UDC 338.43:63

ISSN 0352-3462

ЕКОНОМИКА ПОЉОПРИВРЕДЕ
ECONOMICS OF AGRICULTURE

Vol.LXXI, №2 (353-720), 2024

BELGRADE

UDC 338.43:63

ISSN 0352-3462

ЕКОНОМИКА ПОЉОПРИВРЕДЕ
ECONOMICS OF AGRICULTURE

Journal is indexed and abstracted in Emerging Sources Citation Index.

71.

Према категоризацији научних часописа, у Листи домаћих часописа за 2023. годину, Табела 25. КАТЕГОРИЗАЦИЈА ДОМАЋИХ НАУЧНИХ ЧАСОПИСА ЗА ЕКОНОМИЈУ И ОРГАНИЗАЦИОНЕ НАУКЕ,
"Економика пољопривреде"
је сврстана у категорију **М 23 - Међународни часопис"**
https://nitra.gov.rs/cir/nauka/kategorizacija-naucnih-casopisa

Београд, април - јун 2024. године
Belgrade, April - June, 2024

Часопис
◊ ЕКОНОМИКА ПОЉОПРИВРЕДЕ ◊

Journal
◊ ECONOMICS OF AGRICULTURE ◊

Основан 1954. године / Established 1954

<u>ИЗДАВАЧИ / PUBLISHERS</u>

Научно друштво аграрних економиста Балкана, Београд
The Balkan Scientific Association of Agrarian Economists, Belgrade

Институт за економику пољопривреде, Београд (Србија)
Institute of Agricultural Economics, Belgrade, (Serbia)

Академија економских наука, Букурешт (Румунија)
Academy of Economic Studies, Bucharest (Romania)

Национални институт за економска истраживања „Costin C. Kiritescu“ – Румунска академија, Букурешт (Румунија)
National Institute for Economic Research “Costin C. Kiritescu” - Romanian Academy, Bucharest (Romania)

Адреса уредништва / Editorial office

Београд, Волгина 15; тел/факс (+381)11/6972-848; E-mail: economicsofagriculture@ea.bg.ac.rs
Belgrade, Volgina 15; phone/fax (+381)11/6972-858; E-mail: epoljoprivrede@gmail.com

http://ea.bg.ac.rs

UDC 338.43:63 **ISSN 0352-3462**

ECONOMICS OF AGRICULTURE

CONTENT

1. Marko Janaćković, Ognjen Dimitrijević
RESEARCH ON THE ATTITUDE OF YOUNG PEOPLE REGARDING THE ATTRACTIVENESS OF AGRICULTURE: A CASE STUDY OF SERBIA 365

2. Milena Stojić, Biljana Pejović, Vojkan Bižić
CORRELATION BETWEEN SOLVENCY OF SERBIAN AGRICULTURAL SECTOR AND INVESTMENTS IN ENVIRONMENTAL RESPONSIBILITIES 381

3. Marija Koprivica, Jelena Kočović, Drago Cvijanović
A MODEL FOR DETERMINING PREMIUM RATES IN INDEX-BASED CROP INSURANCE 397

4. Vesna Gantner, Franjo Poljak, Tina Bobić, Ranko Gantner, Zvonimir Steiner, Klemen Potočnik
THE OCCURRENCE, PERSISTENCE, AND COSTS OF ACIDOSIS-RELATED ISSUES IN DAIRY COWS CONCERNING PARITY 413

5. Miloš Krstić
AGRICULTURE AND GREENHOUSE GAS EMISSION – RESULTS OF ECONOMETRIC ANALYSIS 427

6. Nada Kosanović, Mirjana Bartula, Mihajlo Karna, Slobodan Nićin
THE IMPORTANCE OF RURAL TOURISM DEVELOPMENT IN THE SREM DISTRICT 443

7. Jelena Ignjatović, Milan Blagojević, Marija Bajagić, Vera Rašković
IMPROVEMENT OF SUSTAINABLE ENVIRONMENTAL AND ECONOMIC COMPETENCES USING THE E-ACADEMY FOR THE DEVELOPMENT OF RURAL AREAS 453

8. Bogdan Jocić, Dragan Milić, Vladislav Zekić, Dragana Novaković, Tihomir Novaković, Zoran Ilić
ANALYSIS OF THE POSSIBILITY OF BANKRUPTCY IN MEDIUM-SIZED AGRIBUSINESS COMPANIES IN AP VOJVODINA 469

9. Mirela Tomaš Simin, Danica Glavaš-Trbić, Dragan Milić, Dejan Janković
HUMAN CAPITAL AS A DEVELOPMENT FACTOR OF ORGANIC AGRICULTURE IN THE REPUBLIC OF SERBIA. 485

10. Žaklina Stojanović, EmilijaManić, Irena Janković
FORMAL VS INFORMAL CONTRACTS (NETWORKS) AND SUSTAINABILITY OF RASPBERRY FARMS IN WEST SERBIA – AN EXPLORATORY RESEARCH 503

11. Stevan Tomašević, Mirela Momčilović, Nada Milenković, Dragana Milić
DETERMINANTS OF PROFITABILITY OF FOOD ENTERPRISES FROM THE TERRITORY OF THE REPUBLIC OF SERBIA 519

12. Vasili Vasilije Ostojić, Riste Elenov, Zorica Sredojević
COMPARING THE ECONOMIC EFFECTS OF OPEN FIELD AND PROTECTED AREA ORGANIC TOMATO CULTIVATION SYSTEMS 535

13. Aleksandar Radivojević, Rastko Marković, Ksenija Marković, Ana Langović, Miloš Marjanović, Filip Stojilković, Ivan Filipovic, Tin Lukić
UNLOCKING POTENTIAL: GEOGRAPHICAL BRANDING AS A POSSIBLE FACTOR OF REVITALIZATION OF SERBIAN VILLAGES – A CASE STUDY OF THE VISOK MICROREGION 551

14. Milica Marčeta, Ljiljana Keča, Sreten Jelić
ECONOMIC ASPECTS OF THE USE OF FORESTRY PRODUCTS FOR COMMERCIAL PURPOSES 569

15. Sonja Lazarević, Tanja Stanišić, Raluca Andreea Ion
SLOW TOURISM AS A CONTEMPORARY TENDENCY IN THE TOURISM MARKET: IMAGE CONTENT AND GEOTAG ANALYSIS ON INSTAGRAM 589

16. Dejan Dašić, Biljana Vitković, Marija Ilievska Kostadinović, Gruja Kostadinović, Milijanka Ratković
PLACE AND ROLE OF MARKETING COMMUNICATION IN RURAL AREAS IN CENTRAL SERBIA 599

17. Đorđe Kotarac, Simo Stevanović
INFLUENCE OF PRODUCTION OF PRIMARY PRODUCTS ON THE RATE OF INFLATION IN THE REPUBLIC OF SERBIA 613

18. Mersida Jandrić, Grujica Vico, Željko Savić
OPTIMIZATION OF MILK PROCESSING PROCESSES AND ANALYSIS OF OBTAINED SOLUTIONS 627

19. Miroslav Nedeljković, Radomir Jovanović, Goran Maksimović
SELECTION OF MARKETING COMMUNICATION CHANNELS IN AGRIBUSINESS 639

20. Lidija Madžar, Jasmina Stojiljković, Janko Todorov
EMPIRICAL EVALUATION OF SUSTAINABLE AGRICULTURAL MANAGEMENT IN SOUTHEAST EUROPEAN COUNTRIES USING PANEL DATA ANALYSIS 653

21. Ivan Milojević, Dalibor Krstić, Ivan Božović, Dragan Bataveljić
APPLICATION OF A DEFINITE INTEGRAL CALCULUS IN RENT CALCULATION 667

22. Milan Mihajlović, Milan Milunović, Uroš Ćeramilac
ECONOMIC ANALYSIS OF THE ROLE OF AGRICULTURAL PRODUCTION IN MEETING THE DEFENSE NEEDS OF THE REPUBLIC OF SERBIA 679

23. Leposava Zečević, Olgica Zečević Stanojević, Dragan Nedeljković
ETHNO EVENT IN THE FUNCTION OF DEVELOPMENT OF RURAL TOURIST DESTINATIONS: CASE STUDY “COUNTRY WEDDING“ AT GOSTOLJUBLJE 697

RESEARCH ON THE ATTITUDE OF YOUNG PEOPLE REGARDING THE ATTRACTIVENESS OF AGRICULTURE: A CASE STUDY OF SERBIA

Marko Janaćković[1], Ognjen Dimitrijević[2]

**Corresponding author E-mail: janackovic.marko@gmail.com*

ARTICLE INFO

Original Article

Received: *30 November 2023*

Accepted: *10 February 2024*

doi:10.59267/ekoPolj2402365J

UDC 316.644-053.6:631(497.11)

Keywords:

youth, agriculture, logistic regression, stereotypes

JEL: *Q19, M20*

ABSTRACT

Agriculture plays a crucial role in any economy. However, agricultural work is often regarded as unpopular, dirty and lacking prestige. As a consequence, young people frequently migrate from rural to urban areas in search of alternative activities. This study addresses the challenge of integrating youth into the agricultural workforce. The objective is to assess the reasons behind youth's (un) willingness to engage in agricultural work, using Serbia as a case study. Data were collected through a questionnaire and 308 responses were analyzed with the help of Binary Logistic Regression. The findings indicate that the attitude of young individuals to engage in agricultural work is significantly shaped by area of residence, family involvement, ownership of rural property, the economic viability of the agricultural sector and concerns about long-term employment stability. A few positive and negative stereotypes were also identified. The findings underscore the imperative to attract young people to work in agriculture.

Introduction

The present circumstances give rise to numerous questions about the survival of humans globally. Ensuring an adequate food supply has become imperative due to the ever-growing human population. The agricultural sector is of paramount importance as it facilitates food production, significantly alleviating the widespread issues of hunger and poverty. Many countries, as part of their national economic policies, consider agriculture a cornerstone for their future development (Milić et al., 2023). It profoundly impacts the macroeconomic indicators of each country, particularly the gross domestic

1 Marko Janaćković, PhD, senior lecturer, Academy of Professional Studies South Serbia, Partizanska 7, 16000 Leskovac, Serbia, Phone: +381641590735, E-mail: janackovic.marko@gmail.com, ORCID ID (https://orcid.org/0000-0002-1789-3453)

2 Ognjen Dimitrijević, M.Sc., Assistant, Academy of Professional Studies South Serbia, Partizanska 7, 16000 Leskovac, Serbia, Phone: +381641464396, E-mail: dimitrijevic.ognjen@vpsle.edu.rs, ORCID ID (https://orcid.org/0009-0003-0439-9493)

product (GDP) (Vučkovski et al., 2022). Notably, agriculture contributes 4% to the global GDP, according to the latest World Bank data (World Bank, 2023). In Serbia, data from the Republic Institute of Statistics indicates that agriculture constituted 6.29% of the GDP in 2021 (Statistical Office of the Republic of Serbia, 2022). Over the past decade, its contribution was at its lowest in 2019 (5.95% of GDP) and reached its peak in 2011 (7.45% of GDP), underscoring the substantial role of agriculture in Serbia's economic structure. However, this hasn't always been the case, particularly in the early years of the new millennium when agriculture in Serbia faced challenges due to neglect by economic policymakers (Ljubojević et al., 2022).

It is a well-known catchphrase that the world belongs to the young. Franklin D. Roosevelt stated on several occasions that the future of the nation lies in the hands of the youth. They must not be neglected, as nations deteriorate faster without their involvement. Young people should be the backbone of economic transformation in countries. To realize their role and bring about positive changes in society, young people must assert themselves and receive state support. National governments worldwide have recognized the importance of this sensitive category for their future prosperity. Although numerous youth empowerment programs have been developed, a lot of them have not sufficiently stimulated young people's engagement (Genovez et al., 2022; Chipfupa & Tagwi, 2021; Girdziute et al., 2022; Quijano-Pagutayao et al., 2020; Mulema et al., 2021; Bagshaw & Maddison, 2022; Kusi, 2022; Duah, 2021; Akrong & Kotu, 2022; Dedieu et al., 2022; Geza et al., 2021). This situation arose due to the wrong orientation of these programs. Most of them are focused on understanding the reasons behind young people's poor performance in solving social issues rather than on ways to contribute to social betterment. Recognizing this gap, many global youth education programs have been initiated with the aim of better informing young individuals and helping them acquire the necessary knowledge and skills.

Agriculture is among the sectors where numerous global initiatives have been launched in this regard. This holds true for Serbia as well. A recent example of encouraging young people to engage in agriculture is the project titled „Empowering young farmers to utilize local incentives in agriculture." The initiative for launching and implementing this project was a joint effort by the Center for Sustainable Agriculture and Rural Development and the Association of Young Farmers of Serbia. Their collaboration led to the creation of a platform where young farmers can access comprehensive information about public calls and active support programs related to agricultural and rural development policies. This platform has proven highly beneficial for young individuals aspiring to work in the agricultural sector. Opting for an agricultural profession presents a significant challenge for them, given the numerous obstacles they face, including limited financing options, a lack of experience and knowledge, and high initial production costs. These programs have unveiled a new dimension in young people: their creative spirit and eagerness to adopt innovative and sustainable agricultural practices.

To reshape young people's perceptions of agriculture, a shift in their value system is imperative. This assertion is based on analyses focused on understanding the views of young individuals regarding agriculture at present. This study deals with the factors influencing the willingness or unwillingness of young people to engage in agricultural occupations, with a special focus on Serbia, particularly in its southeastern parts, as a representative case. To conduct this research, a survey questionnaire was distributed among the young population in Southeastern Serbia from May to September 2023. Our primary goal was to identify the factors that affect the desire of young people to engage in agriculture. Other goals include: 1) developing a BLR model that yields good results on new respondents; 2) discovering the stereotypes present among young people regarding agricultural work; and 3) providing recommendations that may be important to the government, farmers, the scientific community, and practitioners. The analysis presented here holds relevance for economic policymakers, agricultural professionals, and the academic community, offering insights for devising innovative strategies to effectively integrate young people into the agricultural workforce.

Considering all that was previously mentioned, the paper is structured as follows: following the introductory section, the first part provides a review of prior studies exploring this topic. The second part delves into the sample of respondents and the research methods used. The third part presents the research results, while the final section addresses concluding considerations and recommendations that may be useful to economic policymakers, the academic community, and other important stakeholders.

Literature review

Examining the collective awareness of the young population for employment in the agricultural sector is increasingly attracting the attention of the academic community and economic policy makers of different countries. This issue is prominent in a significant number of research studies. Many of them are more recent, which indicates an increase in the interest of the young population in agricultural occupations.

The opinion of young people regarding agricultural occupation is the subject of the following research study (Prasetyaningrum, Ruminar, Irwandi, 2022). In it, students of the Faculty of Agriculture of Brawijaya University in Indonesia were examined. For the purposes of the analysis, a survey questionnaire was used. For the purposes of the analysis, the factors of the internal (personal attitudes, stereotypes, hopes, focus, personal improvement, aspirations and interests, experiences) and external environment (family environment, availability of information, support of the organization where the individual works, ability to communicate with others at work) were considered. place). The results obtained in the work show that among the young population there is a moderate interest in working in agriculture. Individual and environmental factors (ecological factors) contributed significantly to this. In addition, almost half of the surveyed students believe that the low income in the agricultural sector is one of the reasons that deters them from choosing agriculture as their future profession.

A subsequent research study deals with the key competencies that are necessary for young people to work in the agricultural sector (Hendrix, Morrison, 2018). The research was conducted on students of the Faculty of Humanities. It is a faculty that is part of the Mississippi State University in the United States of America. A survey, in which the set of skills was specified, was used for the purpose of the research. The statistical data obtained indicate that the key competencies refer to: independence in work, loyalty, and behavior that implies a high degree of responsibility in the performance of work duties and respect for colleagues at the workplace.

The central question posed in the following research study is: does working in agriculture provide a solid income that enables a normal life (Agumagu, Ifeanyi-obi, Agu, 2019). For these purposes, the analysis was conducted on final year students of the Faculties of Agriculture located within the University of Port Harcourt and the State University of Science and Technology. The survey technique was used for data collection purposes. The results obtained through the application of descriptive statistics showed a great interest of young people in working on agricultural jobs. This is supported by the numbers, where as many as 73% of them expressed their willingness to choose agriculture as their future vocation. The study concludes that the main obstacles standing in the way of this are the following: insufficient support from state authorities in providing initial capital, the inaccessibility of agricultural land and the unfavorable price of agricultural mechanization.

The focus of the following research study is directed towards the analysis of the effects of education of the young population on the selection of agriculture as a future professional career (Omotosho et al., 2020). For the purpose of data collection, a survey questionnaire was prepared. It was distributed to the final year students of the college which is part of Landmark University in Nigeria. Descriptive and chi-square statistical analysis was applied to collected data. The results of the paper point to a high percentage of young people who want to engage in agricultural occupations (64%). In addition, there is a higher percentage of those who want to deal with it in their final years.

The following research study (Fazidah et al., 2021) deals with the consideration of the factors that influence the attitudes of students of state agricultural universities in Malaysia regarding the choice of agriculture as a future occupation. For the purposes of obtaining data, a questionnaire was used that was distributed to students. The resulting results indicate the low interest of young people in agricultural education. The reasons should be sought in the insufficient attractiveness of the training available to students and the insufficient connection of the faculty with the agricultural sector of Malaysia.

The issue of integrating the young population into the active agricultural workforce is the focus of the following research study (Girdziute et al., 2022). For the purposes of the analysis, the young population of Lithuania was taken as a sample. Surveys were distributed to a sample of respondents in which their perceptions regarding the central issue were grouped into three groups: individual, economic and social. The results of the research indicate a significant reluctance of young people to work in the agricultural sector.

In (Twumasi et al., 2019), the authors analysed the factors affecting the attitudes of young population regarding their determination to work in the agricultural sector of Ghana. For the purpose of the research, the technique of descriptive statistics and the model of double obstacles were used. The results of the work suggest that there are numerous obstacles standing in the way of young people who want to engage in agriculture. The key ones are those related to insufficient initial capital for starting an agricultural enterprise, high cost of input inputs, insufficient capacity for accommodation and storage of agricultural foodstuffs, unfavorable agricultural loans and poor understanding of the needs of farmers by the state.

The research study (David et al., 2022) examines the factors that create an environment for farming among the young population. The analysis includes final year students of the Faculty of Agriculture in the Visayas Islands that belong to the Philippines. The results of the work indicate that there is a lack of interest among young people in engaging in agriculture after completing their studies. In addition, there is an increasing percentage of those who do not enroll in studies at the Faculty of Agriculture because they have no intention of pursuing this vocation. Low income from agricultural work is the main obstacle that deters the young population from this occupation.

In (Akrong, Kotu, 2022), the authors tried to identify the key factors influencing the degree of involvement of the youth population in the agribusiness activities of Benin. For the purposes of the research, a survey questionnaire was used, which was distributed to young people aged 18 to 25 years. The findings indicate that the male population is more interested in doing agricultural work. In addition, they are more likely to come from families that have more members, which are less educated. The authors conclude that youth in Benin should be stimulated to engage in agriculture in various ways. Spreading awareness about the positive aspects of this branch of the economy, strengthening the capacity of young people through the organization of training programs in this area, and a package of stimulating state measures are the key issues that must be addressed by Benin's economic policy holders in the coming period.

A subsequent research study examines the attitudes of Jawaharlal Nehru Krishi Vishwa Vidyalaya college students in India about a program of youth involvement in rural agriculture (Khatri et al., 2023). For the purpose of the analysis, a questionnaire was used. It was distributed to graduated students, who had previously attended a program to support young people in agriculture. The obtained results indicate that a small number of students were previously familiar with that program. In addition, the findings indicated the existence of a relationship between thirteen variables concerning their perceptions of this program. The same cannot be said for the age structure dimension, which did not show interdependence with their view of this program.

Examining the opinion of young people in Spain regarding their perspective in the agricultural sector is the focus of the next research study (Pollnow et al., 2023). The results obtained in the work showed that Spain's agriculture is faced with the problem of a lack of youth. This is a consequence of moving to urban areas where they can find better jobs. In addition, the paper indicated that it was more difficult for the young population to decide to build their career in the agricultural sector for the following reasons: difficult access to initial capital for starting a business in this sector, insufficient education, as well as limited access to land.

Consideration of the factual situation in Hungary's agricultural sector is the focus of the following research study (Finta et al., 2020). The paper indicated that the biggest problem of agriculture in this country is the unfavorable age structure. This sector is unpopular within the young population due to difficult working conditions and the opportunities it provides in terms of income. One of the aggravating circumstances for the young population is the lack of knowledge regarding starting agricultural activities.

Analysis of the influence of the environment on the choice of an agricultural occupation by the young population is the focus of the author in (Kandula, 2021). The research was conducted among young people in the Indian state of Telangana. The obtained data drew attention to the fact that the family and society itself have the greatest influence on the choice of an agricultural occupation by young people.

Identifying factors influencing the selection of agricultural occupation by students of Ekiti State University, Nigeria is the subject of the following research study (Abayomi et al., 2015), where 160 students participated in the research and questioned through interviews. The results of the paper indicated that most of them are ready to work in agriculture. At the same time, they perceive agriculture as a springboard for further advancement in their career. In general, the key obstacles that stand in the way of their longer engagement in the agricultural sector are insufficient financial allocations, limited access to land and prejudices regarding the quality of agricultural land and livestock.

Theory and methodology

The research conducted in this paper is based on Binary Logistic Regression (BLR), a statistical method commonly used to model the relationship between a binary dependent variable and one or more independent variables. This method is widely applied to solve classification problems when the target variable has only two possible outcomes, usually labeled as 0 or 1. Outcomes labeled as 0 represent the "fail," "no," "false," etc., while outcomes labeled as 1 represent the "pass," "yes," "true," etc. Independent variables (predictors) can be either continuous or categorical. The effects of the independent variables on the dependent variable reflect the probability of the occurrence of an event within a given category of the dependent variable (Nayebi, 2020).

Logistic regression is based on the logistic function, an S-shaped curve that transforms any continuous value into a probability, always ranging between 0 and 1 (Pampel, 2020). If the estimated probability surpasses a predefined threshold (usually 0.5), the model predicts that the instance belongs to a particular class. The main assumptions of logistic regression are: a) predictors exhibit a linear relationship with the log of the output variable; b) non-collinearity between predictors, meaning that the explanatory variables are independent of each other; c) the output variable is binary; and d) a large sample size.

The logistic regression model can be expressed as:

$$\log\left(\frac{p(X)}{1-p(X)}\right)=\beta_0+\beta_1\cdot X_1+\cdots+\beta_p\cdot X_p \qquad (1)$$

, where X=(X_1,…, X_p) are p predictors or independent variables, β_0 is the intercept term, and β_0, β_1,…, β_p are coefficients. The interpretation of logistic model coefficients usually involves their exponentiation, which allows them to be understood as odds ratios (Hilbe, 2015). The quantity $p(X)/(1-p(X))$ is called the odds ratio and can take any value between 0 and ∞. The left-hand side of equation (1) is called the log odds, or logit, and is linear in X. Equation (1) can be rewritten as:

$$p(X)=\frac{e^{\beta_0+\beta_1\cdot X_1+\cdots+\beta_p\cdot X_p}}{1+e^{\beta_0+\beta_1\cdot X_1+\cdots+\beta_p\cdot X_p}} \qquad (2)$$

where β_0, β_1,…, β_p are coefficients estimated using maximum likelihood. The likelihood function can be written as:

$$1\left(\beta_0+\beta_1\cdot X_1+\cdots+\beta_p\cdot X_p\right)=\prod_{i:y_i=1}p(x_i)\prod_{i':y_{i'}=0}\left(1-p(x_{i'})\right) \qquad (3)$$

and the estimates β_0, β_1,…, β_p are chosen to maximize this likelihood function.

For the purpose of this research, data were collected using a questionnaire. All respondents were divided into a training group and a test group and accordingly labeled. Our target binary variable, codenamed agri_like, represents youth's willingness to work in the agricultural sector. It is based on the question: Would you like to work in the agricultural sector? Those who would like to work in the agricultural sector were labeled as 1. Other respondents were labeled as 0.

As for the independent variables, the following socio-demographic characteristics, coded as dummy variables, were considered: gender (variable name: gender), age (variable name: age), area of residence (variable name: resid_area), family members engaged in agriculture (variable name: family_memb), relatives or friends engaged in agriculture (variable name: cousin_friend), student status (variable name: student), and work status (variable name: employed). In addition, as proposed by Magagula & Tsvakirai (2020), three separate groups of statements related to agricultural work were developed and given to respondents. These statements were developed with the understanding that: 1) certain stereotypes regarding agricultural work do exist, and 2) answers to these questions should reveal different individual, economic, and social perceptions of the respondents. For the purpose of the analysis, answers were ranked on a Likert scale (1 = totally disagree; 2 = disagree; 3 = do not have an opinion; 4 = agree; 5 = totally agree). In total, 31 variables (24 perception variables and 7 socio-demographic variables) were considered for this research. A detailed explanation of all variables can be found in Table 1.

Table 1. Independent variables

Socio-demographical variables	
gender	dummy variable: 1 = male, 0 = female
age	continuous variable
resid_area	dummy variable: 0 = rural, 1 = urban
family_memb	dummy variable: 1 = yes, 0 = no
cousin_friend	dummy variable: 1 = yes, 0 = no
student	dummy variable: 1 = yes, 0 = no
employed	dummy variable: 1 = yes, 0 = no
Perception variables	
Variable	Statements (measured on Likert scale)
Individual variables	
youth_agri	Young people should work in agriculture
my_own_farm	I would choose to work in agriculture if I had my own farm/real estate in the countryside
nature_animals	I would like to work in agriculture because I love nature and animals
abroad	I would choose to work in agriculture only abroad
circumstances	Under no circumstances would I choose to work in agriculture
educat_motiv	Specialized educational programs would motivate me to work in agriculture
Economic variables	
seasonal	Agricultural work is mostly seasonal
self_realization	Agriculture does not provide opportunities for self-realization
profitable	Working in agriculture is profitable
signif_role	The agriculture sector ranks well because of its significance
perspective	Agricultural work has no perspective
fin_resources	Modern farmers have significant financial resources at their disposal
tech_innovations	Thanks to technological innovations, work in agriculture is becoming more and more attractive
steady_job	Agricultural jobs are not secure in the long term
Social variables	
physical_effort	Agricultural work requires a lot of physical effort
dirty	Agricultural work is dirty
unpopular_work	Agricultural work is not popular
responsibility	Agricultural work requires great responsibility
unskiled_workers	Agricultural jobs are intended for unskilled workers
lifestyle	Agricultural work is becoming a life-style
nat_environment	Working in agriculture means being surrounded by nature
social_shortcomings	The social life of young people in rural areas is incomplete and full of shortcomings
flex_schedule	Work schedule in agriculture is flexible
urban_rural_diff	There is a difference between urban and rural lifestyle

Source: author's own account

Our sample consists of 308 respondents. All respondents represent Serbian youth, ages 19–30. Data gathered from 215 randomly chosen respondents (or 70% of the total number) were used to build and train a BLR model, while the remaining 93 respondents (or 30%) were used to test our model. The whole analysis was conducted in Python v3.9 (packages: pandas, numpy, matplotlib, seaborn, sklearn, and statsmodels) and SPSS v26.

Before delving into the development of our BLR model or any other form of analysis, addressing the issue of multicollinearity is essential. Multicollinearity exists when there is correlation between predictors in the model, and its presence can adversely affect regression results. In this paper, testing for the presence of multicollinearity was based on Variance Inflation Factors (VIF). VIF estimates how much the variance of a regression coefficient is inflated due to multicollinearity in the model. VIFs are calculated for each predictor by regressing it against every other predictor. This yields R-squared values, which are then used in the VIF formula: $VIF=1/(1-R_i^2)$. The threshold at which a VIF value causes issues is a subject of debate. However, it is known that as the VIF increases, the reliability of the results decreases. Generally, a VIF above 10 indicates a high correlation and is cause for concern.

Finally, for evaluating our training model, standard statistical measures were used: Accuracy, Precision, Recall, and F1 score. Accuracy is a simple measure, indicating the percentage of correctly classified instances out of all instances. Precision measures the proportion of true positive predictions out of all positive predictions. Recall measures the proportion of true positive predictions out of all actual positive cases. The F1 score is the harmonic mean of precision and recall. It combines the two metrics to provide a more balanced evaluation of the model's performance.

Results and discussion

The target population for this research comprises young people in Serbia aged 19-30. The main survey was conducted from May 2023 to September 2023, with a total of 308 questionnaires completed and analyzed. Descriptive statistics for the respondents' main sociodemographic characteristics are presented in Table 2.

Table 2. Respondents' socio-demographic profile (N = 308)

Variable	**N**	**%**
Gender		
Male	106	34.41%
Female	202	65.59%
Age		
19-24	285	92.53%
25-30	23	7.47%
Area of Residence		
City	226	73.37%
Village	82	26.63%
Family members engaged in agriculture (Yes)	85	27.59%
Cousin/Friend engaged in agriculture (Yes)	164	53.25%
Student (Yes)	170	55.19%
Employed (Yes)	22	7.14%

Source: author's own account

According to our data, there are almost twice as many females than males among the respondents. Most of our respondents (92.53%) are in the age group 19-24 and live in urban areas (73.37%). 27.59% have a family member engaged in agriculture, while 53.25% have a cousin or friend engaged in agriculture. Over half of our respondents are students (55.19%), and only 7.14% are employed.

The youth's motivation to work in agriculture was also analyzed with the help of responses collected through a Likert scale. The results can be summarized as follows: Nearly 90% of respondents agreed, or totally agreed, that agricultural labor is difficult and requires great responsibility. About 84% thought that the social life of young people in the countryside is full of shortcomings, and nearly 77% believed that there is a difference between urban and rural lifestyles. As many as 85% believed that the earnings brought by working in agriculture were inadequate. Also, the great majority stated that agriculture is unpopular but is becoming more attractive thanks to technological innovations. Half of the respondents agreed that agricultural work is dirty but offers perspective and opportunities for self-realization. Approximately one-third of the young people would like to engage in agriculture, but on the assumption that they own a farm or property in the countryside, while 40% felt indifferent. Over 70% of the respondents believed that educational programs and being surrounded by nature and animals were important motivational factors. It is worrying that only 44% consider that the agricultural sector has an important role. Only 13% of the respondents would not work in agriculture under any circumstances, and very few of the respondents would like to go and work abroad. The results also showed that one-quarter of the respondents did not have any opinion on whether young people should work in agriculture or not.

The next part of our research is dedicated to addressing the problem of multicollinearity. To tackle this issue, we utilized Variance Inflation Factors (VIFs). As there is no consensus on the threshold beyond which a variable should be excluded from further research based on its VIF score, we chose not to include variables with a VIF value greater than 10. Initially, we calculated VIFs for all predictors. Subsequently, we iteratively dropped the variable with the highest VIF score and recalculated VIFs for the remaining variables until each had a VIF score lower than 10. After accounting for multicollinearity, we were left with 16 mutually independent variables. Fifteen variables excluded due to multicollinearity are: age, responsibility, nat_environment, physical_effort, educat_motiv, social_shortcomings, nature_animals, seasonal, urban_rural_diff, youth_agri, signif_role, tech_innovations, unpopular_work, lifestyle, and circumstances. VIF scores for the remaining variables can be found in Table 3.

Table 3. VIF scores of the remaining variables

Variable	**VIF score**	**Variable**	**VIF score**
gender	1.639754	self_realization	3.757275
resid_area	3.875567	profitable	5.442730
student	2.854216	perspective	8.279385
employed	1.409746	fin_resources	9.071339
family_memb	2.010011	dirty	9.573634
cousin_friend	2.682503	steady_job	9.237504

Variable	**VIF score**	**Variable**	**VIF score**
my_own_farm	8.607208	unskiled_workers	6.757233
abroad	6.681982	flex_schedule	7.351926

Source: author's own account

These remaining variables were used to develop our train model, which is presented in Table 4.

Table 4. BLR model (train sample data). Logistic Regression Results

Dep. Variable:		agri_like	No. Observations:				215
Model:		Logit	Log-Likelihood:				-67.242
Method:		MLE	LL-Null:				-130.91
converged:		True	LLR p-value:				7.060e-20
Omnibus Tests of Model Coefficients:		χ^2 = 163.570 p = 0.000	Cox & Snell R^2: Nagelkerke R^2:				0.533 0.710
Variables	Coef (log odds)	std err	z	P>|z|	CI 0.025	CI 0.975	Odds Ratios
gender	-0.2080	0.479	-0.434	0.664	-1.147	0.731	0.812
resid_area	-2.2080	0.487	-4.538	**0.000**	-3.162	-1.254	**0.109**
student	0.7274	0.529	1.375	0.169	-0.309	1.764	2.069
employed	1.0179	0.957	1.064	0.287	-0.857	2.893	2.767
family_memb	1.8543	0.540	3.434	**0.001**	0.796	2.912	**6.387**
cousin_friend	-0.8227	0.544	-1.511	0.131	-1.890	0.244	0.439
my_own_farm	0.7904	0.216	3.656	**0.000**	0.367	1.214	**2.204**
abroad	-0.5535	0.238	-2.330	**0.020**	-1.019	-0.088	**0.574**
self_realization	-0.2281	0.210	-1.087	0.277	-0.640	0.183	0.796
profitable	0.5388	0.250	2.153	**0.031**	0.048	1.029	**1.713**
perspective	-0.3531	0.253	-1.395	0.163	-0.849	0.143	0.702
fin_resources	0.1402	0.226	0.619	0.536	-0.304	0.584	1.150
dirty	0.1093	0.232	0.471	0.638	-0.346	0.564	1.115
steady_job	-0.4755	0.196	-2.423	**0.015**	-0.860	-0.091	**0.621**
unskiled_workers	-0.2127	0.217	-0.980	0.327	-0.638	0.213	0.808
flex_schedule	0.1131	0.206	0.548	0.584	-0.292	0.518	1.119

Source: author's own account

First of all, according to Omnibus goodness of fit test, the logistic regression model is statistically significant. P-value (p = 0.000) tells us that model is statistically significant and the dependent variable is well predicted. Cox & Snell and Nagelkerke R^2 values are methods of calculating the explained variation. The Nagelkerke modification is considered to be a more reliable measure. In our model, Nagelkerke R^2 accounts for 0.710, indicating that 71% of the relationship between the predictors and the prediction is explained. The accuracy and f1 score of our train model are 84% and 80% respectively.

As we can see from Table 4, there are six statistically significant variables with p-values less than 0.05. Two of them represent socio-demographical characteristics of the respondents: resid_area and family_memb. The next two variables are within respondents' individual beliefs (my_own_farm and abroad). Variables labeled as profitable and steady_job are from the group of economic variables. There were no statistically significant social variables. These six variables have significant influence on youth' willingness to work in agricultural sector and can be interpreted as follows. Our first variable (labeled as resid_area) has a coefficient value of -2.208 and an odds ratio of 0.109. This negative coefficient value tells us that young people living in urban areas were less willing to work in agricultural sector in comparison to those living in rural areas. We can also say that living in the urban area is associated with a 89.1% reduction (1-0.109) in young people's desire to work in agriculture. According to our second variable (labeled as family_memb), positive coefficient value of 1.85 suggests that youth whose family members were engaged in agricultural activities were more likely to choose the agriculture work as well. Or, in terms of odds, we can say that odds of choosing to work in agriculture are 6.38 times greater for youths who have a family member already engaged in agriculture. From the third variable (labeled as my_own_farm) and its coefficient value of 0.790, we can conclude that owning a farm or real estate has a positive impact on young people and their desire to engage in agriculture. The odds of working in agriculture for young people increase by 2.2 if they own a farm/real estate in the countryside. Forth variable (labeled as abroad) with a negative coefficient value of -0.55 implies that choosing to work abroad in the agricultural sector has a negative effect on youths' willingness to work in agriculture, in general. It seems that working abroad or domestic in the agricultural sector is not an option for young people in Serbia. Regarding the fifth significant variable (labeled as profitable), its coefficient value of 0.54 suggests that respondents who believed that agricultural engagement is profitable were more inclined to work in agriculture. It was interesting to find out that, although great majority (85%) of respondents agreed/completely agreed that earnings in agriculture are inadequate, the odds of choosing agricultural work for those who believe otherwise were 1.7 times greater. Finally, according to our last variable (labeled as steady_job), the opinion related to agriculture not offering a secure job in the long term can be associated with reduced desire among the young people to work in agriculture. Its negative coefficient value of -0.47 suggests that young people who find agricultural work unsecure, have 38% less odds of choosing agricultural work, compared to those who find it secure. Model evaluation results are presented in Table 5. As we can see from Table 5, indicators obtained from train data are very close to indicators based on test data. There is a small difference in accuracy (2%) and in f1-score (5%). These small differences lead us to the conclusion that we didn't overfit and our model is good.

Table 5. Model evaluation results

	Results on train data (215 obs)			**Results on test data (93 obs)**		
	precision	recall	f1-score	precision	recall	f1-score
0	0.88	0.89	0.88	0.89	0.87	0.88
1	0.73	0.72	0.72	0.61	0.64	0.62
accuracy	0.84			0.82		
macro avg	0.81	0.80	0.80	0.75	0.75	0.75
weighted avg	0.84	0.84	0.84	0.82	0.82	0.82

Source: author's own account

Conclusions

The focus of this study was to analyze the reasons behind the youth's (un)willingness to work in agriculture, using Serbia as the case study. With the help of a questionnaire, responses from 308 respondents were collected, and all the goals we set at the beginning of this paper have been met. After addressing the problem of multicollinearity, the BLR model was created, and important variables were identified. Finally, the model was evaluated on new data set to see how well it performs in practice. The results from this research may find practical application in the development of government programs aimed at attracting young people to engage in agriculture.

It should also be noted that the present study has limitations. We could say that our sample is unbalanced since there are twice as many female respondents. Also, most of our respondents live in urban areas and only a small percentage are employed. The next limitation is related to the data collection technique. For the purpose of this research, a closed questionnaire was used to collect only quantitative, easy to process data. There were no open questions, which, although difficult to process, can provide us with meaningful insights. Therefore, a more complex data gathering technique could be carried out in the future.

Summarizing the research results, it can be said that there are both positive and negative stereotypes, with the number of negative ones being higher. As for positive stereotypes, we were able to identify the following: i) educational programs and technological innovations are important and needed, and they can attract young people to agriculture; ii) agricultural work offers a perspective and opportunities for self-realization. On the other side, the negative stereotypes that are present among the youth are: i) the young people thought that agricultural work was unpopular; ii) working in agriculture is not profitable and requires a lot of physical effort; iii) the social life in rural areas is incomplete, and there is a difference between urban and rural lifestyles. These negative stereotypes can be corrected only in the long-term using a variety of measures, such as training, educational programs, etc. Also, we found some of the results to be slightly contradictory. For example, the opinion of the majority of our respondents is that young people should work in agriculture. But, on the other hand, approximately the same majority agreed and completely agreed that, under no circumstances, they would choose to work in agriculture, not even abroad. Having in mind this contradiction, we can say that the majority of young people in Serbia have an opinion that can be expressed like this: It is ok for my peers to be engaged in agriculture, as long as I don't have to.

In addition to the positive and negative stereotypes about agriculture, other important socio-demographic characteristics were identified. The desire to work in agriculture is significantly affected by having family members in this field, as well as the living area. Having a family member engaged in agriculture and living in a rural area positively increases the odds of choosing to work in agriculture. Unlike other authors, we didn't find gender to be a statistically significant variable. Maybe the reason for this is the fact that our sample is imbalanced: there are almost twice as many female respondents then male respondents.

Next, we found that owning a farm increases the odds of engaging young people in agriculture. This is important because not so long ago, the Serbian government introduced a national program that helps people acquire real estate in the countryside. By keeping this program alive for years to come, it will inevitably attract young people to agriculture. Another variable we identified as significant is the profitability of the agricultural sector. This variable is also under the influence of the government. The government could attract more young people to agriculture simply by applying measures that affect its profitability: increasing benefits, investing in infrastructure (roads, canals, etc.), opening new markets (Middle East, China), stimulating diversification, various educational programs, etc. Finally, our research has revealed that long-term employment uncertainty negatively affects youth's willingness to work in agriculture. Promoting steady jobs is a difficult task for any government, not just in agriculture, and definitely not something that can be easily achieved in the short term. Also, other factors not directly under government control, such as technological progress, climate change, and the seasonal nature of agriculture, have a strong influence and must be respected as well.

Now that we know what attracts young people to agriculture, the next step of the research will be to analyze government measures and programs already implemented in the Serbian agricultural sector, but from the aspect of variables we have identified as significant. This will help us determine whether government measures and programs are adequate and whether they are able to deliver results, such as attracting young people to agriculture. Additionally, we could focus on previously identified significant variables and investigate them more thoroughly. We could, for example, explore what is the most preferred way to influence profitability of the agricultural sector or what has the greatest impact on long-term employment uncertainty. Finally, we could deal with the problem of the negative stereotypes and try to answer questions such as: how they arise and where they come from, how widespread they are among young people and what can be done to eradicate them.

Conflict of interests

The authors declare no conflict of interest.

References

1. Abayomi, A.A., Eniola, V.N., & Etoade, W.F. (2015). A study on factors determining the choice of Agriculture professional career among the Students of the Faculty of Agricultural Sciences in Ekiti State University, Nigeria, *International Journal of Agricultural Extension and Rural Development*, 8 Vol. 2 (4), pp. 082-087.
2. Agumagu, A.C., Ifeanyi-obi, C.C., Agu, C. (2019). Perception of Agriculture Students Towards Farming as a Means of Sustainable Livelihood in Rivers State, Nigeria, *Journal of Agricultural Extension* 22(1), pp. 4143-4148. DOI: 10.4314/jae.v22i1.12S
3. Akrong, R., & Kotu, B.H. (2022). Economic analysis of youth participation in agripreneurship in Benin, *Heliyon*, 8(1):e08738. DOI: 10.1016/j.heliyon.2022.e08738

4. Akrong, R., Kotu, B.H. (2022). Economic Analysis of Youth Participation in Agripreneurship in Benin, *Heliyon* 8: e08738. DOI: 10.1016/j.heliyon.2022.e08738
5. Bagshaw, A., & Maddison, M. (2022). *New national education program seeks to attract students to the agriculture sector*, Available at: https://www.abc.net.au/news/rural/2022-08-14/new-rural-research-program-links-kids-to-agriculture-career/101322014 (Accessed 20.07.2023.)
6. David, J.A.S., Fortuna, H.D.F., Sanchez, K.A.B., Rosete, M.A.L. (2022). Determinants of Tertiary Students' Intention to Participate in the Agriculture Sector in Visayas, Region 8 Philippines, *Journal of Industrial Engineering & Management Research*, Vol. 3, No. 1, pp. 20-44. DOI: https://doi.org/10.7777/jiemar.v3i2.249
7. Dedieu, B., Contzen, S., Nettle, R., & De Alencar Schiavi, S.M. (2022). The Multiple Influences on the Future of Work in Agriculture: Global Perspectives, *Frontiers in Sustainable Food Systems*, 6:889508. DOI:10.3389/fsufs.2022.889508
8. Duah, J.A. (2021). *Tell the Success Story of Youth in Agribusiness*, Available at: https://www.linkedin.com/pulse/tell-success-story-youth-agribusiness-jeffrey-agyemang-duah?trk=articles_directory (Accessed 29.07.2023.)
9. Fazidah, R., Tengku Halimatun Sa'adiah, T.A.B., Mohd Afiq, A.M., Norhafizah, M.Z. (2021). *Factors influencing perception towards agriculture field in high level education among public University students in East Coast Region*, AIP Conference Proceedings 2347. https://doi.org/10.1063/5.0051871
10. Finta, Z., Palkovics, A., & Koszegi Iren, R. (2020). AZ AGRÁRKÉPZÉSI SZAKOK NÉPSZERŰSÉGÉNEK ALAKULÁSA A MAGYAR FELSŐOKTATÁSBAN 2019-IG, *Journal of Central European Green Innovation*, *8*(1-2), 25–43. https://doi.org/10.33038/jcegi.2653
11. Genovez, D.S., Pérez, S.M., Tapia, F.H., & Ortega, A.E. (2022). Rural youth: a perspective of agricultural labor from their protagonists, *Convergencia,* vol.29, e16508. https://doi.org/10.29101/crcs.v29i0.16508
12. Geza, W., Ngidi, M., & Ojo, T. (2021). Youth Participation in Agriculture: A Scoping Review, *Sustainability*, 13, 9120. https://doi.org/10.3390/su13169120
13. Girdziute, L., Besuspariene, E., Nausediene, A., Novikova, A., Leppala, J., Jakob, M. (2022). Youth's (Un)willingness to work in agriculture sector, *Front, Public Health* 10:937657. DOI: 10.3389/fpubh.2022.937657
14. Hendrix, R., Morrison, C.C. (2018). Student Perceptions of Workforce Readiness in Agriculture, *Journal of Agricultural Education*, 59(3), pp. 213-228. DOI:10.5032/jae.2018.03213
15. Hilbe, J.M. (2015). *Practical Guide to Logistic Regression*, (1st edition), Chapman and Hall/CRC. https://doi.org/10.1201/b18678, p. 3
16. Kandula, V.K. (2021). Factors affecting students after graduation in choosing agricuture as career in Telangana, *Juni Khyat Journal*, 11(1): 736-751.

17. Khatri, M., Singh, S.P., Bisht, K., Khatri, K. & Shinde, R. (2023). Perception of students on rural agricultural work experience (RAWE) programme, *Pharma Innovation Journal*, 12(3): 2508-2512.
18. Kusi, R.O. (2022). *Attirer les jeunes vers l'agriculture*, Available at: https://rightforeducation.org/fr/2022/02/21/attirer-les-jeunes-vers-lagriculture/ (Accessed 23.07.2023.)
19. Ljubojević, R., Blanuša, A., & Petrović, S. (2022). Agrarian strategy and policy of the Republic of Serbia, *Economics of Agriculture*, 69(3), pp. 897-909. DOI: 10.5937/ekoPolj2203897L
20. Magagula, B., & Tsvakirai, C. (2019). Youth perceptions of agriculture: influence of cognitive processes on participation in agripreneurship, *Development in Practice*. https://doi.org/10.1080/09614524.2019.1670138
21. Milić, D., Jocić, B., Novaković, T., Tekić, D., Ilić, Z., & Maksimović, B. (2023). Investments in Serbian agriculture, *Economics of Agriculture*, 70(2), pp. 411–422. DOI: https://doi.org/10.59267/ekoPolj2302411M
22. Nayebi, H. (2020). *Advanced Statistics for Testing Assumed Casual Relationships: Multiple Regression Analysis Path Analysis Logistic Regression Analysis*, Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-54754-7, p. 79.
23. Omotosho, A., Asani, E., Ayegba, P., Ayoola, J. (2020). Impact of Agricultural Education on Students' Career Choice: A Survey, *International Journal of Emerging Technologies in Learning* ,Vienna, Vol. 15, Iss. 3, pp. 51-61. DOI:10.3991/ijet.v15i03.11260
24. Pampel, F.C. (2020). *Logistic Regression: A primer*, (2st edition), SAGE Publications, Inc. https://doi.org/10.4135/9781071878729, p. 9.
25. Pollnow, G. E., Caldas, N. V., & Anjos, F. S. (2023). Sucessão geracional e instalação de jovens na agricultura: a percepção de organizações sindicais da Espanha, *Revista de Economia e Sociologia Rural*, 61(4), e263213. https://doi.org/10.1590/1806-9479.2022.263213
26. Prasetyaningrum, D.I., Ruminar, H., Irwandi, P. (2022). The Perception and Interest of Career Choices in Agriculture: Case of Agroecotechnology and Agribusiness Students, *HABITAT* 33 (2), pp. 186-200. DOI: 10.21776/ub.habitat.2022.033.2.19
27. Twumasi, M.A., Jiang, Y., Acheampong, M.O. (2019). Determinants of agriculture participation among tertiary institution youths in Ghana, *Journal of Agricultural Extension and Rural Development*, Vol. 11, No. 3, pp. 56-66. DOI:10.5897/JAERD2018.1011
28. Vučkovski, B.G., Simonović, Z., Ćurčić, N., & Miletić, V. (2022). The role of agriculture in the economic structure of Serbia and budget support for rural development of Kladovo municipality, *Economics of Agriculture*, 69(3), pp. 863–876. DOI: https://doi.org/10.5937/ekoPolj2203863G
29. World Bank (2023). *Agriculture and Food*, Available at: https://www.worldbank.org/en/topic/agriculture/overview (Accessed 30.07.2023.)

