17,686,868	58,020,725	74,601,482	56.1	47,390,259	54,258,784	69,328,265	51.6	113.8
walnuts	4,799,232	6,446,764	14,102,841	9.5	10,717,628	13,541,430	20,417,092	13.5	176.2
Total	**40,005,894**	**110,918,081**	**116,952,913**	**100.0**	**94,278,996**	**108,795,637**	**127,985,782**	**100.0**	**123.6**
Export of walnut production									
Fruits and nuts	60,977,459	167,624,748	194,658,725	71.2	155,823,843	221,584,638	196,429,637	76.6	135.6
walnuts	30,740,819	59,835,863	101,078,273	32.2	85,462,964	98,640,218	96,329,091	37.4	146.3
Total	**112,308,102**	**228,666,507**	**253,724,834**	**100.0**	**205,448,220**	**300,301,020**	**243,801,425**	**100.0**	**126.0**
Trade balance walnut production (export-import difference)									
Fruits and nuts	43,290,591	109,604,023	120,057,243	83.5	108,433,584	167,325,854	127,101,372	96.3	147.6
walnuts	25,941,587	53,389,099	86,975,432	50.9	74,745,336	85,098,788	75,911,999	56.3	141.8
Total	**72,302,208**	**117,748,426**	**136,771,921**	**100.0**	**111,169,224**	**191,505,383**	**115,815,643**	**100.0**	**128.0**

Source: National Bureau of Statistics.

The evolution of the volume of the import-export of the walnut production of the Republic of Moldova, in quantitative aspect, is presented in Table 8.

Table 8. Dynamics of the import-export of the walnut production of the Republic of Moldova, (years 2005-2018, kg)

Specification	Years			Average per 2005-2015	Years			Average per 2016-2018	Deviations, % (average in 2016-2018 / average in 2005-2015)
	2005	2010	2015		2016	2017	2018		
Import									
Fruits and nuts									
walnuts	5,373,848	3,974,008	4,606,879	4,651,578	4,692,842	5,058,885	6,707,482	5,486,403	117.9
Export									
Fruits and nuts									
walnuts	10,486,203	9,822,015	15,104,114	11,804,111	15,796,558	15,265,929	14,263,359	15,108,615	128.0

Source**:** National Bureau of Statistics.

So, we noticed, that during the period 2016-2018 as compared to the period 2005-2015, the import of walnuts, in quantitative expression, increased by 17.9%, and the export of walnuts - by 28%. The predominance of the export, on the import of walnuts, is an appreciable thing for our country.

The main countries where walnuts are exported from the Republic of Moldova are EU countries (France, Germany, Poland, Romania), Turkey. These markets require both shell walnuts and kernels.

Export markets for horticultural production require qualitative diversification (including in the case of walnut production). The traders continue to explore traditional markets without making any effort to diversify and increase the value of exports to new, more advantageous and strategic markets.

The analysis of the export shows us a diversified market for walnuts (dominated by the European Union, but without great difficulties to be oriented to other markets, because there is demand and the consumption is developing).

Table 9. Structure of the export of walnuts of the Republic of Moldova on the top markets, period 2017-2018

Product specification	Year	Top market 1	Top market 2	Top market 3	Top market 4	Top market 5	Observation
Walnuts	**2017**	France (61.9%)	Germany (27%)	Turkey (7.8%)	Romania (2.3%)	Poland (1%)	Diversified
	2018	France (26%)	Germany (20.9%)	Austria (11.7%)	Holland (10.9%)	Other countries (30.6%)	Diversified

Source: National Bureau of Statistics.

The policy of the purchase prices of the walnut production is influenced by the intermediaries and exporters, who actually export in a relatively small number and can influence the collection prices - acquisition, which was in average 50 lei / kg of peeled walnuts. (walnut kernel) for 2018, and in 2019 the purchase price adjusted and makes 60-95 lei / kg depending on the quality of the kernel.

Table 10. Size and dynamics of the export price of walnuts from the Republic of Moldova and the import price for the countries where we export walnuts

Specification	Year		
	2016	2017	2018
Analysis of the export of walnuts from the Republic of Moldova			
Quantity of walnuts exported, t	15,797	15,266	14,400
Value of exports, USD	85,463	98,640	95,631
Average export price, USD/kg	**5.41**	**6.46**	**6.64**
Analysis of Germany's import of walnuts (country with high import of walnuts from the Republic of Moldova**)**			
Germany - imported quantity, t	232,964	268,878	272,430
Germany - value of the import, thousands of USD	1,954,834	2,010,571	2,115,021
Germany - average import price, USD/kg	**8.39**	**7.48**	**7.76**
Analysis of the import of walnuts of France (country with high import of walnuts from Moldova)			
France - imported quantity, t	92,970	99,841	98,248
France - value of the import, thousands of USD	756,565	733,968	735,890
France - average import price, USD/kg	**8.14**	**7.35**	**7.49**

Source: National Bureau of Statistics.

In the following table, you may find the analysis of the value chain for domestic walnuts for different clusters, depending on the current sales on markets and the potential for future export.

Table 11. Analysis of value chain and value added for walnuts in the Republic of Moldova, 2018

Specification	Value chain when marketing walnuts on regional markets					
	East		EU		Moldova	
	Euro/kg	Share, %	Euro/kg	Share, %	Euro/kg	Share, %
Final supermarket price	**13.351**	**100.0**	**13.968**	**100.0**	**8.969**	**100.0**
Commercial margin supermarket	6.215	46.6	6.574	47.1	3.567	39.8
Cost and export logistics	0.921	6.9	0.819	5.9		
Final export price or local market entry	**5.294**	**39.7**	**5.755**	**41.2**	**5.351**	**59.7**
Commercial margin intermediaries	2.730	20.4	3.191	22.8	2.786	31.1
VAT refund	**0.424**		**0.460**			
Price of walnuts to the producer with VAT	2.564	19.2	2.564	18.4	2.564	28.6

Source: Analysis developed by the group of authors.

The marketing of walnuts is much more advantageous and this is explained by the fact of the increased interest on international markets and the deficit of walnut kernel. In the case of walnuts, the traditional export market is the EU, but it is also a stable export to the East.

The EU market will remain a core customer and will continue to be, but other new markets in Asia should not be neglected, for trade diversification and for creating added value in the marketing of walnuts.

The forecast for the development of the walnut sector of the Republic of Moldova indicates a positive trend of increasing the volume of the production of walnuts, given the modernization / application of modern technologies of production and the increase of

the productivity of the sector at a surface unit. *The nut crop* is experiencing a rapid development, stemming from the trends on the world market, and the surface of the plantations of nut crops is growing rapidly and by 2026 will make approx. 38.5 thousand hectares (including 26.27 ha fruiting, or 34.7% higher than in 2019). The production of walnuts faces a higher demand and the annual consumption is increasing. In the period 2014-2018, in the Republic of Moldova, considerable areas of nut crops were planted (annually about one thousand hectares), which will be conditioning the growth of walnut production by 82.3% (16.5 thousand tons) by 2026, compared to 2019.

Table 12. Forecast for the development of the walnut sector in the Republic of Moldova, period 2020-2026

Specification	Years						
	2020	2021	2022	2023	2024	2025	2026
Total surface with nut crops, thousands ha	**32.15**	**33.14**	**34.15**	**35.20**	**36.28**	**37.39**	**38.54**
Surface on fruiting, thousands ha	**20.05**	**21.17**	**22.19**	**23.48**	**24.39**	**25.31**	**26.27**
The global crop of nuts, thousands tons	**22.76**	**24.90**	**26.95**	**29.60**	**31.71**	**34.06**	**36.46**
Productivity of nut crops, tons/ha	**1.14**	**1.18**	**1.21**	**1.26**	**1.30**	**1.35**	**1.39**
Surface harvested mature plantations, thousands t	18.61	18.59	18.57	18.55	18.53	18.51	18.49
Average harvest of mature plantations, t / ha	1.12	1.15	1.18	1.21	1.24	1.27	1.30
Production volume in orchards, thousands t	20.88	21.42	21.88	22.44	22.93	23.52	24.02
Surface harvested new plantations, thousands t	1.44	2.58	3.62	4.93	5.86	6.80	7.78
The average crop of new plantations, t/ha	1.30	1.35	1.40	1.45	1.50	1.55	1.60
Production volume in new orchards, thousands t	1.88	3.48	5.07	7.15	8.79	10.54	12.44
Establishment of new orchards, thousands ha	1.00	1.04	1.07	1.10	1.13	1.17	1.20
Deforestation of old orchards, thousands of hectares	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Balance of planting orchards	0.98	1.02	1.05	1.08	1.11	1.15	1.18

Source: Forecast developed by the group of authors [1, 2, 3].

At the same time, the hazelnut is requested on the markets, and the Republic of Moldova has the necessary conditions for its cultivation and it is necessary to diversify the production in case of ensuring all the factors necessary for cultivation. The forecast of the investments necessary for the modernization of the infrastructure of the nut sector for the years 2020-2026 foresees an estimated need of 2,330.4 million lei, of which 913.5 million lei will make the subsidies to compensate a part of the investments. The harmonious development of the nut sector, in the Republic of Moldova, for the period 2020-2026 also refers to the modernization of the production technologies and the progression of the applied researches in order to increase the efficiency of the cultivation of the nut crops.