CORRELATION BETWEEN SOLVENCY OF SERBIAN AGRICULTURAL SECTOR AND INVESTMENTS IN ENVIRONMENTAL RESPONSIBILITIES

Milena Stojić[1]*, Biljana Pejović*[2]*, Vojkan Bizic*[3]

**Corresponding author E-mail: stojic.milena87@gmail.com*

A R T I C L E I N F O

Original Article

Received: *30 January 2024*

Accepted: *15 May 2024*

doi:10.59267/ekoPolj2402381S

UDC 338.439:631.95(497.11)

Keywords:

Environmental protection, agricultural companies, solvency, reporting ,correlation

JEL: *C1, Q12, Q14, Q51, Q56*

A B S T R A C T

Whether investment in environmental protection is conditioned by the solvency of agricultural companies, due to the growing importance of environmental sustainability, is the topic of this paper. The goal of the research is to determine, on a sample of 40 agricultural companies, whether investment in environmental protection is conditioned by solvency in a three-year period. Solvency, which is relatively good in the sampled companies, is not correlated with investment in the environment, in the analyzed time period, based on the quantification of descriptive data from the annual report. The level of disclosure of the environmental dimension of the sustainability of agricultural companies in Serbia is at a very poor level and the ESG reporting concept is necessary. The research indicates non-compliance with the legal obligation of non-financial reporting on environmental protection of agricultural companies, which indicates that educational, legal and regulatory measures must be urgently taken in order to make the reporting as representative as possible.

Introduction

An old Indian proverb says: “We did not inherit nature from our ancestors, we borrowed it from our descendants.” Every conscientious inhabitant of Planet Earth should have this attitude towards nature, especially those who make a profit by exploiting its wealth. This especially applies to agricultural producers. Agriculture and environmental

1 Milena Stojić, Assistant Professor, Faculty of Geoeconomics, Megatrend University, Bulevar Mihajla Pupina 117, Belgrade, Phone: +381604727770, E-mail:stojic.milena87@gmail.com , ORCID ID (https://orcid.org/0009-0001-9436-7182)

2 Biljana Pejović, PhD, AP production, Blagoja Marjanovića Moše 7, Serbia, Phone: +381646610010, E-mail: biljanapejovic9@gmail.com, ORCID ID (ORCID ID https://orcid.org/0000-0002-8840-2498)

3 Vojkan Bizic, PhD assistant, “Dositej” College of Academic Studies, Belgrade, Nušićeva street no. 12A, 11000 Belgrade, Serbia, E-mail: vbizic@yahoo.com, ORCID ID (https://orcid.org/0000-0002-4181-7784)

protection are inextricably linked fields that require a careful balance between food production and ecosystem preservation.

Environmental protection, contributes in the long term to the preservation of resources, the maintenance of biological diversity and the reduction of negative impacts of agricultural production on the environment. Sustainable development in agriculture includes economic, ecological and social aspects. Socially responsible behavior implies the integration into business activities of the concept of concern for social issues, environmental protection, concern for all stakeholders and all issues that affect the quality of life in the long term. Integrating these dimensions helps to achieve a balance between food production, environmental conservation and improved living conditions for communities dependent on agriculture. Sustainable agriculture can be successfully implemented if there is an adequate cooperation between agricultural producers, the government, research institutions and local communities.

It is necessary to raise awareness about the importance of environmental protection, to educate agricultural producers about organic farming and the advantages that such a business concept has for them, for the users of their products and for the broader socio-economic community. Also to implement regulations that stimulate sustainable agricultural production. Responsible business behavior includes the use of renewable energy sources, when and where possible, using solar energy, wind energy and biomass. Adequate management of waste from agricultural production, applying recycling and composting of organic waste in order to improve soil structure, also contributes to the preservation of the environment.

As the stakeholders' interest in all the above-mentioned information about agricultural enterprises is increasing, efforts are being made not only to apply it, but also to adequately report on environmental performance. Research shows that a higher level of economic development of a country is accompanied by a higher level of disclosure of information about environmental moves. This is further followed by a greater number of scientific studies from developed countries than from developing countries, such as the Republic of Serbia. In Europe, some of the studies dealing with environmental indicator reporting are Radhouane et al. (2018) in France, D'Amico et al. (2016) in Italy, Borgstedt et al. (2019) in Germany and others. Outside the European Union, research is conducted in China Liu et al. (2021), Yang et al. (2021) in Australia, Chelli et al. (2018) in Canada. All these countries belong to the group of developed countries. A smaller number of studies are conducted in developing countries, primarily due to incomplete information in financial reports and lack of adequate integrated reporting. One of the newer studies in our area is the study by Denčić-Mihajlov et al. (2023) which deals with companies operating on the Belgrade Stock Exchange and their level of reporting on environmental indicators. In the results of the research, the same problem of inadequate reporting is encountered, where in the eight-year period of the entire sample, only one company continuously reports on environmental indicators, with a note that the sample includes 27 of the most successful and liquid companies, and potential polluters on the territory of the Republic of Serbia (Denčić-Mihajlov et al., 2023; Popescu & Andrei, 2011).

The research was conducted with the aim of establishing whether there is a dependency between the solvency of the Serbian agricultural sector and investment in environmental protection. The research hypothesis of this paper is that better solvency of the agricultural sector causes greater investment in environmental protection. According to the defined goal of the work, it is structured as follows. After the introductory part on the trends of sustainable agriculture and the analysis of research related to the reporting of companies on that topic, in the second part, a brief review of the institutional frameworks that define the obligations of non-financial reporting of companies on investment in environmental protection, both in the European Union and in the Republic of Serbia, is made. In the third part of the paper, the methodology applied in the research is explained. The fourth part presents the results of the research that show whether financial reporting is correlated with the solvency of the sampled companies. After the concluding remarks, the literature and sources used in the research are presented.

Institutional frameworks related to environmental protection

The regulations adopted at the level of the European Union regarding sustainable development, and thus environmental protection, which are becoming binding and strive for a more transparent presentation of the company's operations, can be seen in the last ten years. In that transition period, a special step forward was made in the adoption of specific directives, starting with the European Union Directive on non-financial reporting, originally adopted in 2013 and then revised in 2014, with concrete binding information that large companies must contain (Non-financial Reporting Directive –NFRD, Directive 2014/95/EU). After that, the European Commission was trying to publish guidelines on non-financial reporting in 2017 (European Commission, 2017) and 2019 (European Commission, 2019). A significant milestone is the adoption of the Regulation on reporting on sustainable financing (Sustainable Finance Disclosure Regulation –SFDR, Regulation (EU) 2019/2088),which emphasizes sustainable development and the obligation of participants in the financial market to look at investments through that aspect as well. The Regulation on Taxonomy from 2020, which prescribes the objectives of environmental protection and economic activities that are considered to be climate neutral, is also important for environmental protection (EU Taxonomy, Regulation (EU) 2020/852). As efforts have been made to achieve a more transparent financial reporting since 2022, the Directive on reporting on corporate sustainability was adopted (Corporate Sustainability Reporting Directive –CSRD, Directive (EU) 2022/2464) combining financial and non-financial information and instructions for auditors on forming an assessment of the fulfillment of the stated reporting conditions. The new framework of obligations will apply from the financial year 2024, and will be quite restrictive compared to the previous free choice of application of reporting standards.

The European Union applies strict standards for organic farming, which relate to the use of chemicals, soil management, animal health and other aspects of food production. Products marked with the "EU organic" certificate must meet these standards. The

2030 Agenda for sustainable development also speaks of commitment to environmental protection (Sustainable Development Goals – SDG) which is followed by the adoption of the European Green Deal (2019) to eliminate the emission of harmful gases with the greenhouse effect by 2050 (European Commission, 2019). By adopting a set of legal regulations that, depending on the identity of the business entity, would bring a specific package of benefits (tax exemptions), and direct those funds to investment in support of the development of sustainable development goals (Pejović, B., Petrović, S., 2022; Andrei & Darvasi, 2012)

Five Sustainability reporting frameworks help to implement ESG principles in the company: Global Reporting Initiative (GRI), International Organization for Standardization (ISO), Principles for Responsible Investments (PRI), Sustainability Accounting Standards Board (SASB) and United Nations Global Compact. GRI standards include performance measurement and reporting on the company's positive and negative impact on the environment, social environment and economy. SASB defines sustainable accounting standards for the disclosure of ESG topics. These two frameworks are the most important for ESG reporting. ISO is an international standard that provides a framework and set of guidelines for environmental management. PRI integrates ESG factors into investment decision-making, and UNGC is a voluntary initiative for companies to implement the 10 principles of the UN Global Compact Initiative in their operations (The GRI Standards, 2022). It is also important to mention the GRI 300 standards (Global Reporting Initiative), which include 28 environmental indicators that can be expressed quantitatively. According to a 2020 KPMG survey, 73% of the world's largest companies prepare their sustainable development reports based on the GRI standard (The KPMG, 2020).

The National Strategy for Sustainable Development in the Republic of Serbia contains guidelines for sustainable agriculture and environmental protection. The Law on Incentives in Agriculture and Rural Development defines provisions related to agricultural production practices and negative impacts on the environment. The Law on Environmental Protection provides environmental protection standards for all production sectors, including agriculture, as well as Local self-government contributes to the implementation of all laws and prescribed regulations by measures of stimulation, supervision and control of the application of environmental protection measures.

In the Republic of Serbia, non-financial reporting began in 2019, when the first changes and adoption of the Accounting Act were made, which is in accordance with the European Union Directive on non-financial reporting, adopted in 2013 and amended in 2014. The newly adopted Law entered into force on January 1, 2020, and for that reason, the reporting period 2020-2022 was taken into account. As the regulations on non-financial reporting at the level of the European Union are continuously improved, it is necessary to keep up and harmonize the way of reporting with the trends.

From 2021, large legal entities in Serbia with over 500 employees will be obliged to report non-financially. They are obliged to include in the Annual Business Report a non-financial report that includes ESG qualitative disclosures and quantitative measurements of the impact of their company on the environment, social environment and the way the company is managed. Agricultural companies in Serbia that want to have access to the European market and become part of the supply chains of large companies must have an adopted ESG concept.

Research methodology

Given that in the Republic of Serbia, agriculture is a highly developed industrial branch and that by performing its activities, it belongs to the polluters of the environment, the research idea in this paper is to draw attention to the level of reporting of this economic branch and to the monitoring of trends. A three-year period was used for the research, one year before and two years after the passing of the law on mandatory reporting on environmental protection.

295 agricultural enterprises were analyzed, whose data were taken from secondary sources, the Agency for Economic Registers, and from their business reports. The sample was taken by random selection from the total number of legal entities that were operating in the Republic of Serbia at the time of the research. In order for the data to be as representative as possible, only large and medium-sized legal entities were analyzed, since only they had complete publicly available financial and business reports. In addition to regular financial reporting, in accordance with Article 12 of the Rulebook, from 2021, legal entities that were subject to audit, except for entrepreneurs, were required to submit, among other things, an annual report on operations in accordance with the Law. For the purposes of the research, 40 of the stated number met this requirement. The remaining number of legal entities consisted of small and micro legal entities, and they were not taken into account. The sample consisted of 5 large and 35 medium enterprises. A three-year analysis of the company's financial reports was made. We covered the period 2020-2022, where 2021 was assumed to be a turning point in financial reporting in terms of reporting on environmental protection. Although it would have been better if a larger sample had been used for the correlation, the lack of a business report in which the public was informed descriptively about investments in environmental protection was shown by a very small number of respondents.

The analysis of financial reports by means of financial indicators largely depends on the activity and sub-activity that the company deals with. For this reason, Table 1 shows the structure of sub-activity of the analyzed sample.

Table 1. Characteristics of the sample

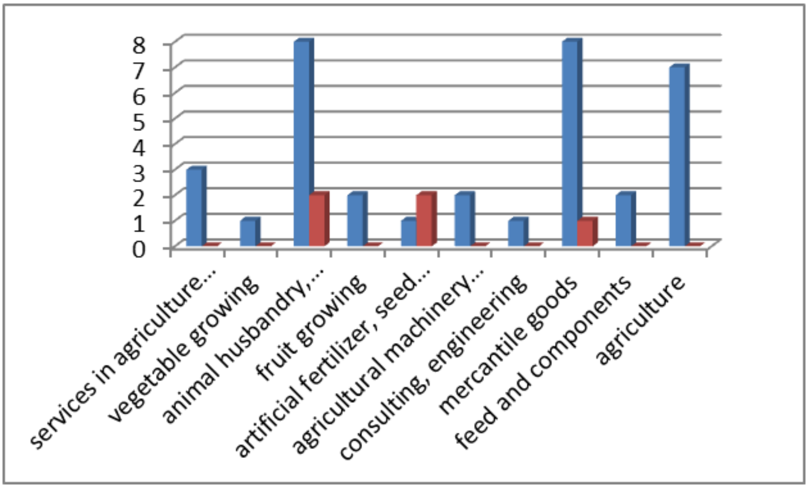
Ord.Num.	Sub-activities	Number	Percentage share
1.	Animal husbandry, poultry farming	9	22,50%
2.	Artificial fertilizer, seed products and protective agents	3	7,50%
3.	Vegetable farming	1	2,50%
4.	Fruit farming	2	5,00%

Ord.Num.	Sub-activities	Number	Percentage share
5.	Farming	7	17,50%
6.	Fodder and components	3	7,50%
7.	Mercantile goods	9	22,50%
8.	Services in agriculture and animal husbandry	3	7,50%
9.	Agricultural machinery and equipment	2	5,00%
10.	Consulting, engineering	1	2,50%
Total:		**40**	

Source: Authors' calculations

In the analyzed sample, there is the largest number of companies from the field of animal husbandry and poultry farming and companies that deal with mercantile goods.

Figure 1. Crosstabulations of company size and activity



Source: Authors' calculations

In Figure 1, it can be seen that two large companies each participated in the research within the company's activities: animal husbandryand poultry farming and artificial fertilizers, seed goods and environmental protection, while one large company participated in the mercantile goods sample. Among medium-sized enterprises, the most are those engaged in animal husbandryand poultry farming (8), mercantile goods (8) and farming (7).

The following four formulas were used to calculate solvency ratios in the research. (Bogavac-Cvetković, N., 2009)

$$Fixed\ Assets\ Covered\ Ratio\ (FACR) = \frac{Equity}{Fixed\ Assets} \tag{1}$$

$$Real\ Assets\ Covered\ Ratio\ (RACR) = \frac{(Equity + Long\ Term\ debt)}{(Fixed\ Assets + Stocks)} \quad (2)$$

$$Covered\ Current\ Assets\ by\ Net\ Working\ Capital\ Ratio\ (CCANWCR) = \frac{((Equity + Long\ term\ debt) - Fixed\ Assets))}{Current\ Assets}$$

(3)

$$Covered\ stocks\ by\ Net\ Working\ Capital\ Ratio\ (CSNWCR) = \frac{((Equity + Long\ term\ debt) - Fixed\ Assets))}{Stocks} \quad (4)$$

These solvency ratios are based on horizontal funding rules and are called asset coverage ratios. In practice, ratios of solvency indicators based on funding sources are also used, which are based on vertical funding rules. In this research, only ratio indicators based on asset coverage were used. The capital coverage ratio of fixed assets should preferably be greater than 100%, that is, all permanently invested assets are financed from long-term sources. The coverage ratio of real assets should preferably be around 100%, because for agricultural producers, especially crop producers who realize stock turnover once a year, stocks should also be financed from long-term sources. The optimal amount of net working capital depends on the type, size and activity of the company, profitability rate, procurement and sales policy, the ratio between capital and liabilities and the amount and conditions of using long-term loans. For agricultural companies, it is desirable that the net working capital is positive.

After analyzing all financial reports, it was observed that information on environmental protection was either not available or was available qualitatively within the Annual Business Report. We decided to code the variables with numerical codes based on belonging to a certain category. In order to verify the existence of a correlation between solvency and reporting on environmental protection, the coding went as follows: a legal entity that has not published an Annual Business Report for a given year is marked with a mark 0 (zero), a legal entity that has published an Annual Business Report, but within it there is no information about the actions undertaken in the matter of environmental protection, is marked with the symbol 1 (one), a legal entity that has a published Annual Business Report, and within it there is very concise information about the actions undertaken regarding the issue of environmental protection, is marked with the symbol 2 (two) and the label 3 (three) marks a legal entity that has published an Annual Business Report, and within it there is detailed information on actions taken and plans in terms of environmental protection.

Under the assumption that the increase in awareness of the need for environmental protection leads to progress in the part of financial reporting by including and disclosing activities related to it, the goal was to establish a correlation between indicators showing stability in business and positions related to the allocation of funds for the protection of environment.

Research results

The connection between the solvency of the agricultural sector and environmental protection was reflected in the influence of environmental factors on the business viability of agricultural enterprises, as well as in the decisions of enterprises to take steps towards more sustainable business operations. Sustainable agricultural practices can contribute to the long-term sustainability and resilience of businesses to environmental challenges.

Table 2. Average values of solvency ratios by years

Ord. Num.	Sub-activities	FACR			RACR		
		2020	2021	2022	2020	2021	2022
1.	**Animal husbandry, poultry farming**	509	382	377	281	295	289
2.	**Artificial fertilizer, seed products and protective agents**	72	158,671	374,125	263	76	93
3.	**Vegetable farming**	8	9	9	9	212	277
4.	**Fruit farming**	113	51	54	81	60	62
5.	**Farming**	55	68	115	68	55	65
6.	**Fodder and components**	52	96	66	95	111	94
7.	**Mercantile goods**	2,612	3,208	109,668	49	65	80
8.	**Services in agriculture and animal husbandry**	103	99	71	107	110	87
9.	**Agricultural machinery and equipment**	104	144	198	63	53	50
10.	**Consulting, engineering**	102	106	108	100	103	101

Source: Authors' calculations

Out of all respondents, 17.5% have a negative value of net working capital, so the ratio of coverage of current assets and inventories, which were shown in Table 3, was not even calculated in that case. Among the other respondents, there were large deviations in the coverage of current assets and stocks with net working capital, which indicated different activities within agricultural enterprises.

Based on the obtained values of the calculated indicators, grouped by sub-activities and years, shown in Table 2, the following can be concluded. The coverage ratios of fixed assets for almost all respondents individually in the time period for which the research was carried out were without large deviations. Large differences in absolute amounts were explained by different activities within agricultural enterprises. Companies engaged in providing services and trade within agriculture had higher ratios than manufacturing companies, which generally had large capital investments.

The coverage ratio of real assets was in most cases less than 100%, which indicated that most companies' inventories were not financed from long-term sources.

Table 3. Average values of solvency ratios by years

Ord. Num.	**Sub-activities**	**CCANWCR**			**CSNWCR**		
		2020	2021	2022	2020	2021	2022
1.	**Animal husbandry, poultry farming**	219	218	215	239	259	248
2.	**Artificial fertilizer, seed products and protective agents**	31	23	30	249	93	151
3.	**Vegetable farming**	-653	1,115	1,083	-1,063	8,335	4,318
4.	**Fruit farming**	41	22	23	68	38	41
5.	**Farming**	11	0	15	24	-4	29
6.	**Fodder and components**	43	29	32	98	130	80
7.	**Mercantile goods**	17	25	20	26	51	85
8.	**Services in agriculture and animal husbandry**	21	28	-45	2,562	1,687	-228
9.	**Agricultural machinery and equipment**	14	16	22	15	23	30
10.	**Consulting, engineering**	69	85	82	99	171	115

Source: Authors' calculations

Based on the analysis of the financial statements of the companies from the sample, balance sheets, profit and loss statements, cash flow statements, notes to the financial statements for the three-year period, as well as the annual business report for the last two years, no quantitative indicators related to environmental protection were found, which could be analyzed in the planned correlation with the solvency of the companies in the sample.

In the profit and loss account, within all expenses, it was not possible to conclude which of the expenses were invested in environmental protection. Expectations were that medium and large legal entities, for the sake of completeness of financial reporting, would more precisely explain the recording in the annual report on operations.

Based on the analysis of the financial statements of the companies from the sample, for the three-year period, as well as the annual business report for the last two years, no quantitative indicators related to environmental protection were found. Although it was an obligation, according to the Law from 2021, that all manufacturers had to declare in their financial reports at the end of the year how they had contributed to environmental protection, all respondents stated descriptively what and when they planned to do in this regard, without any quantitative indicators. This type of information could not be used for precise research, since it could be of a subjective nature and did not necessarily indicate the real activities of the company. By quantifying the descriptive data, we came up with quantitative indicators that we used for the correlation test of solvency indicators and investments in environmental protection .

Table 4. The relationship between solvency indicators and environmental protection in 2020. (Pearson's linear correlation coefficient)

	Statistics	**Fixed Assets Covered Ratio (FACR)**	**Real Assets Covered Ratio (RACR)**	**Covered Current Assets by NWC Ratio (CCANWCR)**	**Covered Stock by NWC Ratio (CSNWCR)**
Environmental protection in 2020.	r	/	/	/	/
	p	/	/	/	/
	N	40	40	40	40

Source: Authors' calculations

In Table 4, it can be seen that there was no statistically significant correlation between solvency indicators and environmental protection, given that companies were not obliged to prepare an annual report containing data on investment in environmental protection in 2020. The variable environmental protection in 2020 was a constant, so there was no data related to the coefficient and the level of significance of the correlation.

Table 5. Correlation between solvency indicators and environmental protection in 2021. (Pearson's linear correlation coefficient)

	Statistics	**Fixed Assets Covered Ratio (FACR)**	**Real Assets Covered Ratio (RACR)**	**Covered Current Assets by NWC Ratio (CCANWCR)**	**Covered Stock by NWC Ratio (CSNWCR)**
Environmental protection in 2021.	r	-0.106	0.063	0.180	0.184
	p	0.514	0.701	0.266	0.256
	N	40	40	40	40

Source: Authors' calculations

Table 5 shows that there was no statistically significant correlation between indicators of solvency and environmental protection in 2021.

Table 6. The relationship between solvency indicators and environmental protection in 2022 (Pearson's linear correlation coefficient)

	Statistics	Fixed Assets Covered Ratio (FACR)	Real Assets Covered Ratio (RACR)	Covered Current Assets by NWC Ratio (CCANWCR)	Covered Stock by NWC Ratio (CSNWCR)
Environmental protection in 2022.	r	-0.156	0.123	0.146	0.087
	p	0.337	0.448	0.369	0.593
	N	40	40	40	40

Source: Authors' calculations

Table 6 shows that there was no statistically significant correlation between solvency indicators and environmental protection in 2022.

The established correlation between financial indicators and environmental performance was, to a greater extent, present in research that used a qualitative environmental variable. Relying on quantitative data pointed to the problem of financial reporting of agricultural enterprises on environmental protection. Based on the research, it can be concluded that it is necessary to introduce some radical changes in the way of reporting in order to be able to reliably monitor indicators of socially responsible behavior of agricultural producers.

Conclusions

The research indicated that in the financial reporting of Serbian agricultural companies, it was not possible to reliably establish the extent to which investments were made in environmental protection. Apart from the descriptive reports, no quantitative indicators were disclosed in the financial statements in the time period (2020-2022) in which the research was done. Quality reporting of agricultural companies should provide information to all stakeholders to what extent the companies adhere to a sustainable business concept in their operations and provide them with the opportunity to differentiate themselves from their competitors. Based on the conducted research, it can be concluded that the initial hypothesis of the research was rejected. Solvency of the agricultural sector is not correlated with investment in environmental protection. It is a consequence of inadequate financial reporting or regulations that should impose on all agricultural producers to disclose special reports for that purpose within the framework of financial reporting. Those reports should include quantitative indicators that demonstrate socially responsible behavior.

The quality of financial reporting in the Republic of Serbia is affected by insufficiently developed awareness of the importance of reporting on sustainable business and the absence of responsibility towards the public. The aforementioned problems may call into question the confidence in the accuracy and truthfulness of the reporting of the agricultural sector of the Republic of Serbia. As the purpose of their compilation is still reflected as an obligation to submit a report at the end of the current period, and not as a presentation of the image and responsible behavior of the company, it follows that any type of analysis, based on financial indicators, can be questioned.

In order to eliminate this problem, it is first necessary to improve the regulation, to train experts on improved reporting for the preparation of reports from this area of the economic sector, and to implement greater control in the area of financial reporting by the state. It is necessary to raise awareness about the importance and responsibility of non-financial reporting to the public, considering that the business operations of a company cannot be observed in isolation in relation to the environment in which it operates. Reports should include specific data, whether the investment has contributed to the reduction of carbon dioxide emissions, the increase in recycling of waste material, the reduction of water pollution and the increase in the use of renewable energy sources. Also, it could be useful to increase in reimbursement for companies that take care of environmental protection, as well as better information about it for small agricultural legal entities. For this reason, more and more attention is drawn to the importance of socially responsible business, and within it, the importance of adequate reporting on environmental protection, which can affect the differentiation of agricultural producers.

Conflict of interests

The authors declare no conflict of interest.

References

1. Akpan, J., Oluwagbade, O., (2023). Social and Environmental Responsibility in Accounting: Beyond Financial Metrics. *International Journal of social sciences and management research*.,Vol 9, no. 9, DOI: 10.56201/ijssmr.v9.no9.2023.pg148.173.
2. Andrei, J. V., & Darvasi, D. (2012). Perspectives and challenges in financing the new Common Agricultural Policy, a new paradigm. *Journal of Food, Agriculture & Environment*, 10(1), 904-907.
3. Popescu, G., & Andrei, J. (2011). From industrial holdings to subsistence farms in Romanian agriculture. Analyzing the subsistence components of CAP. *Agricultural Economics*, *57*(11), 555.
4. Bobitan, N., Dumitrescu, D.,&Burca. V.,(2023). Agriculture's Efficiency in the Context of Sustainable Agriculture—A Benchmarking Analysis of Financial Performance with Data Envelopment Analysis and Malmquist Index.*Sustainability* 15, no. 16: 12169. https://doi.org/10.3390/su151612169
5. Bogavac-Cvetković, N., (2009), *Finanisjska anlaiza preduzeća*, Megatrend univerzitet, Beograd [*in English*:Bogavac-Cvetković, N., (2009), Financial analysis, Megatrend university, Belgrade].

6. Borgstedt, P., Nienaber, A. M., Liesenkötter, B., & Schewe, G. (2019). Legitimacy strategies in corporate environmental reporting: A longitudinal analysis of German DAX companies' disclosed objectives. *Journal of Business Ethics*, 158(1),177–200. DOI:10.1007/s10551-017-3708-y
7. D'Amico, E., Coluccia, D., Fontana, S., & Solimene, S. (2016). Factors influencing corporate environmental disclosure. *Business Strategy and the Environment,* 25(3),178–192. DOI:10.1002/bse.1865
8. European Commission. (2017).Communication from the Commission. Guidelines on non financial reporting (methodology for reporting non-financial information). (2017/C 215/01). *Official Journal of the European Union,* C215/1, 1-20.Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017XC0705(01) (20.12.2023.).
9. European Commission. (2019). Communication from the Commission. The European Green Deal. (COM(2019) 640 final). Brussels. Retrieved from
10. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019XC0620(01)&from=EN (20.12.2023.).
11. European Commission. (2019a). Communication from the Commission. Guidelines on nonfinancial reporting: Supplement on reporting climate-related information. *Official Journal of the European Union*, C 209/01. Retrieved from https://eurlex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:52019XC0620(01)&from=EN(20.12.2023.)
12. European Commission. (2019) Regulation (EU) 2019/2088 of the European parliament and of the council of 27 November 2019on sustainability-related disclosures in the financial services sector. *Official Journal of the European Union*, l317/1, Retrieved from https://eur-lex.europa.eu/eli/reg/2019/2088/oj (21.12.2023.)
13. European Commission. (2020). Regulation (EU) 2020/852 of the European Parliament and of the council of 18 June 2020on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088. *Official Journal of the European Union*, L198/13, Retrieved fromhttps://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32020R0852 (25.12.2023)
14. European Commission. (2022).DIRECTIVE (EU) 2022/2464 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCILof 14 December 2022
15. amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting. *Official Journal of the European Union*, L322/15, Retrieved from https://eurlex.europa.eu/legalcontent/EN/TXT/?uri=CELEX%3A32022L2464 (25.12.2023)
16. Friede, G., Busch, T., &Bassen, A:, (2015) ESG and financial performance: aggregated evidence from more than 2000 empirical studies.*Journal of Sustainable Finance & Investment*, 5:4, 210-233, DOI: 10.1080/20430795.2015.1118917

17. GRI. (2020). Consolidated set of GRI sustainability reporting standards. Amsterdam: Global Reporting Initiative. https://www.globalreporting.org/standards/ (25.12.2023)

18. Hayo M.G.W., & Petit, J., (2002) Evaluation of the environmental impact of agriculture at the farm level: a comparison and analysis of 12 indicator-based methods. *Agriculture, Ecosystems & Environment*,Vol. 93, Issues 1–3, 131-145,ISSN 0167-8809,https://doi.org/10.1016/S0167-8809(01)00354-1.

19. Heras-Saizarbitoria, I., Boiral, O. & Díaz de Junguitu, A. (2020). Environmental management certification and environmental performance: greening or greenwashing? *Business Strategy and the Environment*,29, 2829–2841.DOI:10.1002/bse.2546

20. Kawai, N., Strange, R., & Zucchella, A. (2018). Stakeholder pressures, EMS implementation, and green innovation in MNC overseas subsidiaries. *International Business Review*, 27(5), 933-946.DOI:10.1016/j.ibusrev.2018.02.004

21. KPMG. (2020). The KPMG survey of sustainability reporting2020. Retrieved from https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2020/11/the-time-has-come.pdf (25.11.2023.)

22. Krstić, J., Jezdimirović, M.,& Đukić, T., (2010),*Finansijsko računovodstvo*, Univerzitet u Nišu, Ekonomski fakultet. Niš[*in English*:Krstić, J., Jezdimirović, M.,& Đukić, T., (2010), Financial Accounting, University of Nis, Faculty of Economics, Nis].

23. Liu, C., Su, K., &Zhang, M. (2021). Water disclosure and financial reporting quality for social changes: Empirical evidence from China. *Technological Forecasting and Social Change*, 166(C),120571, 1-20. DOI:10.1016/j.techfore.2021.120571

24. Pejović, B., Petrović., S., (2022), Financing sustainable development under the legislation of the Republic of Serbia: deficiencies and proposals for improvement. Ecologica. Vol 29, No 107, 438, https://doi.org/10.18485/ecologica.2022.29.107.18

25. Petrović, Z. (2013) *Finansijsko izveštavanje*. Beograd: Univerzitet Singidunum.[*in English*:Petrović, Z. (2013), Financial reporting, Belgrade, Singidunum University].

26. Radhouane, I., Nekhili, M., Nagati, H., Paché, G. (2018). Customer- related performance and the relevance of environmental reporting. *Journal of Cleaner Production,* 190,315–329. DOI: 10.1016/j.jclepro.2018.04.149

27. Republika Srbija. (2019). Zakon o računovodstvu. Beograd. Službeni glasnik Republike Srbije, br.73/2019 i 44/2021 - dr. zakon. [*in English*:Republic of Serbia (2019), Law on Accounting, Belgrade, Off.Herald of RS, Nos.73/2019 and 44/2021 – other law].

28. Republika Srbija (2008). Nacionalna strategija održivog razvoja. Beograd. Službeni glasnik Republike Srbije, br.57/2008 [*in English*:Republic of Serbia (2008), National strategy for sustainable development, Belgrade, Off.Herald of RS, Nos.57/2008]

29. Republika Srbija (2018). Zakon o zaštiti životne sredine. Beograd. Sl. glasnik RS, br. 135/2004, 36/2009, 36/2009 - dr. zakon, 72/2009 - dr. zakon, 43/2011 - odluka US, 14/2016, 76/2018, 95/2018 - dr. zakon i 95/2018 - dr. zakon[in English: Republic of Serbia (2018), Law on environmental protection, Belgrade, Off.Herald of RS, Nos. 135/2004, 36/2009, 36/2009 - other law, 72/2009 - other law, 43/2011 - decision, 14/2016, 76/2018, 95/2018 - other law i 95/2018 - other law]
30. Velte, P. (2017). Does ESG performance have an impact on financial performance? Evidence from Germany.*Journal of Global Responsibility*, Vol. 8 No. 2, 169-178. https://doi.org/10.1108/JGR-11-2016-0029
31. United Nations. (2015). Resolution adopted by the General Assembly on 25 September 2015. Transforming our world: the 2030 Agenda for Sustainable Development. A/RES/70/pp. 1-35, Retrieved fromhttps://sdgs.un.org/2030agenda (13.11.2023)
32. Yang, H., Le Luo, L.,& Bhattacharyya, A. (2021). Mandatory environmental reporting in Australia:An in-depth analysis of quantity and quality. *Abacus*, 57(4),737-779.DOI:10.1111/abac.12231
33. Yin, H., & Li, M., Ma, Y., & Zhang, Q., (2019). The Relationship between Environmental Information Disclosure and Profitability: A Comparison between Different Disclosure Styles. *International Journal of Environmental Research and Public Health*. 16. 10.3390/ijerph16091556 DOI:10.3390/ijerph16091556
34. Zhou, G., Liu, L., & Luo, S., (2022). Sustainable development, ESG performance and company market value: Mediating effect of financial performance. *Business Strategy and the Enviroment*, Vol.31, Issue 7, 3371-3387, DOI:10.1002/bse.3089

A MODEL FOR DETERMINING PREMIUM RATES IN INDEX-BASED CROP INSURANCE

Marija Koprivica[1], Jelena Kočović[2], Drago Cvijanović[3]
**Corresponding author E-mail: marija.koprivica@ekof.bg.ac.rs*

A R T I C L E I N F O

Original Article

Received: *11 February 2024*

Accepted: *24 February 2024*

doi:10.59267/ekoPolj2402397K

UDC 368.021.26:368.54

Keywords:

index-based crop insurance, flood risk, drought risk, premium rate

JEL: *G22, Q14, Q54*

A B S T R A C T

The paper deals with index-based crop insurance as a tool for managing flood and drought risks in agriculture. We introduce a novel model for determining premium rates in index-based crop insurance which combines the loss cost method and the average yield method. The proposed model was applied to data related to the production of selected crops in Serbia to calculate unique premium rates for index-based insurance for cereals, industrial crops and fodder plants. The paper also outlines the prerequisites for index-based crop insurance to become technically, operationally, and financially feasible in Serbia. We propose the introduction of mandatory index-based crop insurance, along with necessary legislative amendments and subsidization of insurance premiums.

Introduction

The last three decades have been marked by a rise in the frequency and intensity of catastrophic risks globally, leading to substantial material losses and numerous human casualties (Swiss Re, 2023). Climate change, resulting in an increasing occurrence of floods, droughts, frost, and other weather-related risks, disproportionately impacts the agricultural sector more than any other economic activity. With the growing global population, the risk of hunger due to food scarcity poses an escalating threat to sustainable development. Given the aforementioned reasons, the issue of insuring agricultural crops gains considerable importance in today's world.

The contribution of insurance to sustainable development has been given special

1 Marija Koprivica, Ph.D., Associate Professor, Faculty of Economics, University of Belgrade, Kamenička 6, 11000 Beograd, Serbia, Phone: +381641470084, E-mail: marija.koprivica@ekof.bg.ac.rs, ORCID ID (https://orcid.org/0000-0003-4239-2252)

2 Jelena Kočović, Ph.D., Full Professor, Faculty of Economics, University of Belgrade, Kamenička 6, 11000 Beograd, Serbia, +381652399444, E-mail: jelena.kocovic@ekof.bg.ac.rs, ORCID ID (https://orcid.org/0000-0003-3219-4746)

3 Drago Cvijanović, Ph.D., Full Professor, Faculty of Hotel Management and Tourism in Vrnjačka Banja, University of Kragujevac, Vojvođanska 5a, 36210 Vrnjačka Banja, Serbia, Phone: +38163295111, E-mail: dvcmmv@gmail.com; drago.cvijanovic@kg.ac.rs, ORCID ID (https://orcid.org/0000-0002-4037-327X)

emphasis in the 2030 Agenda for Sustainable Development (United Nations, 2015). In developed economies, agricultural insurance has a long-standing tradition, with established operational models and a remarkable market penetration. Nevertheless, the situation regarding the availability and penetration of crop insurance is markedly different in underdeveloped and developing countries, which heavily depend on the agricultural sector and are generally most threatened by natural disasters (Kočović et al., 2016; Fedajev et al, 2016; Luković & Stojković, 2020; Sulyok et al., 2022; Sima & Gheorghe, 2015). The primary reason for the underdevelopment of conventional agricultural insurance is the inability of the majority of rural population to bear the cost of insurance premium due to their poor financial status. Likewise, with low demand, insurers lack the necessary financial capacity to offer insurance against natural hazards at affordable rates, resulting in a limited supply (Cvijanović et al., 2018). As a result, alternative forms of agricultural insurance are being developed worldwide, serving the needs of rural communities. One of them that is becoming more prominent both in theoretical discussions and practical considerations, is index-based crop insurance.

Index-based insurance is a new insurance product where indemnification is not necessarily contingent upon the occurrence of an economically harmful event. Insurance payouts are triggered when a selected parameter reaches a predetermined threshold. Index-based insurance is most commonly used for insuring crops and is primarily intended for poorer segments of the population. The sum insured is determined at a low level and is independent of the magnitude of the risks that may occur. It will be paid out to every policyholder in the area if the realized average yield falls below a predefined percentage (area-yield index insurance), or if the realized value of the index, which may correlate with adverse weather conditions, exceeds or falls short of a predefined threshold (weather index crop insurance), regardless of whether damage occurred or not.

The scientific literature on index-based crop insurance is rapidly growing. Majority of studies are focused on the ability of different indices to reduce basis risk in index-based crop insurance, which refers to the disparities between index-dependent payouts and actual losses (Bucheli et al., 2021; Okpara et al., 2017; Hohl et al., 2020; Fedajev et al., 2023; Dusmanescu et al., 2014). Other studies primarily deal with farmers' willingness to pay for index-based crop insurance (Ali, 2013; Lin et al., 2015; Fonta et al., 2018; Adjabui et al., 2019). The determination of premium rates for index-based crop insurance has been discussed to a limited extent in the literature. In rare studies addressing this issue, damages are modeled using indices, and the pure premium is calculated based on historical index values rather than actual losses (Benso et al., 2023).

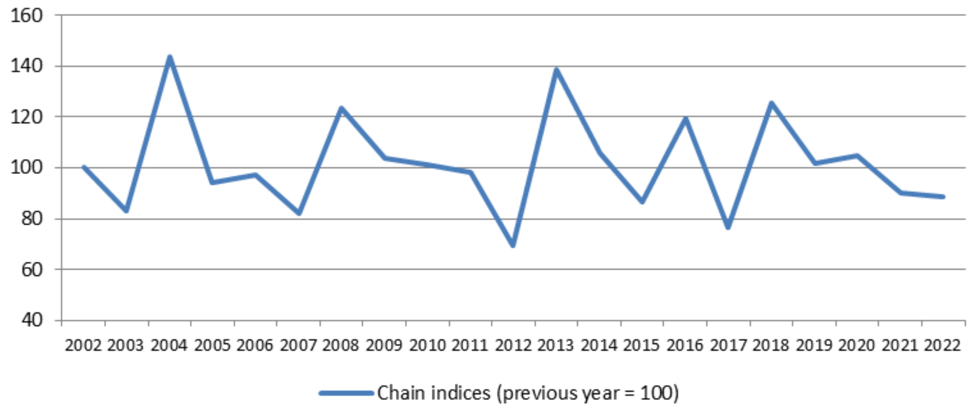
This study adds to the existing literature by introducing a novel model for determining premium rates in index-based crop insurance. This model combines elements of the average yield method commonly employed in indemnity-based crop insurance with the loss cost method. The insurance premium is calculated by applying the derived premium rate to the specified sum insured, which is paid out when the corresponding threshold of the chosen index is reached. As a weather parameter, we have opted to use the Standardized Precipitation Index (SPI), which is monthly calculated based on the most up-to-date precipitation data. The application of the proposed model for determining premium rates in index-based crop insurance was simulated using data on the yields of selected crops in Serbia.

Modified index-based insurance, respecting legal constraints, is currently offered only by one insurance company in Serbia, with a 40% premium subsidy provided by the government. The insurance coverage is limited to mercantile and seed maize, mercantile and seed soy and mercantile sugar beet (Žarković et al., 2016). In addition to proposing a new model for determining premium rates in index-based crop insurance, the contribution of this paper also lies in exploring the possibilities and limitations of broader implementation of this type of insurance in Serbia.

Index-based insurance as a tool for managing flood and drought risks in agriculture

Floods and droughts are major sources of risks for the agricultural sector, as shown by farmers' experience in terms of damage caused by natural disasters (Kozarević & Ćetković, 2022; Luković et al., 2023). Excessive rainfall leading to flooding or prolonged periods of drought can result in significant financial losses for farmers. These losses may stem from lower yields, crop damages, impaired livestock well-being, diminished soil fertility for future agricultural activities, and disruptions of regular farming practices, causing delays in planting or harvesting. Reduced agricultural production due to floods or droughts has a detrimental impact on the entire economy, manifested through lower economic output, inflation driven by fluctuations in food prices, supply chain disruptions as agricultural products are crucial inputs for various industries, a deterioration in the trade balance, and increased government expenditures.

Figure 1. Chain indices of crop production in Serbia



Source: Statistical Office of the Republic of Serbia, 2003-2023

The crop production indices in Serbia (*Figure 1.*) indicate that the largest yield declines occurred in years with extreme droughts (2003, 2007, 2012), as well as in years with significant floods (2017) or immediately following them (e.g., floods in 2014 led to land degradation and inability to use it for the next season). Climate change is projected to increase rainfall variability at a global scale, leading to significant fluctuations between periods of drought and heavy precipitation (Zhang et al., 2021). Hence, there is a growing need for suitable mechanisms for managing flood and drought risks in agriculture, among which insurance has an important role.

The penetration rate of agricultural insurance in developing countries is very low, and the risks of drought and floods are typically not covered by conventional indemnity-based insurance. Providing agricultural insurance against floods and droughts is challenging for a number of reasons. First, the likelihood of occurrence of extreme flood or drought events is hard to quantify given their rare frequency. Second, it is not easy to attribute and value the damage they cause (Hazell, 1992). Delineating agricultural damages resulting from floods or droughts is difficult as they can manifest both directly (e.g., crop losses) and indirectly (e.g., business disruptions due to damaged infrastructure). Moreover, potential damages vary significantly based on the timing of floods or droughts during the crop production cycle and their duration, complicating the modeling of these risks and the pricing of insurance products. Third, traditional indemnity-based agricultural insurance suffers from adverse selection and moral hazard. Farmers in areas susceptible to floods and droughts are often aware of the imminent risks, unlike their counterparts outside perceived flood/drought zones who tend to underestimate the potential for severe flooding and drought. Hence, a voluntary insurance scheme may predominantly attract farmers in high-risk areas. In agricultural insurance, moral hazard can arise when farmers take more risks in the presence of insurance coverage than they would in the absence of such coverage (Schnitkey & Sherrick, 2014). Fourthly, catastrophic floods and droughts affect a large number of farmers simultaneously, resulting in claims that surpass the insurers' capacities. Hence, insufficient risk dispersion hinders the financial sustainability of agricultural insurance against floods and droughts (Lotsch et al., 2010).

An index-based insurance holds the potential to overcome many of these challenges, providing an avenue to improve the feasibility and accessibility of insurance in the agricultural sector. Weather index crop insurance indemnifies the insured based on the level of a specific weather parameter (i.e., meteorological index) measured over a predetermined period at a particular weather station, rather than damage to the crop. Insurance can be designed to provide protection against either excessively low or excessively high index values. For instance, both too little or too much rainfall can be expected to result in crop damages. Hence, compensation can be triggered either when the realized value of the index surpasses a predetermined threshold or when the index falls below the threshold. Adverse selection and moral hazard problems become irrelevant because payouts are linked to external index beyond the control of both farmers and insurers. With no need for actual damage assessment, cost savings are achieved, allowing insurers to offer their products at lower prices. Also, payouts can proceed without delay, as soon as the impact of the weather event on the index is assessed (Carter et al., 2017; Pantović et al., 2022). Therefore, index-based insurance ensures that financial resources for mitigating losses are available immediately upon the occurrence of a natural disaster, precisely when they are most needed by the affected farmers.

Materials and methods

The aim of the study is to create a specific model for determining premium rates in index-based crop insurance, combining the loss cost method and the average yield method, as well as to define the prerequisites for its practical implementation. The gross premium rate, expressed as a percentage of the sum insured, comprises two elements: the pure premium and the expense loading. The pure premium covers losses and loss-adjustment expenses and is calculated based on statistical data on insured cases within the observed homogeneous risk group over several years (Kočović et al., 2021: 408). Expense loading is meant to cover the insurance company's expenses, including acquisition and administrative costs.

The loss cost method (also known as pure premium method) is used as a standard rate-making approach in non-life insurance (Brown, Gottlieb, 2007). In accordance with the loss cost method, loss cost ratio is calculated by dividing sum of incurred losses with the exposure to risk, i.e. amount of insurance coverage (sum insured):

$$Loss\ cost\ ratio = \frac{Sum\ of\ incurred\ losses}{Sum\ insured} \tag{1}$$

Incurred losses in crop insurance are implied by the yield data. In this study yield is expressed in terms of revenue, i.e. by multiplying the physical yield by the purchase price of agricultural product. The model assumes that the indemnity equals the damage. Following the average yield method, sum of incurred losses for each year during the preceding ten-year period is determined as the negative deviation between the actual annual yield and the 10-year historical average yield of specific crop categories:

$$Sum\ of\ Incurred\ losses_s = max[\mu_t - x_s, 0],\ \ s = t-1, \dots, t-10 \tag{2}$$

where x_s denotes the historical yield of the crop category in year s, and the 10-year historical average yield of the same crop category is being calculated in the current year t as:

$$\mu_t = \frac{\sum_{s=t-1}^{t-10} x_s}{10} \tag{3}$$

Assuming further that all harvested areas were insured, meaning that the total actual yield in one year equals the sum insured, this leads to a formula for calculating the loss cost ratio for each individual year s and crop category:

$$Loss\ cost\ ratio_s = \frac{max[\mu_t - x_s, 0]}{\mu_t}, s = t-1, \dots, t-10 \tag{4}$$

The pure premium for insuring a given crop category in year t is equal to the arithmetic average of the loss cost ratios for the previous 10 years:

$$Pure\ premium_t = \frac{\sum_{s=t-1}^{t-10} Loss\ cost\ ratio_s}{10} \tag{5}$$

Adjusting the indicated pure premium for the expense loading leads to the following formula for calculating the gross rate for insuring a given crop category in year t:

$$Gross\ premium\ rate_t = \frac{Pure\ premium_t}{1 - Expense\ loading} \tag{6}$$

where $Expense\ loading$ includes the insurance company's expenses, calculated as a percentage of a gross rate.

Using the proposed model, premium rates for index-based insurance were calculated for three categories of crops: cereals, industrial crops and fodder plants, specifically for Serbia. We employed data on annual crop production for the previous ten-year period (2013-2022) at producers' prices of the current year (Statistical Office of the Republic of Serbia, 2023). For the sake of comparability over time, all monetary values for each year in this study were deflated to the base year 2013 by using consumer price index for Serbia (World Bank, 2023). Thus, the inflation effect on the value of crop production during the observed period has been eliminated.

In order to implement index-based crop insurance against floods and droughts in Serbia, it is necessary to introduce appropriate assumptions regarding the weather parameter, the insured amount, the mandatory nature of index insurance, and premium subsidy.

The chosen weather parameter for index-based crop insurance against floods and droughts is the Standardized Precipitation Index (SPI), developed by McKee et al. (1993). It is widely recognized as one of the most representative and commonly used indicators for monitoring precipitation conditions (Wang et al., 2022). The SPI indicator quantifies precipitation conditions in a given area, based on a comparison of observed total precipitation amounts for an accumulation period of interest (commonly 1, 3, 6, 9, 12, 24, or 48 months) with the long-term precipitation time series for that period. SPI is calculated on a monthly basis with a moving window of the chosen accumulation period. Historic rainfall record (for at least 30 years) is typically fitted to a gamma distribution, which is then transformed into a normal distribution such that the mean and the standard deviation of SPI for that area and period are zero and one, respectively.

The SPI values can be interpreted as the number of standard deviations by which the observed precipitation level deviates from the long-term mean. Following McKee et al. (1993) and Angelidis et al. (2012), calculation of SPI is as follows.

The gamma distribution's probability density function is defined as:

$$g(x) = \frac{1}{\beta^{\alpha}\Gamma(\alpha)} x^{\alpha-1} e^{-\frac{x}{\beta}} \tag{7}$$

where α and β are shape and scale parameters, respectively, x is the amount of precipitation and $\Gamma(\alpha)$ is a gamma function. The cumulative probability $G(x)$ is obtained by integrating the probability density function with respect to x:

$$G(x) = \int_0^x g(x)dx = \frac{1}{\beta^{\alpha}\Gamma(\alpha)} \int_0^x x^{\alpha-1} e^{-\frac{x}{\beta}} dx \tag{8}$$

The gamma distribution is undefined when the variable x equals zero. Since it is possible to have multiple zero values in a precipitation data, the cumulative probability function of gamma distribution with the $x = 0$ case is modified to:

$$H(x) = q + (1 - q)G(x) \tag{9}$$

where q is the probability that the precipitation amount is equal to zero.
The cumulative probability distribution is transformed into the standard normal distribution to obtain the SPI, following the approximate conversion method suggested by Abramowitz & Stegun (1965):

$$SPI = \begin{cases} -\left(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}\right), t = \sqrt{\ln\left(\frac{1}{(H(x))^2}\right)}\ for\ 0 < H(x) < 0.5 \\ t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}, t = \sqrt{\ln\left(\frac{1}{(1.0 - H(x))^2}\right)} for\ 0.5 < H(x) < 1.0 \end{cases} \tag{10}$$

where $c_0 = 2.515517$,$c_1 = 0.802853$, $c_2 = 0.010328$, $d_1 = 1.432788$, $d_2 = 0.189269$, and $d_3 = 0.001308$.

Based on SPI values for a given area and accumulation period, precipitation conditions are classified in seven distinct regimes, as shown in *Table 1.* The SPI values between -1.0 and 1.0 correspond to normal precipitation conditions. A decline in SPI below -1.0 indicates rainfall deficits (i.e., meteorological droughts), while values above 1.0 indicate increasing excess rainfall. Index-based crop insurance is intended to provide protection primarily against catastrophic droughts and floods. According to the presented classification scheme, extremely dry/wet conditions occur when the SPI value is below -2.0 or above 2.0. The probability of occurrence for each of these events is 2.3%. Hence, SPI values of 2.0 and -2.0 have been selected as thresholds in the proposed model of index-based insurance. Upon reaching the drought or flood trigger, the sum insured is paid out, regardless of whether damage to insured crops has occurred.

Table 1. Classification of precipitation conditions based on SPI

Range of SPI values	Precipitation regime	Cumulative probability	Probability of event (%)
2.0 < SPI	Extremely wet	0.977 - 1.000	2.3
1.5 < SPI ≤ 2.0	Very wet	0.933 – 0.977	4.4
1.0 < SPI ≤ 1.5	Moderately wet	0.841 – 0.933	9.2
-1.0 < SPI ≤ 1.0	Normal precipitation	0.159 – 0.841	68.2
-1.5 < SPI ≤ -1.0	Moderately dry	0.067 – 0.159	9.2
-2.0 < SPI ≤ -1.5	Very dry	0.023 – 0.067	4.4
SPI ≤ -2.0	Extremely dry	0.000 – 0.023	2.3

Source: European Drought Observatory, 2020

The sum insured is defined at EUR 1,000. The payout is made no more than once a year regardless of how many times the SPI index threshold is reached throughout the year, whether due to drought or flood.

The assumed expense loading included in the gross rate is 30%. The insurance premium amount is determined by applying the calculated gross rate to the specified sum insured.

In order to be sustainable, index-based insurance in Serbia should be mandatory. With a 50% premium subsidy provided by the government, this insurance would be affordable for the impoverished rural population.

Results and discussion

The main result of the study is a novel model for calculating premium rates in index-based crop insurance, which combines the loss cost and average yield methods. The calculation of the premium rate for index-based crop insurance for cereals using the proposed model in the case of Serbia is shown in *Table 2*. Sum of incurred losses for each year is determined as the negative deviation of the realized yield of cereals expressed in constant prices (base year 2013) from the ten-year average cereal yield according to formula (2). As outlined in (5), the pure premium is determined by averaging the annual loss cost ratios, calculated according to (4). The gross premium rate for index-based crop insurance for cereals, calculated by adding the assumed 30% expense loading to the derived pure premium of 6.1%, is 8.8%. In this type of insurance, all policyholders would pay a premium at a uniform aggregate tariff rate for all cereals, regardless of the risk zone in which the municipality to which their agricultural enterprise belongs is located, and regardless of the type of cereal they produce. This fosters solidarity and gives the insurance a social dimension.

Table 2. The calculation of the premium rate for index-based insurance for cereals

Year	Historical annual yield in constant prices (base year 2013, RSD million)		Sum of incurred losses (negative deviation from the 10-year average yield, RSD million)	Loss cost ratio
2013		174,602.0	0.0	0.0%
2014		175,129.5	0.0	0.0%
2015		134,859.1	19,979.2	12.9%
2016		157,484.0	0.0	0.0%
2017		105,389.3	49,449.0	31.9%
2018		142,655.8	12,183.5	7.9%
2019		141,514.5	13,324.8	8.6%
2020		163,614.9	0.0	0.0%
2021		183,099.9	0.0	0.0%
2022		170,034.1	0.0	0.0%
10-year average yield		154,838.3	**Pure premium**	6.1%
			Gross premium rate	8.8%

Source: Authors' calculations based on Statistical Office of the Republic of Serbia (2023) and World Bank (2023)

Similarly, applying the proposed model, we derived the pure premium and gross premium rate for index-based insurance of industrial crops (*Table 3.*) and fodder plants (*Table 4.*) in the case of Serbia.

Table 3. The calculation of the premium rate for index-based insurance for industrial crops

Year	Historical annual yield in constant prices .(base year 2013, RSD million)		Sum of incurred losses (negative deviation from the 10-year average yield, RSD million)	Loss cost ratio
2013		51,487.0	5,256.5	10.8%
2014		53,283.3	4,460.2	7.7%
2015		46,858.9	10,884.6	18.8%
2016		56,312.5	1,431.0	2.5%
2017		54,142.9	3,600.5	6.2%
2018		56,815.9	927.5	1.6%
2019		56,343.4	1,400.0	2.4%
2020		60,908.7	0.0	0.0%
2021		75,130.2	0.0	0.0%
2022		66,151.9	0.0	0.0%
10-year average yield		57,743.5	**Pure premium**	5.0%
			Gross premium rate	7.2%

Source: Authors' calculations based on Statistical Office of the Republic of Serbia (2023) and World Bank (2023)

Table 4. The calculation of the premium rate for index-based insurance for fodder plants

Year	Historical annual yield in constant prices .(base year 2013, RSD million)		Sum of incurred losses (negative deviation from the 10-year average yield, RSD million)	Loss cost ratio
2013		16,626.0	6,836.7	29.1%
2014		23,205.0	257.7	1.1%
2015		16,959.0	6,503.7	27.7%
2016		25,856.1	0.0	0.0%
2017		19,440.6	4,022.2	17.1%
2018		26,030.9	0.0	0.0%
2019		29,936.1	0.0	0.0%
2020		35,108.0	0.0	0.0%
2021		22,186.5	1,276.2	5.4%
2022		19,279.0	4,183.7	17.8%
10-year average yield		23,462.7	**Pure premium**	9.8%
			Gross premium rate	14.1%

Source: Authors' calculations based on Statistical Office of the Republic of Serbia (2023) and World Bank (2023)

In order for index-based crop insurance to become technically, operationally, and financially feasible in Serbia, specific prerequisites must be fulfilled.

The choice of the SPI indicator as a weather parameter for index-based crop insurance is driven by several factors. Because it is normalized, the SPI indicator is equally effective in analyzing both extremely dry and extremely wet conditions (Svoboda et al., 2012). This makes it suitable for application in index-based insurance against drought as well as against flood. Empirical studies show a strong correlation between the yields of various agricultural crops and the values of this index (Vicente-Serrano et al., 2012; Zurovec & Cadro, 2012; Okpara et al., 2017; Hohl et al., 2020), often attributing better performance to it compared to other indices (Guttman, 1998; Mpelasoka et al., 2008; Luković & Pantović, 2023). Moreover, the prevailing indices investigated in the index-based crop insurance literature are rainfall-based, such as SPI (Abdi et al., 2022). Rainfall is typically unevenly distributed over time and territorially. Due to its standardization, the SPI indicator can be used to compare precipitation anomalies for any location and for any accumulation period (European Drought Observatory, 2020). Additionally, since it is based on only one parameter (precipitation), the SPI is less complex to compute than other indices that also take into account variations in other parameters such as temperature, soil moisture, etc. Furthermore, by not relying on soil moisture conditions, the SPI can be effectively utilized in both summer and winter (Hayes at al., 1999). The SPI has already been successfully implemented in index-based insurance in agriculture. In Argentina, a pilot insurance program used SPI to compensate dairy farmers for reduced milk production in the event of drought (SPI < -2.0) or excessive rainfall (SPI > +2.0) (Mercosur Group, 2016). Finally, the SPI is already being calculated monthly in Serbia based on data from meteorological stations and using a reference period from 1961 to 2005 (Republic Hydrometeorological Service of Serbia, 2009). This is a prerequisite for its use in the proposed index-based insurance model.

The suggested insured sum of EUR 1,000 is essential for this insurance to be applicable in practice and achieve a positive technical result. The insured yield value of each agricultural producer opting for this type of insurance must not be less than EUR 1,000. The maximum amount of sum insured is set at this level to ensure affordability of this insurance, providing partial compensation to farmers immediately after a disaster when it is most needed, and to facilitate the adoption of this insurance in Serbia in line with economic capabilities of agricultural sector.

In index-based insurance, payouts are triggered not by the occurrence of specific economically harmful events, but by the crossing of a predefined threshold by a parameter, such as the SPI index in our case. To enable the implementation of this insurance type in Serbia, amendments to current legal regulations are necessary. These amendments would allow for deviations from the principle of indemnification in index-based insurance, permitting payouts even when no damage has occurred or when the damage is negligible. Until the relevant regulations are amended, modified index-based insurance can be applied, ensuring that payouts are made only to policyholders who have actually suffered losses.

Additionally, index-based insurance in Serbia should be mandatory in order to be sustainable. This insurance would cover all registered agricultural households in Serbia engaged in the crop production, with a minimum production value of EUR 1,000. The premium rate calculation was performed under the assumption of broad coverage across both space and time, which would enable the leveling of flood and drought risks at the lowest level. This can only be achieved if this type of insurance is mandatory.

Experiences from other countries show that without significant premium subsidies, uptake rates of index-based crop insurance remain low (Miranda & Gonzalez-Vega, 2011). The subsidization of index-based insurance premiums by the government and local authorities is necessary to make this type of insurance acceptable for rural population in terms of the premium costs they need to bear. The government should subsidize 50% of the premium to make this insurance affordable for farmers and sustainable until sufficient reserves are established.

In order to accurately determine precipitation accumulation, which forms the basis of the SPI index, it is necessary to have a sufficient number of meteorological stations. Having enough meteorological stations across the entirety of Serbia is crucial for accurately calculating the SPI index, which is updated monthly.

Finally, to ensure sufficient premium rates and the sustainability of the crop insurance market, it is essential to establish a unified database for agricultural losses (Stojanović et al., 2019). A limiting factor for the application of the proposed model for determining premium rates in index-based crop insurance is the inability, based on available data, to discern the extent to which yield shortfalls relative to the average yield are attributable to floods or droughts. Developing a unified database of agricultural losses from various risk sources would enhance the accuracy of calculating premium rates for flood and drought insurance in accordance with the proposed model. Additionally, it would facilitate the development of new insurance products to cover other risks affecting agriculture.

Conclusions

Increasingly frequent natural disasters tend to disproportionately affect impoverished rural populations. Floods and droughts result in escalating financial losses for farmers. Poor countries provide financial support according to their means, which are significantly constrained. In such circumstances, finding adequate financial mechanisms for managing flood and drought risks in the agricultural sector becomes imperative for sustainable development. Unfortunately, the penetration rate of traditional indemnity-based crop insurance in underdeveloped and developing countries is very low. For these reasons, this paper aims to shed light on index-based crop insurance and explore the possibilities and limitations of its broader implementation in Serbia. We have introduced a novel model for determining premium rates in index-based crop insurance and outlined prerequisites necessary for this insurance to become operational, technically sound, and financially viable in Serbia.

The proposed model for calculating premium rates in index-based crop insurance represents a combination of the loss cost method and the average yield method. The model is versatile and could be applied in any country, with adjustments to its parameters based on statistical data regarding precipitation amounts and hazard zones specific to that country. Prerequisites for successful and widespread implementation of index-based crop insurance in Serbia include legislative changes, introducing mandatory elements, subsidizing insurance premiums, and establishing a unified database of agricultural damages.

The study can be further deepened by examining the use of alternative indices that might capture drought and flood risks faced by farmers. Another research possibility is investigating methods to improve the accuracy of the chosen SPI index by incorporating machine learning algorithms. Also, a useful topic for future research would be to explore the feasibility of incorporating climate change scenarios into the premium calculation process. Finally, it would be valuable to examine the potential integration of index-based insurance with other financial instruments, such as loans or savings products, to create comprehensive risk management strategies for farmers.

Conflict of interests

The authors declare no conflict of interest.

References

1. Abdi, M. J., Raffar, N., Zulkafli, Z., Nurulhuda, K., Rehan, B. M., Muharam, F. M., Khosim, N. A., & Tangang, F. (2022). Index-based insurance and hydroclimatic risk management in agriculture: A systematic review of index selection and yield-index modelling methods. *International Journal of Disaster Risk Reduction,* 67, 1-12, doi: 10.1016/j.ijdrr.2021.102653
2. Abramowitz, M., & Stegun, I. A. (eds) (1965). *Handbook of mathematical formulas, graphs, and mathematical tables.* Dover Publications Inc, New York.
3. Adjabui, J. A., Tozer, P. R., & Gray, D. I. (2019). Willingness to participate and pay for index-based crop insurance in Ghana. *Agricultural Finance Review,* 79(4), 491-507. doi: 10.1108/AFR-01-2019-0001
4. Ali, A. (2013). Farmers' willingness to pay for index based crop insurance in Pakistan: a case study on food and cash crops of rain-fed areas. *Agricultural Economics Research Review,* 26(2), 241-248.
5. Angelidis, P., Maris, F., Kotsovinos, N., & Hrissanthou, V. (2012). Computation of Drought Index SPI with Alternative Distribution Functions. *Water Resources Management,* 26(9), 2453–2473. doi:10.1007/s11269-012-0026-0
6. Benso, M. R., Gesualdo, G. C., Silva, R. F., Silva, G. J., Castillo Rápalo, L. M., Navarro, F. A. R., Silva, R. F., & Mendiondo, E. M. (2023). Design and evaluation of weather index insurance for multi-hazard resilience and food insecurity. *Natural Hazards and Earth System Sciences,* 23(4), 1335-1354, doi: 10.5194/nhess-23-1335-2023
7. Brown, R. L., & Gottlieb, L. R. (2007). *Introduction to ratemaking and loss reserving for property and casualty insurance.* Actex Publications, Winsted.
8. Bucheli, J., Dalhaus, T., & Finger, R. (2021). The optimal drought index for designing weather index insurance. *European Review of Agricultural Economics,* 48(3), 573-597. doi:10.1093/erae/jbaa014
9. Carter, M., de Janvry, A., Sadoulet, E., & Sarris, A. (2017). Index insurance for developing country agriculture: a reassessment. *Annual Review of Resource Economics,* 9, 421-438, doi: 10.1146/annurev-resource-100516-053352
10. Cvijanović, D., Vojinović, Ž., Sedlak, O., Sekulić, D. (2018). The risk management and the insurance of agricultural production. *The CAP and national priorities within the EU budget after 2020,* Wigier, M., Kowalski, A. (eds.), Institute of Agricultural and Food Economics, Warsaw, 125-143. doi: 10.30858/pw/9788376587516
11. Dusmanescu, D., Andrei, J., & Subic, J. (2014). Scenario for implementation of renewable energy sources in Romania*. Procedia Economics and Finance*, 8, 300-305.
12. European Drought Observatory (2020). The Standardized Precipitation Index (SPI). *EDO Indicator Factsheet,* Retrieved from https://edo.jrc.ec.europa.eu/documents/factsheets/factsheet_spi.pdf (November 30, 2023)

13. Fedajev, A., Pantović, D., Milošević, I.., Vesić, T., Jovanović, A., Radulescu, M, Stefan, M.C, (2023), Evaluating the Outcomes of Monetary and Fiscal Policies in the EU in Times of Crisis: A PLS-SEM Approach. *Sustainability*, 15 (11), 8466.
14. Fedajev, A., Durkalić, D. i Riznić, D., (2016). Impact Of Natural Disasters Agriculture Production In The Western Balkans Countries, *XXIV International Conference "Ecological Truth" Eco-Ist'16*, Vrnjacka Banja, Serbia, 603-610.
15. Fonta, W. M., Sanfo, S., Kedir, A. M., & Thiam, D. R. (2018). Estimating farmers' willingness to pay for weather index-based crop insurance uptake in West Africa: Insight from a pilot initiative in Southwestern Burkina Faso. *Agricultural and Food Economics,* 6(1), 1-20.
16. Guttman, N. B. (1998). Comparing the Palmer Drought Index and the Standardized Precipitation Index. *Journal of the American Water Resources Association,* 34, 113-121. doi: 10.1111/j.1752-1688.1998.tb05964.x
17. Hayes, M. J., Svoboda, M. D., Wiihite, D. A., & Vanyarkho, O. V. (1999). Monitoring the 1996 drought using the standardized precipitation index. *Bulletin of the American Meteorological Society,* 80(3), 429-438. doi: 10.1175/1520-0477(1999)080<0429:MTDUTS>2.0.CO;2
18. Hazell, P. B. R. (1992). The appropriate role of agricultural insurance in developing countries. *Journal of International Development,* 4(6), 567-581. doi: 10.1002/jid.3380040602
19. Hohl, R., Jiang, Z., Vu, M. T., Vijayaraghavan, S., & Liong, S. Y. (2020). Using a regional climate model to develop index-based drought insurance for sovereign disaster risk transfer. *Agricultural Finance Review,* 81(1), 151-168. doi: 10.1108/AFR-02-2020-0020
20. Kozarević, S., Ćetković, J. (2022). Willingness of agricultural producers to pay the cost of insurance against natural disasters in Bosnia and Herzegovina. *Development of modern insurance market – constraints and possibilities,* Kočović, J., Jovanović Gavrilović, B., Stojanović, Ž., Mladenović, Z., Trifunović, D., Koprivica, M. (eds.), Faculty of Economics, Belgrade, 397-413.
21. Lin, J., Boyd, M., Pai, J., Porth, L., Zhang, Q., & Wang, K. (2015). Factors affecting farmers' willingness to purchase weather index insurance in the Hainan Province of China. *Agricultural Finance Review,* 75(1), 103-113. doi: 10.1108/afr-02-2015-0007
22. Lotsch, A., Dick, W., & Manuamorn, O. P. (2010). *Assessment of innovative approaches for flood risk management and financing in agriculture.* World Bank, Washington.
23. Luković, M., Pantović, D., Kostić, M., Veljović, S., Bugarčić, J. (2023), Food plant diversity in cultural ecosystem services perspective: edible plants as a driver for improving the offer of gastro-tourism, *Ecologica,* 30 (110), 201-208.
24. Luković, S. ., & Stojković, D. . (2020). Covid-19 pandemic and global tourism. *Hotel and Tourism Management*, 8(2), 79–87. https://doi.org/10.5937/menhottur2002079L

25. Luković, M., Pantović, D. (2023), Place of nature-based tourism in ecosystem services valuation in rural landscape, *Thematic proceedings International Scientific Conference: Sustainable agriculture and rural development III*, Institute of Agriculture Economics, Belgrade, Serbia, 419-431.
26. McKee, T. B., Doesken, N. J., & Kleist, J. (1993). The relationship of drought frequency and duration to time scales. In *Proceedings of the 8th Conference on Applied Climatology* (Vol. 17, No. 22, 179-183). American Meteorological Society.
27. Mercosur Group (2016). Parametric insurance applied to agricultural sector in the region of mercosur. *13th meeting of the AIDA Climate Change Working Party,* Lima.
28. Miranda, M. J., & Gonzalez-Vega, C. (2011). Systemic risk, index insurance, and optimal management of agricultural loan portfolios in developing countries. *American Journal of Agricultural Economics,* 93(2), 399-406, doi: 10.1093/ajae/aaq109
29. Mpelasoka, F., Hennessy, K., Jones, R.m & Bates, B. (2008). Comparison of suitable drought indices for climate change impacts assessment over Australia towards resource management. *International Journal of Climatology,* 28, 1283-1292.
30. Okpara, J. N., Afiesimama, E. A., Anuforom, A. C., Owino, A., & Ogunjobi, K. O. (2017). The applicability of Standardized Precipitation Index: drought characterization for early warning system and weather index insurance in West Africa. *Natural Hazards*, 89, 555-583. doi: 10.1007/s11069-017-2980-6
31. Pantović, D., Bošković, N., & Petrović, T. (2022). Measuring Convergence in Tourism Competitiveness of Natural and Cultural Resources: A Case of the Balkans and Eastern Europe. *Ekonomický časopis*, 910 (70/2022), 703 – 722.
32. Sima, V., & Gheorghe, I. G. (2015). Changing consumption patterns in green economy. *In Agricultural management strategies in a changing economy* (pp. 186-212). IGI Global.
33. Schnitkey, G., & Sherrick, B. (2014). Crop insurance. *Encyclopedia of Agriculture and Food Systems,* van Alfen, N. K. (ed.), Academic Press, 399-407, doi: 10.1016/B978-0-444-52512-3.00115-7
34. Statistical Office of the Republic of Serbia (2003-2023). *Statistical Yearbook of the Republic of Serbia.* Belgrade.
35. Stojanović, Ž., Rakonjac-Antić, T., & Koprivica, M. (2019). Farmers willingness to purchase crop insurance: evidence from wheat and raspberry sectors in Serbia. *Economics of Agriculture,* 66(4), 1107-1125. doi: 10.5937/ekoPolj1904107S
36. Svoboda, M., Hayes, M., & Wood, D. (2012). *Standardized Precipitation Index User Guide.* World Meteorogical Organization, Geneva.
37. Swiss Re (2023). Natural catastrophes and inflation in 2022: a perfect storm. *Sigma,* 1/2003.
38. Sulyok, J., Lőrincz, K., & Veres, Z. (2022). Whose responsibility is it? – Evaluation of sustainable tourism development at Lake Balaton . *Hotel and Tourism Management*, 10(2), 9–23. https://doi.org/10.5937/menhottur2202009S

39. United Nations (2015). The 2030 Agenda for Sustainable Development. Retrieved from https://sustainabledevelopment.un.org/post2015 (December 10, 2023)

40. Vicente-Serrano, S. M., Beguería, S., Lorenzo-Lacruz, J., Camarero, J. J., López-Moreno, J. I., Azorin-Molina, C., Revuelto, J., Morán-Tejeda, E., & Sanchez-Lorenzo, A. (2012). Performance of drought indices for ecological, agricultural, and hydrological applications. *Earth Interactions,* 16(10), 1-27. doi: 10.1175/2012EI000434.1

41. Wang, Q., Zhang, R., Qi, J., Zeng, J., Wu, J., Shui, W., Wu, X., & Li, J. (2022). An improved daily standardized precipitation index dataset for mainland China from 1961 to 2018. *Scientific Data,* 9(1), 124, 1-12. doi: 10.1038/s41597-022-01201-z

42. World Bank (2023). World Development Indicators, Retrieved from https://data.worldbank.org/indicator/FP.CPI.TOTL?locations=RS (January 20, 2024)

43. Žarković, N., Miloradić, J., & Samardžić, S. (2016). The risk of drought in crop production insurance. *Economics of Agriculture,* 63(4), 1297-1308, doi: 10.5937/ekoPolj1604297Z

44. Zhang, W., Furtado, K., Wu, P., Zhou, T., Chadwick, R., Marzin, C., Rostron, J., & Sexton, D. (2021). Increasing precipitation variability on daily-to-multiyear time scales in a warmer world. *Science Advances,* 7(31), doi: 10.1126/sciadv.abf8021

45. Zurovec, J., & Cadro, S. (2012). The relationship between Standardized Precipitation Index and yield reduction of significant agricultural crops in North-eastern Bosnia. *Proceedings of the 22nd International Scientific-Expert Conference of Agriculture and Food Industry,* Ege University, Faculty of Agriculture, Sarajevo, 265-268.

46. Кочовић, Ј., Ракоњац Антић, Т., & Јововић, М. (2016). Могућности развоја осигурања пољопривреде у Србији. *Стање и перспективе агропривреде и села у Србији,* Стојановић, Ж., Богданов, Н. (ур.), Економски факултет, Београд [*in English*: Kočović, J., Rakonjac Antić, T., & Jovović, M. (2016). Possibilities for the development of agriculture insurance in Serbia. *Status and Perspectives of Agribusiness and Rural Areas in Serbia,* Stojanović, Ž., Bogdanov, N. (eds.), Faculty of Economics, Belgrade], 205-224.

47. Кочовић, Ј., Ракоњац Антић, Т., Копривица, М., Шулејић, П. (2021). *Осигурање у теорији и пракси,* Економски факултет, Београд [*in English*: Kočović, J., Rakonjac Antić, T., Koprivica, M., & Šulejić, P. (2021). *Insurance in Theory and Practice,* Faculty of Economics, Belgrade].

48. Републички хидрометеоролошки завод Србије (2009). Мониторинг услова влажности/суше у Србији – Анализа промена у појави суше и топлотним условима. *Климатске промене и пољопривредна производња у Србији* – други национални скуп, Нови Сад [*in English*: Republic Hydrometeorological Service of Serbia (2009). Monitoring of humidity/drought conditions in Serbia - Analysis of changes in the occurrence of drought and thermal conditions. *Climate change and agricultural production in Serbia* - second national meeting, Novi Sad] Retrieved from https://www.hidmet.gov.rs/data/agro/klipro_agrorhmzs.pdf (December 20, 2023)

THE OCCURRENCE, PERSISTENCE, AND COSTS OF ACIDOSIS-RELATED ISSUES IN DAIRY COWS CONCERNING PARITY

Vesna Gantner[1], Franjo Poljak[2], Tina Bobić[3], Ranko Gantner[4], Zvonimir Steiner[5], Klemen Potočnik[6]

**Corresponding author E-mail: vgantner@fazos.hr*

ARTICLE INFO

Original Article

Received: *14 February 2024*

Accepted: *15 March 2024*

doi:10.59267/ekoPolj2402413G

UDC 636.2.09:616.152.11

Keywords:

dairy cows; milk production; acidosis; occurrence; persistence; cost

JEL: *Q16*

ABSTRACT

This study aimed to assess the occurrence, persistence, and cost implications of acidosis-related issues in dairy cows concerning parity, utilizing over 8 million test-day records of Holstein and Simmental breeds. The data analysis revealed that the analyzed issues in dairy cattle populations vary regarding the breed and parity. The Holsteins had a higher occurrence of acidosis compared to the Simmentals. Furthermore, Holsteins exhibited a more significant prevalence of acidosis in younger animals, while Simmentals demonstrated an increased incidence in older cows. The acidosis risk significantly reduced milk production in first-parity Holsteins, while older cows were more resilient. Among the Simmental breed, the effect of acidosis risk was limited to first-parity animals. The occurrence of acidosis in both breeds resulted in a significant and persistent reduction in milk production in older cows. Overall, results suggest the importance breed-specific management to minimize the occurrence of acidosis and maximize animal health and productivity.

1 Vesna Gantner, Full Professor, Faculty of Agrobiotechnical Sciences Osijek, J.J. Strossmayer University of Osijek, Vladimira Preloga 1, Osijek, 31000, Croatia; Phone: +385992074490, E-mail: vgantner@fazos.hr, ORCID ID: (https://orcid.org/0000-0002-1962-3131)

2 Franjo Poljak, mag.ing., Croatian Agency for Agriculture and Food, Vinkovačka cesta 63c, Osijek, 31000, Croatia; E-mail: franjo.poljak@hapih.hr

3 Tina Bobić, Associate Professor, Faculty of Agrobiotechnical Sciences Osijek, J.J. Strossmayer University of Osijek, Vladimira Preloga 1, Osijek, 31000, Croatia; Phone: +385992074490, E-mail: tbobic@fazos.hr, ORCID ID (https://orcid.org/0000-0001-9975-1258)

4 Ranko Gantner, Full Professor, Faculty of Agrobiotechnical Sciences Osijek, J.J. Strossmayer University of Osijek, Vladimira Preloga 1, Osijek, 31000, Croatia; E-mail: rgantner@fazos.hr, ORCID ID (https://orcid.org/0000-0001-5426-4886)

5 Zvonimir Steiner, Full Professor, Faculty of Agrobiotechnical Sciences Osijek, J.J. Strossmayer University of Osijek, Vladimira Preloga 1, Osijek, 31000, Croatia; E-mail: zsteiner@fazos.hr, ORCID ID (https://orcid.org/0000-0002-4007-2231)

6 Klemen Potočnik, Associate Professor, Department of Animal Science, Biotechnical faculty, University of Ljubljana, Domžale, 1230, Slovenia; E-mail: klemen.potocnik@bf.uni-lj.si, ORCID ID (https://orcid.org/0000-0003-0734-5733)

Introduction

Metabolic disorders can significantly affect dairy cattle health and productivity (Aitken, 2016). Some of the most common forms include hypocalcaemia (low levels of calcium in the blood), hypomagnesaemia (low levels of magnesium in the blood), and hypophosphataemia (low levels of phosphorus in the blood). Other types of metabolic disorders include fatty liver, in which excess fat accumulates in liver cells; ketosis, which occurs frequently during early lactation and may be associated with other problems such as fat cow syndrome, retained placenta, mastitis, metritis, and displaced abomasum; and ruminal acidosis, in which the pH of the rumen is abnormally low. Furthermore, acidosis represents one of the significant challenges affecting the dairy industry.

According to Antanaitis et al. (2019), acidosis has long-term health and economic consequences, making it a pressing issue in the dairy cattle production industry. Subacute ruminal acidosis (SARA) is a type of acidosis that occurs when there is impaired ruminal health, resulting in a depression of ruminal pH (Danscher et al., 2015). SARA is typically characterized by a ruminal pH that falls below 5.5-5.8 (Plaizier et al., 2008; Zebeli and Metzler-Zebeli, 2012; Danscher et al., 2015.), and it is caused by the consumption of diets high in readily fermentable carbohydrates and low in effective fiber such as grains. The consumption of these diets leads to the production of organic acids that exceed the buffering capacity of the rumen, leading to acidosis. As explained by Nagaraja and Titgemeyer (2007) and Golder et al. (2023), acidosis has severe implications for dairy cattle health and production, and its early detection is crucial for enabling sustainable business. According to Humer et al. (2017), the direct measurement of ruminal pH is the gold standard for SARA detection in cows. However, other indirect parameters, such as the observation of chewing and feeding activities, as well as the monitoring of milk, faecal, urine, and blood variables, can also be used to identify cows at risk. Furthermore, it is recommended to use more than one signal to reliably detect cows at risk of SARA. Given the significant farm costs caused by acidosis, early detection is crucial for enabling sustainable business and promoting animal welfare. Therefore, it is essential to implement effective management practices, such as monitoring feeding practices and rumen health, to prevent and manage acidosis in dairy cattle. Prompt recognition of the potential onset and avoidance of the development of a more severe disorder phase can be achieved through the use of existing data; that is test-day records. Test-day records include data on daily milk output, fat and protein content, and fat-to-protein ratio (F/P ratio). When compared to specific diagnostics, the use of such data is far less expensive and non-invasive (Eicher, 2004).

The prevalence and the effect of acidosis can vary depending on lactation stage and parity, breed, breeding region, etc. For instance, Gantner et al. (2016) reported the highest acidosis prevalence risk within the first 10 days of lactation, with the indication from 16 to 23 %, depending on parity. Similarly, Bramley et al. (2005) and O'Grady et al. (2008) found that between 10 and 15% of dairy cows grazing ryegrass-based pastures perennially have SARA. Golder et al. (2023) reported differences in acidosis risk between regions, with Australia (37.2%) and California (39.2%) having similar prevalence of cows at a high risk of acidosis, whereas Canada had only 5.2%. Furthermore, Bramley et al. (2008); and Stauder et al. (2020) confirmed the effect of parity and stated that primiparous cattle usually have a higher risk of acidosis than multiparous cattle. The reason is that the primiparous cattle have had less exposure to high levels of energy-dense feeds (Humer et al., 2018). According to Penner et al. (2007) and Bramley et al. (2008), they may have fewer rumen papillae and a less-adapted rumen microbiome than older cows.

Since acidosis represents a frequent problem at dairy cattle farms, this study sought to investigate the occurrence, persistence, and cost implications of acidosis-related problems in Holstein and Simmental cows with respect to their age (parity).

Materials and methods

The research was carried out using the milk recording database of dairy cattle that were bred and under the selection in Croatia. The data was received from the Croatian Agency for Agriculture and Food (HAPIH). In Croatia, milk recording is performed using the alternative AT4/BT4 method, which requires measuring and sampling milk from each cow in production during morning or evening milking every four weeks. Milk samples are analysed at HAPIH's Central Laboratory for Milk Quality Control (SLKM) in order to detect the percentages of milk fat, protein, lactose, dry matter, dry matter without fat, urea, and freezing temperature. The chemical quality of milk is determined using infrared spectrophotometry by MilkoScan analyzers. Furthermore, the International Committee for Animal Recording (ICAR, 2017) has defined the procedure for taking milk samples during milk recording, as well as laboratory testing of samples. During the logical data control process, any test-day records outside the following ranges were eliminated from the database: daily milk yield below 3 kg or over 100 kg, daily milk fat content below 1.5% or over 9%, daily protein content below 1% or over 7%, and daily lactose content below 3% or over 6%. Moreover, test-day records with missing or illogical values for lactation stage (below 5 days or over 400 days), parity (below 1 or over 10), age at first calving (below 21 or over 36 months), calving date, milk recording date, and herd code were also removed from the database. Following the logical data control process, the database contained 4,922,751 test-day records for dairy Simmental cows and 3,953,637 test-day records of Holstein cows. These records were recorded between January 1st, 2005 and December 31st, 2022. The cows were classified into four groups depending on their parity: I., II., III., and IV. +. The herd was divided into five classes based on its size, ranging from less than 5 cows to 200 - 500. The test-day records were further divided into four different seasons based on the month of milk recording: winter (December, January, and February), spring (March, April, May), summer (June, July, August), and autumn (September, October, and November). The daily fat-to-protein ratio (F/P) was used to assess the risk of developing acidosis or acidosis occurrence (Eicher, 2004). F/P ratios < 1.1 indicated acidosis risk, while F/P < 1.1 in cows yielding 20 to 43 kg/day indicated the occurrence of subclinical acidosis.

The occurrence of acidosis risk or acidosis in the population of dairy cows refers to the percentage of cows with F/P < 1.1 (and daily milk yield of 20 to 43 kg/day), from the total number of animals. The occurrence was calculated separately for each parity class and breed. To analyse the effect of acidosis occurrence on daily production, only cows at acidosis risk/acidosis were included in the study. As the referent value, daily milk yield at the date of acidosis occurrence was taken. The acidosis index was determined based on the number of days after the acidosis detection, with D-0 being the test-day record on the day of detection, A-1 within 35 days, A-2 between 36 and 70 days, A-3 between 71 and 105 days, and A-4 more than 105 days. The effect of the acidosis index on daily milk yield was analysed separately by parity class and breed using the following statistical model:

$$y_{ijklmno} = \mu + b_1\left(\frac{d_i}{305}\right) + b_2\left(\frac{d_i}{305}\right)^2 + b_3\,ln\left(\frac{305}{d_i}\right) + b_4\,ln^2\left(\frac{305}{d_i}\right) + A_j + P_k + S_l + H_m + M_{nm} + e_{ijklmno} \quad (1)$$

where:

Y_{ijklmn} = estimated daily milk yield;

μ = intercept;

b_1, b_2, b_3, b_4 = regression coefficients;

d_i = stage of lactation (i = 6 to 400 day);

A_j = fixed effect of age at first calving (j = 21 to 36 month) * only for firs parity;

P_k = fixed effect of parity k (k = I., II., III., IV. +);

S_l = fixed effect of season l (l = spring, summer, autumn, winter);

H_k = fixed effect of herd size k (k = I, II, III, IV, V, VI);

M_m = fixed effect of acidosis index m (m = D–0, A–1, A–2, A–3, A–4);

e_{ijklm} = residual.

The statistical significance of the differences between estimated LsMeans was tested by Scheffe's method of multiple comparisons in the MIXED procedure (SAS Institute Inc., 2019). The persistence and cost implications of acidosis were analysed in the four-month period after the acidosis occurrence. The monthly difference was equal to the product of the difference between the estimated daily milk yields at the successive milk recordings and the interval between those recordings. The total difference, in the analysed period, in milk yield (kg) and value (euro) was presented accordingly to parity and breed. The value of milk was calculated according to the current EU price of raw milk amounted 48.00 Eur/100 kg (EC, 2024).

Results

Analysed data on Holstein cows reveal that the likelihood of acidosis-related health issues varies depending on the parity of the animal. The occurrence of Holstein cows at risk of acidosis regarding the parity ranged from 30.26% in the oldest cows in the fourth and higher parities to 32.20% in animals in the second parity (figure 1). The highest occurrence of animals without risk of acidosis-related problems was observed in primiparous cows, with 56.87% being healthy. Furthermore, the occurrence of Holstein cows at acidosis regarding the parity is presented in Figure 2. The highest occurrence of healthy animals (72.89%), and the lowest occurrence of animals with acidosis (22.38%) was observed in the oldest animals (IV. +), while the highest occurrence of cows with acidosis was determined in Holstein cows in first lactation (27.03%). Observed indicates that the risk of developing acidosis in Holstein population decreases as the parity of the cow increases.

Figure 1. The occurrence of Holstein cows at risk of acidosis regarding the parity.

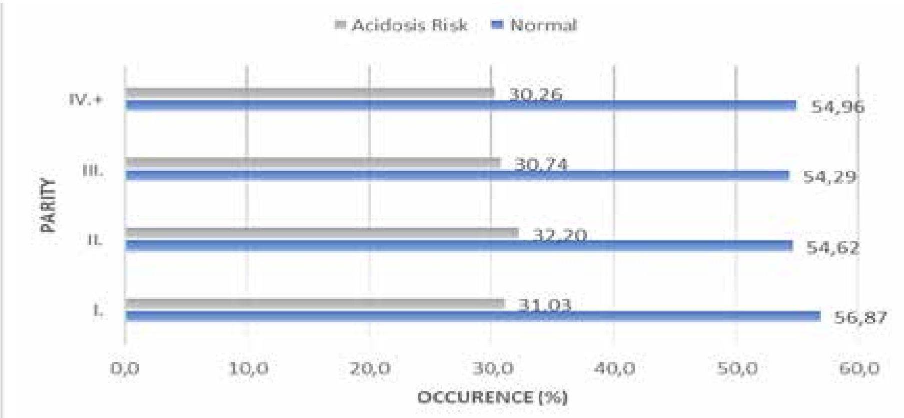
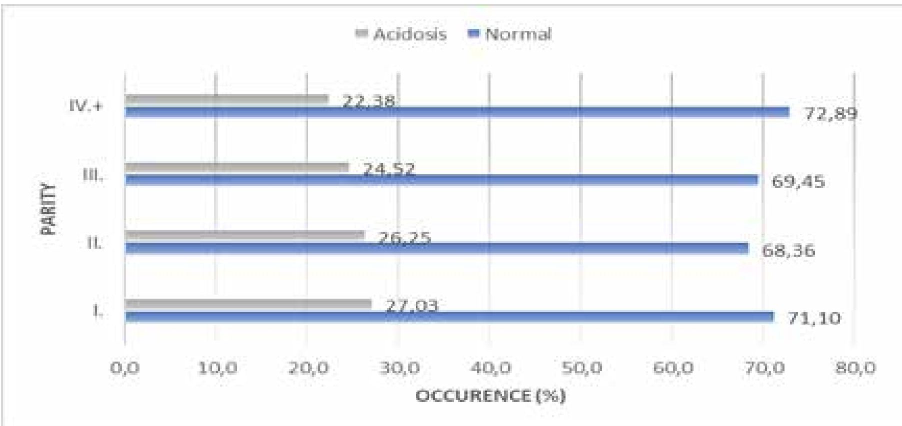


Figure 2. The occurrence of Holstein cows at acidosis regarding the parity.



The analysis of acidosis-related problems in the Simmental population is presented in Figures 3 and 4. The figures show that out of the total Simmental cow population, 30.35% of the animals were at risk of developing acidosis, with the highest risk found in cows in IV. + parities (32.44%) and the lowest risk in first parity cows at 26.92%. This indicates that the risk of developing acidosis increases as the parity of the cow increases. In terms of the occurrence of acidosis (Figure 4), the data shows that 87.12% of the Simmental cow population did not develop acidosis-related problems. However, acidosis was found to be most prevalent in cows in the third lactation at 14.10%, while those in the first lactation had the lowest occurrence of acidosis at 10.12%. This suggests that Simmental cows in their third lactation are more prone to developing acidosis than those in their first lactation. Overall, these findings demonstrate the importance of monitoring the occurrence of acidosis in Simmental cows, particularly in those in their later lactations, to ensure their health and productivity.

Figure 3. The occurrence of Simmental cows at risk of acidosis regarding the parity.

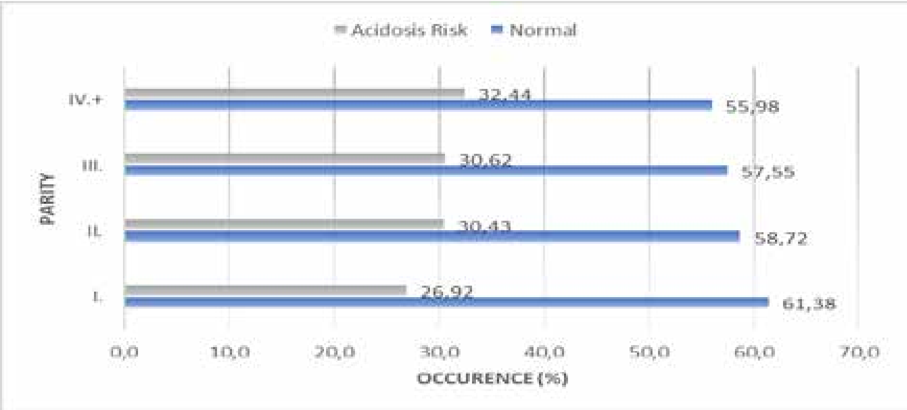
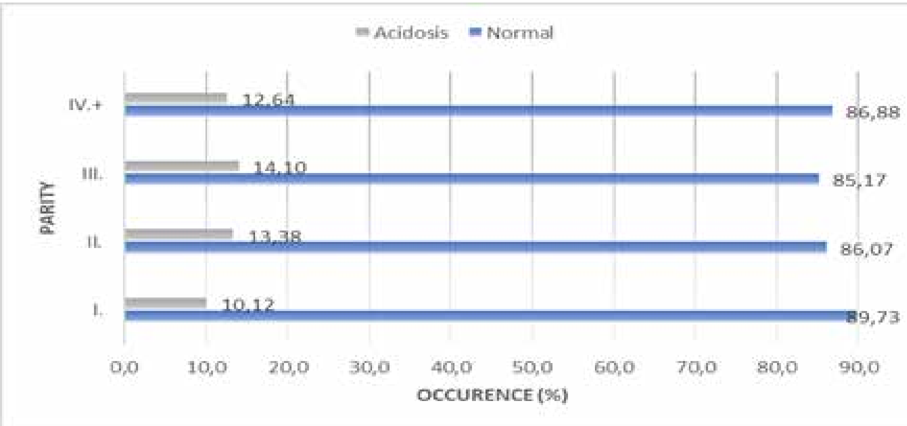


Figure 4. The occurrence of Simmental cows at acidosis regarding the parity



Furthermore, the analysis of the prevalence of acidosis-related issues in the dairy cow population revealed significant breed-related differences. Specifically, the Holstein population exhibited a higher incidence of acidosis than the Simmental breed, and the observed trend varied between the two breeds. In the case of Holstein cows, the occurrence was more pronounced in younger animals, while in Simmental cows, it was more frequent in older cows.

The statistical analysis confirmed that the risk of acidosis/acidosis significantly affected daily milk yield in both cattle breeds (Table 1). The LsMeans for daily milk yield in Holsteins at risk of acidosis varied from 23.52 kg/day on the day when the risk was determined (D-0) to 23.13 kg/day four months later (A-4) in the first parity animals; from 25.37 kg/day at A-2 to 25.04 kg/day at A-4 in the second parity; from 25.60 kg/day at A-1 to 24.43 kg/day at A-3 in the third parity; and from 24.25 kg/day at A-1 and A-2 to 23.88 kg/day at A-4 in the oldest animals (in fourth and higher parities). In Holstein cows in the first lactation during the entire analysed period of 4 months, the daily amount of milk continues to fall continuously after the risk of acidosis, while in cows in the second lactation, a decrease in the amount of milk is recorded at the first subsequent milk recording, while at the second one, there was an evident increase. Furthermore, in older cows (in the third, fourth and higher lactations) an increase in the amount of milk in the milk recordings after the risk of acidosis appeared. This indicates that the persistence of the effect of acidosis risk was most pronounced in primiparous, while older cows regenerate faster and return to productivity.

In Holstein cows in acidosis, the lowest daily milk yield, followed by an increase, was determined when acidosis occurred in the first parity cows (23.15 kg/day), while in older cows the lowest daily production occurred four months after the acidosis occurrence, with the continuous persistent decrease in cows in IV. + parity. This indicates that the persistence of the effect of acidosis occurrence was most pronounced in the oldest cows, while younger animals were able to restore their production potential faster. The established results indicate the opposite trend of the persistence of the effect of acidosis depending on, whether it is the risk of the occurrence or the occurrence of acidosis.