Table 13. Forecast of the development of the walnut sector through investments, period 2020-2026

Specification	Years							Total	Average per year
	2020	2021	2022	2023	2024	2025	2026		
Establishment of walnuts plantations, ha	1,004.3	1,035.2	1,066.9	1,099.5	1,133.0	1,167.5	1,203.0	7,709.4	1,101.35
Need for investments in multi-annual plantations, mln. MDL	135.3	139.4	143.7	148.1	152.6	157.3	162.0	1,038.4	148.34
Subsidizing investments in multi-annual plantations, mln. MDL	30.77	31.72	32.69	33.69	34.72	35.77	36.86	236.22	33.75
Capacity needed to modernize, thousands tons	0.92	0.95	0.97	1.00	1.03	1.06	1.09	7.01	1.00
Capacity needed to modernize, mln. MDL	4.49	4.61	4.74	4.87	5.01	5.15	5.30	34.17	4.88
Subsidizing investments in packinghouses, mln. MDL	1.12	1.15	1.18	1.22	1.25	1.29	1.33	8.54	1.22
Total value of investments in the walnut subsector, mln. MDL	**139.8**	**144.0**	**148.4**	**153.0**	**157.6**	**162.4**	**167.3**	**1,072.5**	**153.2**
Subsidizing investments in the walnut subsector, mln. MDL	**31.9**	**32.9**	**33.9**	**34.9**	**36.0**	**37.1**	**38.2**	**244.8**	**35.0**

Source: Forecast developed by the group of authors [4].

For the sustainable development of the walnut sector for the years 2020-2026, an estimated 1.072.5 million lei are needed, of which 244.8 million lei will make subsidies to compensate a part of the investments.

The impact of the sector development shows a high economic effect, because at a leu invested in the walnut sector of the republic, it is possible to get an additional 15.26 lei, and in the case of subsidies - 66.89 lei can be generated additionally.

Practical recommendations for improving the development of the walnut sector of the Republic of Moldova:

(1)The integrated business with nuts demonstrates the performance of the producers only through professional association and commercial cooperation;

(2)The state, together with the donors, intermediaries and producers of nut crops, will develop and implement a program of measures designed to create favorable conditions for cooperatives in marketing groups, which includes some fiscal facilities, an institutional and economic support framework. especially in the first 5-10 years of activity;
(3)The association of farmers in professional associations must provide an adequate information circuit to the producers and provide operational information on the real situation in the area and regional markets;
(4)Quality standards become a critical necessity in the context of general traceability requirements. Organic certification offers opportunities for marketing at favorable prices and provides opportunities for marketing on the European market;
(5)For the efficient and sustainable development of the walnut sector in the Republic of Moldova it is necessary to introduce intensive technologies for their cultivation;
(6)Walnuts producers recognize the importance of standards and intend to implement HACCP and GlobalGAP in the near future. According to them, quality standards are becoming a critical necessity in the context of general traceability requirements, which concern not only the demanding EU markets, but also the top segment of the CIS markets. The state must include these activities in national support and grant programs.

Table 14. Estimation of the impact for the walnut crops in the Republic of Moldova, period 2020-2026

Specification	Years							Total	Average per year
	2020	2021	2022	2023	2024	2025	2026		
Payroll fund for manual operations for walnut production, mln. MDL	**520.6**	**536.5**	**555.7**	**572.7**	**593.2**	**611.4**	**630.2**	**4,020**	**574.3**
Gross profit from walnut marketing - total, mln. MDL	**1,854**	**1,981**	**2,158**	**2,331**	**2,515**	**2,668**	**2,863**	**16,371**	**2,339**
trade on local market	263.7	268.9	275.7	281.2	288.2	294.0	299.9	**1,971**	**281.6**
trade on export	1,432.5	1,550.3	1,715.8	1,878.2	2,050.0	2,191.1	2,375.2	**13,193**	**1,884.7**
processing	157.4	162.2	167.0	172.0	177.2	182.5	188.0	**1,206**	**172.3**
Value of walnut exports, mln. USD	**123.8**	**136.8**	**150.3**	**167.5**	**183.1**	**200.5**	**219.0**	**1,177**	**168.2**
Profit generated from an investment leu	13.26	13.76	14.54	15.24	15.96	16.43	17.11	15.26	15.26
Profit generated from a leu of subsidies, lei	58.12	60.28	63.72	66.79	69.93	71.98	74.97	66.89	66.89

Source**:** Forecast developed by the group of authors [4].

CONCLUSIONS

The nut cultivation sector in the Republic of Moldova has been developing dynamically over the last ten years, and this trend allows one to conclude that the future of this sector is promising.
The development of value chains for the walnut sector is important through only with the condition of continuous improvement of the technology, post-harvest infrastructure and economic association / cooperation of the producer's nuts for creating benefit to the sector's production and ensuring the sustainable development of the walnut business.

REFERENCES

[1]Zbanca, A., 2014, Developing of generic budgets for businesses in high-value farming. Informative guide, Agricultural Competitiveness and Enterprise Development Project (ACED), Contract: AID-117-C-11-00001, Chisinau 2013-2014.
[2]Zbanca, A., Stratan, A., Morei, V., Litvin, A., 2009, Guide on economic argumentation of the agricultural activities of the Republic of Moldova (vegetal sector), Bons Offices Publishing House, Chisinau, 216 pag.
[3]Zbanca, A., Panuta, S., Fala, Iu., Stratan, A., Morei, V., Litvin, A., 2017, Budgeting of activities in the vegetal sector of the Republic of Moldova, Bons Offices Publishing House, Chisinau, 250 pag.
[4]Zbanca, A., Crigan, A., Pesteanu, A., Nicoleaescu, Gh., National Programme for Horticulture Development in Republic of Moldova for 2020-2026 years, Ministry of Agriculture, Regional Development and Environment.