In cows of the Simmental breed, the daily amount of milk after the established risk of developing acidosis was higher at the first subsequent milk recording (17.12 vs 17.20 kg/day; 17.94 vs. 18.13 kg/day; 18.50 vs. 18.83 kg/day; 17.19 vs. 17.43 kg/day in animals in I., II., III., or IV. + parity), while at the next recording, there was mostly an insignificant decrease in production (Table 1). Furthermore, in Simmental breeds, a continuous drop in milk production after the occurrence of acidosis was evident in all parties. Obtained implicate significant and persistent negative effects of acidosis occurrence on milk production of dairy Simmental cows regardless of the animals age (parity).

Table 1. LsMeans of daily milk yields at and after the milk recording when acidosis risk/ acidosis occurred in accordance with the parity and breed

Parity	MR	Holstein				Simmental			
		Acidosis risk		Acidosis		Acidosis risk		Acidosis	
		Estim	StdEr	Estim	StdEr	Estim	StdEr	Estim	StdEr
I.	D-0	23.52	0.07	23.15	0.05	17.12	0.04	21.77	0.04
	A-1	23.32	0.07	23.26	0.05	17.20	0.04	19.88	0.04
	A-2	23.41	0.07	23.87	0.05	17.21	0.04	19.95	0.04
	A-3	23.18	0.07	24.15	0.05	17.09	0.04	19.65	0.04
	A-4	23.13	0.06	24.95	0.05	17.05	0.04	19.83	0.04
II.	D-0	25.31	0.05	27.61	0.05	17.94	0.05	22.48	0.05
	A-1	25.28	0.05	28.02	0.04	18.13	0.05	20.96	0.05
	A-2	25.37	0.05	27.28	0.04	18.12	0.05	20.80	0.05
	A-3	25.16	0.05	26.44	0.04	18.05	0.05	20.51	0.05
	A-4	25.04	0.05	25.28	0.04	17.98	0.05	20.52	0.05
III.	D-0	25.44	0.06	28.10	0.05	18.50	0.06	22.99	0.05
	A-1	25.60	0.06	28.49	0.05	18.83	0.06	21.58	0.05
	A-2	25.56	0.06	27.61	0.05	18.80	0.06	21.43	0.05
	A-3	24.43	0.06	26.66	0.04	18.72	0.06	21.08	0.05
	A-4	25.21	0.05	25.26	0.04	18.67	0.06	21.07	0.05
IV. +	D-0	24.07	0.06	27.41	0.06	17.19	0.04	22.32	0.05
	A-1	24.25	0.06	27.28	0.06	17.43	0.04	20.55	0.05
	A-2	24.25	0.06	26.40	0.05	17.40	0.04	20.42	0.05
	A-3	24.06	0.06	25.51	0.05	17.36	0.04	20.06	0.05
	A-4	23.88	0.05	24.33	0.05	17.33	0.04	20.01	0.05

*MR – milk recording; D-0 – milk recording when the acidosis prevalence was determined; A-1, A-2, A-3, A-4 – successive milk recordings; Estim – estimate; StdEr – standard error of estimate.

Source: Authors' calculations

Monthly and total differences in milk production (the amount and the value in Eur) after the occurrence of acidosis risk in accordance with the parity and breed are presented in Table 2. The occurrence of acidosis risk has been observed to result in a significant decrease in milk production in Holstein cows, particularly in first parity animals. The highest reduction in milk production was noticed in these cows, amounting to a total of 11.86 kg of milk or 5.69 euros. On the other hand, the lowest cost of acidosis risk occurrence was observed in the oldest Holstein cows, with a loss of only 2.82 euros (5.87 kg of milk). In the Simmental breed, the impact of acidosis risk on milk production was limited to animals in their first parity. The older cows were able to continue with milk production without any significant losses. This suggests that the consequences of acidosis risk may vary depending on the breed of cow and their parity.

Table 2. Estimated monthly and total differences in quantity and value of milk after the occurrence of acidosis risk in accordance with the parity and breed

Parity	Month 1		Month 2		Month 3		Month 4		Total difference	
	kg	euro	kg	euro	kg	euro	kg	euro	kg	euro
Holstein										
I.	-5.92	-2.84	2.45	1.18	-6.74	-3.24	-1.66	-0.80	-11.86	-5.69
II.	-0.81	-0.39	2.56	1.23	-6.31	-3.03	-3.54	-1.70	-8.10	-3.89
III.	4.57	2.19	-0.95	-0.46	-3.86	-1.85	-6.84	-3.28	-7.08	-3.40
IV. +	5.43	2.61	-0.01	0.00	-5.83	-2.80	-5.46	-2.62	-5.87	-2.82
Simmental										
I.	2.33	1.12	0.40	0.19	-3.59	-1.72	-1.31	-0.63	-2.18	-1.05
II.	5.63	2.70	-0.25	-0.12	-2.15	-1.03	-1.92	-0.92	1.30	0.62
III.	10.01	4.80	-1.09	-0.52	-2.33	-1.12	-1.41	-0.68	5.18	2.49
IV. +	7.24	3.48	-0.96	-0.46	-1.17	-0.56	-1.00	-0.48	4.12	1.98

Source: Authors' calculations

Monthly and total differences in milk production (the amount and the value in Eur) after the occurrence of risk in accordance with the parity and breed are presented in Table 3. The occurrence of acidosis in the Holstein population has led to a considerable reduction in milk production, particularly in older cows. The oldest cows experienced the highest losses in milk production, which amounted to 92.36 kg of milk and a value of 44.33 euros. Furthermore, while other cows showed a period of increased production in the first month following the acidosis occurrence, cows in IV. + parities had a continuous and persistent decline in milk production throughout the testing period. On the other hand, the youngest cows experienced a consistent increase in milk production, resulting in a total increase of 53.97 kg of milk, which is valued at 25.91 euros. The effects of acidosis were also observed in the Simmental breed, where the highest losses were also determined in the oldest cows, accounting for a reduction of 69.30 kg of milk. Similarly, younger Simmental cows were also affected by acidosis, resulting in a loss of around 58 kg of milk, valued at 28 euros.

Table 3. Estimated monthly and total differences in quantity and value of milk after the occurrence of acidosis in accordance with the parity and breed

Parity	Month 1		Month 2		Month 3		Month 4		Total difference	
	kg	euro	kg	euro	kg	euro	kg	euro	kg	euro
	Holstein									
I.	3.14	1.51	18.27	8.77	8.48	4.07	24.08	11.56	53.97	25.91
II.	12.31	5.91	-22.15	-10.63	-25.23	-12.11	-34.86	-16.73	-69.93	-33.57
III.	11.71	5.62	-26.53	-12.73	-28.53	-13.69	-41.79	-20.06	-85.14	-40.87
IV. +	-3.81	-1.83	-26.23	-12.59	-26.88	-12.90	-35.45	-17.02	-92.36	-44.33
	Simmental									
I.	-56.81	-27.27	2.17	1.04	-8.94	-4.29	5.32	2.55	-58.27	-27.97
II.	-45.36	-21.77	-4.83	-2.32	-8.85	-4.25	0.46	0.22	-58.58	-28.12
III.	-42.45	-20.38	-4.41	-2.12	-10.31	-4.95	-0.50	-0.24	-57.67	-27.68
IV. +	-53.22	-25.55	-3.79	-1.82	-10.98	-5.27	-1.32	-0.63	-69.30	-33.26

Source: Authors' calculations

Overall, it can be pointed out that the occurrence of acidosis has had a significant effect on milk production in both Holstein and Simmental cows, with the oldest cows being the most affected.

Discussions

Data analysis on Holstein and Simmental cows was conducted to determine the likelihood of acidosis-related health problems based on the cow's parity. The results showed that the risk of acidosis and acidosis occurrence varied depending on the age of the animal. For Holstein cows, the risk of acidosis was highest in the second parity (32.20%) and lowest in the oldest cows (IV. +) with 30.26%. The highest occurrence of cows with acidosis was noted in the first lactation (27.03%), while the lowest occurrence was in the oldest animals (IV. +; 22.38%). This suggests that the risk of developing acidosis in Holstein cows decreases with the age (parity) of the animal. For Simmental cows, the highest risk of acidosis was found in the oldest cows (IV. +) (32.44%), while the lowest risk was found in first parity cows (26.92%). The cows in third lactation had the highest occurrence of acidosis (14.10%), while the first lactation animals had the lowest occurrence (10.12%). This indicates that the risk of developing acidosis in Simmental cows increases as the parity of the cow increases. Furthermore, the analysis of the prevalence of acidosis-related issues in the dairy cow population revealed significant breed-related differences. Specifically, the Holstein population exhibited a higher incidence of acidosis than the Simmental breed, and the observed trend varied between the two breeds. In the case of Holstein cows, the occurrence was more pronounced in younger animals, while in Simmental cows, it was more frequent in older cows.

Several studies have confirmed the impact of parity on the prevalence of acidosis in dairy cattle (Penner et al., 2007; Bramley et al., 2008; Gantner et al., 2016; Humer et al., 2018; and Stauder et al., 2020). In particular, the studies by Bramley et al. (2008) and Stauder et al. (2020) have analyzed the effect of parity and have found that primiparous cattle are more susceptible to acidosis than multiparous cattle. This is because primiparous cattle have had less exposure to high levels of energy-dense feeds, as noted by Humer et al. (2018). Additionally, Penner et al. (2007) and Bramley et al. (2008) have suggested that younger cows may have fewer rumen papillae and a less-adapted rumen microbiome than older cows, which may further contribute to their increased risk of acidosis. On the other hand, Atkinson (2014) in the analysis of dairy cattle in UK, defined the rumen pH ≤5.5 as the indication of SARA and reported that there was no relationship between rumen pH and days in milk or parity.

The performed analysis confirmed that the risk of acidosis/acidosis significantly affected daily milk yield in both cattle breeds. In the first lactation of Holstein cows, milk production decreased steadily for four months after the risk of acidosis. For cows in the second lactation, milk production decreased only at the first milk recording, but increased at the second. In cows that had calved three or more times, milk production increased after the risk of acidosis. This indicates that the effect of acidosis risk was strongest in cows calved for the first time, while older cows recovered more quickly and returned to productivity. Reaction to acidosis occurrence in Holstein population differed regarding the animal's age (parity). Younger cows (from I. to III. parity) with acidosis tend to experience an increase in daily milk yield after the acidosis occurrence. This increase was most pronounced in first-party cows. Older cows, on the other hand, experience the lowest daily production four months after the onset of acidosis. The continuous decrease in cows in IV. + parity suggests that the effect of acidosis occurrence was most persistent in older cows, while younger cows were able to recover their production potential faster. The results indicate that the effect of acidosis-related issues persists differently depending on whether it is the risk of occurrence or the occurrence itself. In Simmental cows, the daily milk production tends to increase after acidosis risk, while after the occurrence of acidosis a continuous drop in milk production was evident in all parities. Obtained findings demonstrate the potential long-term persistent effects of acidosis on dairy Simmental cows, which can lead to reduced milk production and have economic implications for farmers.

Abdela (2016) reported that the Sub Acute Ruminal Acidosis (SARA) is a complex condition that has far-reaching consequences in dairy cattle herds. It can lead to decreased feed intake, fluctuations in feed intake, lower diet digestibility, reduced milk yield, decreased milk fat percentage, gastrointestinal damage, liver abscesses, and lameness. These effects can increase the cost of veterinary care and cause losses due to reduced milk production. Furthermore, Abdela (2016) highlighted that overfeeding grain to dairy cows can temporarily boost milk production but can cause SARA to persist as a significant problem. Therefore, according to Abdela (2016), it is crucial to monitor the cattle regularly to spot the signs of SARA early and limit the economic losses associated with the condition. According to a study conducted by Krause and Oetzel (2005), the financial losses resulting from SARA are significant and can be attributed to various factors such as decreased milk production, decreased efficiency of milk production, premature culling, and increased death loss. Another study conducted by Stone (1999) on a large dairy farm in New York State revealed that SARA can lead to a reduction in milk yield by 2.7 kg/day, milk fat production by 0.3%, and milk protein production by 0.12%. These findings highlight the detrimental effects of SARA on dairy production and emphasize the need for effective prevention and management strategies to mitigate its impact.

As determined in this research, the occurrence of acidosis risk leads to a significant decrease in milk production in Holstein cows, particularly in first-parity animals. The highest reduction in milk production was noticed in these cows, amounting to a total of 11.86 kg of milk or 5.69 euros. In contrast, the oldest Holstein cows were found to be more resilient, with a loss of only 2.82 euros (5.87 kg of milk) in case of acidosis risk. In the Simmental breed, the impact of acidosis risk on milk production was limited to animals in their first parity. The older cows were able to continue with milk production without any significant losses. Furthermore, the occurrence of acidosis in Holstein cattle has resulted in a significant reduction in milk production, especially in older cows. The highest decrease in milk production was observed in the oldest cows, which amounted to 92.36 kg of milk and a value of 44.33 euros per animal. Cows in IV. + parities showed a continuous and persistent decline in milk production throughout the testing period, while other cows showed a period of increased production in the first month following the acidosis occurrence. Conversely, the youngest cows experienced a consistent increase in milk production, resulting in a total increase of 53.97 kg of milk, worth 25.91 euros per animal. The effects of acidosis were also observed in the Simmental breed, where the highest losses were also determined in the oldest cows, accounting for a reduction of 69.30 kg of milk. In addition, younger Simmental cows were also affected by acidosis, resulting in a loss of around 58 kg of milk, valued at 28 euros.

Several research studies have examined the economic implications of acidosis on dairy farms. Decreased milk production, reduced efficiency of milk production, premature culling, and increased death loss are all considered to be the major reasons for financial losses caused by acidosis occurrence (Krause and Oetzel, 2005). Stone (1999) estimated the economic impact of SARA amounted to $400 - $475 lost income per cow/year due to SARA occurrence. Cha et al. (2010) evaluated the costs of acidosis consequences and determined that the sole ulcers, a common consequence of SARA due to laminitis lesions, cost producers $216 per case, with 38% of the costs being due to losses in milk production. Finally, Donovan (1997) estimated that the costs of SARA occurrence in the US dairy industry amounted between $500 million to $1 billion annually.

Conclusions

The results obtained from this study indicate that the prevalence, persistence, and costs of acidosis-related issues in dairy cattle populations vary with respect to the animal's breed and age (parity). The study revealed that the Holstein population had a higher incidence of acidosis when compared to the Simmental breed. Furthermore, the trend of occurrence varied between the two breeds, with Holstein cows exhibiting a more significant prevalence of acidosis in younger animals, while Simmental cows demonstrated an increased incidence in older cows.

Additionally, the study showed that acidosis risk significantly reduced milk production in Holstein cows, particularly in first-parity animals. In contrast, the oldest Holstein cows were found to be more resilient, with lesser losses. Among the Simmental breed, the effect of acidosis risk on milk production was limited to animals in their first parity, while older cows were able to continue with milk production without any significant losses. Moreover, the occurrence of acidosis in Holstein cattle resulted in a significant reduction in milk production, especially in older cows. In the Simmental breed, the highest losses were also determined in the oldest cows.

In light of these findings, it is important to implement breed-specific management practices to minimize the occurrence of acidosis and maximize animal health and productivity.

Acknowledgements

Research and dissemination were supported by the Fund for Bilateral Relations within the Financial Mechanism of the European Economic Area and Norwegian Financial Mechanism for the period 2014-2021 (Grant number: 04-UBS-U-0031/23-14).

Conflict of interests

The authors declare no conflict of interest.

References

1. Abdela, N. (2016): Sub-acute Ruminal Acidosis (SARA) and its Consequence in Dairy Cattle: A Review of Past and Recent Research at Global Prospective. *Achievements in the Life Sciences*. 10, 2, 187-196.
2. Aitken, P. (2016): Metabolic diseases in dairy cows. *Vet Times*. https://www.vettimes.co.uk/app/uploads/wp-post-to-pdf-enhanced-cache/1/metabolic-diseases-in-dairy-cows.pdf
3. Antanaitis, R., Juozaitienė, V., Malašauskienė, D., Televičius, M. & Urbutis, M. (2019): Biomarkers from automatic milking system as an indicator of subclinical acidosis and subclinical ketosis in fresh dairy cows. *Polish Journal of Veterinary Sciences*, 22, 4, 685-693.
4. Atkinson, O. (2014): Prevalence of Subacute Ruminal Acidosis (SARA) on UK dairy farms. *Dairy Farms in Practice*, 122p1, May 2014.
5. Bramley, E., Lean, I.J., Costa, N.D., & Fulkerson, W.J. (2005): Acidosis in pasture fed dairy cows: risk factors and outcomes. Joint Annual Meetin, Cincinnati, Ohio, USA, 24–28 July 2005, *Journal of Dairy Science*, 88.
6. Bramley, E., Lean, I. J., Fulkerson, W. J., Stevenson, M. A., Rabiee, A.R. & Costa, N.D. (2008): The definition of acidosis in dairy herds predominantly fed on pasture and concentrates. *Journal of Dairy Science,* 91, 308–321.
7. Cha, E., Hertl, J.A., Bar, D., Gröhn, Y.T. (2010): The cost of different types of lameness in dairy cows calculated by dynamic programming. *Preventive Veterinary Medicine*, 97, 1, 1-8.
8. Danscher, A.M., Li, Š., Andersen, P.H., Khafipour, E., Kristensen, N.B. & Plaizier, J.C (2015): Indicators of induced subacute rumin.al acidosis (SARA) in Danish Holstein cows. *Acta Veterinari Scandinavica*, 57, 39, 1-14.
9. Donovan, J. (1997): Subacute Acidosis is Costing US Millions. *Hoards Dairyman*, Sept. 25, 1997, p. 666.
10. Eicher, R. (2004): Evaluation of the Metabolic and Nutritional Situation in Dairy Herds: Diagnostic Use of Milk Components. World Association for Buiatrics. Proceedings of World Buiatrics Congress, Québec, Canada, July 11-16, 2004.

11. Gantner, V., Bobić, T. & Potočnik, K. (2016): Prevalence of metabolic disorders and effect on subsequent daily milk quantity and quality in Holstein cows. *Archives Animal Breeding*, 59, 381–386.

12. Golder, H.M., LeBlanc, S.J., Duffield, T., Rossow, H.A., Bogdanich, R., Hernandez, L., Block, E., Rehberger, J., Smith, A.H., Thomson, J. & Lean1, I. J. (2023): Characterizing ruminal acidosis risk: A multiherd, multicountry study. *Journal of Dairy Science*, 106, 3155–3175.

13. Humer, E., Aschenbach, J.R., Neubauer, V., Kröger, I., Khiaosa-ard, R., Baumgartner, W & Zebeli, Q. (2017): Signals for identifying cows at risk of subacute ruminal acidosis in dairy veterinary practice. *Journal of Animal Physiology and Animal Nutrition*, 102, 2, 380-392.

14. Humer, E., Petri, R., Aschenbach, J., Bradford, B., Penner, G., Tafaj, M., Südekum, K.H. & Zebeli, Q. (2018): Invited review: Practical feeding management recommendations to mitigate the risk of subacute ruminal acidosis in dairy cattle. *Journal of Dairy Science*, 101, 872–888.

15. Krause, K.M. & Oetzel, G.R. (2005): Inducing subacute ruminal acidosis in lactating dairy cows. *Journal of Dairy Science*, 88: 3633-3639

16. Nagaraja, T.G. & Titgemeyer, E.C. (2007): Ruminal acidosis in beef cattle: The current microbiological and nutritional outlook. *Journal of Dairy Science*, 90, 17–-38.

17. O'Grady, L., Doherty, M. L. & Mulligan, F. J. (2008): Subacute ruminal acidosis (SARA) in grazing dairy cows, *Veterinary Journal*, 176, 44–49.

18. Penner, G.B., Beauchemin, K. A. & Mutsvangwa. T. (2007): Severity of ruminal acidosis in primiparous Holstein cows during the periparturient period. *Journal of Dairy Science,* 90, 365–375.

19. Plaizier, J.C, Krause, D.O., Gozho, G.N. & McBride, B.W. (2008): Subacute ruminal acidosis in dairy cows: the physiological causes, incidence and consequences. *Veterinary Journal*, 176, 21–3.

20. Stauder, A., Humer, E., Neubauer, V., Reisinger, N., Kaltenegger, A. & Zebeli, Q. (2020): Distinct responses in feed sorting, chewing behavior, and ruminal acidosis risk between primiparous and multiparous Simmental cows fed diets differing in forage and starch levels. *Journal of Dairy Science,* 103, 8467–8481.

21. Stone, W.C. (1999): The effect of subclinical rumen acidosis on milk components. Proceedings of the Cornell Nutrition Conference of Feed Manufacturers, Syracuse, N.Y, Cornell University, Ithaca, NY, USA, 40-46.

22. Zebeli, Q., & Metzler-Zebeli, B. U. (2012): Interplay between rumen digestive disorders and diet-induced inflammation in dairy cattle. *Research in Veterinary Science*, 93, 1099–1108.

AGRICULTURE AND GREENHOUSE GAS EMISSION – RESULTS OF ECONOMETRIC ANALYSIS

Miloš Krstić[1]
**Corresponding author E-mail: milos.krstic1@pmf.edu.rs*

A R T I C L E   I N F O

Original Article

Received: *21 February 2024*

Accepted: *15 March 2024*

doi:10.59267/ekoPolj2402427K

UDC 330.43:[631:504.7

Keywords:

climate change, sustainability, modern technologies, renewable energy sources, dynamic panel analysis

***JEL**: Q10, Q16,Q54*

A B S T R A C T

Agriculture represents the "cause" and the "victim" of climate change. Almost 30 percent of greenhouse gas emissions come from the agricultural sector. They contribute to global warming and therefore significantly affect the sustainability of agricultural production systems. The aim of the paper is to determine which factors have the greatest influence on the greenhouse gas emission from agriculture. For this purpose, a dynamic panel analysis for 26 members of the European Union in the period from 2013 to 2021 in the paper is conducted. The results of the analysis suggest that the capacity for biofuel production, organic agricultural production and greenhouse gas emissions from the previous period have the greatest impact on the same emissions from agriculture. The results of this research can serve policy makers in formulating strategies for the development of food systems that will pollute the environment to a lesser extent and use available resources more rationally.

Introduction

Agriculture is the basic source of food and is very sensitive to climate change. Human activity that includes the burning of fossil fuels in electricity generation, in industry and transportation, as well as agricultural activity that includes the using of artificial fertilizers, the livestock, the changing way of cultivating the land, the growing rice, etc. contribute to the growth of the concentration of greenhouse gases in the atmosphere, that to a significant extent affects climate change and thus leads to an increase in global temperature and other environmental consequences (Houghton et al., 1996).

The share of gas emission from agriculture in total emissions will increase in the future because three reasons: first, gas emissions from other sectors will decrease; second, the volume of food production will increase; and thirdly, the reduction of gas emissions from agriculture is a complex process due to the diversity of its sub-sectors and the complexity of the biophysical processes associated with their activity (Topić,

1 Miloš Krstić, Senior scientific associate, Faculty of Sciences and Mathematics, Višegradska 33, 18000 Niš, Serbia, E-mail: milos.krstic1@pmf.edu.rs, ORCID ID (https://orcid.org/0000-0002-5256-8613)

2020; Balaban et al., 2023). Agricultural sub-sectors can contribute to mitigating the consequences of climate change, if the increasing of food production will not affect the increasing of gases in the atmosphere. Agriculture has mastered a unique carbon sequestration process. Namely, at the current level of development of technologies, one of the main instruments for sequestering carbon dioxide from the atmosphere are forest complexes and restoration of degraded land.

The share of gas emission from agriculture in total emissions will increase in the future because three reasons: first, gas emissions from other sectors will decrease; second, the volume of food production will increase; and thirdly, the reduction of gas emissions from agriculture is a complex process due to the diversity of its sub-sectors and the complexity of the biophysical processes associated with their activity (Topić, 2020; Balaban et al., 2023). Agricultural sub-sectors can contribute to mitigating the consequences of climate change, if the increasing of food production will not affect the increasing of gases in the atmosphere. Agriculture has mastered a unique carbon sequestration process. Namely, at the current level of development of technologies, one of the main instruments for sequestering carbon dioxide from the atmosphere are forest complexes and restoration of degraded land.

The aim of this paper is to examine the influence of selected sources of gas emissions from agriculture, using appropriate econometric methodology. The paper is organized as follows. After the introduction, the second part gives an overview of the literature. In the third part, technology, water resources, agroecology and renewable energy sources, which represent significant determinants of greenhouse gas emissions from this sector, are analyzed. In the fourth part, the methodology and information base of the research are presented. The fifth part refers to the research results and their discussion. The last part presents the most important conclusions.

Literature review

This part presents the results of empirical research that analyzes the influence of numerous factors on greenhouse gas emissions. The special attention is paid to papers that investigate the connection between agricultural production and greenhouse gas emissions, using various econometric techniques.

In a study by Jay Squalli and Gary Adamkiewicz (2018), the effect of organic agriculture on gas emissions in the USA in the period from 1997 to 2010 was investigated. The conducted analysis showed that the impact of organic agriculture was negative and statistically significant. According to the results of this analysis, the increasing area under organic farming by 1% leads to the reducting gas emissions between 0.015% and 0.059%. On the other hand, the results of this analysis robustly and unequivocally indicate the positive impact of the total agriculture - conventional and ecological (organic), on emissions. The increasing area of agricultural land of 1% leads to increasing emissions between 0.103% and 0.131%.

Salari, T. E and colleagues (2021) in the paper "Globalization, renewable energy consumption, and agricultural production impacts on ecological footprint" examined: what effects renewable energy consumption, multilateral and bilateral international trade and agricultural production have on the Ecological footprint index?, using a quantile regression model. The results showed that the consumption of renewable energy at all quantiles, except for the 25th, positively and significantly ($p<0.05$) affects the Ecological footprint index; this effect is more pronounced at higher than at lower quantiles. The agricultural production manifests the strongest influence on the 25th and 50th quantiles.

Siemianowska et al. (2017) surveyed 100 farmers in Poland about the importance of reducing the use of nitrogen fertilizers for a sustainable environment. The results showed that farmers in Poland are well know the agricultural practices of balanced use of artificial fertilizers, as well as that they are aware of the environmental hazards arising from their use. Yasmeen et al. (2021) in the paper "Agriculture, forestry, and environmental sustainability: the role of institutions" analyzed the role of sustainable agricultural production in reducing carbon dioxide emissions. The mentioned empirical study indicated that the use of renewable energy and the adoption of environmentally acceptable practices in agriculture should be encouraged.

Theoretical framework of research

Agriculture and greenhouse gas emissions

This part presents the results of empirical research that analyzes the influence of numerous factors on greenhouse gas emissions. The special attention is paid to papers that investigate the connection between agricultural production and greenhouse gas emissions, using various econometric techniques.

Agriculture represents the "cause" and the "victim" of climate change. Namely, almost 30 percent of greenhouse gas emissions come from the agricultural sector, mainly as a result of the use of chemical fertilizers, pesticides and the use of animal waste (Chataut et al., 2023). Greenhouse gases contribute to climate change and global warming and therefore significantly affect the sustainability of agricultural production systems.

The Food and Agriculture Organization states that greenhouse gas emissions from agriculture, forestry and other land uses (AFOLU) amount to 10.6 gigatonnes (Gt) of CO_2 equivalent. In all regions, the levels and sources of GHG emissions from "Agriculture, forestry and other land use" sector vary. For example, emissions from agriculture represent a significant part of the emissions of the AFOLU sector in all regions of the world, with the exception of sub-Saharan Africa and the Caribbean Basin (FAO, 2016).

When it comes to the sources of gas emissions in agriculture, gas emissions from the intestinal fermentation of ruminants has the largest share (40%); it is the main source of methane emissions. Intestinal fermentation of ruminants is followed by manure that remains on pastures (16%), then artificial fertilizer (12%) and finally, rice cultivation (10%) (FAO, 2016).

At the regional level, the importance of other sources of emissions from agriculture also varies. In East and Southeast Asia, the second main (biggest) source of greenhouse gas emissions is rice cultivation. In Australia, 59 percent of gas emissions arises during cultivating of organic soil. In Sub-Saharan Africa, North Africa and West Asia, as well as in Latin America and the Caribbean basin, the second main source of emissions is manure on pasture, and in the countries of developed regions (North America and Europe) – the consumption of artificial fertilizers.

The determinants of greenhouse gas emission in agriculture

The modern technologies

Not a small amount of greenhouse gases, created by agricultural activity, arrived the atmosphere, contributing to global warming and climate change. Using new technologies, farmers can identify the sources of greenhouse gases and find ways to reduce emissions of these gases. The technique, that uses the stable isotope carbon-13, allows people to assess soil quality and carbon sources from soil. This again provides an opportunity to understand how different combinations of crop rotation, cultivations of the land and land cover can increase production productivity and improve the use of limited natural resources, such as water and different chemical substances (IAEA, 2023).

The absorbing carbon from the atmosphere and retaining or storing carbon in the soil is the best solution for reducing the amount of greenhouse gases in the atmosphere. Modern technologies that reduce the greenhouse gases emission stimulate: the production of biomass, the use of cheap means for regulating the growth of plants and biofertilizers, the use of biochar, nitrogen fixation by leguminous plants, the reduction of the use of pesticides, the application of crop rotation, the mixed livestock production, etc. (Đokić et al., 2022).

The water resources

Lack of water is a real "nightmare" for farmers. For the development of plants in arid regions, it is necessary that every drop of rain to come their roots. The development of plants depends on the soil's ability to absorb and retain water, and the plant can preserve it if soil contains important microorganisms (HLPE, 2015).

With the help of modern technologies, scientists help agricultural farms to sustain "life" in the soil and to adapt themselves to the impacts of climate change. Thanks to technology, farmers have managed not only to adapt the soil to climate change, but also to reduce the greenhouse gases emissions from soil that cause climate change. (Iliut, 2012). Using the laser technology and the neutron moisture meters, farms can analyze and determine how much water is lost through evaporation from the soil and how much water is lost through transpiration into plants. By these instruments, it can be measured the amount of oxygen that is released in the process of evaporation and determined the place of origin of the water vapor: from the soil or from the plant. After that, agrotechnical methods can be applied, for example, techniques for cultivation land of conservation agriculture that are based on minimal disturbance of the soil structure, or the irrigation schedule can be adjusted to ensure that plants receive water when they need it most (Lohaiza et al., 2011).

Plants absorb carbon dioxide from the atmosphere and use it for photosynthesis. The more carbon dioxide and nitrogen oxides in the soil, the reproduction of microorganisms in it is the more active (Joint FAO/IAEA Programme, 2016). Nitric oxide, that is created in the soil and emit from it, is an integral part of many artificial fertilizers. The using modern technologies, it is possible to determine how much nitrogen a plant can absorb (from the ground) naturally. On the basis of these data, it is possible to provide the plant the exact amount of chemical fertilizer that it needs, and at the same time reduce greenhouse gas emissions into the air to a minimum (Salkever, 2011).

The use of artificial fertilizers

In whole the world on an annual level, 1.2 million tons of nitrogen oxide is emitted from artificial fertilizers, which it, when we talk about the creation of the greenhouse effect, is 260 times more powerful than carbon dioxide. Also, the excessive application of chemical fertilizers costs a lot (Rehman et al., 2020).

Farmers are increasingly using sustainable agricultural practices to increase productivity and reduce nitrogen oxide emissions from chemical fertilizers. For example, farmers plant different types of bobs, such as purple or velvet beans, in whose the root system exist bacteria which converts nitrogen oxide from the air into organic matter that enriches the soil with organic food for plant. After harvesting the bobs, the stubble remains, and later on that part of the field grain crops and cereals are planted, which receive already collected, in the soil, nitrogen with the addition of a minimum amount of chemical fertilizer. This method helps farmers save money. Using this method, some countries are getting closer to their goal – a significant reduction in greenhouse gas emissions to 2030 compared to the level of emissions in 2005 (Fisher, 2018).

The agroecology

According to the HLPE report (2016), agroecology applies ecological concepts and principles to agricultural systems. By focusing attention on the interaction between plants, animals, people and the environment, the organic or agroecological approach to agriculture enables the sustainable development of the agricultural household, which in turn ensures food security.

Ecological principles of agricultural production, defined by Nicholls et. al (2016), are extremely important for adapting to climate change, because they are directed at: 1) improving biomass processing, by breaking down nutrients in an optimal way; 2) strengthening the “immunity” of agricultural systems by expanding functional biodiversity, 3) minimizing the consumption of energy, water, nutrients and genetic resources in order to better preserve and rehabilitate soil, water resources and agrobiodiversity, and 4) promoting, and thus, strengthening key environmental processes and services.

The focus of aggregology is the ecosystem as a whole, while the goal is to generate an environment that is productive and rationally uses natural resources, since it is, at the same time, sustainable on the social level (IAAST, 2008; Altieri & Nicholls, 2005; Ensor, 2009; De Schutter, 2010). In the organic system, indigenous knowledge and modern technologies are used aimed at: 1) the management of biological diversity; 2) the inclusion of biological principles and resources in the agricultural system and 3) the intensification of agricultural production.

Olivier De Schutter (2010) indicates that agroecological practices and methods are a key strategy for improving the resilience and sustainability of agricultural systems. The transition from the conventional (capital-intensive) to the ecological or organic way of production in agriculture is a long-term process, conditioned by a series of challenges of an agronomic, economic and educational nature. Agroecological approaches and methods, that ensure the success of traditional, organic farming in conditions of climate change, include the following: the use of local genetic diversity, the polycultural systems, the gardening and the like (Altieri & Koohafkan, 2008).

Renewable energy

Renewable energy sources use natural processes and resources that are, practically, inexhaustible or are relatively quickly renewed naturally. Renewable energy sources are: hydro power, wind energy, solar energy, etc. Renewable energy sources include biomass (Berdin et al., 2018). Biomass refers to living or recently living matter of plant or animal origin, that can be used as fuel.

The simplest and most common way of producing energy from biomass is burning it. Fire starts easily with dry and resinous wood, and the wood should lie in a certain way. This is the reason why researchers are trying to find more economical technologies that will enable more efficient and environmentally friendly burning processes of plant raw materials of different humidity and content (Koul et al., 2022).

Practices in agriculture, which are largely dependent on energy sources and growth of energy price, are the main limiting factor in improving agricultural production. The extensive research on the possibilities of using new energy sources are undertaken. The use of renewable resources (manure of "energetically" agricultural crops, etc.) in the production of energy and nutrition of plants and animals is an area of research in which modern technologies can play a valuable role (Plimmer, 1984).

The fermentation can generate energy in the form of methane or ethanol from cellulose waste. Although the scientific foundations of the mentioned technology are in the beginning, many limitations have appeared. One of them is the limited ability of microorganisms to digest wood, straw and the like. It should also be said that fermentation processes take place only in narrow ranges of acidity or temperature. That is why energy production processes are tested in numerous laboratories around the world. It is assumed that at lower temperatures, the decomposition of woody fibers and fermentation can be accelerated by applying new cultures of microorganisms. Mutants created by radiation are used to increase the degree of decomposition of agricultural waste that remains after fermentation and distillation of alcohol.

Materials and methods

Based on the analysis of the determinants of GHGs emissions from agriculture, as well as the literature review, an econometric model was formulated. The member countries of the European Union are analyzed in the period from 2013 to 2021. All data were taken from the website of the European Statistical Office (Eurostat, 2023). The dependent variable in the observed model is total greenhouse gas emissions from agriculture. The model, in the most general form, explains the total greenhouse gas emissions from agriculture in the country *i* and in period *t* ($lnGGE_{it}$) as a function of the following variables: Public expenditure on research and development related to agriculture in the country *i* and in period *t* ($lnGBARDa_{it}$), Actual evapotranspiration in the country *i* and in period *t* ($lnETa_{it}$), The share of area under ecological (organic) agriculture in total agriculture in the country *i* and in period *t* ($lnSEA_{it}$), The consumption of chemical fertilizers in the country *i* and in period *t* ($lnCCF_{it}$) and The capacity for biofuel production in the country *i* and in period *t* ($lnCPB_{it}$):

$$lnGGE_{it} = lnGBARD_{ait} + lnET_{ait} + lnSEA_{it} + lnCCF_{it} + lnCPB_{it}. \quad (1)$$

Table 1 lists the variables used in the research, along with their explanation and data source.

Table 1. Description of used variables

Variables	Labels	The explanations	Source
Greenhouse gas emissi ons by agriculture	lnGGE	Emissions of CO_2, N_2O in CO_2 equivalent, CH_4 in CO_2 equivale nt, HFC in CO_2 equivalent PFC in CO2 equivalent, SF6 in CO_2 eq uivalent and NF3 in CO_2 equiva alent from agriculture.	Eurostat
Public expenditures for R&D related to agricult ure	lnGBARDa	Public expenditures for R&D rela ted to agriculture and science re presents gowerment budget alloc ations for R&D related to agricul ture and sciences, measured in million euro. This variable refers to modern technologies.	Eurostat

Variables	Labels	The explanations	Source
Actual evapotranspi ration	lnETa	Actual evapotranspiration is quant ity of water that is removed from a surface due to the processes of evaporation and transpiration and is measured in million cubic metr es.	Eurostat
Share of area under ecological agriculture	lnSEA	Area under ecological agriculture divided by utilized agricultural ar ea multiplied by 100. This varia ble refers to the organic or agro ecological approach.	Eurostat
The consumption of chemical fertilizers	lnCCF	The consumption of chemical fert Ilizers refers to consumption of ni trogen fertilizers and is measured in tonne.	Eurostat
Capacities for the pro duction of pure biogasoline	lnCPB	Capacities for the production of pure bioga soline represents pro duction plants for pure biogasoli ne.	Eurostat

Source: Author's creation

Public expenditures for research and development related to agriculture refer to modern technologies and represent the variable that is the focus of the empirical analysis. The main goal of the model is to determine the influence of each of the potentially significant determinants on GHGs emissions from agriculture through the evaluation of parameters next to the variables in the model. The first model that is evaluated is the model with constant parameters (pooled model). The model with constant parameters can be represented by the following equation:

$$\widehat{lnGGE}_{it} = \hat{\beta}_1 + \hat{\beta}_2 lnGBARD_{ait} + \hat{\beta}_3 lnET_{ait} + \hat{\beta}_4 lnSEA_{it} + \hat{\beta}_5 lnCCF_{it} \quad (2)$$

$$+\hat{\beta}_6 lnCPB_{it} + \mu_{it},$$

where β_1 – free term, β_i, $i = 2, 3, ... 6$ – regression parameters and u_{it} – random error.

The first indication of the inadequacy of the application of the pooled model is given by the Ramsey test. Namely, considering that the null hypothesis about the correctness of the specification is rejected, it is concluded that it is necessary to examine alternative specifications of the empirical model. The existence of individual effects or heterogeneity between observation units is tested by the comparing previous model with a fixed effects model whose free term varies by observation unit, while the parameters next to the independent variables are constant (LSDV1 model). This fixed effects model can be represented as follows:

$$\widehat{lnGGE}_{it} = \hat{\alpha}_1 + \hat{\alpha}_2 D_{2i} + \hat{\alpha}_3 D_{3i} + \cdots + \hat{\alpha}_{20} D_{26i} + \hat{\beta}_2 lnGBARD_{ait} + \hat{\beta}_3 lnET_{ait} + \hat{\beta}_4 lnSEA_{it} + \hat{\beta}_5 lnCCF_{it} + \hat{\beta}_6 lnCPB_{it} + \mu_{it}, \tag{3}$$

Based on this model, it is tested whether the individual effects are statistically significant? For this purpose, the F-test was used that compared the sum of squares of the residuals of the LSDV1 model and the model with constant parameters. Given that the F-test statistic was higher than the critical value, it is concluded that the individual effects in the empirical model of emission from agriculture are statistically significant and that it is necessary to take them into account. The next step is to examine the significance of time effects. The significance of time effects is examined by comparing the fixed effects model whose free term varies by year while the parameters next to the independent variables are constant (LSDV2 model) with the model with constant parameters, using the F test.

Since $F_{(8,69)} \approx 2{,}10$ is higher than the obtained value of the F test (0.017, see table 1 in the Annex), it can be said that the LSDV2 model is worse. We now know that the LSDV 1 is better than the Pooled model and that the Pooled model is better than the LSDV2 model. The empirical model is also evaluated in the form of a stochastic specification. The stochastic specification can be represented by the next equation:

$$\widehat{lnGGE}_{it} = \hat{\beta}_1 + \hat{\beta}_2 lnGBARD_{ait} + \hat{\beta}_3 lnET_{ait} + \hat{\beta}_4 lnSEA_{it} + \hat{\beta}_5 lnCCF_{it} + \hat{\beta}_6 lnCPB_{it} + \mu_i + \mu_{it}. \tag{4}$$

Discrimination between fixed and stochastic specifications ss carried out using the modified Hausman test (Hoechle, 2007). The Hausman test showed that the random effects model is more appropriate, but the R^2 is higher in the LSDV1 model $R^2_{FE} = 0.2789 > R^2_{RE} = 0.0333$), and the residual plots are much better (see Supplement). Furthermore, the estimator of the fixed effects model ($\hat{\beta}_{FE}$) is always consistent, regardless of whether the independent variables are correlated with individual effects (free terms) or not, while this is not the case with the random effects model ($\hat{\beta}_{RE}$). Therefore, it is “safer” to pick the fixed effects model (LSDV1 model). The presence of homoscedasticity in the fixed effects model was tested by a modification of the Wald test (Baum, 2001).

Since certain empirical papers confirm the presence of inertia in the movement of greenhouse gas emissions, i.e. point to the fact that greenhouse gas emissions are largely determined by the level of these emissions in the past (for example, see Jula & Jula, 2013), dynamic specification is applied in the further analysis. The dynamic specification can be represented by the following equation:

$$\widehat{lnGGE}_{it} = \hat{\beta}_0 + \hat{\alpha} lnGGE_{it-1} + \hat{\beta}_1 lnGBARD_{ait} + \hat{\beta}_2 lnGBARD_{ait-1} + \hat{\beta}_3$$

$$lnGBARD_{ait-2} + \hat{\beta}_4 lnET_{ait} + \hat{\beta}_5 lnET_{ait-1} + \hat{\beta}_6 lnET_{ait-2} + \hat{\beta}_7 lnSEA_{it}$$

$$+ \hat{\beta}_8 lnSEA_{it-1} + \hat{\beta}_9 lnSEA_{it-2} + \hat{\beta}_{10} lnCCF_{it} + \hat{\beta}_{11} lnCCF_{it-1} + \hat{\beta}_{12} \tag{5}$$

$$lnCCF_{it-2} + \hat{\beta}_{13} lnCPB_{it} + \hat{\beta}_{14} lnCPB_{it-1} + \hat{\beta}_{15} lnCPB_{it-2} + \mu_{it}.$$

An effective methodological tool for evaluating the dynamic panel model are the methods developed by Arellano and Bond (1991) and Blundell and Bond (1999). The Arellano-Bond method use first differences that eliminate individual effects. Blundell and Bond suggest evaluating systems of equations that include not only first difference equations but also level equations.

Discussions

When analyzing the impact of selected determinants on the emission of gases from agriculture, we started from the evaluation of static models. The results of the estimation of static models are shown in Table 1 in the Appendix. Different specifications are estimated: a model with constant parameters, a fixed effects models (LSDV1 and LSDV2) and a random effects model. However, the conclusion based on static specifications is not reliable, taking into account the test results related to these specifications. The non-fulfillment of the initial assumptions directs to the examination of the adequacy of the dynamic specification. The dynamic specification is estimated using the Arellano-Bond method and the Blandel-Bond method. The evaluation results are presented in Table 2.

Table 2. Results of the dynamic panel models

Models Variables	**GMM(1)[(1)]**		**GMM(2)[(2)]**	
	Coef.	P > |z|	Coef.	P > |z|
$lnGGE_{i,t-1}$	.1654905	0.040	.9625664	0.000
$lnGBARDa_{i,t-1}$	-.0407024	0.000	-.0861186	0.000
$lnETa_{i,t}$	.0197961	0.417	.0647495	0.000
$lnSEA_{i,t-1}$	-.1593366	0.015	-.3307523	0.005
$lnCCF_{i,t-1}$	.0703286	0.016	.0365248	0.200
$lnCCF_{i,t-2}$	.0175614	0.005	.0042728	0.807
$lnCPB_{i,t}$	-.109088	0.000	-.0267565	0.108
F test	0.0000		0.0000	
AR (1)	0.1368		(0.1985)	
AR(2)	0.5145		0.6321	

Notes: (1) The column GMM(1) refers to the specification estimated by Arellano and Bonds' method of generalized moments. (2) The column GMM(2) refers to the specification that was estimated by Blandel and Bonds' system method of generalized moments.

Source: Author's calculation in STATA

The effective methodological tool for evaluating the dynamic panel model are the methods developed by Arellano and Bond (1991) and Blundell and Bond (1999). The Arellano- Bond method use first differences that eliminate individual effects. Blundell and Bond suggest evaluating systems of equations that include not only first difference equations but also level equations.

The results indicate a significant and strong inertia in the movement of greenhouse gas emissions from agriculture. The scores of the coefficients next to the dependent variable $lnGGE_{i,t-1}$ are statistically significant at the 5% level. Based on this, it can be concluded that the persistence of gas emissions originating from agriculture characterizes the observed countries.

The research results show that public expenditures for research and development related to agriculture have a statistically significant and negative effect on gas emission. However, the effects of increasing public expenditure on research and development related to agriculture do not manifest immediately, but after a period of one year. The share of areas under ecological method of production in total agriculture in period t-1 ($lnSEA_{i,t-1}$) is statistically significant at the level of 1%. According to the results of this analysis, increasing the area under ecological method of production of 1% in the period t-1 leads to reducting gas emissions from 0.16% to 0.33% in the current period, depending on the specification. The consumption of chemical fertilizers with a time lag of 1 and 2 years ($lnCCF_{i,t-1}$ and $lnCCF_{i,t-2}$) is statistically significant at the 1% level in the GMM(1) model. The coefficient next to $lnCCF_{i,t-1}$ and $lnCCF_{i,t-2}$ has a positive sign. If the consumption of chemical fertilizers increased in the previous period, it is expected that the emission of agricultural GHGs gases will increase in the current period.

The estimated coefficient of the variable Actual evapotranspiration (lnEtai,t) has a positive sign. The variable $lnEta_{i,t}$ is statistically significant at all levels in the GMM(2) model. The coefficient next to the variable Biofuel production capacity or $lnCPB_{i,t}$ has a negative sign as assumed in the existing literature (Salari et al. 2021). The results of this analysis show that increasing The capacity for biofuel production, on average, reduces greenhouse gas emissions from agriculture.

Conclusions

The aim of this paper is to determine the significant determinants of greenhouse gas emissions from agriculture. The paper analyzed the following variables: Public expenditures for research and development related to agriculture, The share of areas under ecological method of production in total agriculture, The consumption of chemical fertilizers and capacity for biofuel production ect. The results of dynamic panel models showed that the variables Emissions of greenhouse gases, Public expenditures for research and development related to agriculture and Share of areas under ecological production in total agriculture in period t-1 are significant in explaining emissions. Public expenditures for research and development related to agriculture and The share of areas under ecological production in period t-1 reduce the emission of agricultural gases, while emissions from period t-1 increase it.

The results obtained in this research showed that the climate is characterized by significant inertia. More closely, there is a "time gap" between the reducting greenhouse gas emissions, through the introducting modern technologies, the increasing areas under ecological production methods and the using renewable energy sources, and the reduction of the concentration of gases in the atmosphere. Carbon dioxide and other greenhouse gases remain in the atmosphere for years, and for reducting gas emissions, that would affect their concentration in the atmosphere, a certain time should pass.

Likewise, there is a time gap between the decreasing amount of gases in the atmosphere and the temperature. The temperature will continue to rise in the future, after the amount of greenhouse gases in the atmosphere stabilizes (IPCC, 2001). Therefore, the dynamics of the climate system do not allow delay measures (such as: development of new technologies and new sources of energy, increasing the share of organic agriculture in total agriculture) for reducing emissions from agriculture. In order to prevent a larger increase in temperature, for example, by more than 2 degrees Celsius, it is necessary to quickly start the process of reducing emissions. The delay of 5 years must be compensated very quickly. In addition, longer delays are generally not compensable (Mignone et al., 2008).

The main limitations of this research are: a short period of observation, a relatively large number of independent variables and a small number of observations. Future research in this field may be extended to NUTS 2 and NUTS3 level, depending on available data.

Acknowledgements

This research was financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia (contract no. for the realization and financing of scientific research work: 451-03-66/2024-03/200124).

Conflict of interests

The author declare no conflict of interest.

References

1. Altieri, M. A., & Nicholis, C. I. (2005). *Agroecology and the Search for a Truly Sustainable Agriculture*. Mexico, MX: UNEP.
2. Altieri, M. A., & Koohafkan, P. (2008). Enduring farms: Climate change, smallholders and traditional farming communities. Penang, MY: Third World Network.
3. Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, *58*(2), 277-297.
4. [*in English*: Balaban, S., Sotirov, A., & Madžar, L. (2023). Economic sustainability in agriculture on the example of the EU countries. *Ecologica*, *30*(110), 239-246.].
5. Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, *87*(1), 115-143.

6. Chataut, G., Bhatta, B., Joshi, D., Subedi, K., & Kafle, K. (2023). Greenhouse gases emission from agricultural soil: A review. *Journal of Agriculture and Food Research*, 100533.
7. De Schutter, O. (2010) *Report submitted by the Special Rapporteur on the right to food to the Human Rights Council*. New York, US: United Nation.
8. Đokić, D., Novaković, T., Tekić, D., Matkovski, B., Zekić, S., & Milić, D. (2022). Technical efficiency of agriculture in the European Union and Western Balkans: SFA method. *Agriculture*, *12*(12), 1992.
9. Ensor, J. (2009). *Biodiverse agriculture for a changing climate*. Rugby, UK: Practical Action.
10. Eurostat (2023). Data Browser. Retrieved from https://ec.europa.eu/eurostat/databrowser/ (November 2-5, 2023).
11. Fisher, M. (2018). Reducing greenhouse gas emissions in agriculture with the help of nuclear techniques. *IAEA Bulletin*, 10-11.
12. Food and Agriculture Organization (FAO) (2016). *The state of food and agriculture: Climate change, agriculture and food security*. Rome, IT: FAO**.**
13. High Level Panel of Experts (HLPE) (2015). *Water for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*. Rome, IT: FAO.
14. *High Level Panel of Experts* (HLPE). 2016. *Sustainable agricultural development for food security and nutrition, including the role of livestock*. Rome, IT: FAO.
15. Houghton J.T., Meira Pilho L.G., Callander B.A., Harris N., Kattonberg A., & Maskeel K. (1996). *Climate change 1995: The science of climate change: contribution of working group I to the second assessment report of the Intergovernmental Panel on Climate Change.* Cambridge, UK: Cambridge University Press.
16. Iliut, I. (2012). Climate Smart Agriculture. *IAEA Bulletin (Online)*, *53*(3), 17-19.
17. International Assessment of Agricultural Science and Technology (IAAST) (2008). *Summary for Decision Makers of the Global Report*. Johannesburg, SA: IAAST.
18. International Atomic Energy Agency (IAEA) (2023). Greenhouse gas reduction. Retrieved from https://www.iaea.org/topics/greenhouse-gas-reduction (November 22, 2023).
19. IPCC (2001). *Synthesis Report, Third Assessment, Working Group III. Summary for Policymakers*. Paris, Fr: IPCC, WMO.
20. Joint FAO/IAEA Programme (2016). *In action: nuclear applications in agriculture. On-the-ground success Part III*. International Atomic Energy Agency/ Food and Agriculture Organization of the United Nations Vienna/Rome, AU/IT.
21. Jula, D., & Jula, N. M. (2013). *Organic Farming And The Greenhouse Gas Emissions*. (Working Paper No. 01). https://scholar.google.com/.

22. Koul, B., Yakoob, M., & Shah, M. P. (2022). Agricultural waste management strategies for environmental sustainability. *Environmental Research*, *206*, 112285.
23. Lohaiza, F. A., Juri Ayub, J., Velasco, H., & Dercon, G. (2011). Fallout radionuclides as indicators of soil degradation and potential loss of agricultural production in Latin American and Caribbean countries. *Soils Newsletter*, *33*(2), 18-20.
24. Nicholls, C.I., Altieri, M.A. & Vazquez, L. (2016). Agroecology: principles for the conversion and redesign of farming systems. *Journal of Ecosystem & Ecography*, S5: 010.
25. Plimmer, J. R. (1984). Chemicals for agriculture. *IAEA Bulletin*, *26*(2), 13-16.
26. Salari, T. E., Roumiani, A., & Kazemzadeh, E. (2021). Globalization, renewable energy consumption, and agricultural production impacts on ecological footprint in emerging countries: using quantile regression approach. *Environmental Science and Pollution Research*, *28*(36), 49627-49641.
27. Salkever, A. (2011). Recording Surface CO 2 Concentration and Isotopic Measurements for Sequestration Research with a Gas Analyzer Mounted on a Mule. *Soils Newsletter*, *33*(2), 8-10.
28. Siemianowska, E., Wesołowski, A., Skibniewska, K. A., Tyburski, J., & Gurzyński, M. (2017). Sustainable agriculture and protection of the environment. In M. Wzorek, G. Królczyk & A. Król (Eds.), *International Conference Energy, Environment and Material Systems (EEMS 2017)* (pp. 1-8). E3S Web of Conferences, 19.
29. Squalli, J., & Adamkiewicz, G. (2018). Organic farming and greenhouse gas emissions: A longitudinal US state-level study. *Journal of Cleaner Production*, *192*, 30-42.
30. Topić, M. (2020). The Sourcing of Stories on Sugar and the Supermarket Industry in the British Press. *Qualitative Report*, *25*(5), 1196-1214.
31. Yasmeen, R., Padda, I. U. H., Yao, X., Shah, W. U. H., & Hafeez, M. (2021). Agriculture, forestry, and environmental sustainability: the role of institutions. *Environment, Development and Sustainability*, 24, 8722-8746.

Appendix

Table 1. Evaluation results of static panel models

Models Variables	Pooled		LSDV1		LSDV2		RE[1]	
	Coef.	P > |z|	Coef.	P > |z|	Coef.	P > |z|	Coef.	P > |z|
lnGBARDa	.261571	0.000	-.002251	0.876	.261872	0.000	.003636	0.829
lnETa	.210544	0.024	-.024011	0.484	.231589	0.031	.002391	0. 952
lnSEA	-.628011	0.000	-.026877	0.306	-.631866	0.000	-.02803	0.357
lnCCF	.784142	0.000	.014758	0.354	.785398	0.000	.021633	0.244
lnCPB	.143161	0.014	-.025623	0.408	.142880	0.021	-.00939	0.791
Constant	5.471596	0.000	10.46938	0.000	5.402825	0.000	9.734	0.000
R^2	0.8479		0.9995(0.2789 [2])		0.8509		0.0333	
Ramsey test	3.74 (0.0147)							

Models Variables	Pooled		LSDV1		LSDV2		RE[1]	
	Coef.	P > |z|	Coef.	P > |z|	Coef.	P > |z|	Coef.	P > |z|
F test			1756.64 (0.0000)					
F test					0.17 (0.9936)			
Wooldridge			1.72 (0.2216)					
M. Wald			193.16 (0.0000)					
M. Hausman					0.02 (1.0000)			

Notes: (1) Column RE refers to the random effects model. (2) The coefficient of determination in the fixed effects model that is estimated by transforming the data within the observation units and that is comparable to the coefficient of determination in the random effects model.

Source: Author's calculations in STATA

THE IMPORTANCE OF RURAL TOURISM DEVELOPMENT IN THE SREM DISTRICT

Nada Kosanović[1], Mirjana Bartula[2], Mihajlo Karna[3], Slobodan Nićin[4]
**Corresponding author E-mail: nada.kosanovic@futura.edu.rs*

A R T I C L E I N F O

Original Article

Received: *07 March 2024*

Accepted: *15 May 2024*

doi:10.59267/ekoPolj2402443K

UDC 338.48-44(1-22)
(497.113 Srem)

Keywords:

Srem District, rural areas, rural tourism, indicators

JEL: *Z32*

A B S T R A C T

Contemporary rural business trends emphasize tourism's vital role in holistic rural development, signaling forthcoming transformations. In the 21st century, rural tourism must adapt to evolving domestic and international demands, showcasing diverse aspects of rural life. Success in family farms will hinge on effective branding, market understanding, customer relations, and product quality. Methodologically, this study compares demographic and economic indicators across seven municipalities in the Srem District over three years, post-COVID-19. Findings reveal Srem's rural tourism product lacks market positioning. To excel domestically, Srem must establish itself as a rural tourism hotspot, leveraging its unique attributes for competitive advantage. This entails integrating diverse offerings into a cohesive market presence, fostering spatial connectivity.

Introduction

Changes in all spheres of life in the early 21st century allow us to foresee global trends affecting rural economics and population dynamics. Rural areas in the Republic of Serbia confront numerous challenges stemming from their isolation, attributed to inadequate infrastructure, aging populations, and environmental degradation. However, the future economic vitality of the Srem District in Serbia is less about available resources and

1 Nada Kosanović, asistant professor, Faculty of Applied Ecology - Futura, Metropolitan University, Požeška, 83, 11131, Belgrade, Serbia, E-mail: nada.kosanovic@futura.edu.rs, ORCID ID (https://orcid.org/0009-0007-9124-4383)

2 Mirjana Bartula, assotiate professor, Faculty of Applied Ecology - Futura, Metropolitan University, Požeška, 83, 11131, Belgrade, Serbia, E-mail: mirjana.bartula@futura.edu.rs, ORCID ID (https://orcid.org/0000-0003-0100-5260)

3 Mihajlo Karna, PhD student, , Faculty of Applied Ecology - Futura, Metropolitan University, Požeška, 83, 11131, Belgrade, Serbia, E-mail: mihajlo.karna23@futura.edu.rs, ORCID ID (https://orcid.org/0009-0008-9716-1877)

4 Slobodan Nićin, Ph.D., assistant professor, „Dositej" College of Academic Studies, Belgrade, Bulevar Vojvode Putnika 7, 11000 Belgrade, Serbia, Phone: +381 65 979 99 11; E-mail: bobanicin@yahoo.com, ORCID ID (http://orcid.org/0009-0001-6579-5321)

geographic location, and more about strong leadership and efficient strategies, aimed at creatively connecting and effectively combining development factors (Kosanović and Vještica, 2021). The strengths of the municipalities in the Srem District are both natural and immovable cultural assets as potential for tourism development. Demographically devastated, yet picturesque and vivid, Srem is considered a tourist region, which successfully bases its sustainable tourism development on rich natural and cultural heritage; urban centers with unique architecture and lifestyle; richness of waterways, lakes, canal networks, and thermal mineral springs; and which successfully combines high-value-added agricultural production with innovative tourist offerings. Adequate rural development policies can significantly contribute to more harmonious regional and overall development (Radovanović, 2010).

The primary research objective concerns the identification of potential development nuclei aimed at assessing the real potentials for the development and improvement of rural tourism in the Srem District. In line with this, a socio-economic analysis of the development of the Srem District has been conducted, based on data from relevant state institutions (Statistical Office of the Republic of Serbia), data from the Regional Chamber of Commerce of Srem, strategic documents of higher orders, and internet presentations of tourist agencies in the Srem region. The base year for comparing tourism indicators is 2020, when the tertiary sector - hospitality and tourism - was most affected due to COVID-19, as well as the following three observed years. Based on the collected information, the authors processed the data and presented it in tabular form.

Methodology

We conducted a professional and independent analysis of the rural area in Srem by observing and examining it closely. Our descriptive analysis led us to uncover findings, observations, and descriptions of the emergence, progression, and development of rural tourism, as well as the issues stemming from the regional and institutional framework of our research subject.

Through empirical methods, which are important analytical tools, empirical data were processed using statistics and mathematics. Statistical methods were employed for data collection, representation (tables), analysis, and interpretation of numerical data. Further quantitative research was conducted using mathematical methods. The results of the research are indicative in nature, as they provide the necessary information for defining the goals of this study.

In addition to the mentioned ones, general methodological procedures were also applied. We utilized the comparative method to analyze numerical data spanning a three-year period relative to the base year of 2020. This analysis enabled us to identify significant insights regarding the progression of rural tourism in the Srem District. This analysis was conducted based on identified issues and the needs of local stakeholders, which were obtained through questionnaires. Acknowledging the sustainability models of rural and suburban settlements as fundamental economic drivers for the functional and spatial integration, as well as the prosperity of rural areas in Srem, constitutes one approach to mitigating its weaknesses and vulnerabilities (Kosanović et al., 2016). Additionally, this article contributes to the advancement of methodological research in this field by delineating the present condition and interconnections within the rural area of Srem.

Rural Tourism - Opportunity for Rural Households

A fundamentally new societal attitude towards the countryside demands a fresh approach to rural areas and agriculture, where rural residents are not treated merely as producers of cheap food. Comprehensive rural development recognizes rural tourism as a nucleus for activation and sustainable development. It aids in preserving local identity, traditions, and customs, protects the environment, strengthens indigenous, traditional, and ecological production, and promotes the development of rural areas based on sustainable development. Therefore, it is a significant component of integrated and sustainable rural development, as well as an important factor in stimulating the development of local agricultural and non-agricultural activities in rural areas. Through their combination, a specific form of tourism product is formed to meet the needs of tourists (Mihić et al., 2013).

The Srem region is known for its fertile land, which has played a significant role in the growth of agriculture (see Table 1). Moreover, it has also contributed to the development of rural tourism, providing an additional source of income for families residing in the countryside and engaging in this form of tourism serves as a supplementary activity for these households. Notable among the various tourism offerings are rural, event-based, hunting and fishing, wine, ethno-gastronomic, and ecotourism experiences. Gastronomy stands out as one of the key tourist attractions, playing a crucial role not only in the development of ethno-gastronomic tourism but also in event-based, rural, and ecotourism endeavors.

Table 1. The overview of key data and figures of the Srem District area

City and municipalities of the Srem District	City of Sremska Mitrovica, Municipality of Šid, Municipality of Inđija, Municipality of Irig, Municipality of Ruma, Municipality of Stara Pazova, Municipality of Pećinci
The number of agricultural households engaged in another profitable activity (which is not agricultural) and the number of SMEs (Small and Medium-sized Enterprises).	739/ 300/51
Average age	43,6 years
Number of inhabited places	109 (7 urban и 102 rural)
Surface area	762km^2
Arable land area	229,195 ha arable land and gardens, 213.715 ha orchards, 5.153 ha vineyards, 7,409 ha meadows and pastures

Average size of holdings	7.82 ha 4% of households have arable land of up to one hectares
Number of agricultural households (2022)	21.818
Population count (2022)	284,436 residents, which is 27,842 or 9.1% fewer compared to the previous census when there were 312,278 residents living here
Rural settlement with the largest and smallest number of inhabitants (2022)	Лаћарак-10638 Ерем-100
Population density (residents/km2)	89,58 res./km^2
Average age (2021) **Number of youth aged 15-29**	43,7 years 46.932
Absolute population decline 2002/2011	9.1%
Number of employed/number of unemployed (2022)	95.243 / 9.800
Main economic sectors	Agriculture is the primary economic sector in Srem, accounting for 36.3 % of the region's GDP, while the manufacturing industry represented with 20.3 % also holds significant importance
Incentives for regional development in thousands of RSD for the Srem District: **Year 2020:** **Year 2021:**	4.328.373.000,00 4.537.980.000,00
Natural values	National Park Fruška Gora, Fruška Gora Monasteries, the Sava River, 12 natural assets, Special Nature Reserve Zasavica and Obedska Bara
Typical products of the area	Srem kulen, Fruška Gora wine, linden honey, Srem cheese, traditional cuisine
Nights spent by tourists in 2020: **Domestic:** **Foreign:** **Nights spent by tourists in 2021:** **Domestic:** **Foreign:**	164.508 139.739 24.769 257.611 204.312 53.299
Dependency ratio (non-working population/working population)	46,67%

Source: Statistical yearbook of the Republic of Serbia 2021

As observed in the previous table, Srem possesses significant potential for rural tourism development. However, the region faces challenges in this regard, notably due to the continued dominance of agriculture as the primary economic activity in most areas. Infrastructure remains underdeveloped, and existing facilities suffer from poor maintenance and functionality issues, particularly concerning future needs. Moreover, there is a lack of institutional development and notable disparities in the level of development among municipalities. The population density indicator categorizes the Srem District as rural, given that the indicator falls below 150 inhabitants per square kilometer.

The dependency ratio is calculated as the ratio of the non-working population (those younger than 15 and older than 65 years) to the working-age population (aged 15 to 65 years). This indicator illustrates the extent to which the non-working population relies on the working population, which is crucial both demographically and for general social and economic development. The mentioned index of 46.67% indicates that the working-age population in the municipalities of the Srem District is significantly burdened by the non-working population, largely due to the age distribution across these municipalities. It implies that an influx of population under the age of 40 would have a positive impact on the dependency ratio parameter. The fundamental assumption of the social development of any community is based on its population, where the working-age population represents the source of existence.

Human resources play a crucial role in agricultural production, influencing economic activities both in terms of quantity and quality (Subić, 2010). Rural areas typically rely on agriculture as their primary economic sector, engaging a significant portion of the population. In contrast, the manufacturing sector in rural areas involves a smaller portion of the population, often relying on agricultural production. Based on this research, it is recommended that there are opportunities for the integrated development of agriculture alongside other economic, service, and intermediary activities. These may include small-scale industrial operations, crafts, trade, service provision, financial services, tourism, and domestic labor. The aim would be to activate and optimize the production potential of agriculture and other economic and service sectors.The development and promotion of rural tourism in the Srem District would contribute to creating conditions for ensuring the necessary population in an appropriate age structure, increasing employment rates, developing the manufacturing sector, and enhancing the attractiveness of local areas in the municipalities. These expected results stem from the specificities that can be developed, as well as the education and capacity building of key stakeholders in promoting teamwork, collaboration, and partnership. This is aimed at facilitating more significant and faster development of rural tourism, which would have a multiplier effect on the socio-economic life of the Srem District.

Indicators of tourism in Srem

Tourism and hospitality are service sectors that were severely affected by the COVID-19 epidemic situation, given that the business operations of entities in this area are directly dependent on tourist traffic. Tourism traffic was almost completely halted in 2020, with some improvement seen in 2021. Challenges faced by the tourism industry in the Srem District:

- Lack of accommodation capacity;
- Insufficient funds for the renovation and reconstruction of existing accommodation facilities;
- Shortage of workforce, weak interest of young people in certain occupations, insufficient interest in self-employment projects, a significant portion of the population has completed secondary education, but there is significant

mismatch with new trends, insufficient vocational training for unemployed women, and insufficient number of highly educated personnel.

In order to promote domestic tourism, in May 2021, an additional 20,000 vouchers for vacations in Serbia were distributed. In July, another 150 million was allocated for an additional 30,000 vouchers.

The results of these measures can be seen in the Table 2. It is evident that the number of arrivals and overnight stays in the Srem District is significantly higher compared to 2020 and shows a growing trend. Since we were unable to obtain numerical data on the number of tourist arrivals and overnight stays by municipalities, we contacted tourist organizations and processed the data obtained.

Table 2. Number of arrivals and overnight stays in the Srem District

Criterion/ Municipality	Sremska Mitrovica	Inđija	Irig	Pećinci	Ruma	Stara Pazva	Šid
Incentives for regional development in thousands of RSD for the Srem District: Year 2020: 4,328,373,000.00 Year 2021: 4,537,980,000.00	607.677 427.561	417.397 668.394	632.228 380.464	424.306 533.334	656.936 383.403	1.203.182 1.702.766	373.687 411.804
Tourist arrivals 2020-2021	2.340 4.311	1.068 1.512	33.372 56.569	978 1516	12.214 16.453	9.018 17.750	2.923 2719
Tourist overnight stays 2020 Total: Domestic Foreign	5.911 4.679 1.232	5.664 4.759 905	102.751 96.438 6.313	978 694 284	12.214 7.665 4.549	9.018 6.788 2.230	2.923 1.783 1.140
Tourist overnight stays 2021 Total: Domestic Foreign	7.917 5.607 2.310	6.826 6.129 697	157.436 137.816 19.612	1.516 1.288 228	16.453 9.841 6.612	17.750 11.948 5.802	3.935 1.973 1.962
Tourist arrivals by municipalities - monthly data (number), March 2023.	Укупно: 495 Д.240/ С.255	278 128/ 150	6.457 5.193/ 1.264	71 24/47	979 659/ 320	1.215 721/ 494	138 82/ 56
Tourist overnight stays by municipalities - monthly data (number), March 2023.	1.640 765/ 876	2.763 1.373/ 1.390	13.465 10.729/ 2.736	98 29/ 69	2.157 976/ 1.181	6.098 3.725/ 2373	371 168/ 203

Source: Authors' analysis based on collected information from Tourist Organisations of the Srem District (Sremska Mitrovica, Inđija, Irig, Pećinci, Ruma, Stara Pazova)

Results of questionnaire analysis

The study involved 12 owners of rural households, distributed by municipalities as follows: 5 respondents from Sremska Mitrovica, 5 respondents from Irig, and 2 respondents from Stara Pazova. The results showed that all those who offer accommodation advertise on platforms where accommodations are offered (booking.com, airbnb.com), while only half of them also use social media (Facebook, Instagram).

Among the respondents, 75% are registered as households, with the remaining engaged in other activities, primarily hospitality. Accommodation services are provided by 91% of the respondents, yet only 41.7% offer meal preparation for guests. Additionally, 7 households cultivate fruit, allowing guests to pick and enjoy fruit on their own, while 2 households focus on vegetable cultivation. Moreover, one of the mentioned households not only grows fruit but also sells brandy, jam, and homemade cured meats to guests.

Some respondents mentioned that, in addition to offering accommodation rentals, they provide guests with:

1. Purchase of local products;
2. Bicycle rentals with planned routes and cycling paths;
3. Panoramic tours by catamaran, canoe, paddleboard, or boat rentals.

An intriguing finding from our research is that 62.5% of the respondents indicate having over 30% of foreign guests staying overnight (detailed breakdown below), which may signal that tourism in Srem should be further developed to be even more attractive to foreign guests. Regarding the income generated through this activity, 50% of the respondents are satisfied, while the other 50% are not. Although 54.5% stated that they wouldn't engage in this as a primary activity but rather as an additional job, 66.7% of the respondents expressed considering expanding or renovating their facilities or services they provide.

After the formal questions, participants were asked to provide recommendations and suggestions based on their experience on what needs to be improved to advance tourism. The suggestions are summarized as follows:

- Increase advertising and support through marketing efforts.
- Despite already having strong collaboration with the municipal tourist organization, respondents believe it would be beneficial for the tourist organization to unify offerings from various places and deliver them to the Tourist Information Center (TIC). This would create more activities for guests (e.g., horse stud farm visits, museum tours, monastery visits, quad bike rentals), encouraging guests to stay longer and visit us for leisure purposes, thus reducing accommodation costs (Stari Banovci).
- Infrastructure improvement is needed (e.g., Ležimir often lacks water).
- Pedestrian and hiking trails need to be improved (Vrdnik).

- Monasteries often have female dormitories, which has drastically reduced the business of the Tourist Information Center (TIC). Therefore, the recommendation from surveyed TICs is that if clearer monastery visit tours were organized, tourists would choose private accommodations.
- Education on tourism-related regulations is necessary. Respondents emphasize the need for someone to come and observe how they work so they can better understand what needs improvement and change.
- State assistance through subsidies and promotion is needed, i.e., utilizing funds for tourism development from higher levels of government.
- Networking among tourism industry stakeholders at the municipal level is essential for development, encompassing participants from the tourism sector, the local economy, and government authorities.

Conclusions

Diversification of activities in rural areas towards non-agricultural activities related to farming can significantly contribute to the survival of rural areas and prevent the migration of young people to cities.

Key demand factors that will contribute to the development of rural tourism, and whose impact will continue to be significant, include: increasing levels of education, growing interest in natural and cultural heritage, increased leisure time, raising awareness of the importance of health, rising interest in traditional and specialty foods. High among tourists' motives for travel due to increasing stress levels are "peace and tranquility" (OECD, 1994).

The entire Srem District offers ideal conditions for developing various forms of rural tourism outlined in the Tourism Development Strategy of the Republic of Serbia, including agro, eco, agro-eco, ethno, ethno-organic, excursionist, transit, and sports tourism. Rural tourism, coupled with cultural, nautical, and gastro tourism (notably the Danube Limes in Srem and Fruška Gora), ecotourism (like the Zasavica Special Nature Reserve), as well as youth, volunteer, and event-based tourism, shows significant potential for growth and development.

If we take into account the elements that contribute to rural tourism, such as the landscape's beauty, heritage, culture, and the engagement of the local population in rural activities, alongside offering tourists the chance to immerse themselves in the traditions and lifestyle of the hosts, it becomes clear that the interactive and personalized relationship between tourists and hosts is fundamental to rural tourism. This aspect forms the basis for economic diversification, which can operate independently of agriculture. Given the structural population imbalances, including not just numerical but also age-related disparities, it becomes evident that fostering a critical mass of young people and enhancing the local human capital are essential. From this perspective, rural tourism emerges as a pivotal strategy for addressing the negative trends impacting rural areas in Srem and its vicinity. Effectively marketing an integrated rural tourism product internationally, while maintaining quality standards, could attract foreign guests, leading to "invisible exports" and a positive impact on the country's balance of payments.

Additionally, rural tourism development holds social and political significance, fostering cultural exchange and better understanding among nations (Radović et al., 2012). Given the diverse natural, cultural-historical, and gastronomic assets in the municipalities of the Srem District, there is significant potential for tourism to become a major economic sector.

Based on the information presented, it is evident that the diverse range of natural, cultural-historical, and gastronomic resources within the municipalities of the Srem District offers significant potential for tourism development to emerge as a key economic sector.

Conflict of interests

The authors declare no conflict of interest.

References

1. Kosanović, N., & Vještica, S. (2021). „Blue Village" Integral Program for Improvement and Sustainability of Rural and Suburban Settlements. *Knowledge Based Sustainable Development Book of Abstracts,* 85–86. https://eraz-conference.com/wp-content/uploads/2022/03/ERAZ_2021-BoA-WEB.pdf
2. Kosanović, N., Jović, L., & Tomić, V. (2016). *Model reintegracije povratnika po readmisiji u agro-biznis sektor Republike Srbije: monografija*. Institut za primenu nauke u poljoprivredi. [*In English:* Kosanović, N., Jović, L., & Tomić, V. (2016). *Model of reintegration of returnees after readmission into the agro-business sector of the Republic of Serbia: monograph*. Institute for the Application of Science in Agriculture].
3. Mihić, S., Muhi, B., Domazet, S., Mihajlović, M., & Supić, D. (2013). Razvojni pravci turizma uz podršku fondova Evropske unije - šansa za privredni oporavak Vojvodine. *Poslovna ekonomija,* 7(2), 271-298. [*In English:* Mihić, S., Muhi, B., Domazet, S., Mihajlović, M., & Supić, D. (2013). Development directions of tourism with the support of European Union funds - a chance for the economic recovery of Vojvodina. *Business Economics*, 7(2), 271-298].
4. OECD (1994). Tourism strategies and rural development. Organisation of Economic Co-operation and Development: Paris, Retrieved from https://one.oecd.org/document/OCDE/GD(94)49/En/pdf (March 7, 2023).
5. Radović, G., Pejanović, R., & Njegovan, Z. (2012). Značaj i uloga integrisanog ruralnog turističkog proizvoda u Republici Srbiji. *Ekonomski vidici,* 17(4), 577-591. [*In English:* Radović, G., Pejanović, R., & Njegovan, Z. (2012). The importance and role of the integrated rural tourism product in the Republic of Serbia. *Economic Perspectives*, 17(4), 577-591].

6. Radovanović, V. (2010). Integralni ruralni razvoj – ka skladnijem regionalnom razvoju, Zbornik Matice srpske za društvene nauke. [*In English:* Radovanović, V. (2010): Integral rural development - towards more harmonious regional development, Proceedings of Matica Srpska for Social Sciences].
7. Statistical Yearbook of the Republic of Serbia 2021, Republic Institute of Statistics of the Republic of Serbia, Belgrade, Retrieved from https://publikacije.stat.gov.rs/G2021/PdfE/G20212054.pdf (December 6, 2023).
8. Subić, J. (2010). Radna snaga – značaj ekonomski potencijal poljoprivredi. 115–128. [*In Engliish:* Subić, J. (2010). Labor force - the importance of economic potential for agriculture. 115–128, Retrived from http://www.sgd.org.rs/publikacije/globus/30/10%20Jonel%20Subic%20-%20RADNA%20SNAGA%20-%20ZNACAJAN%20EKONOMSKI%20POTENCIJAL%20U%20POLJOPRIVREDI.pdf (December 6, 2023)].
9. Turistička organizacija opštine Inđija (TO Inđija), https://indjijatravel.rs/?script=lat [*In English:* Tourist organization of the municipality of Inđija (TO Inđija), Retrieved from https://indjijatravel.rs/?script=lat (March 7, 2023)].
10. Turistička organizacija opštine Irig (TO Irig), http://www.turorgirig.org.rs/ [*In English:* Tourist organization of the municipality of Irig (TO Irig), Retrieved from http://www.turorgirig.org.rs (March 7, 2023)].
11. Turistička organizacija opštine Pećinci (TO Pećinci), https://www.turizampecinci.rs/ [*In English:* Tourist Organization of Pećinci (TO Pećinci), Retrieved from https://www.turizampecinci.rs/ (March 7, 2023)].
12. Turistička organizacija opštine Ruma (TO Ruma), http://rumatourism.com/sr/. [*In English:* Tourist organization of the municipality of Ruma (TO Ruma), Retrieved from http://rumatourism.com/sr/ (March 7, 2023)].
13. Turistička organizacija Sremska Mitrovica (TO Sremska Mitrovica), https://tosmomi.rs/ [*In English* Tourist organization of the municipality of Sremska Mitrovica (TO Sremska Mitrovica), Retrieved from https://tosmomi.rs/ (March, 7 2023)].
14. Turistička organizacija opštine Stara Pazova (TO Stara Pazova), https://turizampazova.rs . [*In English:* Tourist organization of the municipality of Stara Pazova (TO Stara Pazova), Retrieved from https://turizampazova.rs (March 7 2023)].
15. Turistička organizacija opštine Šid (TO Šid), https://vojvodina.travel/turisticka-organizacija-opstine-sid/, [*In English:* Tourist organization of the municipality of Šid (TO Šid), Retrieved from https://vojvodina.travel/turisticka-organizacija-opstine-sid/ (March 7 2023)].

IMPROVEMENT OF SUSTAINABLE ENVIRONMENTAL AND ECONOMIC COMPETENCES USING THE E-ACADEMY FOR THE DEVELOPMENT OF RURAL AREAS

Jelena Ignjatović[1], Milan Blagojević[2], Marija Bajagić[3], Vera Rašković[4]

**Corresponding author E-mail: bajagicmarija@yahoo.com*

A R T I C L E I N F O

Original Article

Received: *15 February 2024*

Accepted: *20 March 2024*

doi:10.59267/ekoPolj2402453I

UDC 004.738:911.373

Keywords:

sustainability, ecological competences, economic competences, E-Academy, development.

JEL: *I25, O18, Q01, Q50*

A B S T R A C T

Today, sustained development faces major challenges, which is based on economic, ecological and sociocultural principles, and which is a prerequisite for the development of rural areas. The goal of the work is the implementation of the professional education model for people from rural areas through the improvement of sustainable environmental and economic competencies using the E-Academy platform. The research is based on data obtained through the Survey (164 respondents), from Serbia, Slovenia and Croatia. The results show that 57% of respondents have secondary education and all are from rural areas. It has been established that the majority have elementary knowledge of the use of digital platforms and tools, so the interest in such education is at an enviable level. The significance of the results is reflected in the inclusion of the rural population in the E-Academy, monitoring the course of education and helping those who strive to improve agriculture.

Introduction

Although sustainable development faces many challenges (Ignjatović et al. 2024; Fisher et al., 2023; Mensah & Ricart Casadevall, 2019; Sima & Gheorghe, 2009) and

1 Jelena Ignjatović, PhD, Lecturer, Academy of Applied study Šabac, Dobropoljska 5, 15000 Šabac, Serbia, Phone: +381652086261, E-mail: jignjatovic985@gmail.com, ORCID ID (https://orcid.org/0000-0001-9946-6916)

2 Milan Blagojević, PhD, Senior Lecturer Academy, Academy of Applies studies Šabac, Dobropoljska 5, 15000, Šabac, Serbia, Phone: +381637524607, E-mail: blagojevicmilan@ymail.com, ORCID ID (https://orcid.org/0000-0002-3587-4360)

3 Marija Bajagić, PhD, Assistant Professor, University Bijeljina, Faculty of Agriculture, Pavlovića put bb, 76300 Bijeljina, Republic of Srpska, Bosnia and Herzegovina, Phone: +381638858185, E-mail: bajagicmarija@yahoo.com, ORCID ID (https://orcid.org/0000-0001-9537-8302)

4 Vera Rašković, Ph.D, Full Professor, Academy of Applied studies Šabac, Dobropoljska 5, 15000 Šabac, Serbia, Phone: +38115344580, E-mail: vera.raskovic75@gmail.com, ORCID ID (https://orcid.org/0000-0002-2565-5623)

continues to create the conditions for the economy to develop smoothly in accordance with ecological principles (Environment engenering group, 2024; Cepeliauskaite & Stasiskiene, 2020). Sustainable development as a concept is a prerequisite for rural development because it is based on economic, ecological and socio-cultural principles (Ignjatović, Đorđević, 2023). European rural areas are largely different, due to their natural, economic, social, cultural, political and institutional differences, as well as development opportunities (Gajić et al. 2021; Todorović, Štetić, 2009; Pantović et al., 2023; Miletić et al., 2023), also circularity (Mashović et al. 2022).

Agricultural production is an important part of economic activity. The population that mainly engages in agriculture is highly represented, while incomes from this activity are relatively small (no more than 5% of total household incomes). In recent years, the abandonment of villages has been one of the biggest problems in rural areas, along with insufficiently developed infrastructure, small and fragmented farms. The decrease in the number of inhabitants in rural areas is a constant problem in the last decades, while the potentials for the development of agriculture and rural development remain as a hope to slow down and stop this trend (Antic et al., 2017). In order for rural areas to start living and attract a larger number of inhabitants, it is necessary to invest in their development, through the improvement of infrastructure and amenities in the countryside, but also additional education as well as in populated and more developed cities.

Agricultural production plays a major role in the development of rural areas and the impact on the ecosystem in the form of reducing environmental degradation and providing healthy and safe food (Bajagić et al., 2022; Ilić-Kosanović et al., 2019; Podhorska et al., 2019). Cvijanović et al. (2020) states that food production at the local level directly affects the development of sustainable regional level, and as such is the main factor for implementing the strategy of sustainable regional development. Agriculture certainly has great potential in the development of specific products, which makes it a very rich activity (Smolović, 2022). This is especially expressed today in the production of perennial crops or vegetable gardens, where the earnings per unit area are higher, especially in intensive production (fruit growing and viticulture, vegetable production, etc.), with the possibility of producing products with added value (processed vegetables, fruit and grapes). In addition to the visions and opportunities that need to be developed and financially supported by development agencies and the EU itself, that is, the fund for rural development, another type of aid is certainly needed in order to encourage rural development as strongly as possible (IPARD, 2024). Rural development should provide current and future farmers, as well as their associations and cooperatives, with easy and accessible information, provision of advisory services related to the development of business plans. In addition, rural development would initiate the creation of databases, creation of project documentation, networking (connection), education, connection with domestic and foreign donors, promotion of potential, brands and services. The goal would certainly be to use the potential of agriculture and rural development, which is still developing poorly and slowly in Serbia (Bogdanov and Babović, 2019).

When it comes to the digital literacy of the population, inequalities are decreasing over time, thanks to the fact that the share of the population with basic or more advanced digital skills is increasing, especially in the female population. However, it should be borne in mind that the data in relation to the type of settlement in which women and men live were not publicly available, so it cannot be accurately claimed whether there are differences in both urban and rural areas (Cvejić, 2010; Lakićević et al., 2022). That is why digital literacy is necessary through the development of e-platforms, in order to improve people and provide them with support, which would further contribute to innovation and rural development.

The aim of the research

The aim of the work is to indicate the development of a model of high-quality vocational education of people from rural areas through the improvement of sustainable ecological and economic competences using the E-Academy. The primary task of this research is the collection of information and the analysis of the current situation and the necessary measures, which represent the basis for finding the best model.

Materials and methods

For the process of data collection, a quantitative approach to public opinion polling in the form of a closed and anonymous questionnaire and a statistical method (sample method) was used. The work is based on data collected from three different geographical areas: Serbia (Mačva), Croatia (Vukovar-Srijemska County) and Slovenia (Dolenjska). The survey was conducted by the Academy of Vocational Studies Šabac - Department for Agricultural and Business Studies and Tourism Republic of Serbia, Society for the Development of Voluntary Work Novo Mesto Slovenia and Technical College Vinkovci Republic of Croatia. The survey was conducted indirectly, based on a completely random sample. The period for completing the questionnaire is September - November 2023. The number of respondents was: for Serbia 53, of which two are not valid, for Slovenia 50 and Croatia 63, which for the analysis is the total number of respondents 164. The survey consists of 37 questions (*Table 1*). Data summarization was subjected to descriptive analysis, the results of which are presented descriptively and graphically. Additionally, in the research, an analysis of the existing situation and a clearer presentation of the conditions, education, experience and other facts, which further enable the finding of the best methods for the implementation of the basic goals, were carried out.

Table 1. Layout of the survey used in the research

1. The gender of the respondent?	1. Male 2. Female
2. Age of the respondent?	1. 15-19 2. 20-29 3. 30-39. 4. 40-49 5. 50-59 6. 60 +
3. Level of Education?	1. No qualification 2. Secondary vocational education 3. Higher education or higher professional education 4. Master of Science 5. Doctor of Science
4. Permanent residence?	1. Rural area 2. Urban area
5. Difficult access to residence?	1. Yes 2. No
6. Have you escaped from the war in Ukraine?	1. Yes 2. No
7. Do you have the technical conditions for work (computer, tablet, phone, etc.)?	1. Yes 2. No
8. If the answer to question number 7 is YES - which of the listed devices would you use to participate in the e-Academy?	1. Smartphone (Android) 2. Smartphone (iOS) 3. Desktop computer/laptop 4. Tablet (Android)
9. If the answer to question number 7 is NO - It is acceptable for me to participate in the e-Academy in the premises of the project partners in:	1. Jarmina 2. Šabac 3. Vinkovci 4. Other
10. Is translation with subtitles acceptable?	1. Yes 2. No
11. Is video work acceptable?	1. Yes 2. No
12. Is "chat" an appropriate tool for interaction with the lecturer?	1. Yes. 2. No
13. Do you need help using the chat tool?	1. Yes 2. No
14. If the answer to question number 13 is YES - Do you accept education as a type of professional help?	1. Yes 2. No
15. Do you think offline access is important?	1. Yes 2. No
16. Is an always available Q&A useful?	1. Yes 2. No
17. Do you have experience in education through an online platform?	1. Yes 2. No
18. If the answer to question number 17 is YES - Please specify which one?	
19. If the answer to question number 17 is YES - What caught your attention?	1. Good transparency of content 2. Interaction with the lecturer 3. Ease of access 4. Existence of Offline Content 5. Other

In the following questions, circle the number that best describes the extent to which you expect/believe the following statements (1. I do not expect/believe, 2. I expect/believe a little, 3. I expect/believe a lot 4. I expect/believe more, 5. The most I expect/believe).

20. Expectations of the e-Academy? Availability and access to modules!	1	2	3	4	5
21. Expectations of the e-Academy? Adapting to experiences and trends.	1	2	3	4	5
25. Expectations of the e-Academy? Learning flexibility.	1	2	3	4	5
26. Expectations of the e-Academy? Adapting to your own learning style	1	2	3	4	5
27. Expectations of the e-Academy? Ability to select modules.	1	2	3	4	5
28. Expectations of the e-Academy? Availability of materials.	1	2	3	4	5
29. Expectations of the e-Academy? Availability of multimedia content.	1	2	3	4	5
30. Expectations of the e-Academy? Continuous self-check.	1	2	3	4	5

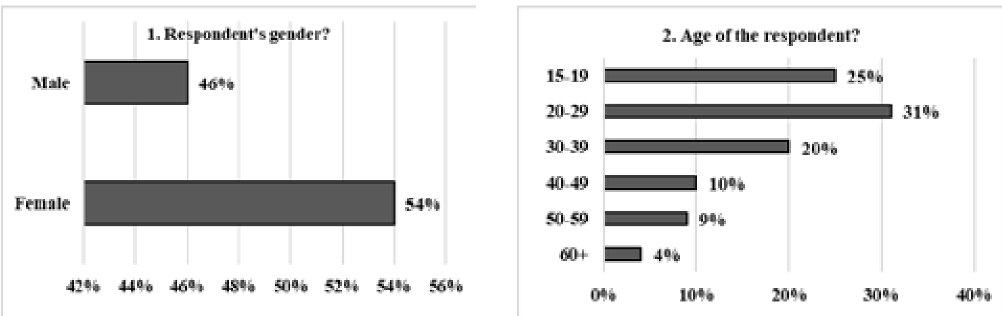
25. Expectations of the e-Academy? Learning flexibility.	1	2	3	4	5
26. Expectations of the e-Academy? Adapting to your own learning style	1	2	3	4	5
27. Expectations of the e-Academy? Ability to select modules.	1	2	3	4	5
31. Trust factor: High-quality course content and instructors?!	1	2	3	4	5
32. Trust factor: Positive user reviews?	1	2	3	4	5
33. Trust Factor: Customer Support?!	1	2	3	4	5
34. Trust factor: Data protection and privacy?	1	2	3	4	5
35. Trust factor: Good design?!	1	2	3	4	5
36. Trust Factor: Regular Updates?!	1	2	3	4	5
37. Suggestions? Specify.					

Source: Authors

Results and Discussions

The total number of respondents who participated in the survey was 166 people, but two surveys were canceled due to malfunctions, which implies that the sample used for the research results was 164 respondents. Of that number, 89 respondents were female, and 75 were male (*Figure 1, Question 1*). Expressed as a percentage, 54% of respondents are female, and 46% are male. The age structure of the respondents (*Figure 1, Question 2*) was analyzed through six clearly defined groups, namely: The first group (from 15 to 19 years old), respondents participate with 25%, i.e. 41 respondents belong to this group; The second group (20 - 29) make up 31% (51 respondents), which also represents the most numerous surveyed population, in relation to all other groups; The third age group, consists of 20% (33 respondents), while, the fourth group (from 40 to 49 years old) consists of 10% (17 respondents); The fifth group of respondents aged 50 to 59 participates with 9% (15 respondents) and the sixth, oldest group over 60 participates with 4% (7 respondent).

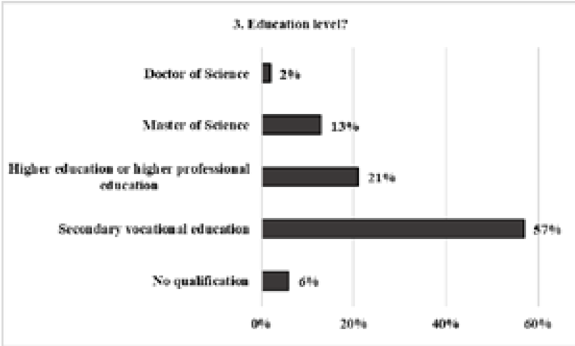
Figure 1. Results of the survey questionnaire (*question 1 and 2*)



Source: Authors

The level of education of the respondents, which is shown in Fig. 2 (*Question 3*), shows that 6% of respondents, i.e. 10 people, have no qualifications. The largest number of respondents in the amount of 94 persons (57%) have a high school diploma, followed by 21% (35 respondents). Furthermore, 13% of the respondents (21 respondents) have a master's degree, and 2% (4 respondents) have a doctorate.

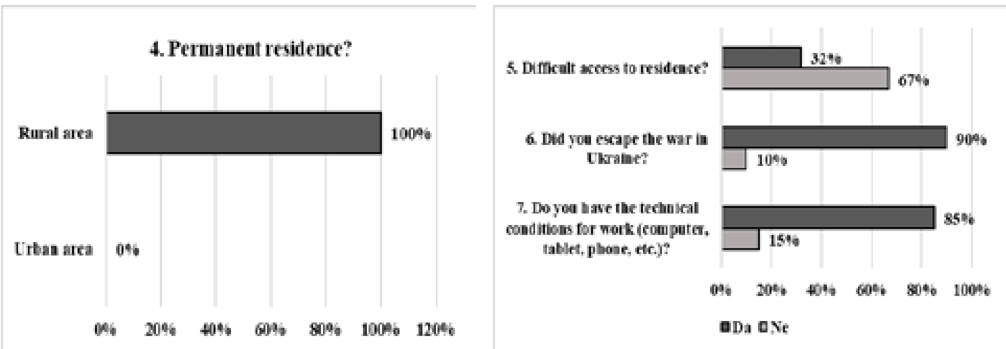
Figure 2. Results of the survey questionnaire (*question 3*)



Source: Authors

To question no. 4 (*Figure 3*), which refers to the respondent's area of residence, all answered (100%) that they live in a place that belongs to the rural type, while there is not a single respondent in the urban area. When answering question no. 5, whether they have difficult access to their residence, 32% (53 respondents) answered affirmatively, where 2 respondents stated that the reason was limited or less frequent public transportation (*Figure 3*). There are 67% (109 people) of negative answers, and 2 respondents (1%) belong to the other category (none of the above). The number of respondents who belong to the group who escaped from Ukraine (*Figure 3, Question 6*), considering the current state of war, is 10% (16 respondents), while 90% (148 people) do not belong to this category. Results of the survey on question no. 7 (*Figure 3*) about the state of technical conditions for work says that 85% (140 respondents) have the conditions for distance education, while 24 respondents (15%) do not have the conditions. Some of the reasons are a bad internet connection or not having the necessary equipment.

Figure 3. Results of the survey questionnaire (*question 4, 5, 6 and 7*)

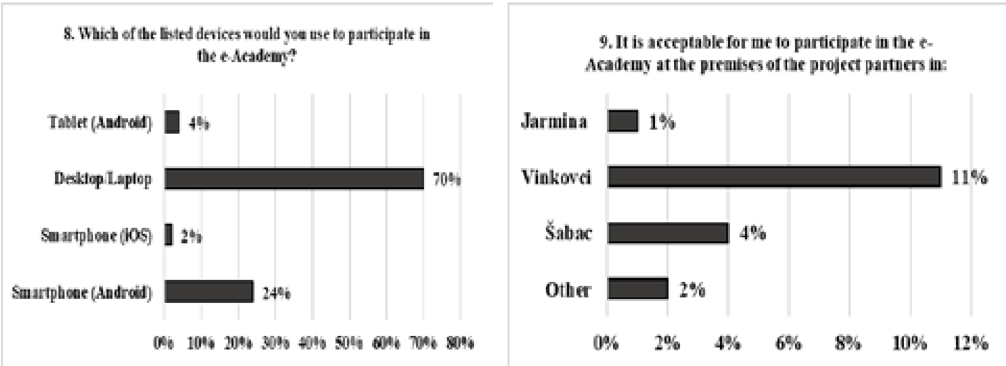


Source: Authors

Of the total number of respondents who answered affirmatively to the previous question (140 persons), to question no. 8 (*Figure 4*): What would they use to participate in the e-Academy, the survey shows that 4% (5 respondents) own a Tablet (Android), 70% (98 respondents) have a desktop computer, while 2% have an iOS smartphone (3 respondents), and 24% (34 respondents) own an Android smartphone.

Respondents who answered negatively to question number 7 (24 respondents) were offered the choice to choose places where the premises of project partners are located that are acceptable to them for participation in the e-Academy (*Figure 4; Question 9*). Holding education in the place: 1% (1 respondent) would accept Jarmin, 11% (15 respondents) would attend in Vinkovci, 4% (5 respondents) in Šabac, while 2% (3 respondents) are interested in other places. Also, it is important to note that people who have the technical conditions to access the e-Academy are interested in attending "live" education, and have listed places where they would like to come, such as Šabac, Novo mesto, Vinkovci, Županja, etc.

Figure 4. Results of the survey questionnaire (*question 8 and 9*)



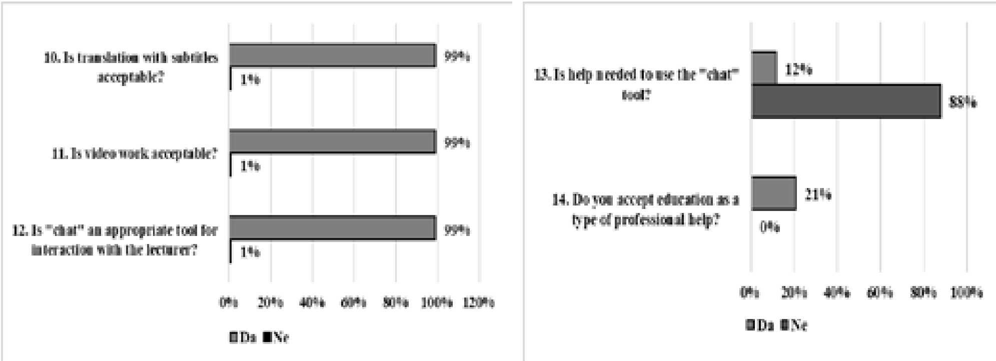
Source: Authors

To questions no. 10. Is translation with subtitles acceptable?, no. 11. Is video work acceptable? and no. 12. Is "chat" an appropriate tool for interaction with the lecturer? Figure 5 shows that of the total number of respondents, 99% (162 respondents) answered yes, while 1% (2 respondents) gave a negative answer.

By asking question no. 13. Is help needed to use the "chat" tool?, 12% (19 respondents) declared that they would like help, while 88% of them (145 respondents) are familiar with the use of the "chat" tool (*Figure 5*).

For respondents who want help (19 people), by question no. 14. Is education acceptable to them as professional help, only 4 respondents answered in the affirmative (21%), while the rest did not declare (*Figure 5*). Also, it is important to point out that 6 respondents who do not need help using "chat" would like an additional course in order to improve the use of this tool for online communication.

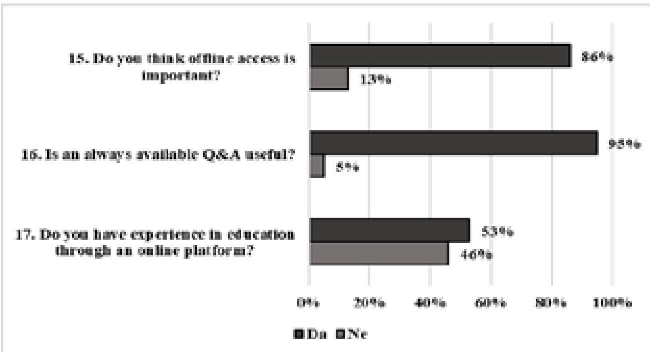
Figure 5. Results of the survey questionnaire (*question 10, 11, 12, 13 and 14*)



Source: Authors

Results of the survey on question no. 15. (*Figure 6*), Do you think that offline access is important?, 86% (141 respondents) think that it is important to access education even without the network, while for 13% (22 respondents) offline access is not important. Question: Is the always available Q&A useful? (*Figure 6, Question 16*), 95% (156 respondents) agreed, and 5% (8 people) indicated that it was not useful. Next question no. 17. (*Figure 6*), which refers to having experience for education through an online platform, 54% (88 persons) have experience, while 45% (75 persons) have not used distance education, and 1 respondent (1%) did not answer .

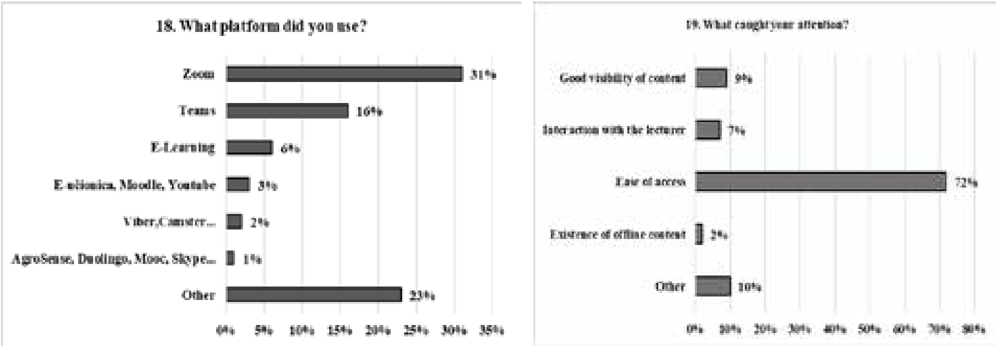
Figure 6. Results of the survey questionnaire (*question 15, 16 and 17*)



Source: Authors

Question no. 18 refers to respondents who answered the previous question in the affirmative (88 respondents), and they were asked to indicate which online platform they used (*Figure 7*). Of the above responses, the largest number used the platform Zoom (27 respondents), Teams (14 respondents), E-learnig (5 respondents), E-classroom, Moodle and Youtube (3 respondents), Campster and Viber (2 respondents), AgroSence, Duolingo, Google Meet, Graphic design, Coding, Mooc, Photoshop, Renault manufacturin e-learning, Skype and Sova (1 respondent), and 20 respondents refrained from giving an answer.

Figure 7. Results of the survey questionnaire (*question 18 and 19*)



Source: Authors

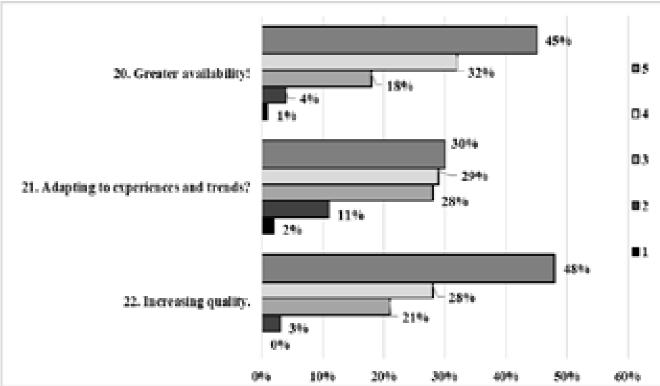
The same number of respondents (88) additionally answered question no. 19. What attracted attention for using the platform? (*Figure 7, Question 19*). 9% (8 respondents) opted for good visibility of the content, 7% (6 respondents) were interested in interaction with the lecturer, ease of access is important for 72% (63 respondents), existence outside the network access is important for 2% (2 respondents), while 10% (9 respondents) did not choose any of the offered answers.

Furthermore, the Survey consisted of a group of questions (from 20 to 30 questions) related to the expectations of education through the e-Academy, where respondents were offered statements that should be answered (circled): 1. I do not expect, 2. A little I expect, 3. I expect a lot, 4. I expect more, 5. I expect the most.

To question no. 20. Is greater availability and access to education-related modules expected?! (*Figure 8*), respondents answered as follows, 1% (2 respondents) do not expect, 4% (7) expect a little, 18% (29) expect a lot, 32% (52) have more expectations and 45% (74) expects maximum availability of the e-Academy platform. Furthermore, expectations in adapting to the experiences of respondents and trends that are current (*Figure 8, Question 21*), 2% (3 respondents) have no expectations, 11% (18) expect a shift in monitoring experience and trends, 28% (46) expect a lot of adaptation to experiences and trends, 29% (47) expect more, and 30% (50) have the highest expectations in monitoring the existing systems of respondents, as well as the current current trends occurring in online education.

When it comes to expectations regarding an increase in the quality of education through the platform (*Figure 8, Question 22*), all respondents expect a certain percentage, namely: 5% (3) expect a little increase in quality, then 21% (35) have a lot of expectations in quality online education, 28% (46) expect more in the quality of this type of learning and 48% (78) the largest number of respondents expect a serious quality of education through the e-Academy.

Figure 8. Results of the survey questionnaire (*question 20, 21 and 22*)



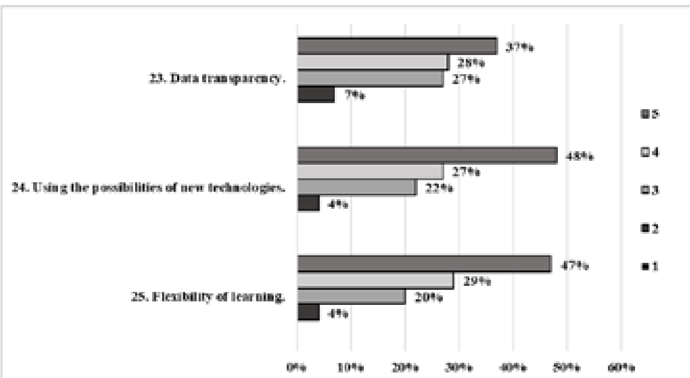
Source: Authors

Expectations related to the transparency of data, i.e. all lectures, exercises, literature that are available (*Figure 9, Question 23*), the respondents expect that it is also present: 7% (12) expect a little transparency, 27% (45) expect a lot, 28% (46) have more expectations, and the largest percentage of respondents, 37% (61), expect maximum transparency.

All survey participants expect the use of new technologies (*Figure 9, Question 24*), according to the following: 4% (6) have little expectations for the use of new technologies, 22% (36) expect a lot of use of new technologies, 27% (44) have more expectations, and 48% (78) fully expect accessibility and the possibility of using new technologies during education through the e-Academy.

Flexible learning (*Figure 9, Question 25*) is expected by everyone to an extent: 4% (6) have low expectations, 20% (33) expect a lot of flexible learning, 29% (48) expect more understanding for flexible learning and 47% (77) believe that it is necessary to enable the flexibility of education through the platform.

Figure 9. Results of the survey questionnaire (*question 23, 24 and 25*)



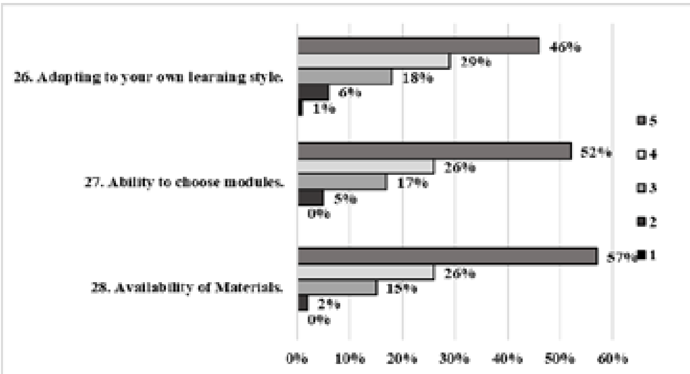
Source: Authors

In this regard, question 26 was asked about the expectation of adaptation to one's own style of learning and education through personal style and manner, where 1% (1 respondent) does not expect permission to change the style of education, 6% (10) expect some adaptation from professionals, 18% (29) expect a lot, 29% (48) expect more, while 46% (75) expect complete understanding and adaptation of students' style during education. One person did not respond to any of the offered expectations (*Figure 10*).

To question 27 (*Figure 10*), whether they expect the possibility of choosing educational modules according to their own needs and potential, all answered positively, namely: 5% (9) have low expectations, 17% (28) expect a lot of choice, 26% (42) expect more, while 52% (85) of respondents have the highest expectations for the possibility of choosing educational modules according to their own needs and potential.

When it comes to the availability of learning materials, 2% (4) have low expectations, 15% (24) expect a lot of present and available material, 26% (42) expect more, and the largest number of respondents, 52% (85), expect maximum availability of all materials for easier online education (*Figure 10, Question 28)*.

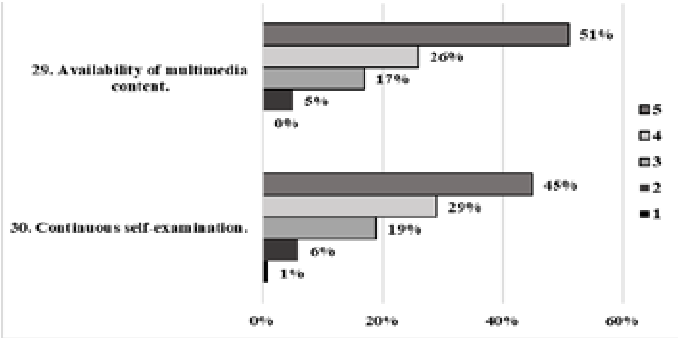
Figure 10. Results of the survey questionnaire (*question 26, 27 and 28*)



Source: Authors

For the availability of multimedia content (*Figure 11, Question 29*), 5% (8) have low expectations, 17% (28) expect quite good availability, 26% (43) expect more, while 51% (84) definitely expect always presence multimedia data. One respondent did not answer. Expectations regarding continuous self-checking (*Figure 11, Question 30*), 1% (1 respondent) do not expect self-checking, 6% (10) expect little, 19% (31) expect a lot of engagement for self-checking, 29% (47) expect more, and 45% (74) are interested in constant continuous self-checking during education through the e-Academy. One respondent did not state his expectation.

Figure 11. Results of the survey questionnaire (*question 29 and 30*)



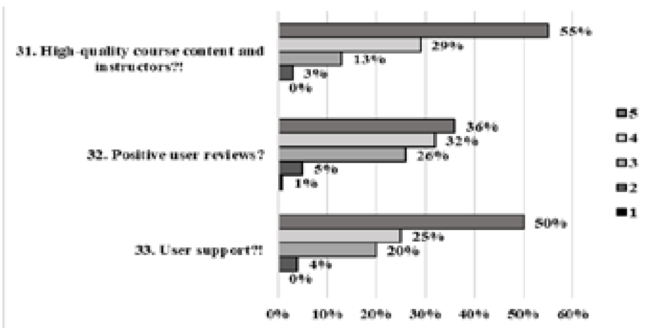
Source: Authors

The following 6 questions of the Survey refer to trust factors during the education offered by the e-Academy platform (from 31 to 36 questions), and the respondents marked the answer to what extent they trust the set factors: 1. I do not believe, 2. I believe a little, 3. I believe a lot, 4. I believe more, 5. I believe the most.

To question 31 (*Figure 12*), whether they believe that the e-Academy represents high-quality course content and the quality of the expertise of the instructors who run the e-Academy, respondents answered positively, so that 3% (5 respondents) have little confidence, 13% (21) believe a lot, 29% (47) believe more and 55% (90) of respondents have full confidence in the quality of the course and the instructor. One respondent did not answer.

Do they believe in positive user reviews based on the content of the course and the instructor's presentation (*Figure 12, Question 32*), the respondents answered according to the following, 1% (1 respondent) have no confidence, 5% (9) have little confidence, 26% (42) trust a lot, 32% (52) trust more, and 36% (59) have the most trust in the presence of positive user reviews. Only one person did not answer. Regarding user support during e-learning (*Figure 12, Question 33*), 4% (7) have little faith in support during education, 20% (33) believe a lot, 25% (41) believe more, while 50% (82) has maximum confidence in the customer support of the platform when using it.

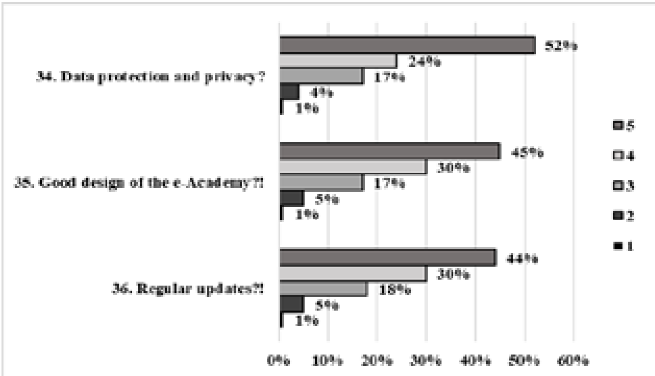
Figure 12. Results of the survey questionnaire (*question 31, 32 and 33*)



Source: Authors

When it comes to the protection of data and privacy of all persons using the e-Akademija platform (*Figure 13, Question 34*), 1% (1) of respondents do not trust the protection, 4% (7) have little faith that the protection is present, 17% (28) believe a lot, 24% (40) believe more, and 52% (86), more than half of respondents believe in the support of the e-platform that offers protection of all data and complete privacy. One respondent did not answer question no. 33 and 34. Question 35 (*Figure 13*) refers to the belief that the design of the e-Academy is good, respondents answered as follows: 1% (1 respondent) do not believe in a good design of the platform, 5% (8) believe little, 17 % (28) believe a lot in good design, 30% (50) believe more and 45% (74) completely believe in good design of the e-Academy for ease of using the platform. Do they believe in regular updates of the e-Academy (*Figure 13, Question 36*), 1% (1) respondents do not believe in regular updates, 5% (8) little believe, 18% (30) believe a lot, 30% (50) believe more in the help of platform updates, while 44% (72) completely believe that updates will be essential from the customer service during any changes to the platform. On questions 35 and 36, 2%, that is, 3 respondents did not give answers to the offered trust factors.

Figure 13. Results of the survey questionnaire (*question 34, 35 and 36*)



Source: Authors

The respondents had the opportunity to make suggestions regarding the improvement of the strategy and the provision of the best conditions for online learning through the e-Academy application (*Question 37)*, where some respondents answered that an extremely good internet connection is necessary, that the platform be as easy to use as possible, and that there is a certain level educational and cultural education during group educations (no talking, no jobs that can interfere with the course of education).

Conclusions

Sustainable development, which today faces major challenges, is a prerequisite for the development of rural areas. It is based on economic, ecological and socio-cultural principles that together lead to development. Abandonment of villages, in recent years, is considered the biggest problem in rural areas, along with insufficiently developed infrastructure, small and fragmented farms. One of the ways to stop migration is digital literacy, which can be improved by developing e-platforms, with the aim of training people, that is, providing support, which would result in innovation and rural development.

According to the results of the Survey, the views of respondents indicate that most respondents are interested in education through the e-Academy, continuing education, that they have the technical conditions for education, as well as basic knowledge of the application of various e-platform tools. The problem of the population in rural areas is the distance from urban areas where educational institutions are located, and most of them are already engaged in some form of agriculture, which requires constant presence and work.

An additional satisfaction of the success of this kind of education is that the respondents are from rural areas, and there is a motivation and desire to improve both in the educational and practical sense. In this way, educated profiles of the population would be created, favorable conditions for the improvement of agricultural farms and rural tourism, as well as their synergies with those who are already engaged in these activities, on the one hand, as well as those interested in starting a business in the mentioned activities, on the other hand. Also, it is important to point out that the e-Academy platform was designed and built in accordance with the expectations of the respondents, and it does not need to be additionally modified. The direction of further research should be based on starting the education of people through the e-Academy, monitoring the course of education and guiding people who complete the education, and additionally work on marketing and promoting this type of learning for future generations who live in remote places and have the desire to improve in in every respect.

Acknowledgements

The paper was written within the Erasmus + project Better Soil to Better Tomorrow (BS2BT), no. 2023-1-HRO1-KA220-VET-000160995.

Conflict of interests

The authors declare no conflict of interest.

References

1. Antic, M., Santic, D., Kašanin-Grubin, M., Malic, A. (2017). Sustainable rural development in Serbia-relationship between population dynamicss and environment. *Journal of Environmental Protection and Ecology*, 18(1), 323-331.
2. Bajagić, M., Stošić, N., Rašković, V., Cvijanović, V., Đukić, V. (2022): Potential of organic production from the perspective of youth in Serbia. *Economics of Agriculture*, 69(2), 411-424. https://doi.org/10.5937/ekoPolj2202411B
3. Bogdanov, N., & Babović, M. (2019). Labor force and work on agricultural farms - situation and trend. Republic Institute of Statistics, Belgrade.

4. Cepeliauskaite, G. & Stasiskiene, Z. (2020). The Framework of the Principles of Sustainable Urban Ecosystems Development and Functioning. *Sustainability* 12(2), 720; https://doi.org/10.3390/su12020720
5. Cvejić, S., Babović, M., Petrović, M., Bogdanov, N., & Vuković, O. (2010). Social exclusion in rural areas of Serbia. UNDP, Sector for Inclusive Development, Belgrade.
6. Cvijanović D, Ignjatijević S, Vapa Tankosić J, Cvijanović V. (2020). Do Local Food Products Contribute to Sustainable Economic Development? *Sustainability*. 12(7):2847. https://doi.org/10.3390/su12072847
7. Gajić, A., Krunić, N. & Protić, B. (2021). Classification of Rural Areas in Serbia: Framework and Implications for Spatial Planning. *Sustainability* 13(4), 1596. https://doi.org/10.3390/su13041596
8. Environment engenering group. Sustainable development. Retrieved from https://www.activity4sustainability.org/odrzivi-razvoj/ (Mart 08, 2024).
9. Fischer, M., Foord, D., Frecè, J, Hillebrand, K., Kissling-Näf, I., Meili, R., Peskova, M., Risi, D., Schmidpeter, R. & Stucki, T. (2023). The Concept of Sustainable Development. *Sustainable Business,* 17-27. https://doi.org/10.1007/978-3-031-25397-3_2
10. Ignjatović, J., Filipović, S., & Radovanović, M. (2024). Challenges of the green transition for the recovery of the Western Balkans. Energy, *Sustainability and Society* 14(2), 1-13. https://doi.org/10.1186/s13705-023-00421-4
11. Ignjatović, J., Đorđević, A. (2023). Sustainable development of rural tourism: case study of the region of Western Serbia, *First international conference Global challenges throught the prism of rural development in the sector of agriculture and tourism*, Academy of Applied studies Šabac, Serbia, 321-327. Retrieved from www.girr.vpssa.edu.rs
12. Ilić Kosanović, T., Pažun, B., Langović, Z., & Tomić, S. (2019). Perception of small farmers in Serbia regarding the use of ICT and possibilities of organic agriculture. *Economics of Agriculture*, 66(4), 989-1001. https://doi.org/10.5937/ekoPolj1904989I
13. Instrument for Preaccession Assistance in Rural Development (IPARD). EU for rural areas. Retrieved from https://ipard.rs/ (Mart 08, 2024).
14. Lakićević, M., Kostić, M., Pantović, D., & Žarevac-Bošković, M. (2022). Effects of climate change on sustainable tourism development in the Republic of Serbia - a case study of Vrnjačka Banja,. *Ekonomika*, 68(1), 81-93.
15. Mashovic, A., Ignjatović, J. & Kisin, J. (2022), Circular economy as an imperative of sustainable development in North Macedonia and Serbia, *Ecologica,* XXIX (106), 169-177. https://doi.org/10.18485/ecologica.2022.29.106.5
16. Miletić, R., Pantović, D., & Veliverronena, L. (2023). Dark tourism in Serbia: Case study of the Kragujevački oktobar Memorial Park. *Hotel and Tourism Management,* 11(1), 127–144. https://doi.org/10.5937/menhottur2301127M

17. Mensah, J. Ricart Casadevall, S. (2019). Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review, *Cogent Social Sciences*, 5:1. DOI: 10.1080/23311886.2019.1653531
18. Pantović, D., Luković, M., Lakićević, M. (2023), Evaluation of tourism at rural areas in the European Union, *Proceedings of the Faculty of Economics in East Sarajevo*,, Issue 27, 11-18.
19. Podhorska, I., Gajanova, L., Kliestikova, J., & Popescu, G. H. (2019). Analysis of internally generated goodwill indicators: a case study of the Slovak republic. *Organizacija*, 52(4), 271-285.
20. Smolović, S. (2022). The importance of rural tourism and agriculture from the aspect of sustainable development of Montenegro. Doctoral dissertation. Alfa BK University. Belgrade.
21. Sima, V., & Gheorghe, I. (2009, June). The 'green dimension' of customer satisfaction. *In The 11th IBIMA Conference,"Creating Global Economies through Innovation and Knowledge Management*", Kuala Lumpur, Malaysia (pp. 1638-1641).
22. Todorović, M., Štetić, S. (2009). Rural tourism, University of Belgrade, Faculty of Geography, Belgrade.

ANALYSIS OF THE POSSIBILITY OF BANKRUPTCY IN MEDIUM-SIZED AGRIBUSINESS COMPANIES IN AP VOJVODINA

Bogdan Jocić[1], Dragan Milić[2], Vladislav Zekić[3], Dragana Novaković [4], Tihomir Novaković [5], Zoran Ilić [6]

**Corresponding author E-mail: bogdan.jocic@polj.uns.ac.rs*

A R T I C L E I N F O

Original Article

Received: *11 March 2024*

Accepted: *20 April 2024*

doi:10.59267/ekoPolj2402469J

UDC 347.736:[631:334.021.61-022.55(497.113)

Keywords:

Altman Z' scor, Kralicek Quick test, Springate model, agriculture, food industry

JEL: *G00, G33, Q14*

A B S T R A C T

In the context of a volatile economy marked by diverse global crises, it becomes imperative to proactively assess the potential insolvency among economic entities. This study focuses on medium-sized companies involved in agricultural and food production within the AP Vojvodina, spanning the time frame from 2018 to 2022. The primary objective is to assess the likelihood of bankruptcy within the observed companies, applying Altman's modified Z score (Z'), Kralicek Quick test and the Springate model. The data utilized for this research are sourced from the financial reports of the observed companies. Based on the performed analysis, it can be concluded that the modified Altman's Z' score and the Springate model in most cases gave identical results on the occurrence of bankruptcy. Using the Kralicek Quick test, the solvency ratings are quite divergent. In the observed period, the possibility of bankruptcy was higher for agricultural companies compared to ones from the food industry.

1 Bogdan Jocić, Msc, Junior Researcher, University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21101 Novi Sad, Serbia, Phone: +381 61 6655044, E-mail: bogdan.jocic@polj.uns.ac.rs, ORCID ID(https://orcid.org/0000-0002-1745-3255)

2 Dragan Milić, PhD, Associate Professor, University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21101 Novi Sad, Serbia, Phone: +381 63 560135, E-mail: dragan.milic@polj.edu.rs, ORCID ID (https://orcid.org/0000-0003-0377-1540)

3 Vladislav Zekić, PhD, Full Professor, University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21101 Novi Sad, Serbia, E-mail: zekic@polj.uns.ac.rs, ORCID ID (https://orcid.org/0000-0002-7377-2402)

4 Dragana Novaković, PhD, Assistant Professor, University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21101 Novi Sad, Serbia, Phone: +381 69 1994316, E-mail: dragana.tekic@polj.uns.ac.rs, ORCID ID (https://orcid.org/00000002-1924-6196)

5 Tihomir Novaković, PhD, Assistant Professor, University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21101 Novi Sad, Serbia, Phone: +381 (21) 4853 380, E-mail: tihomir.novakovic@polj.uns.ac.rs, ORCID ID (https://orcid.org/0000-0002-8405-3403)

6 Zoran Ilić, Mr. Sci, ECOVIS FinAudit doo Beograd, Ljubana Jednaka 1, 11000 Beograd, Serbia, Phone: +381 65 8323762, E-mail: zoranilic.sudskivestak@gmail.com, ORCID ID (https://orcid.org/0000-0001-6955-6443)

Introduction

Agribusiness is defined as the economic undertaking of agricultural holdings or entities engaged in the production and/or processing of raw agricultural commodities, culminating in the creation of final products for subsequent distribution. The observed activity also includes all economic activities that support agricultural production and conversion of raw materials (Katchova and Enlov, 2013). Agricultural production is traditionally a very significant economic activity in the Republic of Serbia, which is a consequence of relatively favorable agroecological conditions, as well as historical and developmental circumstances (Jakšić, et al., 2015). Notably, approximately 45% of the total utilized agricultural land within the country is situated in the territory of AP Vojvodina, as per data from the Statistical Office of the Republic of Serbia (2018). In the domain of sector A - Agriculture, companies in Vojvodina are predominantly structured as micro and small entities. However, the pivotal impact on the augmentation, evolution, and sustainability of agricultural production emanates from medium and large enterprises. These entities, contributing to over one-third of the total turnover in this sector, employ approximately 60% of the workforce within the agricultural domain (Kalas et al., 2017). Within the life cycle of a company, periods of both positive (successful) and negative (unsuccessful) trajectories transpire. When the negative phase evolves from a transient state to a structural and chronic disposition, persisting over time, the enterprise often confronts an impending fate of bankruptcy (Altman et al., 2013). Assessing the possibility of bankruptcy in market conditions is imperative for sustainable financial management. Bankruptcy can be defined as the incapacity of a company to fulfill due obligations, stemming from either present or past operational activities. This phenomenon not only detrimentally impacts the company itself but also extends its repercussions to other economic entities with whom it maintains direct or indirect collaborations (Bordeianu et al., 2011). Analysis of financial reports and the assessment of financial ratios offer valuable insights into the operational stability of a business. The basic premise is that if the observed enterprise achieves high marks in the financial analysis, there is less chance of bankruptcy. Bernhardsen (2001) states that conventional ratio indicators confront limitations due to the disparate properties in various economic sectors. The author advocates for the contextual evaluation of these relationships, incorporating additional information about the companies themselves and the markets in which they operate. Although traditional ratio indicators are still used today as a supplementary tool for assessing the possibility of bankruptcy, their use in the observed domain is more common in the creation of statistical models that assess financial position or the probability of bankruptcy. The latter half of the preceding century witnessed the inception of the first statistical models for bankruptcy assessment, initially grounded in discriminant analysis, linear probability, and logit/probit analysis. The escalating interest in the domain of bankruptcy prediction prompted extensive exploration by numerous scholars, resulting in the formulation of diverse models. Noteworthy among these are models stemming from the research efforts of William H. Beawer, Edward I. Altman, Edward B. Deakin, James A. Ohlson, Robert O.

Edmister, Christine V. Zavgren, and Peter Kralicek (Zenzerović et al., 2006). Aligned with the aforementioned considerations, this paper centers its research on medium-sized companies involved in agricultural and food production within the AP Vojvodina region during the period spanning 2018 to 2022. The primary objective of this research is to analyze the potential bankruptcy among the designated economic entities, applying Altman's modified Z score (Z'), the Kralicek quick test and the Springate model.

Literature review

Various scholars have engaged in the evaluation of financial positions and the analysis of bankruptcy likelihood within agricultural enterprises and entities in the food industry. Cîrciumaru (2011) applied Altman's Z score, Conan and Holder, Ohlson, Anghel and Circiumaru model to assess bankruptcy possibilities for 11 companies in the food industry operating in Romania from 2007 to 2009. The study concluded that general models were more appropriate for assessing bankruptcy likelihood in the observed case. Rajin et al. (2016) conducted a bankruptcy risk analysis for 5 agricultural companies in the Republic of Serbia from 2010 to 2013, utilizing Altman's modified Z' score, Kralicek DF indicator and Kralicek quick test. The results of this research point to more rigorous assessments of the possibility of bankruptcy using Altman's model. Vukadinović et al. (2018) also assessed the financial position of agricultural companies in the Republic of Serbia from 2014 to 2016, applying the modified Altman's Z' score, Kralicek Quick test and moderate growth model. The authors concluded that the applied models gave similar results and that there is a high risk of bankruptcy in the observed companies. Kovács et al. (2020) reached comparable conclusions in their research but used the modified Altman Z' score, Springate, Comerford and Fulmer method. The observed agricultural enterprises operated on the territory of Hungary in the period from 2014 to 2018. An assessment of the possibility of bankruptcy of mill companies in the territory of AP Vojvodina was presented in the research conducted by Tekić et al. (2020). The paper evaluated 5 economic entities that operated in the period from 2015 to 2019. Using Altman's Z score and Kralicek Quick test, the authors concluded that both models gave similar results when assessing the likelihood of bankruptcy. The application of specially created models for assessing the possibility of bankruptcy in Slovak agriculture (G and CH index) is presented in the research of Bencová et al. (2021). The authors presented an analysis of the financial position of Slovak farms for the period from 2009 to 2020. Also, general models were used in the paper: modified Altman Z' score, IN 05, Creditworthiness index and Taffler model. The research results showed that Altman's modified Z' score and G index gave more rigorous ratings of bankruptcy than other models. Milić et al. (2021) also concluded that Altman's Z' evaluated the possibility of bankruptcy more rigorously compared to other models. Using Altman's modified Z' score, the Kralicek DF indicator and the Kralicek Quick test, the authors analyzed the likelihood of bankruptcy occurrance in large agribusiness companies on the territory of AP Vojvodina in the period from 2015 to 2019. Stoyancheva et al. (2023) assessed financial viability and bankruptcy risk in Bulgarian agricultural enterprises from 2017 to 2021, using Altman's Z score, Springate, IN05, and Zmijewski model with Springate, Altman and IN05 offering the most rigorous evaluations. Angelova et al. (2023) also supported the adequacy of the Springate model and Altman's Z score in assessing bankruptcy possibilities, analyzing 34 agricultural companies engaged in animal husbandry in Bulgaria from 2017 to 2021.

Materials and methods

The study focuses on assessing the likelihood of bankruptcy among economic entities involved in agricultural and food production within the AP Vojvodina region. Five agricultural companies, namely Agros (A), Best Seed Producer (B), Libela produkt (C), PIK Juzni Banat (D) and Vrebalov Agrar (E), were analyzed. Also, in research will be shown an evaluation of bankruptcy occurrence in five business entities from the food sector: Biospringer RS (F), Kristal So (G), Master Fruits (H), BB Minaqua (I) and Superior Foods (J). All the tested companies are legally structured as limited liability companies (l.l.c). Data spanning the period from 2018 to 2022 were sourced from the Serbian Business Registers Agency (SBRA) website, specifically from financial reports.

The following models will be used to analyze the possibility of bankruptcy:

Altman's modified Z score (Z')

The application of discriminant analysis within bankruptcy assessment models was pioneered by Edward I. Altman in 1968. Drawing insights from the financial performance of 66 manufacturing companies (half of which faced bankruptcy while the other half demonstrated sound solvency), he formulated a model specifically made for evaluating the financial health of entities with publicly traded shares. Among the 22 financial indicators analyzed, Altman identified and incorporated 5 key variables into the final Z score model (Altman, 1968). Recognizing the limitation of the initial model in appraising manufacturing companies absent from stock exchange listings, Altman subsequently redefined his formula in 1983 (Altman, 1983) as follows:

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5$$

Indicators in the discrimination function were calculated according to:

Z' = Z' score

X_1 = (current assets-current liabilities) / total assets

X_2 = retained earnings / total assets

X_3 = earnings before interest and taxes / total assets

X_4 = book value equity / total liabilities

X_5 = sales / total assets

Based on the obtained result, companies are classified into 3 zones: safe (Z'>2.9), gray (potential risk of bankruptcy; 1.23<Z'<2.9) and distressed zone (Z'<1.23).

Kralicek Quick test

The Kralicek Quick test was developed in 1990 and provides an opportunity for a quick assessment of the company's solvency. This model is based on the calculation of four indicators, two indicators of financial stability and two indicators of profitability (Didenko et al, 2012). The derived values of these model components dictate the allocation of points on a scale ranging from 1 to 5. Firms manifesting robust financial health garner 1 or 2 points, while the threshold between favorable and unfavorable financial positions is demarcated by 3 points. A score of 4 points designates a suboptimal financial state, and 5 points indicates a heightened risk of insolvency or bankruptcy (Kubenka, 2016). The final results are obtained as an average of previously calculated averages of indicator values, expressed in points (table 1).

Table 1. Kralicek Quick test methodology

Indicators	**Points and grades**				
	1 Excellent	2 Very good	3 Good	4 Bad	5 Risk of Insolvency
X_1	>0.3	0.2-0.3	0.1-0.2	0.0-0.1	Negative
X_2	<3	3-5	5-12	12-30	>30
Financial stability S1 = $(X_1+ X_2)/2$					
X_3	>0.15	0.12-0.15	0.08-0.12	0.0-0.08	Negative
X_4	>0.1	0.08-0.1	0.05-0.08	0.0-0.05	Negative
Total performance and profitability S2 = $(X_3+ X_4)/2$					
Total rating T= $[(X_1+ X_2)/2+(X_3+ X_4)/2]/2$					

Source: Kralicek (2007), adapted by the authors

The indicators used in this model were calculated according to:

X_1 = equity / total assets

X_2 = total liabilities-cash / net profit + depreciation

X_3 = earnings before interest and taxes / total assets

X_4 = net profit + depreciation / business revenue

Indicator X_1 denotes the self-participation within the aggregate sources of financing. As delineated by the predefined critical thresholds outlined in Table 2, this indicator is deemed satisfactory when attaining a value of 10% or higher. The period of debt repayment is shown by X_2, where the risk of insolvency arises with the value of the indicator greater than 30 years. It is advisable to maintain the observed indicator below 12 years. A negative value of the profitability of total assets indicator (X_3) signals solvency challenges, with a recommendation for values exceeding 8%. The share of cash flow in business income is represented by X_4. The observed indicator should have a value of 5% or greater.

Springate model

Gordon L.V. Springate modified Altman's Z score to align with the Canadian economy. Out of the 19 observed variables, a subset of 4 was strategically incorporated into the ultimate model designed for evaluating the potential of bankruptcy. Remarkably, the model demonstrated a 92.5% accuracy in forecasting bankruptcy (Springate, 1978):

$$S = 1.03X_1 + 3.072X_2 + 0.66X_3 + 0.4X_4$$

Indicators in the discrimination function were calculated according to:

S = S score

X_1 = (current assets-current liabilities) / total assets

X_2 = earnings before interest and taxes / equity

X_3 = earnings before taxes / current liabilities

X_4 = sales / total assets

Based on the obtained result, companies are classified as healthy (without risk of bankruptcy, $S > 0.862$) or endangered (high risk of bankruptcy, $S < 0.862$).

The economy in the Republic of Serbia markedly differs from the countries for which the analyzed bankruptcy prediction models were originally formulated (USA; Canada; Germany, Switzerland, and Austria). Some scholars (Platt and Platt (1990), Opler and Titman (1994), Maksimović and Phillips (1998), Grice and Dugan (2001), Niemann et al. (2008), Wu et al. (2010), Alihodžić (2013)) believe that the effects of industry should also be included in models for predicting bankruptcy. Karas et al. (2017) state that agricultural activity is specific, especially to other production activities (for which the observed models were primarily formed). However, given the dynamics in the economy, instances in the literature advocate for the appropriateness of utilizing general models for bankruptcy prediction (Cîrciumaru, 2011; Khorasgani, 2011; Zarei et al., 2012; Bencová et al., 2021). These "universal models" demonstrate efficacy contingent upon the economic conditions in the regions where businesses operate, along with the reliability of the financial data used in the applied models (Sušický, 2011).

Results and discussion

The collected data underwent an initial assessment using Altman's Z' score model to ascertain the potential for bankruptcy within the observed economic entities. The computed values of the modified Z' score for agricultural enterprises are presented below (table 2).

Table 2. Values of Z' indicators for observed agricultural companies

Company	Values of Z' indicator				
	2018	2019	2020	2021	2022
A	1.655	1.537	1.962	2.404	2.936
B	0.850	1.462	1.533	1.666	1.094
C	3.151	1.562	2.052	3.688	3.119
D	1.668	1.449	1.258	0.883	0.779
E	1.772	1.488	1.480	1.905	2.308

Source: Authors' calculations based on data from financial reports, Business Register Agency

Based on the established criteria outlined in Table 2, company A's operations primarily fall within the gray zone, indicating an unstable financial status with potential for recovery (1.23<Z'<2.9). Notably, in the most recent year of observation, enterprise A transitioned into the secure zone (Z'>2.9), signifying improved financial stability. In contrast, the assessed values for company B's operational indicators reveal a consistent high-risk profile in both the initial and final years (Z'<1.23), with intermittent periods of risk in between. Enterprise C exhibits discernible fluctuations in the Z' indicator throughout the observed timeframe, initially securing a position in the safe zone, followed by two years in the gray zone, and ultimately returning to financial stability. The analysis of company D's indicator highlights an initial placement in the gray zone, subsequently progressing into the distressed zone. During the observed period, enterprise E consistently maintains Z' values between 1.23 and 2.9, placing it within the gray zone.

The analysis of the possibility of bankruptcy, as well as the financial stability and profitability of the observed agricultural enterprises, is shown through the Kralicek Quick test (table 3).

Table 3. Results of Kralicek Quick test for observed agricultural companies

Company	Year	Indicators				Points				Score		
		X_1	X_2	X_3	X_4	P_1	P_2	P_3	P_4	S_1	S_2	T
	2018	0.49	7.15	0.05	0.09	1	3	4	2	2	3	2.5
	2019	0.50	7.81	0.03	0.09	1	3	4	2	2	3	2.5
A	2020	0.54	3.29	0.11	0.18	1	2	3	1	1.5	2	1.75
	2021	0.63	2.57	0.09	0.16	1	1	3	1	1	2	1.5
	2022	0.70	2.11	0.10	0.14	1	1	3	1	1	2	1.5
	2018	0.03	58.97	0.02	0.02	4	5	4	4	4.5	4	4.25
B	2019	0.11	12.53	0.08	0.07	3	4	3	3	3.5	3	3.25
	2020	0.20	8.10	0.11	0.12	3	3	3	1	3	2	2.5
B	2021	0.29	5.78	0.14	0.20	2	3	2	1	2.5	1.5	2
	2022	0.23	18.36	0.06	0.09	2	4	4	2	3	3	3
	2018	0.60	4.49	0.08	0.05	1	2	4	4	1.5	4	2.75
	2019	0.41	21.36	0.04	0.05	1	4	4	4	2.5	4	3.25
C	2020	0.50	9.35	0.06	0.07	1	3	4	3	2	3.5	2.75
	2021	0.69	2.40	0.13	0.09	1	1	2	2	1	2	1.5
	2022	0.67	3.87	0.09	0.07	1	2	3	3	1.5	3	2.25

Company	Year	Indicators				Points				Score		
D	2018	0.70	12.92	0.01	0.08	1	4	4	2	2.5	3	2.75
	2019	0.66	13.95	0.00	0.06	1	4	4	3	2.5	3.5	3
	2020	0.61	6.41	0.02	0.17	1	3	4	1	2	2.5	2.25
	2021	0.52	9.56	0.01	0.16	1	3	4	1	2	2.5	2.25
	2022	0.48	10.03	0.01	0.18	1	3	4	1	2	2.5	2.25
E	2018	0.21	12.37	0.08	0.05	2	4	3	3	3	3	3
	2019	0.20	22.38	0.04	0.03	3	4	4	4	3.5	4	3.75
	2020	0.20	18.01	0.05	0.04	3	4	4	4	3.5	4	3.75
	2021	0.25	7.91	0.11	0.07	2	3	3	3	2.5	3	2.75
	2022	0.27	7.92	0.11	0.05	2	3	3	3	2.5	3	2.75
Average	2018	0.41	19.18	0.05	0.06	1.8	3.6	3.8	3	2.7	3.4	3.05
	2019	0.37	15.61	0.04	0.06	1.8	3.8	3.8	3.2	2.8	3.5	3.15
	2020	0.41	9.03	0.07	0.11	1.8	3	3.6	2	2.4	2.8	2.6
	2021	0.48	5.65	0.10	0.13	1.4	2.2	2.8	1.6	1.8	2.2	2
	2022	0.47	8.46	0.07	0.11	1.4	2.6	3.4	2	2	2.7	2.35

Source: Authors' calculations based on data from financial reports, Business Register Agency

Throughout the observed period, company A had no challenges in asset financing (X_1>10%) and demonstrated efficiency in the timely repayment of liabilities (X_2<12). The average of the previously presented indicators is used to assess financial stability (S_1), which can be rated here as very good (S_1<2) and excellent (S_1<1). Notably, the profitability indicator (X_3) indicates an improvement in profitability, progressing from an initial 5% to a commendable 10% in the final year (reference value 8%). The proportion of cash flow to operating income (X_4) surpassed the established benchmark (5%), signifying lucrative operations. The combined indicator (S_2), calculated as the mean of X_3 and X_4, validates the positive outcomes regarding profitability (S_2<3). The overall solvency rating (T), derived from the average values of S_1 and S_2, attests to the good (T<3) and very good (T<2) performance of the observed company. Conversely, enterprise B underwent a notable improvement in solvency, transitioning from a pronounced risk of insolvency at the beginning of the analysis period. The initial indicators for financial stability (X_1<10% and X_2>30%) and profitability (X_3<8% and X_4<5%) suggested a heightened risk of bankruptcy. In the following years, the solvency ratings improved, so the company was rated as good (T<3) in the last year of analysis. The financial stability (S_1) of company C exhibited a positive trajectory, garnering assessments of good, very good and excellent throughout the observed period. In contrast, profitability (S_2) faced challenges in the initial three years, substantiated by values of indicators X_3 (<8%) and X_4 (<5%). Consequently, the solvency appraisal for the entity in 2019 was bad (T<4) with subsequent years receiving positive evaluations of good (T<3) and very good (T<2). Enterprise D consistently maintained a good solvency rating (T<3) over the analyzed period. However, the profitability indicator X_3 displayed notably low values (0%-2%) compared to the reference (8%), significantly influencing the overall solvency rating. At the beginning of the observed period, company E had values of indicators of financial stability and profitability close to the reference ones, and the overall solvency was rated as good (T<3). In the next two years, there was an increase in the repayment period (22.38 years and 18.01 years) and a decrease in the profitability indicators X_3 and X_4 below the reference values (8% and 5%). The analyzed changes caused the overall solvency rating drop to bad in this subperiod. In the following years, all indicators improved except for X_4, which had a marginal value (5%) in the last year of the analyzed period and the overall solvency was assessed as good.

The mean values of pertinent indicators concerning agricultural enterprises reveal a substantial presence of internal funding sources (X_1>10%). In the years 2018 and 2019, these companies encountered challenges in the duration of debt repayment (X_2>12), yet their solvency remained unimpaired. The overall assessment of financial stability, on average, leans towards a favorable categorization as good (S_1<3) and very good (S_1<2). In 2018 and 2019, the observed companies did not reach the reference value (8%) in terms of the share of profit before taxation in the total value of assets (X_3), but the value was positive and the companies were solvent. Subsequent years witnessed an improvement in profitability as measured by X_3 and the indicator X_4 consistently surpassed the reference value (5%) throughout the analyzed period. The mean rating of profitability for agricultural enterprises (S_2) points to poor solvency in 2018 and 2019 precisely because of the previously explained indicator X_3, while in the following years solvency was rated as good.

The analysis of the possibility of bankruptcy in agricultural enterprises assessed by the Springate model is presented below (table 4).

Table 4. Values of S indicators for observed agricultural companies

Company	Values of S indicator				
	2018	**2019**	**2020**	**2021**	**2022**
A	0.686	0.541	1.197	1.266	1.495
B	1.983	2.938	2.345	2.201	1.172
C	1.562	0.902	1.129	2.188	1.497
D	0.240	0.252	0.253	0.080	0.059
E	1.795	1.167	1.390	1.961	2.019

Source: Authors' calculations based on data from financial reports, Business Register Agency

According to the established indicators in Table 4, in the first two years of the analysis, the viability of company A faced jeopardy, marked by classification as precarious with a heightened susceptibility to bankruptcy (S<0.862). In the other years of observation, this enterprise was in the safe zone (S>0.862). The values of the analyzed indicator related to business entities B, C and E, indicate healthy businesses without the risk of bankruptcy. During the observed period, company D had the S indicator values below the reference (0.862) and as such was classified in the distressed zone.

The subsequent section of this discourse entails a comprehensive evaluation of the potential for bankruptcy within companies operating in the food industry throughout the analyzed period, elucidated in Table 5.

Table 5. Values of Z’ indicators for observed food processing companies

Company	Values of Z’ indicator				
	2018	**2019**	**2020**	**2021**	**2022**
F	2.323	3.082	2.246	2.205	2.349
G	2.575	2.575	2.493	2.559	2.796
H	2.838	1.060	1.506	1.946	2.638
I	5.933	8.983	6.852	9.574	25.606
J	5.021	5.934	7.233	6.432	7.296

Source: Authors’ calculations based on data from financial reports, Business Register Agency

Throughout the observed timeframe, Company F predominantly exhibited Z’ indicator values ranging between 1.23 and 2.9, categorizing it within the gray zone. This classification signifies the entity as financially unstable with prospects of recuperation. Noteworthy is the discernment that only in 2019 did enterprise F attain classification within the secure zone The values of the indicator Z’ related to company G point to a financially unstable company in the analyzed time interval. In adherence to the stipulated indicators delineated in Table 5, the operational dynamics of enterprise H predominantly inhabit the gray zone, indicative of an unstable financial standing (1.23<Z’<2.9). However, in 2019, the company faced an elevated risk, as indicated by Z’<1.23. In contrast, business entities I and J enjoyed classification within the secure business zone throughout the analyzed period (Z’>2.9).

The evaluation of the potential for bankruptcy, financial stability, and profitability within the observed companies operating within the food sector has been explicated through the utilization of the Kralicek quick test, as elucidated in Table 6.

Table 6. Results of Quick test for observed food processing companies

Company	Year	Indicators				Points				Score		
		X_1	X_2	X_3	X_4	P_1	P_2	P_3	P_4	S_1	S_2	T
	2018	0.70	0.56	0.13	0.30	1	1	2	1	1	1.5	1.25
	2019	0.79	0.74	0.18	0.34	1	1	1	1	1	1	1
F	2020	0.69	1.48	0.15	0.34	1	1	2	1	1	1.5	1.25
	2021	0.68	1.65	0.15	0.33	1	1	2	1	1	1.5	1.25
	2022	0.67	1.69	0.17	0.29	1	1	1	1	1	1	1
	2018	0.38	4.82	0.12	0.08	1	2	2	3	1.5	2.5	2
G	2019	0.40	6.79	0.09	0.05	1	3	3	3	2	3	2.5
	2020	0.46	8.64	0.05	0.04	1	3	4	4	2	4	3
G	2021	0.47	7.21	0.06	0.05	1	3	4	4	2	4	3
	2022	0.44	8.53	0.06	0.03	1	3	4	4	2	4	3
	2018	0.68	1.53	0.19	0.18	1	1	1	1	1	1	1
	2019	0.45	15.31	0.03	0.06	1	4	4	3	2.5	3.5	3
H	2020	0.46	7.63	0.06	0.09	1	3	4	2	2	3	2.5
	2021	0.47	4.84	0.11	0.11	1	2	3	1	1.5	2	1.75
	2022	0.59	2.87	0.15	0.11	1	1	1	1	1	1	1

Company	Year	Indicators				Points				Score		
I	2018	0.92	0.84	0.04	0.16	1	1	4	1	1	2.5	1.75
	2019	0.95	0.85	0.01	0.08	1	1	4	2	1	3	2
	2020	0.94	0.90	0.03	0.20	1	1	4	1	1	2.5	1.75
	2021	0.95	-0.32	0.07	0.35	1	1	4	1	1	2.5	1.75
	2022	0.98	-0.29	0.12	0.57	1	1	2	1	1	1.5	1.25
J	2018	0.19	5.73	0.13	0.03	3	3	2	4	3	3	3
	2019	0.23	5.35	0.11	0.03	2	3	3	4	2.5	3.5	3
	2020	0.31	3.80	0.15	0.03	1	2	1	4	1.5	2.5	2
	2021	0.26	6.13	0.08	0.02	2	3	4	4	2.5	4	3.25
	2022	0.36	3.50	0.14	0.03	1	2	2	4	1.5	3	2.25
Average	2018	0.57	2.70	0.12	0.15	1.4	1.6	2.2	2	1.5	2.1	1.8
	2019	0.56	5.81	0.08	0.11	1.2	2.4	3	2.6	1.8	2.8	2.3
	2020	0.57	4.49	0.09	0.14	1	2	3	2.4	1.5	2.7	2.1
	2021	0.56	3.90	0.09	0.17	1.2	2	3.4	2.2	1.6	2.8	2.2
	2022	0.61	3.26	0.13	0.21	1	1.6	2	2.2	1.3	2.1	1.7

Source: Authors' calculations based on data from financial reports, Business Register Agency

Throughout the observed period, company F consistently achieved excellent financial stability (S_1) and very good to excellent ratings in terms of profitability (S_2). The solvency of this enterprise remained unthreatened, evident in the sustained excellent assessment in the last year, preceded by a very good solvency rating at the beginning of the period. Company G, while maintaining a very good financial stability rating ($S_1<2$) over the analyzed period, encountered challenges in profitability indicators X_3 and X_4 falling below the reference values (8% and 5%) in 2020, 2021 and 2022. This trend influenced the overall solvency rating (T), resulting in a very good rating in 2018 and good ratings in subsequent years. Enterprise H exhibited dynamic solvency trends, ranging from excellent in the initial and final years to very good in 2019 and 2020. While facing a slightly extended debt repayment period in 2019, the overall solvency remained robust. In 2021, improved financial stability and profitability indicators led to a very good overall solvency rating. Company I maintained excellent financial stability (S_1) throughout the observed period. Although the profitability indicator X_3 often fell below the reference value (8%), resulting in a predominantly good profitability rating (S_2), the overall solvency rating indicator (T) consistently pointed to a very good solvency rating. In the analyzed period, the financial stability of business entity J was assessed as good and very good. The profitability indicator X_4 had values below the benchmark (5%), which affected the overall profitability rating (S_2). The overall solvency rating indicator (T) indicates a good solvency rating in most years except for 2021, when the overall solvency rating was poor.

Aggregate indicators for observed food industry companies revealed no challenges in asset financing ($X_1>10\%$) and timely obligation repayment ($X_2<12\%$). The average financial stability was very good ($S_1<2$). In the observed period, the companies reached the reference values of profitability indicators ($X_3>8\%$ and $X_4>5\%$). The average profitability (S_2) was assessed as good. Overall solvency ratings (T) pointed to very good solvency in 2018 and 2021 with good solvency achieved in other observed years.

The computed values of the Springate model (S) for food companies are presented in Table 7.

Table 7. Values of S indicators for observed food processing companies

Company	Values of S indicator				
	2018	2019	2020	2021	2022
F	1.280	1.658	1.699	1.484	1.574
G	1.880	1.521	1.182	1.212	1.373
H	1.868	0.369	0.880	1.385	1.673
I	0.745	0.375	0.648	1.476	5.542
J	3.822	3.574	4.105	3.294	3.867

Source: Authors' calculations based on data from financial reports, Business Register Agency

The values of the analyzed indicator related to business entities F, G and J indicate healthy businesses without the risk of bankruptcy (S>0.862). Conversely, in 2019, company H faced a precarious operational scenario, marked by classification as unstable with a heightened susceptibility to bankruptcy (S<0.862). In subsequent years under observation, the enterprise effectively navigated into the safe zone (S>0.862). Indicator S related to company I, signifies an initial period of operational vulnerability during the first two years of analysis. However, in the subsequent this business entity consistently operates within the secure zone.

Considering the previously presented findings and solvency assessments of medium-sized enterprises involved in agricultural and food production within the AP Vojvodina region, the following conclusions can be drawn:

Using the Altman Z' score, similar results were obtained as using the Springate model. In relation to previous researches, certain differences can be observed. In their work, Vukadinović et al. (2018) found that Altman's Z' score gave the same results as Kralicek's quick test, which was partially obtained in this research. Kovács et al. (2020) in their paper, determined identical scores using the Altman Z' score and the Springate model, which was also confirmed in this research. In the other mentioned studies, in which the modified Z' score was used (Rajin et al. (2016); Bencová et al. (2021) and Milić et al. (2021)), more rigorous evaluations of the possibility of bankruptcy were obtained with this method compared to other applied models. Given that, the other mentioned models were not used in this paper, it is not objective to make a comparison.

The analysis of the possibility of bankruptcy using the Kralicek Quick test in this paper gave identical results to the aforementioned studies (Rajin et al. (2016); Vukadinović et al. (2018); Tekić et al. (2020) and Milić et al. (2021)). This model gave different assessments of the solvency and financial position of the observed economic entities. The results of the research related to the Springate model coincide with the conclusions of previous research (Kovács et al. (2020); Stoyancheva et al. (2023) and Angelova et al. (2023)). This model gave identical estimates of the likelihood of bankruptcy as Altman's Z scores. A comprehensive comparative analysis of the potential for bankruptcy and financial position of the studied agricultural and food companies is delineated based on the mean values of the Kralicek Quick test indicators:

Enterprises in both sectors exhibited substantial internal financing capacity (X_1>10%). Although the agricultural companies encountered challenges in meeting the debt repayment period (X_2>12) in 2018 and 2019, their overall solvency remained unimpaired. Conversely, entities in the food sector consistently met their obligations within the stipulated timeframe (X_2<12). The average financial stability throughout the observed period favored companies in the food sector. In 2018 and 2019, agricultural entities failed to attain the reference values (8%) for the profitability indicator (X_3), a distinction not shared by their counterparts in the food sector. Both agricultural and food sector businesses, however, achieved profitability indicator X_4 values exceeding 5%. Notably, the average profitability over the analytical timeframe was superior among companies in the food sector. The composite solvency rating (T) underscores that entities in the food industry enjoy a more favorable solvency rating, implying a diminished risk of bankruptcy.

Conclusions

Amid a volatile economy precipitated by a myriad of global crises, a preemptive analysis of the potential for bankruptcy in enterprises becomes imperative. Drawing insights from previous findings and solvency evaluations of medium-sized companies operating in agricultural and food production within the AP Vojvodina, it is evident that the modified Altman's Z' score and the Springate model yielded predominantly identical solvency ratings. Conversely, the utilization of the Kralicek Quick test resulted in significantly divergent results compared to the aforementioned models. In the observed period, the possibility of bankruptcy was higher for agricultural companies compared to economic entities from the food industry. The merits of this type of research are: the simple application of already formulated models, the availability of a comprehensive database pertinent to the observed models (SBRA) and the lucid presentation of findings. Nonetheless, questions arise concerning the appropriateness of the methodologies used for gauging the likelihood of bankruptcy. The implemented models were not specifically created for the economy of the Republic of Serbia and the analyzed sectors. Therefore, the authors advocate for the development of a dedicated bankruptcy prediction model tailored to the specific economy of the Republic of Serbia. Emphasizing the importance of incorporating considerations for both company size and industry (specifically for agriculture and the food industry), the authors propose the necessity of a nuanced approach in future predictive models. Furthermore, the authors recommend expanding the scope of research by utilizing larger sample sizes and incorporating diverse models for assessing the likelihood of bankruptcy. This includes applying models specifically created for nearby countries.

Acknowledgments

This research was funded by the Provincial Secretariat for Higher Education and Scientific Research of the Autonomous Province of Vojvodina, the Republic of Serbia during the project assessment of the economic performance of the agricultural and food sector of AP Vojvodina, grant number 142-451-2567/2021-01/3.

Conflict of interests

The authors declare no conflict of interest.

References

1. Alihodžić, A. (2013). Testing the Kralicek DF indicator application on the Belgrade Stock Exchange. *Banking,* 3, 70-95.
2. Altman, E. I. (1983). Corporate Financial Distress and Bankruptcy. Wiley
3. Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance, 23*(4), 589-609. https://doi.org/10.1111/j.1540-6261.1968.tb00843.x_
4. Altman, E. I., Danovi, A., Falini, A. (2013). Z-Score Models' application to Italian companies subject to extraordinary administration. *Journal of Applied Finance*, 23(1): 128–137.
5. Angelova, R., & Stoyancheva, D. (2023). Digitalization, financial insolvency and bankruptcy risk forecasting of Bulgarian agricultural enterprises. *Scientific Papers Series Management, Economic Engineering in Agriculture & Rural Development*, *23*(2).
6. Bencová, T., Boháčiková, A., Tóth, M., & Pindešová, D. (2021). Are Slovak farms financially healthier as a result of the Common Agricultural Policy of the European Union? In *SHS Web of Conferences* (Vol. 129, p. 09002). EDP Sciences.
7. Bernhardsen, E. (2001). A model of bankruptcy prediction (No. 2001/10). Working Paper. Available at: https://www.econstor.eu/bitstream/10419/209799/1/nb-wp2001-10.pdf (assesed 08.02.2024.).
8. Bordeianu, G. D., Radu, F., Paraschivescu, M. D., & Păvăloaia, W. (2011). Analysis models of the bankruptcy risk. *Economy Transdisciplinarity Cognition*, *14*(1), 248-259.
9. Cîrciumaru, D. (2011). The Analysis of the bankruptcy risk for the Romanian companies. Case study: The food Industry. *REVISTA ECONOMICĂ*, 132.
10. Didenko, K., Meziels, J., and Voronova, I. (2012). Assessment of enterprises insolvency: challenges and opportunities. *Economics and Management*, 17(1), 69-76.
11. Grice J.S., Dugan M.T., (2001), The limitations of bankruptcy prediction models: Some cautions for the researchers. *Review of Quantitative Finance and Accounting*, 17.
12. Jakšić, D., Mijić, K., Zekić, S., Poljašević, J. (2015). Comparative profitability analysis of milk production companies to milk processing companies in Serbia. Custos e @gronegocio on line, 11 (3), 206-226.

13. Karas, M., Reznakova, M., & Pokorny, P. (2017). Predicting bankruptcy of agriculture companies: Validating selected models. *Polish Journal of Management Studies*, *15*(1), 110-120.
14. Katchova, A. L., Enlow, S. J. (2013). Financial Performance of Publicly Traded Agribusiness. *Agricultural Finance Review*, no. 73 (2013), pp. 58–73.
15. Khorasgani, A. (2011). Optimal accounting based default prediction model for the UK SMEs. *Proceedings of ASBBS. ASBBS Annual Conference*: *Las Vegas*, *18* (1), 149-168.
16. Kovács, S., Fróna, D., & Rózsa, A. (2020). ANALYSING THE SITUATION OF AGRICULTURAL ENTERPRISES IN LIQUIDATION BY MEANS OF BANKRUPTCY PREDICTION MODELS. *SEA: Practical Application of Science*, *8*(1).
17. Kralicek, P. (2007). Income and asset analysis (quick test). *Business management consulting*, available at: http://www.kralicek.at/pdf/qr_druck.pdf (assesed 07.12.2023.).
18. Kuběnka, M. (2016). The strictness of traditional indicators for creditworthiness measuring, in *The 10th International Days of Statistics and Economics, Conference Proceedings,* Prague, September 8-10, Libuše Macáková, Melandrium, 985-995.
19. Maksimovic, V., & Phillips, G. (1998). Asset Efficiency and Reallocation Decisions of Bankrupt Firms. *The Journal of Finance*, 53 (5), pp. 1495-1532.
20. Milić, D., Tekić, D., Zekić, V., Novaković, T., Popov, M., & Mihajlov, Z. (2021). Bankruptcy prediction models for large agribusiness companies in AP Vojvodina. *Economics of Agriculture*, *68*(3), 805-822.
21. Niemann M., Schmidt J.H., Neukirchen M., 2008, Improving performance of corporate rating prediction models by reducing financial ratio heterogeneity. *Journal of Banking and Finance*, 32.
22. Opler, T., & Titman, S. (1994). Financial Distress and Corporate Performance. *Journal Of Finance*, 49 (3), pp. 1015-1040.
23. Platt D.H., Platt M.B., 1990, Development of a Class of Stable Predictive Variables: The Case of Bankruptcy Prediction. *Journal of Business Finance and Accounting*, 17.
24. Rajin, D., Milenković, D., & Radojević, T. (2016). Bankruptcy prediction models in the Serbian agricultural sector. *Economics of Agriculture*, *63*(1), 89-105.
25. Serbian Business Registers Agency: financial reports for observed companies, available at: https://fin.apr.gov.rs/JavnaPretraga (type name of companies in proper search bar, assessed 05.02.2024).
26. Statistical Office of the Republic of Serbia (SORS), (2018): *Survey on the structure of agricultural holdings*, Land, available at: https://publikacije.stat.gov.rs/G2019/Pdf/G20196003.pdf (assessed 12.02.2024).
27. Springate, Gordon L., "Predicting the Possibility of Failure in a Canadian Firm: Discriminant Analysis ", Unpublished Master of Business Administration Project, *Simon Fraser University*, (January 1978).
28. Sušický, J. (2011). Applicability of Bankruptcy Models at Agricultural Companies. *Economic Studies & Analyses/Acta VSFS*, *5*(3).

29. Tekić, D., Mutavdžić, B., Novković, N., Novaković, T., & Vukelić, N. (2020). Analysis of the financial position of mill companies in Vojvodina. *Journal on Processing and Energy in Agriculture*, *24*(3-4), 119-122.
30. Stoyancheva, D., & Angelova, R. (2023). Assessment of financial sustainability and risk of bankruptcy of agricultural enterprises in Bulgaria. In *SHS Web of Conferences* (Vol. 176, p. 03002). EDP Sciences.
31. Wu Y., Gaunt C., Gray S., 2010, A comparison of alternative bankruptcy prediction models. *Journal of Contemporary Accounting and Economics*, 6.
32. Zarei, S., Dadashi, I., i Akbari, M. A. (jul 2012). Localized distress prediction models in the economic environment of Iran. *African Journal of Business Management, 6 (29),* 8651-8658.
33. Zenzerović, R., & Peruško, T. (2006). Kratki osvrt na modele za predviđanje stečaja. *Ekonomska istraživanja* 19(2), 132–151. [*in English:* Short retrospection on bankruptcy prediction models (2006). *Economic Research*, 19(2), 132–151].

HUMAN CAPITAL AS A DEVELOPMENT FACTOR OF ORGANIC AGRICULTURE IN THE REPUBLIC OF SERBIA

Mirela Tomaš Simin[1], *Danica Glavaš-Trbić*[2], *Dragan Milić*[3], *Dejan Janković*[4]

**Corresponding author E-mail: danicagt@polj.uns.ac.rs*

A R T I C L E I N F O

Original Article

Received: *19 March 2024*

Accepted: *20 April 2024*

doi:10.59267/ekoPolj2402485T

UDC 005.96:631.147(497.11)

Keywords:

Organic agriculture, human capital, development, sustainability

JEL: *Q, J24, Q01*

A B S T R A C T

Authors explore the role of human capital in organic agriculture in Serbia. Through semi-structured interviews with 64 individual farmers holding organic production certificates, key aspects of human capital, including education level, language proficiency and ICT usage were analyzed. Findings reveal a disparity between conventional and organic farming in terms of computer literacy and ICT utilization, underscoring the need for targeted interventions to enhance technological adoption in organic farming. Moreover, the study identifies the importance of membership in agricultural associations for organic farmers, facilitating knowledge exchange and market penetration. The results suggest that human capital plays a pivotal role in driving advancements in organic agriculture, with implications for the sustainability and growth of the sector in Serbia. This underscores the necessity for future research to go deeper into human capital dynamics and their implications for sustainable agricultural development.

1 Mirela Tomaš Simin, PhD, Assistant Professor, University of Novi Sad, Faculty of Agriculture, Department of Agricultural Economics and Rural Sociology, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia, Phone: +381214853514, E-mail: mirelat@polj.uns.ac.rs, ORCID ID (https://orcid.org/0000-0003-1833-9857)

2 Danica Glavaš – Trbić, PhD, Assistant Professor, University of Novi Sad, Faculty of Agriculture, Department of Agricultural Economics and Rural Sociology, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia, Phone: +381214853508, E-mail: danicagt@polj.uns.ac.rs, ORCID ID (https://orcid.org/0000-0002-5990-6558) *Corresponding author.

3 Dragan Milić, PhD, Associate Professor, University of Novi Sad, Faculty of Agriculture, Department of Agricultural Economics and Rural Sociology, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia, Phone: +381214853274, E-mail: dragan.milic@polj.edu.rs, ORCID ID (https://orcid.org/0000-0003-0377-1540)

4 Dejan Janković, PhD, Full-time Professor, University of Novi Sad, Faculty of Agriculture, Department of Agricultural Economics and Rural Sociology, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia, Phone: +381214853381, E-mail: jankovic@polj.uns.ac.rs, ORCID ID (https://orcid.org/0000-0002-2609-125X)

Introduction

Organic agriculture has gained significant attention and importance in recent decades as a sustainable agricultural production system. Initially described as an alternative to conventional farming methods by Beauchesne and Bryant (1999), organic farming transcends the simple dichotomy of old versus new methodologies. Krause and Machek (2018) emphasize that organic agriculture has increasingly been given both academic and general attention and significance. It is commonly perceived as a revival of ancient farming techniques, yet as Cifrić (2003) points out, it is distinct from mere “rustic farming.” He notes that while rustic farming is inherently ecological and sustainable, involving holistic lifestyle and societal aspects, organic farming should not be seen as a mere reversion to preindustrial or traditional life.

Organic agriculture should be viewed as a social innovation, challenging the prevailing industrial agriculture paradigm and enabling diverse benefits such as increased employment opportunities on family farms, efficient production on small land plots, and the development of closed-loop systems utilizing natural energy and processes. This approach expands upon rustic practices by integrating scientific advancements to ensure ecological integrity, thereby addressing not just the nutritional value of food but also aligning it with lifestyle choices, as suggested by Lowe et al. (2008). For the transformation of rural agriculture into well-sustainable agriculture, organic farming might become a panacea that can build a plinth for sustainable agriculture, reimburse conversion costs, and maintain the sustainability of the soil (Sahu, Pradhan, 2023; Soni et al., 2022; Dipesh, Sagar, 2022).

Organic agriculture has to reach the stringent requirements of a sustainable production system. As Tomaš Simin et al. (2019) argue sustainability in organic farming encompasses economic, social and environmental dimensions. Katić et al. (2010) and Milić et al. (2018) further emphasize that organic farming, more than any other type, significantly contributes to environmental protection and sustainable principles. Shin et al. (2024) and Gamage et al. (2023) perceive that sustainable agriculture, including organic farming, offers a potential remedy for addressing environmental pollution.

The evolution of organic agriculture involved pioneers who initially shared their knowledge informally, which later led to the formation of supportive organizations and a gradual acceptance within legal and market frameworks, illustrating a shift from marginalization to mainstream acceptance (Tomaš Simin, Glavaš-Trbić, 2016). Research, which is usually an important factor of agricultural development, played only a minor part in this case (Padel, 2001).

Producers are switching to an organic production system for various reasons. The first organic producers emphasized a healthy lifestyle, as well as escape from the cities and a different lifestyle, while today’s producers are mainly driven by higher profits. Aeberhard and Rist (2008) state that organic agriculture is supported by subventions in many countries today.

The trajectory of acceptance of organic agriculture progressed in phases: in phase one, the organic movement was stimulated by pioneers (or innovators according to the diffusion of innovations theory) (Tomaš Simin, Janković, 2014) who developed new ideas and concepts and did not necessarily follow the common lifestyle. They often faced misunderstanding for their opinions and ideas. Phase two is followed by increase and various types of incentives and phase three marked production area increase (Tomaš Simin, Glavaš-Trbić, 2016). Today, organic agriculture is governed by legislation, has a good market position, is widely accepted by society and organic farmers are no longer viewed as outsiders.

In this type of production, economic and technological results are largely influenced by human capital. Pindado et al. (2018) states that farmers need to become more entrepreneurial in order to compete in modern agriculture. Human capital in agriculture can be defined as the education, experience, skills and knowledge that person (farmer) have and can use in order to perform certain tasks (Dimov, Shepherd, 2005; Vesala, Vesala, 2010; Unger et al., 2011). Bearing in mind Beckers (1975) distinction between general and specific human capital, Dimov and Sheperd (2005) conclude that general human capital refers to knowledge and skills acquired through formal education and work experience, while specific human capital refers to knowledge and skills with application limited to certain activities as organic agriculture is.

The socio-economic characteristics of the actors greatly influence the development of this type of production. Combined with natural resources and sustainability it can be said that sustainable use of natural resources cannot be achieved without educated and skilled human capital (Zafar et al., 2019; Ahmed et al., 2020). Overall, human capital can be seen as a critical determinant of success in organic agriculture. By investing in education, training, and skill development programs tailored to organic farming, stakeholders can enhance human capital and drive the continued growth and sustainability of organic agriculture. Also, Leduc et al. (2023) investigated which factors and values influenced producers to decide for a certain type of production in France, Ireland and Sweden and other EU countries.

According to data from the Ministry of Agriculture, Forestry, and Water Management of the Republic of Serbia, as reported by Simić (2020), organic farmers in Serbia fall into two main categories. The first group consists of independent producers who carry out certification. They sell their own organic products. The second group consists of cooperatives operating under group certification as per the Organic Farming Act. These cooperatives maintain contractual relationships with export companies, provide production materials, cover certification costs, and offer other necessary support. This cooperative model has proven successful, with a significantly higher number of farmers involved compared to independent producers (see Table 1)

Table 1. The number of organic farmers in the Republic of Serbia from 2010 to 2022

Year	Organic farmers – certificate holders	Cooperants	Total
2010	137	n.d.a.	137
2011	323	n.d.a.	323
2012	237	836	1,073
2013	258	970	1,228
2014	291	1,575	1,866
2015	334	1,955	2,289
2016	390	2,404	2,794
2017	434	5,719	6,153
2018	500	6,206	6,706
2019	534	5,727	6,261
2020	596	5,513	6,109
2021	616	n.d.a.	616
2022	651	5,650	6,301
*n.d.a. – no data available			

Source: Simić I., 2020 and MAFWM, 2024

Researching human capital in organic agriculture is crucial for several reasons. Firstly, understanding the education, skills, and experience of individuals involved in organic farming helps to identify areas for targeted training and capacity-building initiatives. This, in turn, enhances the adoption and implementation of sustainable farming practices, ultimately contributing to the overall success and viability of organic agriculture systems. Secondly, by examining the socio-economic characteristics of organic farmers, the development of policies and support programs will be influenced. Additionally, studying of human capital function in innovation and adaptation within the organic agriculture sector allows for the identification of strategies to foster continued growth and resilience in the face of changing environmental and market conditions. Overall, research on human capital in organic agriculture is essential for promoting the long-term sustainability, productivity, and competitiveness of organic farming systems.

The aim of this study is estimation of the human capital influence on the development of organic agriculture, particularly focusing on factors such as farmers' education levels, language proficiency, access to information and technology, as well as their participation in agricultural associations. Also, the study aims to provide insights into how human capital shapes the organic production practices in the Republic of Serbia.

Materials and methods

Research results were obtained by means of a semi-structured interview. The choice of conducting semi-structured interviews in this research was deliberate and essential for several reasons. Firstly, semi-structured interviews allow for flexibility in questioning, enabling researchers to delve deeper into specific topics while maintaining a degree of structure to ensure consistency across interviews. This approach is particularly advantageous in exploring the multifaceted nature of organic agriculture, as it provides the opportunity to probe participants' experiences, perspectives and practices comprehensively. Additionally, the attitudes of the producers were mainly examined with the help of survey and closed-ended questions (Sweikert, Gigliotti, 2019).

Moreover, semi-structured interviews facilitate a more interactive and dynamic exchange between the researcher and participant, fostering a deeper understanding of the subject matter. By allowing participants to express themselves freely and elaborate on their responses, researchers can gain nuanced insights into the complexities of organic farming practices, including the challenges, motivations and decision-making processes involved.

In terms of conducting semi-structured interviews, the process typically begins with the formulation of a set of open-ended questions that cover key themes or topics of interest. These questions serve as a guide for the interview while allowing room for spontaneous exploration of additional areas as they arise during the conversation. Researchers often adapt their questioning based on the responses provided by participants, probing further into areas of interest or seeking clarification on specific points.

The interviews themselves are usually conducted in-person, as was the case in this research, to facilitate rapport-building and a more natural flow of conversation. Prior arrangements are made with participants via phone communication to schedule the interviews at mutually convenient times. During the interviews, researchers employ active listening skills to ensure participants feel heard and understood, while also maintaining a neutral and non-directive stance to encourage openness and honesty.

The research methodology employed semi-structured interviews to gather insights from agricultural farmers holding organic certification in Serbia. Specifically, the study focused on individual farmers, excluding cooperatives. Notably, the research concentrated on farms already certified, rather than all others. The study encompassed 64 participants, representing approximately 15% of all certificate holders, and took place between March and November 2019. Conducting semi-structured interviews necessitated direct visits to the farms, arranged via phone communication. On average, interviews lasted about an hour, though some extended due to participants' willingness to elaborate on their farming practices, revealing valuable insights into their perspectives. Subsequently, collected data underwent coding and was transferred into a database for analysis, utilizing SPSS software for statistical analysis and data presentation.

The statistical methods used in the presented research include descriptive statistics and inferential statistics. Descriptive statistics were employed to summarize and describe the participants' main characteristics. These statistics include measures such as percentages, means, and standard deviations.

Inferential statistics were used to analyze relationships and general conclusions about the broader population. For example, inferential statistics were utilized to examine associations between variables, such as the relationship between education level and knowledge of foreign languages or the association between association membership and perceived benefits. Additionally, inferential statistics was used to assess differences between groups.

Results and Discussions

Jansen (2000) states that present-day organic farmers differ from their counterparts in the previous century or in earlier phases of the rise and development of organic production. In the 1960s and 1970s, organic farmers most often came from urban areas and had no previous experience in agricultural production. Their reasons for entering the “organic world” were chiefly ideological and expressed a form of protest against industrial society and what it stood for. Recently, organic farming has increasingly come to reflect an integral way of thinking of rural community which is trying to redefine agricultural production and make it acceptable and more sustainable for the environment. Consequently, the characteristics of present-day organic farmers differ from those of the pioneers of this type of production.

Related to that, Seufert et al. (2023) in their research identified three core groups of organic farmers - wealthy “hobby farmers”; poorer “noncertified farmers”; and middle class “export farmers”. They conclude that these types of producers differ in lifestyle, motivation, commitment to this production system and satisfaction with their choice.

The research conducted in the Republic of Serbia included 64 participants or individual farms which hold a certificate of organic production. The most of the studied sample were male (73.4%), while the rest were female. However, the opinion often expressed in the literature on this subject is that women are more prone to organic farming. In his study, Jansen (2000) claims that “although it appears that, to date [until the time of the publication], no one has documented this phenomenon quantitatively, many observers agree that women’s participation is remarkably higher in organic farming than in conventional farming.” For both organic and conventional sectors, it has been observed in literature that it is women who have spearhead the shift to more sustainable agricultural systems which are more environmentally-friendly (Meares, 1997; Chiappe, Flora, 1998; Hall, Mogyorody, 2007). The care about the environment and consumers’ health is seen as parallel to the role that women have in society as those who protect and care for the people in their community (Jansen, 2000). However, this is not currently the situation in Serbia in this production system.

Table 2 shows the age structure of the participants. The largest number of participants is the ages of 51 to 60 whereas the least number of participants are under 30 or over 60 years of age. According to these findings, majority of Serbian organic farmers are middle-aged. Most of these producers were engaged in conventional agriculture and then switched to organic production or they had another profession before this. Again, not so in line with mentioned characteristic of organic farming pioneers in today developed countries. Related to this, Liu et al. (2019) argue that farmers’ age is a significant barrier when talking about conversion to organic agriculture.

Table 2. Age structure of organic farmers in the Republic of Serbia

Characteristic	Number	Percentage
21-30 years old	5	7.8
31-40 years old	12	18.8

Characteristic	Number	Percentage
41-50 years old	19	29.7
51-60 years old	21	32.8
Over 60 years old	7	10.9
Total	**64**	**100.0**

Source: Authors' research

When researching human capital, the educational structure must be taken into account as one of the important influencing factors. According to the level of education, it can be stated that a half of the participants, or 33 of them (51.6%), have higher education. The other half, numbering 30, finished high school (46.9%). One participant had education up to year 8 only. The largest number of participants does not have education in the field of agriculture whereas only 14% had formal education in this field, with the majority of them having graduated from agricultural high school. The precise distribution of participants according to their formal education in agriculture is shown in Table 3.

In his study, Jansen (2000) states that frontrunners of present-day organic farming are most commonly younger people (which was not confirmed by our research) who have a higher level of education than conventional farmers. For the development of organic production, it is very important to include as many young people with higher education as possible who are ready to get an education, invest in their knowledge, as well as adopt and apply new technologies in practice. That approach is often not accepted by a wider community and is very often not sufficiently grounded in practice and comes with a degree of risk. Experience has shown that more educated individuals accept this form of agriculture more easily and quickly, with all these requirements, which entails all advantages and risks associated with alternative technology.

Table 3. The characteristics of organic farmers in the Republic of Serbia according to formal agricultural education

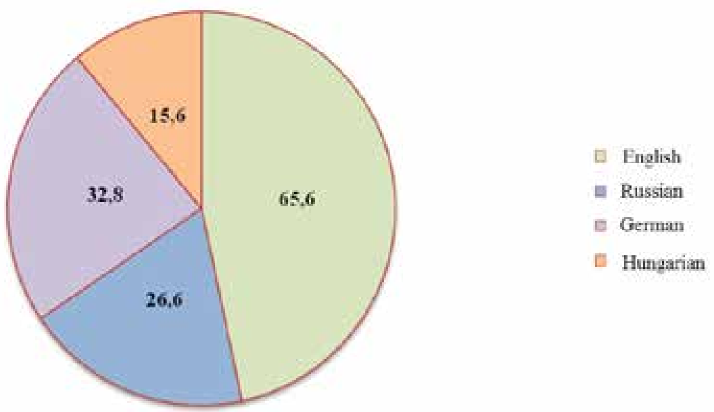
Characteristic	Number	Percentage
Attended or finished agricultural high school	7	10.9
Attended or finished two-year agricultural college	1	1.6
Attended or graduated from the faculty of agriculture	6	9.4
A student in agriculture – in the process of schooling	1	1.6
No formal agricultural education	49	76.6
Total	**64**	**100.0**

Source: Authors' research

An essential aspect of human capital is farmers' proficiency in one or more foreign languages. Mastery of a foreign language holds significant importance for organic farmers for several reasons. Firstly, the relatively recent adoption of organic production practices in Serbia, coupled with enduring opposition from conventional agricultural circles and scientific communities, has limited the dissemination of technical expertise associated with this mode of production. Consequently, organic farmers often find themselves grappling with challenges independently. Moreover, the underdevelopment of organic farming in Serbia results in farmers lacking access to information regarding new technologies aligned with organic principles, potentially leading to suboptimal yields. With a scarcity of written resources available in the Serbian language, including online platforms dedicated to organic farming, farmers resort to alternative methods for acquiring knowledge. Consulting foreign literature, websites, and engaging in international forums emerge as primary avenues for accessing information, underscoring the necessity of foreign language proficiency in navigating the evolving landscape of organic agriculture.

In total (Figure 1), organic farmers in Serbia show a high degree of knowledge of foreign languages, with no participants claiming no knowledge of the given foreign languages.

Figure 1. Understanding of foreign languages by organic farmers in the Republic of Serbia (in %)



Source: Authors' research

Issues related to collaboration among agricultural farmers are more commonly associated with conventional farming practices (Pejanović et al., 2017). In contrast, organic farmers generally don't have reservations about working together and collectively entering the market. In fact, only one participant in our study wasn't affiliated with any agricultural association, cooperative, or organization. The majority of farmers are part of the Vojvodina Organic Cluster (VOK) (67.8%), Serbia Organica (43.8%), Organic NS (10.9%), Teras (14.1%) and local associations (46.9%). A significant 84.4% of all participants believe that being a member of such associations contributes positively to the productivity of their farms. The reasons for joining these associations and the benefits perceived by farmers are detailed in Table 4. Related to this, Blockeel et al. (2023) conducted a research on organic farming initiatives and their effect of smallholder farmers' sustainability in Sub-Saharan Africa. Their results show that the initiatives were able to trigger significant positive effects mainly for the environmental sustainability goals.

Table 4. Benefits of membership in an association, cooperative or organization

Characteristic	Number	Percentage
Better production results	54	84.4
Better information access	41	64.1
Exchange of experience	34	53.1
Joint market penetration	32	50.0
Other	9	14.1

Source: Authors' research

In the official statistical database of Serbia, there is no information on the use of ICT in organic production, which should be improved, bearing in mind the great importance this factor has on the development of organic production. According to the 2011 census, 34.21% of the population is computer-literate, with 44.09% of those living in urban areas and 19.84% in rural (i.e. other) areas (Table 5).

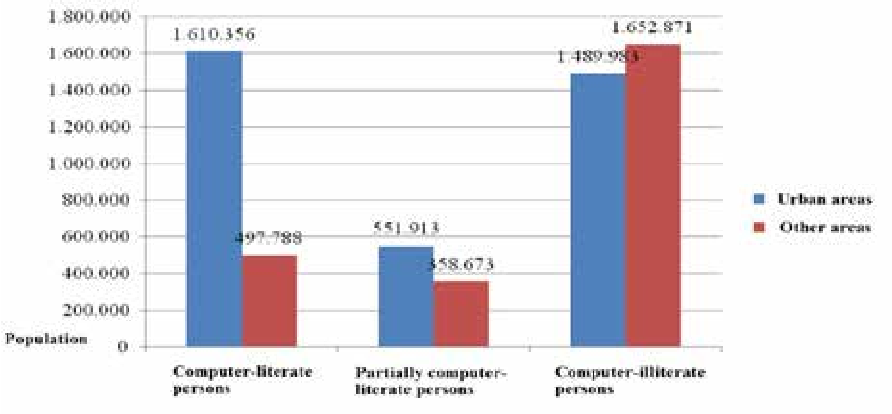
Table 5. The structure of computer-literate persons in the Republic of Serbia according to sex and type of area

	Computer-literate persons			**Partially computer-literate persons**			**Computer-illiterate persons**		
	Total %	**Men %**	**Women %**	**Total %**	**Men %**	**Women %**	**Total %**	**Men %**	**Women %**
Total	**34.21**	35.74	32.79	**14.78**	15.61	14.01	**51.01**	48.66	53.20
Urban areas	**44.09**	46.51	41.94	**15.11**	15.63	14.65	**40.80**	37.86	43.41
Other areas	**19.84**	20.93	18.75	**14.29**	15.58	13.02	**65.87**	63.49	68.24

Source: Statistical Office of the Republic of Serbia, Census 2011

The number of people who use computers is three times higher in urban than in rural areas. The discrepancy between urban and other areas is not as pronounced with regards to partially computer-literate and computer-illiterate persons (Figure 2).

Figure 2. Population distribution according to the level of computer literacy and the type of area in the Republic of Serbia



Source: Statistical Office of the Republic of Serbia, Census 2011

In contrast to the discouraging situation in conventional agricultural and rural areas in Serbia production in terms of computer literacy, more positive sides can be observed in this matter in organic production:

– Organic farmers typically possess at least a high school or college-level education, suggesting a basic proficiency in computer usage.

– Organic farmers heavily rely on ICT to access necessary information, necessitating proficiency in foreign languages.

– The certification process and maintenance of detailed production records in organic farming necessitate computer usage.

The research reveals that every participant in the study owns a computer in their household. Among them, the majority (60.9%) claim familiarity with advanced computer functions, while the remaining participants possess basic skills. Additionally, 84.4% of participants confirm using a computer to maintain production records on their property. Of these, the largest portion (45.3%) handle record-keeping themselves, while others either share the responsibility with household members or delegate it entirely. Further distribution details are provided in Table 6.

Table 6. The use of computer for keeping records of production on organic farms in the Republic of Serbia

Characteristic	**Number**	**Percentage**
Yes, I	29	45.3
Yes, someone else in the household	7	10.9
Yes, together	18	28.1
We do not keep records	10	15.6
Total	**64**	**100.0**

Source: Authors' research

As ICT usage is linked to the modernization and enhancement of production processes, a section of the interview focused on its correlation with production improvement and information acquisition. Participants varied in their methods of obtaining information for farm enhancement. Consulting experts and farmer associations emerged as the most common avenues. Conversely, breeding organizations were least utilized, a trend expected given the limited prevalence of organic animal husbandry in Serbia and the minor role such organizations play in organic farming. The mean values and standard deviations of responses are presented in Table 7.

Table 7. Answers to the question how organic farms in the Republic of Serbia obtain information

	Minimum	Maximum	Arithmetic mean	Standard deviation
Consultants	1.00	5.00	2.90	1.42
Experts	1.00	5.00	3.25	1.16
Associations	1.00	5.00	3.07	1.38
Breeding organizations	1.00	4.00	1.59	0.84
Neighbors	1.00	5.00	2.56	1.13

Source: Authors' research

Regarding the medium of information, of all channels of communication, organic farmers most frequently use the Internet, followed by journals. Listening to the radio or obtaining information from input dealers are the least frequently used channels of communication. Table 8 shows results about medium information used by producers.

Table 8. Answers to the questions about medium of information used by organic farms in the Republic of Serbia

	Minimum	Maximum	Arithmetic mean	Standard deviation
Television	1.00	5.00	2.70	1.04
Radio	1.00	4.00	2.15	0.91
Newspapers	1.00	5.00	2.71	1.04
Input dealers	1.00	5.00	2.31	1.11
Journals	1.00	5.00	3.29	1.30
Internet	1.00	5.00	4.48	1.08

Source: Authors' research

Due to the fact that the participants stated that their dominant and most frequently used medium of obtaining information was the Internet, we asked which of the following websites they most frequently visit: the website of the Ministry of Agriculture, Provincial Secretariat for Agriculture (Autonomous Province of Vojvodina), the website of any agricultural association and the website of the Agricultural Consulting Agency of Vojvodina. The results showed that the most frequently visited website is that of the Ministry of Agriculture. The exact figures are given in Table 9.

Table 9. Obtaining information via the Internet

	Minimum	Maximum	Arithmetic mean	Standard deviation
The Ministry of Agriculture	1.00	5.00	3.96	1.23
Provincial Secretariat for Agriculture	1.00	5.00	3.23	1.68
Agricultural Association	1.00	5.00	3.26	1.33
The Agricultural Consulting Agency of Vojvodina	1.00	5.00	2.34	1.50

Source: Authors' research

The findings of this study highlight substantial disparities in human capital between organic and conventional farming, particularly concerning computer literacy and ICT utilization in production. This discrepancy suggests a potential avenue for enhancing organic agriculture in Serbia. Building upon these insights, it is opportune to reflect on the conclusions drawn by Nathaniel et al. (2020), who underscore the significance of understanding human capital in the context of sustainable development and ecological impact. Given the pivotal role of human activities in ecological distortions, exploring and harnessing human capital in organic agriculture becomes imperative for advancing the sector.

Similar to the presented results, Kamau et al. (2018) in their research confirm that understanding the diversity of smallholder farms is key for the development of interventions, strategies and policies aimed at addressing the numerous challenges these farmers face as well as for those shaping the future of smallholder farming. Kamau et al. (2018) emphasizes that organic production was associated with higher realized incomes per unit of invested capital, producers were older farmers, holdings were larger, with legal ownership of land, greater gender equality and social connection, and others. Sarker and Itohara (2011) agree that a combination of social, human and physical capital is important in improving sustainable livelihood of small farmers which can be connected to organic farmers in developing and developed countries (together with Serbia).

Sapbamrer and Thammachai (2021) did a comprehensive study on factors influencing farmers' adoption of organic farming. The identified factors were systematized into the following groups: the group of factors related to the characteristics of the farmers and the household itself; a group of factors related to psychophysical and psychosocial characteristics of farmers; a group of factors related to the production system, costs and techniques; and a group of supporting factors of this production. Through these groups of factors, the authors describe the most common profile of an organic producer as a young woman with a high level of education, producers who own a farm and, in addition to this production, generate income outside of this production. As factors of extremely great importance for the further development and wider adoption of organic production, the authors single out advisory services, associations, cooperation between producers and supporting participants, as well as t he government support through various programs, education, financial assistance, credits, subsidies and other ways of motivation.

Conclusions

The findings of this study shed light on the intricacies of human capital within the sector of organic agriculture in Serbia. The research revealed significant differences in education levels, language proficiency, and ICT utilization between organic and conventional farmers. Notably, organic farmers exhibited a higher propensity for advanced education and foreign language skills, which are essential for navigating the evolving landscape of sustainable agricultural practices. Research shows that the computer literacy of farmers is of great importance in the development of this type of production, especially the participation of young people in this production who are more willing to educate and who are more computer literate. Organic farming in Serbia demonstrates potential for growth and innovation, particularly through leveraging the diverse skill sets and knowledge base of its practitioners.

Moving forward, it is imperative to continue exploring avenues for enhancing human capital within the organic agriculture sector. Initiatives aimed at providing farmers with access to advanced training, technological resources, and networking opportunities can have positive impact to sustainability and development of organic production in the Republic of Serbia. Moreover, fostering collaboration and knowledge-sharing among stakeholders, including government agencies, academic institutions, and agricultural associations, can facilitate the dissemination of best practices and innovative solutions. By investing in human capital development and creating an enabling environment for organic farmers, Serbia can have positive impact on sustainability, environmental protection and other aspects of this agricultural sector.

Further research on this issue in Serbia should focus on several key areas to advance our understanding and support the growth of the sector. Firstly, longitudinal studies tracking the evolution of human capital within organic farming communities over time would provide valuable insights into trends, challenges, and opportunities for professional development. Additionally, investigate into the efficacy of training programs, extension services and other types of education of actors in this sector. Also, researching the intersection of human capital with other factors such as access to land, market dynamics, and policy frameworks would offer a more holistic understanding of the drivers of success and barriers to entry in organic agriculture. Comparative studies between organic and conventional production practice could also clarify the contributions of human capital to sustainability outcomes and economic resilience. Lastly, research on innovative technologies and practices that leverage human capital to improve resource efficiency, biodiversity conservation, and climate resilience in organic farming contexts would be instrumental in shaping future agricultural policies and practices.

Some of the limitations of this research are:

- It is territorially limited only to the Republic of Serbia, which reduces the possibility of making general conclusions regarding this issue in this production sector;
- The input data used in the research is based on the self-reported data from participants, which may affect on objectivity of the results.

In conclusion, this study sheds light on the unique characteristics of human capital in organic agriculture in Serbia, highlighting its potential for improvement and underscoring the importance of further research in this area to foster sustainable development in agricultural practices.

Acknowledgements

This paper results from the project at Faculty of Agriculture in Novi Sad funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant no 451-03-65/2024-03/200117

Conflict of interests

The authors declare no conflict of interest.

References

1. Aeberhard, A. & Rist, S. (2008). Transdisciplinary co-production of knowledge in the development of organic agriculture in Switzerland. *Ecological Economics*, 68(4), 1171-1181. https://doi.org/10.1016/j.ecolecon.2008.08.008
2. Ahmed, Z., Asghar, M.M., Malikm, M.N. & Nawaz, K. (2020). Moving towards a sustainable environment: The dynamic linkage between natural resources, human capital, urbanization, economic growth and ecological footprint in China. *Resources Policy*, 67, 101677. https://doi.org/10.1016/j.resourpol.2020.101677
3. Beauchesne, A. & Bryant, C. (1999). Agriculture and innovation in the urban fringe: the case of organic farming in Quebec, Canada. *Tijdschrift voor Economische en Sociale Geografie*, 90(3), 320-328. https://doi.org/10.1111/1467-9663.00073
4. Becker, G.S. (1975). *Human Capital*, 2nd ed. Chicago University Press, Chicago.
5. Blockeel, J., Schader, C., Heidenreich, A., Grovermann, C., Kadzere, I., Egyir, I. S., Muriuki, A., Bandanaa, J., Tanga, C.M., Clottey, J., Ndungu J. & Stolze, M. (2023). Do organic farming initiatives in Sub-Saharan Africa improve the sustainability of smallholder farmers? Evidence from five case studies in Ghana and Kenya. *Journal of Rural Studies*, 98, 34-58. https://doi.org/10.1016/j.jrurstud.2023.01.010
6. Chiappe, M.B. & Flora, C.B. (1998). Gendered elements of the alternative agriculture paradigm. *Rural Sociology*, 63(3), 372-393. https://doi.org/10.1111/j.1549-0831.1998.tb00684.x
7. Cifrić, I. (2003). Importance of peasant agriculture experience for organic farming. *Sociology and Space*, 41(1-2), 5-27. [*In Serbian*: Cifrić, I. (2003). Značaj iskustva seljačke poljoprivrede za ekološku poljoprivredu. *Sociologija i proctor*. 41(1-2), 5-27.].
8. Dimov, D.P. & Shepherd, D.A. (2005). Human capital theory and venture capital firms: exploring "home runs" and "strike outs. *Journal of Business Venturing,* 20(1), 1–21. https://doi.org/10.1016/j.jbusvent.2003.12.007

9. Dipesh, G. & Sagar, P. (2022). Organic farming for sustainable agriculture: a review. *Russian Journal of Agricultural and Socio-Economic Sciences*, 10(130), 23-32. http://doi.org/10.18551/rjoas.2022-10.03
10. Gamage, A., Gangahagedara, R., Gamage, J., Jayasinghe, N., Kodikara, N., Suraweera, P. & Merah, O. (2023). Role of organic farming for achieving sustainability in agriculture. *Farming System*, 1(1), 100005. https://doi.org/10.1016/j.farsys.2023.100005
11. Hall, A. & Mogyorody, V. (2007). Organic farming, gender, and the labor process. *Rural Sociology*, 72(2), 289-316. https://doi.org/10.1526/003601107781170035
12. Jansen, K. (2000). Labour, livelihoods and the quality of life in organic agriculture in Europe. *Biological agriculture & horticulture*, 17(3), 247-278. https://doi.org/10.1080/01448765.2000.9754845
13. Kamau, J.W., Stellmacher, T., Biber-Freudenberger, L. & Borgemeister, C. (2018). Organic and conventional agriculture in Kenya: A typology of smallholder farms in Kajiado and Murang'a counties. *Journal of rural studies*, 57, 171-185. https://doi.org/10.1016/j.jrurstud.2017.12.014
14. Katić, B., Savić, N. & Popović, V. (2010). Organic livestock production – Serbian unused chance. *Economics of Agriculture*, 57(2), 245-256. [*In Serbian*: Katić, B., Savić, N. & Popović, V. (2010). Organska stočarska proizvodnja - neiskorišćena šansa Srbije. *Ekonomika poljoprivrede*, 57(2), 245-256.].
15. Krause, J. & Machek, O. (2018). A comparative analysis of organic and conventional farmers in the Czech Republic. *Agricultural Economics – Czech*, 64(1), 1-8. https://doi.org/10.17221/161/2016-AGRICECON
16. Leduc, G., Billaudet, L., Engström, E., Hansson, H. & Ryan, M. (2023). Farmers' perceived values in conventional and organic farming: A comparison between French. *Irish and Swedish farmers using the Means-end chain approach, Ecological Economics,* 207, 107767. https://doi.org/10.1016/j.ecolecon.2023.107767
17. Liu, X., Pattanaik, N., Nelson, M. & Ibrahim, M. (2019). The Choice to Go Organic: Evidence from Small US Farms. *Agricultural Sciences*, 10, 1566-1580. https://doi: 10.4236/as.2019.1012115
18. Lowe, P., Phillipson, J. & Lee, R. (2008). Socio-technical innovation for sustainable food chains: roles for social science. *Trends in Food Science & Technology*, 19(5), 226-233. https://doi.org/10.1016/j.tifs.2007.11.005
19. Meares, A.C. (1997). Making the transition from conventional to sustainable agriculture: Gender, social movement participation, and quality of life on the family farm. *Rural Sociology*, 62(1), 21-47. https://doi.org/10.1111/j.1549-0831.1997.tb00643.x
20. Milić, D., Lukač Bulatović, M. & Milić, D. (2018). Comparative analysis of organic fruit production in the European union and Serbia. *Agroeconomics*, 47(80), 13-23. [*In Serbian*: Milić, D., Lukač Bulatović, M. & Milić, D. (2018). Uporedna analiza organske proizvodnje voća u Evropskoj uniji i Srbiji. *Agroekonomika,* 47(80), 13-23.].

21. Nathaniel, S.P., Yalçiner, K. & Bekun, F.V. (2020). Assessing the environmental sustainability corridor: Linking natural resources, renewable energy, human capital, and ecological footprint in BRICS. *Resources Policy*, 70, 101924. https://doi.org/10.1016/j.resourpol.2020.101924
22. Padel, S. (2001). Conversion to organic farming: a typical example of the diffusion of an innovation. *Sociologia Ruralis*, 41(1), 40-61. https://doi.org/10.1111/1467-9523.00169
23. Pejanović, R., Glavaš – Trbić, D. & Tomaš Simin, M. (2017). Problems of agricultural and rural development in Serbia and necessity of new agricultural policy. *Economics of Agriculture*, (64)4, 1619-1633. https://doi.org/10.5937/ekoPolj1704619P
24. Pindado, E., Sánchez, M., Verstegen, J.A. & Lans, T. (2018). Searching for the entrepreneurs among new entrants in European Agriculture: the role of human and social capital. *Land Use Policy*, 77, 19-30. https://doi.org/10.1016/j.landusepol.2018.05.014
25. Sahu, B. & Pradhan, L. (2023). Organic Farming: A Sustainable Approach of Agriculture, In book: Rural development: Possibilities and challenges in the present perspectives, Chapter: 2, Ganga Prakashan Sadatpur Extn. Delhi 110094.
26. Sapbamrer, R. & Thammachai, A. (2021). A systematic review of factors influencing farmers' adoption of organic farming. *Sustainability*, 13(7), 3842. https://doi.org/10.3390/su13073842
27. Sarker, M.A. & Itohara, Y. (2011). Developing Organic Agriculture and Its Effect on Sustainable Livelihood Improvement of Small Farmers in Bangladesh. *Asia-Pacific Journal of Rural Development*. 21(1), 29-44. https://doi.org/10.1177/1018529120110102
28. Seufert, V., Austin, S.E., Badami, M.G., Turner, S. & Ramankutty, N. (2023). The diversity of organic farmer motivations and livelihoods in the Global South–A case study in Kerala, India. *Geoforum*, 138, 103670. https://doi.org/10.1016/j.geoforum.2022.103670
29. Shin, E., Shin, Y., Lee, S. W. & An, K. (2024). Evaluating the Environmental Factors of Organic Farming Areas Using the Analytic Hierarchy Process. *Sustainability*, 16(6), 2395. https://doi.org/10.3390/su16062395
30. Simić, I. (2017). *Organic agriculture in Serbia 2017*. National Organic Development Association Serbia Organica, Belgrade. [*In Serbian*: Simić, I. (2017). *Organska poljoprivreda u Srbiji 2017*. Nacionalno udruženje za razvoj organske proizvodnje Serbia Organica, Beograd].
31. Simić, I. (2020). *Organic agriculture in Serbia 2020*. National Organic Development Association Serbia Organica, Belgrade. [*In Serbian*: Simić, I. (2020). *Organska poljoprivreda u Srbiji 2020*. Nacionalno udruženje za razvoj organske proizvodnje Serbia Organica, Beograd].

32. Soni, R., Gupta, R., Agarwal, P. & Mishra, R. (2022). Organic farming: A sustainable agricultural practice. *Vantage: Journal of Thematic Analysis*, 3(1), 21-44. http://doi.org/10.52253/vjta.2022.v03i01.03
33. Sweikert, L.A. & Gigliotti, L.M. (2019). A values-based private landowner typology to improve grassland conservation initiatives. *Society & Natural Resources*, 32(2), 167-183. https://doi.org/10.1080/08941920.2018.1501526
34. The Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia, Organic production in Serbia, Electronic database, Retrieved from http://www.minpolj.gov.rs/organska/?script=lat (February 29, 2024)
35. The Statistical Office of the Republic of Serbia, Census 2011, Electronic database, Retrieved from www.stat.gov.rs (September 01, 2020)
36. Tomaš Simin, M., Rodić, V., Glavaš – Trbić, D. (2019). Organic agriculture as an indicator of sustainable agricultural development: Serbia in focus. *Economics of Agriculture*, 66(1), 265-281. https://doi.org/10.5937/ekoPolj1901265T
37. Tomaš Simin, M. & Glavaš – Trbić, D. (2016). Historical development of organic production. *Economics of Agriculture*, 63(3), 1083-1098. https://doi.org/10.5937/ekoPolj1603083T
38. Tomaš Simin, M. & Janković, D. (2014): Applicability of diffusion of innovation theory in organic agriculture. *Economics of Agriculture*, 61(2), 517-529. https://doi.org/10.5937/ekoPolj1402517T
39. Unger, J.M., Rauch, A., Frese, M. & Rosenbusch, N. (2011). Human capital and entrepreneurial success: A meta-analytical review. *Journal of Business Venturing,* 26(3), 341–358. http://doi.org/10.1016/j.jbusvent.2009.09.004
40. Vesala, H.T. & Vesala, K.M. (2010). Entrepreneurs and producers: Identities of Finnish farmers in 2001 and 2006. *Journal of Rural Studies*, 26(1), 21-30. https://doi.org/10.1016/j.jrurstud.2009.06.001
41. Zafar, M.W., Zaidi, S.A.H., Khan, N.R., Mirza, F.M., Hou, F. & Kirmani, S.A.A. (2019). The impact of natural resources, human capital, and foreign direct investment on the ecological footprint: the case of the United States. *Resources Policy,* 63, 101428. https://doi.org/10.1016/j.resourpol.2019.101428

FORMAL VS INFORMAL CONTRACTS (NETWORKS) AND SUSTAINABILITY OF RASPBERRY FARMS IN WEST SERBIA – AN EXPLORATORY RESEARCH

Žaklina Stojanović[1], Emilija Manić[2], Irena Janković[3]
**Corresponding author E-mail: zaklina.stojanovic@ekof.bg.ac.rs*

ARTICLE INFO

Original Article

Received: *26 March 2024*

Accepted: *15 May 2024*

doi:10.59267/ekoPolj2402503S

UDC 004.738:634.711 (497.11-15)

Keywords:

formal/informal, contracts/ social networks, raspberry sector, sustainability.

JEL: *Q01, Q12, Q13*

ABSTRACT

Serbia has gained international recognition for its fruit production, particularly establishing itself as one of the top five global producers and exporters in the raspberry sector. Given the highly intensive nature of raspberry production and the diverse range of producers, spanning from small farms to large corporate entities, research on the sustainability of production and future strategies has become increasingly important. The study explores the significance of economic, environmental, and social factors influencing raspberry producers' practices. It also delves into their future production strategies, examining these aspects from the perspective of farmers. The findings derived from interviews with farmers reveal statistically significant differences between the two subsamples, namely formal and informal, across basic socio-economic and sustainability indicators, as well as in their anticipated future production strategies. The specific approaches and measures in achieving overall sustainability were emphasised in the concluding remarks.

Introduction

Starting from the fact that sustainable agriculture aims to minimize the environmental impact of farming practices by simultaneously promoting social justice and economic viability for farmers, the sustainability concept in agricultural sector manifests through two primary aspects: as a criterion guiding agricultural change (impacts of agriculture) and as a response to different changes in the environment (threats to agriculture)

1 Žaklina Stojanović, Full Proffessor, University of Belgrade – The Faculty of Economics and Business, Kamenička 6, Belgrade, Serbia, Phone: +381 112628923, E-mail: zaklina.stojanovic@ekof.bg.ac.rs, ORCID ID (https://orcid.org/0000-0003-2878-9835)

2 Emilija Manić, Full Professor, University of Belgrade – The Faculty of Economics and Business, Kamenička 6, Belgrade, Serbia, Phone: +381 112628923, E-mail: emilija.manic@ekof.bg.ac.rs, ORCID ID (https://orcid.org/0000-0002-6592-1068)

3 Irena Janković, Professor Associate, University of Belgrade – The Faculty of Economics and Business, Kamenička 6, Belgrade, Serbia, Phone:+381 112628923, E-mail: irena.jankovic@ekof.bg.ac.rs, ORCID ID (https://orcid.org/0000-0003-1115-4702)

(Hansen, 1996). Regardless of the focus, it is anticipated that incorporating the sustainability concept in agriculture should aid in resolving the dilemma of how to intensify agricultural production while simultaneously reducing its negative impact on the environment. The use of the term “environment” here encompasses not only the ecological aspect but also the economic and social aspects. This is crucial because, often, the economic aspect of agricultural production takes precedence over social and ecological considerations (Lee et al., 2006; Struik, Kuyper, 2017).

Since the ecological consequences of intensified agriculture become apparent almost immediately, numerous studies have covered a broad range of aspects, from soil, climate, and other environmental conditions to themes connecting social factors and constraints to agriculture. Simultaneously, these studies delve into themes with a traditional economic orientation, treating agriculture as a food supplier and a market-relevant activity (Cassman, 1999; Rodríguez et al., 2014; Schiefera et al., 2016; Norton, 2016; Komlavi et al., 2019). These studies incorporate different subjects of the agriculture system, attempting to discern any patterns in their behaviour when evaluating potential risks and constraints in agricultural production (Buttel, 1993; Shreck et al., 2006; Pilarova et al., 2018, Stojanović et al., 2019).

A considerable number of new studies present innovative sustainable concepts in agricultural production, with a focus on farmers (Garnett et al., 2013; Pretty, Bharucha, 2014; Tittonell, 2014; Petersen, Snapp, 2015). One such practice gaining attention is sustainable intensification - a practice intended to enable intensive agricultural production while minimizing ecological impacts. The acceptance of this practice implies that farmers are willing to change their agricultural production methods and, importantly, are open for considering and learning about different factors influencing their practices. In most cases, the introduction of such concepts usually comes from the governmental level (Santos, 2016; Kuhfuss, Subervie, 2018; Mazhar, 2021; Bougherara, 2021) although the private sector could play a certain role (Cholez, 2020).

While economic and environmental themes within agricultural production still heavily influence sustainability, recent studies focus on analysing the influence of farm contracting on green, smart approaches in agriculture production (Guo Jiang, 2007; Begum et al., 2012; Wang et al., 2014; Bellemare, Bloem, 2018; Meemken, Bellemare, 2020; Ikeda, Natawidjaja, 2022; Junjin Chen, Yhou, 2023). This aspect of research includes broader social context of farming. Topics that investigate farmers’ quality of life, their social networks and connections with other producers, as well as socio-demographic backgrounds and production approaches, can also be considered through farm contracting/networking status (Herrera et al., 2016; Janker et al., 2019; Wojewodzka-Wiewiorska et al., 2020; Brennan, 2021; Weituschat et al., 2023). Most of these studies use empirical evidence to demonstrate that farmers with formal contracts/networks are more prone to accept changes leading to new practices in their productions. An effective institutional arrangement can promote win-win situation, including income increasing and other aspects of sustainability, among various stakeholders within food chain.

Sustainable agriculture aims to establish a well-balanced and resilient farming system through a holistic approach that considers the interconnectedness of environmental, social, and economic factors in agricultural production. Emerging methodologies emphasize the economic well-being of farmers and rural communities, focusing on fair-trade practices, supporting local economic development, social justice, and building resilience against various uncertainties. The nature of networks within the agricultural production system plays a crucial role in determining sustainable business practices. However, there is no clear indication of whether formal contracts (networks) are superior to informal ones. Formal agreements may include clauses that promote sustainable practices, such as biodiversity conservation, the adoption of environmentally friendly methods, improved soil conservation, waste reduction, and optimized use of inputs. These agreements contribute to economic sustainability by ensuring a stable income for farmers through clear payment terms, pricing agreements, and risk-sharing mechanisms. Nevertheless, informal networks in rural communities also offer significant advantages as they rely on strong community relationships, providing farmers with greater flexibility to adapt to the specific needs of their local communities. Shared values within this system can promote collective efforts for environmental and social well-being, fostering sustainable practices.

The analysis in this paper includes identification of characteristics of traditional and entrepreneurial farmers in terms of business strategies (Zakić, Stojanović, 2008; Tošović et al., 2020). These two groups of producers may choose different contracts/ social networks for conducting their businesses. Social networks can have a substantial impact on the strategies employed in the context of sustainable business development in the future (Stojanović, Radosavljević, 2013). Considering sustainability indicators, this paper explores new considerations that emphasize the role of contracts/social networks in achieving an overall sustainable business orientation within raspberry production in West Serbia. The paper is structured as follows: after the introduction and literature review, the research hypothesis, methodology and the analysed sample are presented, followed by empirical results and discussion. The main conclusions are provided at the end of the paper, indicating statistically significant differences between formal and informal raspberry production subsamples, laying the groundwork for further policy actions.

Research context: hypothesis, methodology and sample description

Serbia has been well known by its fruits production in general, having establishing itself the position of the regional leader in fruits exports during the last two decades (Pantić et al., 2021). This especially stands for the raspberry sector in West Serbia, a region that has been at the leading position both in the quantity and the quality of the raspberry production within the country (several municipalities within Moravički and Zlatiborski county, produce the famous brand of ”Ariljska malina”) (Kljajić et al, 2017). As a consequence of the decades-long practice of small family farming in the Region, raspberry producers are organized either as traditional or entrepreneurial farms (Paraušić, Simenunović, 2016). The research aims to establish a connection between the type of agreement that farmers have while organizing their agricultural production in Serbia (formal vs. informal contracts or networks) and different indicators and strategies referring to sustainability they consider in raspberry production. Basically, it is an exploratory research focused on one agricultural product with the aim to check whether the formality of agreements in agriculture affects sustainability and farmers' production strategies in the Region. The research was based on the structured face-to-face interview (Vigani et al. 2018).

The sample was consisting of 131 farms. The farms are predominantly small in size, below 2ha, managed by individuals or families. Only 45 farms in the sample are larger than 2ha. Concerning the gender structure, farms are mostly managed by male managers or owners (108 vs 23). The age structure is unfavourable – predominant age of owners is above 51 years (in 87 households) while there is only 24 farmers younger than 40 years. In educational structure the primary and secondary education dominates, with very rare examples of specialization in agricultural education. Producers are mainly producing as individual entities and in small number of cases they are members of collective schemes (108 vs 23).

The sample further divide is based on the formality of the sales contract into, so called, formal and informal subsamples (*Table 1*). Formal subsample includes legal contract before or during production and the ones agreed at the time of sale. It also includes collective organization memberships. The informal subsample includes informal agreements before or during the production and the ones at the time of sale. The farms that were not clearly classified in this manner were excluded from analysis (4 in total). Thus, formal sample includes 57 farms, while informal includes more, even 70 farms.

Table 1. Sample division into formal and informal subsamples

	No. of farms	Contract/Network form
Formal	49	legal contract before or during production
Formal	3	legal contract agreed at the time of sale
Formal	5	collective organization membership
Informal	47	informal agreement before or during the production
Informal	23	informal agreement at the time of sale
	1	other
	0	not applicable
	3	do not know
	131	Total

Source: Stojanović et al. (2018): H2020 SUFISA WP2 National Report (Serbia), https://www.sufisa.eu/wp-content/uploads/2018/09/D__2.2-Serbia-National-Report.pdf

The implemented methodology is based on hypothesis testing in order to be able to investigate whether formal and informal subsamples are different in basic and advance indicators (ecological, social, economic sustainability) and in their future business strategies. For such a purpose, it is used Mann-Whitney test (Bhatta, Doppler, 2010; Hlouskova, Prasilova, 2020). The Mann-Whitney test is a non-parametric test that allows comparison of two independent samples. Test can determine if the samples may be considered identical or not on the basis of their ranks. This test can only be used to study the relative positions of the samples. So, having all that in mind, the hypotheses considering the samples that are the research object could be formulated as follows:

H0: The difference of location between the samples is equal to 0.

Ha: The difference of location between the samples is different from 0.

For the variables given in absolute size and currency measurement units, the standard two-tailed t-test for two independent samples on the difference between the means was conducted.

Results and Discussions

a) Basic socio-demographic and economic indicators

The group of basic indicators encompasses socio-demographic characteristics such as age, gender, education/agri-education of the owner and economic indicators related to legal status of the farm, sale channel, total and commodity area, and farm income. The results showed that there are significant differences between formal and informal sectors in four out of eight basic indicators. Only the age and total area indicators did not show significant differences while income and education show certain differences but not so significant as it was in the case of legal status, gender, specific agri-education and area under raspberry production (*Table 2a* and *Table 2b*).

Table 2a. Demographic indicators: Mann-Whitney test / Two-tailed test

	Age	Gender	Education	Agri-education
U	2196.500	1634.500	1577	1969
U (standard.)	1.035	0.000	-2.284	0.000
Expected value	1995.000	1995.000	1995.000	1995.000
Variance (U)	37738.189	18936.667	33405.840	7536.667
p-value	0.301	< 0.0001	0.022	< 0.0001
Significance level: 5%				

Source: Authors' calculations

Table 2b. Legal and economic indicators: Mann-Whitney test / Two-tailed test

	Legal status	**Sale channel**	**Total area**	**Area under raspberry production**	**Income**
Difference	2863.500	1974.500	0.536	0.347	2960.047
t (Observed value)	5.039	0.000	1.310	2.961	2.280
|t| (Critical value)	1995.000	1995.000	1.979	1.979	1.979
DF	29672.539	18936.667	125	125	125
p-value (Two-tailed)	< 0.0001	< 0.0001	0.193	0.004	0.024
Significance level: 5%					

Source: Authors' calculations

Generally, older farmers dominated in both subsamples corresponding to the age structure of farms in the Region. However, females had higher share in the formal subsample. Although the significant differences between formal and informal subsamples were not noticed in the context of highest level of education, specific agri-education delivered in the form of workshops, discussion groups, trainings or other is more represented in the group of producers that relay on formal contracting. Regarding legal status, in the formal subsample 89.5% of producers were individual farmers, while 7% were family farm partnerships, and only 3.5% were organized in the form of companies. In the informal subsample the situation was as follows 44.29%, 52.86% and 2.86% respectively. In the formal subsample average income was EUR 9775.76, while in the informal subsample average income was EUR 12735.8. In both subsamples less than 40% of farms had higher income than average in the subgroup. Farms in both subsamples were generally small in size, while differences were noticed in the context of average size of commodity area - in the formal subsample the average area under raspberry was 0.8 ha and in the informal subsample 1.15 ha. At the same time, only 17.5% of producers in the formal subsample had larger farms than 1 ha, while 40% of producers in the informal subsample cultivated larger area.

b) Sustainability indicators

When investigating the potential impact of the sale agreement (contract/network) on production choices that farmers made considering sustainability, it was noticed that there were statistically significant differences between formal and informal subsamples for all investigated variables. The results showed that more than half of the respondents within formal subsample had no idea whether type of agreement had any influence on given ecological, social or economic aspects of sustainability, while considerably higher proportion of the informal subsample respondents were better informed.

The analysis of the farmers' answers about the importance of the ecological factors generally revealed difference between two subsamples (*Table 3a*). There were four different indicators over which respondents supposed to give an opinion regarding the connection to the sales agreement type (maintain biodiversity, support animal welfare, maintain water quality and soil organic matter). The informal subsample respondents clearly indicated that the type of agreement did not help them to accept ecological sustainability within their agriculture production in a greater amount (around 6% agreed or strongly agreed). At the same time, the group of formal agreement respondents who answered the questions related to ecological aspects, showed greater awareness of agreement type influence on certain ecological indicators (around 12% agreed or strongly agreed).

Table 3a. Sustainability indicators – ecological, social, economic; Mann-Whitney test / Two-tailed test: Ecological indicators

	Biodiversity	Animal welfare	Water quality	Organic matter	Average	Median
U	999	935.500	990.500	1068	956.500	968.500
U (standardized)	-5.161	-5.422	-5.111	-4.672	-5.187	-5.225
Expected value	1995.000	1995.000	1995.000	1995.000	1995.000	1995.000
Variance (U)	37211.824	38147.736	38590.571	39322.520	40046.240	38560.650
p-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Significance level: 5%						

Source: Authors' calculations

Interviewed farmers showed that there were also certain differences between two subsamples when the social indicators of sustainability were taken into consideration (*Table 3b*). Four indicators had been put in front of the farmers in order to score them having in mind their own sale agreement type: creation of good connections with buyers and input providers, connections with other farmers, societal recognition and succession.

Table 3b. Sustainability indicators – ecological, social, economic; Mann-Whitney test / Two-tailed test: Social indicators

	Vertical cooperation	Horizontal cooperation	Societal recognition	Succession	Average	Median
U	1173.500	1183	1167.500	1169	1172	1158.500
U (standardized)	-4.125	-4.082	-4.173	-4.144	-4.089	-4.182
Expected value	1995.000	1995.000	1995.000	1995.000	1995.000	1995.000
Variance (U)	39617.618	39513.268	39267.165	39685.814	40461.896	39958.596
p-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Significance level: 5%						

Source: Authors' calculations

Regarding the creation of good connections with buyers and input providers (vertical cooperation), formal agreement respondents show greater level in agreement type influence on their social sustainability (only 18% of respondents within formal subsample did not agree versus 39% within informal subsample). Connection with other farmers (horizontal cooperation) was perceived as not important/not existing by 16% of respondents within formal subsample and 40% in the informal subsample. Achievement of societal recognition and succession were indicators which respondents in both subsamples consider as expected – informal subsample respondents showed more negative attitude regarding this issue (50% to 20% respondents disagreed).

It was expected that the economic indicators such as maintain profitability, investment in a farm business, selling the products in periods of greater difficulty where prices were low and changing market conditions were considered as most important generally. Comparing the two subsamples, the differences were more than evident (*Table 3c*).

Respondents within the formal subsample showed that formal agreement/network had low influence on farmers' economic sustainability (18-20% of the respondents disagreed about this influence considering all four indicators: profitability, investments, prices and market conditions). On the other side, the informal subsample respondents, which were better acquainted about these issues generally, showed even higher disagreement (from 45% up to 53%). It has to be emphasised that economic sustainability generally has the highest influence on farmers future business strategies.

Table 3c. Sustainability indicators – ecological, social, economic; Mann-Whitney test / Two-tailed test: Economic indicators

	Profitability	**Investments**	**Low prices**	**Market conditions**	**Average**	**Median**
U	1113.500	1166.500	1164	1126.500	1149	1121
U (standardized)	-4.445	-4.174	-4.192	-4.392	-4.213	-4.395
Expected value	1995.000	1995.000	1995.000	1995.000	1995.000	1995.000
Variance (U)	39289.980	39356.181	39257.690	39064.449	40273.018	39495.315
p-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Significance level: 5%						

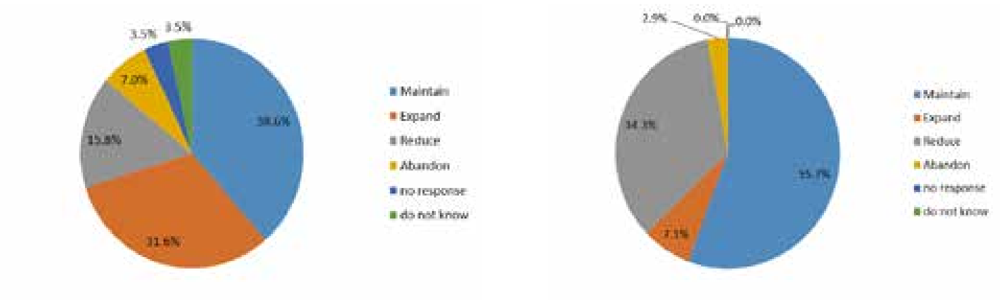
Source: Authors' calculations

c) Strategies and drivers of farming

The conducted analysis investigated the wider strategies producers adopt in their farming activities, with a special reference to the changes that they could implement in their business in the next five years, having in mind the type of their sale agreement. The farmers were asked to choose one among four strategies: maintenance of the existing scale of operations, expansion, reducing the production or abandoning.

Figure 1: Strategies of farming in the next 5 years

a) Formal subsample b) Informal subsample



Source: Stojanović et al. (2018): H2020 SUFISA WP2 National Report (Serbia), https://www.sufisa.eu/wp-content/uploads/2018/09/D__2.2-Serbia-National-Report.pdf

In both subsamples maintain farming was generally highly ranked. However, in the formal subsample, strategy based on expanding scale accounted for one third of respondents, while reducing scale or abandoning farming account for more than third of all respondents within the informal subsample.

In further analysis, the farmers were asked about the changes they expected to implement to their farm business in order to achieve the strategy they chose as preferable (production and market related changes). The results indicated statistically significant differences for both subsamples (*Table 4a* and *Table 4b*). Within the production related changes (Future strategy I), the respondents of both subsamples who had earlier chose one of three strategies (to maintain, expand or reduce the production), supposed to express their attitude related to further business plans in production facilities, possible externalizing of particular aspect of their business, specialization plans of their production and insurance against crop losses (*Table 4a*).

Table 4a. Mann-Whitney test / Two-tailed test: Future strategy I

	Invest	Externalize	Specialize	Insure	No plans
U	1338.500	1454	1454	1584.500	2024.500
U (standardized)	0.000	0.000	0.000	0.000	0.000
Expected value	1666.000	1666.000	1666.000	1666.000	1666.000
Variance (U)	19532.414	13931.207	13931.207	8373.086	24559.138
p-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Significance level:	5%				

Source: Authors' calculations

Around 60% of the formal subsample respondents said they have no specific plans for their business in the future. Supporting previous finding, the informal subsample respondents chose in a greater amount all four production related changes comparing to the formal subsample (93% of them said that they have plans to insure their production, 88% had plans to externalize or to specialize their production and 81% had plans to invest in production facilities).

The drivers related to market activities were presented in *Table 4b*. Totally five different drivers in this area were identified: diversification, insurance against volatile prices and costs to avoid income loss, development of new partnerships (with other producers, retailers, processors), development of a new sale channels, as well as adding value (e.g. conversion to organic or processing). More than 60% of the formal subsample respondents indicated that they had no plans in the next five years considering this issue. Producers with informal type of agreement showed greater willingness to improve their business (85% for insurance, 87% for new channels, 91% connected to the new partnerships and 97% for add value). Only regarding diversification, the formal subsample respondents showed greater interest which is generally well accepted strategy of traditional producers all over the world. Farmers within the informal subsample simply seek for wider range of activities that will lead them to higher risk control.

Table 4b: Mann-Whitney test / Two-tailed test: Future strategy II

	To diversify	**To insure**	**New partnership**	**New channels**	**Add value**	**No plans**
U	1688	1571	1201	1546.500	1569.500	1960.500
U (standardized)	0.000	0.000	0.000	0.000	0.000	0.000
Expected value	1666.000	1666.000	1666.000	1666.000	1666.000	1666.000
Variance (U)	13931.207	13931.207	16028.069	13371.086	6261.862	24487.328
p-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Significance level:5%						

Source: Authors' calculations

Concluding remarks

The tradition of raspberry production in West Serbia, especially in the Arilje and surrounding municipalities, has a long history (Paraušić, Simenunović, 2016; Kljajić et al, 2017). This selected area has significant importance due to the large number of agricultural producers who fully or partially derive their income from raspberry cultivation. Moreover, this region has significant export potential, which not only contributes to the agricultural sector development but also to the overall economy of Serbia (Pantić et al, 2021).

The exploratory analysis presented in this paper provides initial insights into the characteristics of raspberry farmers in Serbia, particularly regarding the formality of contracts or social networks they utilize in developing their businesses. This aspect of research was not exploited in the national literature so far. Additionally, the paper investigates how identified farmer characteristics influence the drivers and choices of sustainable business strategies, which is generally an important topic highly investigated worldwide (Herrera et al., 2016; Wojewodzka-Wiewiorska et al., 2020; Brennan 2021;

Weituschat et al., 2023). The profiles of farmers are summarized in *Table 5*. Considering the broader context of Serbian agriculture and the raspberry sector, the obtained results indicate the important differences among farmers based on the type of sales agreements/networks. Furthermore, these differences significantly influence their sustainability.

Table 5. Farmers profiles – most important differences

Characteristic/group	Formal contracts/networks	Informal contracts/networks
Representation of family farms	89.5%	52.9%
Socio-demographic characteristics		
Age (<40)	26.3%	12.9%
Gender (females)	28.1%	10.0%
Education (higher education)	17.5%	2.9%
Economic indicators		
Land (average size)	0,8 ha	1,15 ha
Income (average)	9776 euro	12736 euro
Sustainability		
General awareness	Not informed	Better informed
Overall contracts influence on sustainability	Included	Do not consider sustainability at all
Drivers and strategies		
No plans	60%	40%
General strategies	Prone to maintain and expand	Prone to maintain and reduce

Source: Authors' calculations

Our findings confirm the prevalence of family farming within the raspberry sector, aligning with this sector structure in the practice. However, family-owned farms were disproportionately represented in the subset of farmers who favoured formal contracts or networks in their operations. Farms within this subset tended to be smaller in terms of both property size and annual income. In terms of demographics, farmers involved in formal contracts or networks were, on average, younger and more formally educated, with a higher representation of female owners compared to the informal counterpart. The quality of formal agreements or networks demonstrated higher capacity to facilitate vertical connections within the food chain and overall sustainability of their businesses which is in the line with the previous research (Janker et al., 2019; Weituschat et al., 2023).

Farmers within formal subsample showed lower levels of awareness regarding sustainability in general, yet the contracts they entered into or the networks they joined demonstrated a stronger orientation towards sustainability issues. It was surprising that sustainability concerns were largely absent within informal contacts or networks. It appears that farmers belonging to the informal subset tended to be more entrepreneurial in nature due to higher income and average farm size. However, the perceived lack of institutional support hindered the implementation of sustainable business strategies. As it was noticed in the discussion part of this paper, they simply ask for better institutional arrangements that will help them to shape their future businesses fully aligned with sustainability as the main goal.

Traditionally organized farmers typically adhere to conventional farming practices, exhibiting resistance to change and a slower adoption of new technologies and innovative farming methods. It might be assumed that traditionally oriented farmers in developing countries lean towards sustainable business practices due to their focus on traditional supply chains and local or regional markets. Conversely, entrepreneurially oriented farmers are more inclined to adopt new technologies, employ modern farming techniques, and explore alternative production methods to improve efficiency and profitability. They actively seek out new markets, view risks as opportunities for growth, and maintain flexibility in selecting future farm strategies to maximize returns. Based on the previously mentioned differences, the question which group of our farmers can be identified as traditionally or entrepreneurially oriented is raised. Our analysis showed that informal subsample belonged more to the entrepreneurially oriented farmers, although most of their characteristics suggested the opposite. This group of farmers should be more supported by the agricultural policy measures in general, including better institutional arrangements among stakeholders within the food chain. Contrary to the above, traditionally oriented farmers should be in the focus of broader, rural development policy.

The production decisions made by raspberry producers in relation to their primary sales agreements (formal/informal) led to different perspectives on the potential impact on sustainable production (environmental, societal, and economic). In general, respondents from the formal subset recognized a greater influence of their agreements on all economic indicators, as well as most ecological and societal indicators. Due to an underdeveloped market, a consumer-oriented approach as the main driver may not incentivize farmer-entrepreneurs to adopt advanced farming techniques that prioritize both productivity and sustainability. Sustainability could be achieved through a more incentive-based approach. Generally, in our case the overall capacity of contracts or social networks is recognized as a highly influential factor that can shape entrepreneurs' behaviour in achieving more sustainable production models. Without strong institutional connections among stakeholders within the food chain, the prospect of sustainability is jeopardized in every aspect, particularly in the economic sphere, which still remains the most important aspect of sustainability in Serbia.

Acknowledgements

The findings are based on the survey conducted under EU's Horizon 2020 SUFISA research and innovation programme, Grant Agreement No 635577.

Conflict of interests

The authors declare no conflict of interest.

References

1. Begum, I.A., Alam, M.J., Buysse, J., Frija, A., van Huylenbroeck, G. (2012). Contract Farmer and Poultry Farm Efficiency in Bangladesh: A Data Envelopment Analysis. *Applied Economics*, 44, 28, 3737–47
2. Bellemare, M.F., Bloem, J.R. (2018). Does contract farming improve welfare? A review. World Development Volume 112, 259-271, https://doi.org/10.1016/j.worlddev.2018.08.018.
3. Bhatta, G.D., Doppler, W. (2010). Socio-Economic and Environmental Aspects of Farming Practices in the Peri-Urban Hinterlands of Nepal. *The Journal of Agriculture and Environment,* 11, 26-39.
4. Bougherara, D., Lapierre, M., Pr´eget, R., Sauquet, A. (2021). Do farmers prefer increasing, decreasing, or stable payments in Agri-environmental schemes? *Ecol. Econ.,* 183, https://doi.org/10.1016/j.ecolecon.2021.106946.
5. Brennan, M., Hennessy, Th., Dillon, E., Meredith, D. (2021). Putting social into agricultural sustainability: Integrating assessments of quality of life and wellbeing into farm sustainability indicators. *Sociologia Ruralis*, Spatial Issue, 629-660, https://doi.org/10.1111/soru.12417.
6. Buttel, F.H. (1993). The sociology of agricultural sustainability: some observations on the future of sustainable agriculture. *Agriculture, Ecosystems and Environment,* 46, 175-186.
7. Cassman, K.G. (1999). Ecological intensification of cereal production systems: yield potential, soil quality, and precision agriculture. *Proc. Natl. Acad. Sci. U.S.A.,* 96, 5952–5959.
8. Cholez, C., Magrini, M.-B., Galliano, D. (2020). Exploring inter-firm knowledge through contractual governance: a case study of production contracts for faba-bean procurement in France. *J. Rural. Stud.* 73, 135–146, https://doi.org/10.1016/j.jrurstud.2019.10.040.
9. Garnett, T., Appleby, M.C., Balmford, A., Bateman, I.J., Benton, T.G., Bloomer, P., Burlingame, B., Dawkins, M., Dolan, L., Fraser, D., Herrero, M., Hoffmann, I., Smith, P., Thornton, P.K., Toulmin, C., Vermeulen, S.J., Godfray, H.C.J. (2013). Agriculture. Sustainable intensification in agriculture: premises and policies. *Science 341 (6141),* 33–34, https://doi.org/10.1126/science.1234485.
10. Guo, H., Jiang, W. (2007). Practice and Implications of the Contract Farming Model of Association + Firm + Cooperative + Farms. *Chinese Rural Economy*, 4, 48–52.
11. Hansen,J. W. (1996). Is Agricultural Sustainability a Useful Concept? *Agricultural Systems 50*(1), 17- 143.
12. Herrera, B., Gerster-bentyna, M., Knierim, A. (2016). Social indicators of farm-level sustainability. *FLINT Deliverable D5.2E.* Available at: www.flint-fp7.eu/downloads/reports/D5.2e.pdf

13. Hlouskova, Z., Prasilova, M. (2020). Economic outcomes in relation to farmers' age in the Czech Republic. *Agric. Econ. – Czech* 66, 149-159.
14. Ikeda, Sh., Natawidjaja, R.S. (2022). The Sustainability of Contract Farming with Specialized Suppliers to Modern Retailers: Insights from Vegetable Marketing in Indonesia. *Agriculture,* 12 (3), https://doi.org/10.3390/agriculture12030380.
15. Janker, J., Mann, S., Rist, S. (2019). Social sustainability in agriculture–a system-based framework. *Journal of Rural Studies*, 65, 32–42.
16. Junjin Chen, J., Yhou, H. (2023). The Role of Contract Farming in Green Smart Agricultural Technology. *Sustainability,* 15 (13), https://doi.org/10.3390/su151310600.
17. Kljajić, N., Subić, J., Sredojević, Z. (2017). Profitabilnost proizvodnje maline na gazdinstvima na području Arilja. *Ekonomika poljoprivrede, 64* (1), 57-68.
18. Komlavi, A., Amos T. K., Sander J. Z. (2019). Agricultural land suitability analysis: State-of-the-art and outlooks for integration of climate change analysis. *Agricultural Systems, 173*, 172–208.
19. Kuhfuss, L., Subervie, J. (2018). Do European Agri-environment measures help reduce herbicide use? Evidence from viticulture in France. *Ecol. Econ.* 149, 202–211, https://doi.org/10.1016/j.ecolecon.2018.03.015.
20. Lee, D.R., Barrett, C.B., McPeak, J.G. (2006). Policy, technology, and management strategies for achieving sustainable agricultural intensification. *Agric. Econ. 34 (2),* 123–127, https://doi.org/10.1111/j.1574-0864.2006.00112.x.
21. Mazhar, R., Ghafoor, A., Xuehao, B., Wei, Z. (2021). Fostering sustainable agriculture: do institutional factors impact the adoption of multiple climate-smart agricultural practices among new entry organic farmers in Pakistan? *J. Clean. Prod.,* 283, https://doi.org/10.1016/j.jclepro.2020.124620.
22. Meemken, E.M., Bellemare, M.F. (2020).Smallholder farmers and contract farming in developing countries. *Proc. Natl. Acad. Sci., 117*, 259–264.
23. Norton, L.R. (2016). Is it time for a socio-ecological revolution in agriculture? *Agriculture, Ecosystems and Environment, 235*, 13–16.
24. Pantić, N., Cvijanović, D., Imamović, N. (2021). Economic analysis of the factors influencing the supply and demand of raspberry. *Ekonomika poljoprivrede, 68* (4), 1077-1087.
25. Paraušić, V., Simeunović, I. (2016). Tržišna analiza u sektoru proizvodnje malina u Srbiji i razvoj klasterskih inicijativa. *Ekonomika poljoprivrede, 63* (4), 1417-1431. [*In English*: Paraušić, V., Simeunović, I. (2016). Market analysis within raspberry sector in Serbia and cluster initiative development. *Ekonomika poljoprivrede, 63* (4), 1417-1431.]
26. Petersen, B., Snapp, S. (2015). What is sustainable intensification? Views from experts. *Land Use Policy,* 46, 1–10, https://doi.org/10.1016/j.landusepol.2015.02.002.

27. Pilarova, T., Bavorova, M., Kandakov, A. (2018). Do farmer, household and farm characteristics influence the adoption of sustainable practices? The evidence from the Republic of Moldova? *International Journal of Agricultural Sustainability, 16* (4-5) 367-384.

28. Pretty, J., Bharucha, Z.P. (2014). Sustainable intensification in agricultural systems. *Ann. Bot.* 114 (8), 1571–1596, https://doi.org/10.1093/aob/mcu205.

29. Rodríguez, D., Cox, H., de Voil, P. (2014). A participatory whole farm modeling approach to understand impacts and increase preparedness to climate change in Australia. *Agric. Syst., 126*, 49–60.

30. Santos, R., Clemente, P., Brouwer, R., Antunes, P., Pinto, R. (2016). Landowner preferences for Agri-environmental agreements to conserve the montado ecosystem in Portugal. Ecol. Econ. 118, 159–167, https://doi.org/10.1016/j.ecolecon.2015.07.028.

31. Schiefera, J., Laira, G.L., Bluma, W. E.H. (2016). Potential and limits of land and soil for sustainable intensification of European agriculture. *Agriculture, Ecosystems and Environment, 230*, 283–293.

32. Shreck, A., Getz,Ch., Feenstra, G. (2006). Social sustainability, farm labor, and organic agriculture: Findings from an exploratory analysis. *Agriculture and Human Values, 23*, 439–449.

33. Stojanović, Ž., Radosavljević, K., (2013). Food Chain, Agricultural Competitiveness and Industrial Policy: A Case Study of The Serbian Raspberry Production and Export. *Ekonomika preduzeća*, 3-4, 174-182.

34. Stojanović, Ž., Manić, E., Dragutinović-Mitrović, R., Ranđelović, S., Janković, I., Popović, S., Rakonjac-Antić, T., Ristić, B., Jovović, M. (2018): H2020 WP2 National Report (Serbia), H2020 SUFISA, https://www.sufisa.eu/wp-content/uploads/2018/09/D__2.2-Serbia-National-Report.pdf.

35. Stojanović, Ž., Rakonjac Antić, T., Koprivica, M. (2019). Farmers' willingness to purchase crop insurance: evidence from wheat and raspberry sectors in Serbia. *Ekonomika poljoprivrede, 66* (4), 1107-1125.

36. Struik, P.C., Kuyper, T.W. (2017). Sustainable intensification in agriculture: the richer shade of green. *A review. Agron. Sustain. Dev. 37 (5),* https://doi.org/10.1007/s13593-017-0445-7.

37. Tošović Stevanović, A., Ćalović, D. Lalić, G., Žuža M., Cvijanović, G. (2020). Comparative analysis of the economic potential of the small and family farms in the Republic of Serbia and Romania. *Ekonomika poljoprivrede*, *67* (3), 667-681.

38. Tittonell, P. (2014). Ecological intensification of agriculture—sustainable by nature. *Curr. Opin. Environ. Sustain.,* 8, 53–61, https://doi.org/10.1016/j.cosust.2014.08.006.

39. Vigani, M., Maye, Kirwan, D.J., Chiswell, H. (2018). WP 2 Producer Survey Report, H2020 SUFISA, https://www.sufisa.eu/wp-content/uploads/2018/11/D2.4-producer-survey-report.pdf.
40. Wang, H.H, Wang, Y., Delgado, M.C. (2014). The Transition to Modern Agriculture: Contract Farming in Developing Economies. *American Journal of Agricultural Economics*, *96* (5), 1257-1271, https://doi.org/10.1093/ajae/aau036.
41. Weituschat, Ch., S., Pascucci, S., Materia,V., C., Caracciolo, F., (2023). Can contract farming support sustainable intensification in agri-food value chains? *Ecological Economics, 211*, https://doi.org/10.1016/j.ecolecon.2023.107876.
42. Wojewodzka-Wiewiorska, A., Kłoczko-Gajewska, A., Sulewski, P. (2020). Between the social and economic dimensions of sustainability in rural areas - in search of farmers' quality of life. *Sustainability*, 12, 148 - 174.
43. Zakić, Z., Stojanović, Ž. (2008). *Ekonomika agrara*, CID, Ekonomski fakultet u Beogradu, Beograd. [*In English*: Zakić, Z., Stojanović, Ž. (2008). *Agricultral economics*. CID, The Faculty of Economics in Belgrade, Belgrade]

DETERMINANTS OF PROFITABILITY OF FOOD ENTERPRISES FROM THE TERRITORY OF THE REPUBLIC OF SERBIA

Stevan Tomašević[1], Mirela Momčilović[2], Nada Milenković[3], Dragana Milić [4]
**Corresponding author E-mail: stevan.tomasevic@vps.ns.ac.rs*

ARTICLE INFO

Original Article

Received: *07 April 2024*

Accepted: *15 May 2024*

doi:10.59267/ekoPolj2402519T

UDC 338.486.4:338.439.02(497.11)

Keywords:

profitability, determinants of profitability, food industry, Republic of Serbia, panel data analysis

JEL: *C33, L25, L66*

ABSTRACT

This paper aims to identify, evaluate, and analyze determinants of the profitability of food enterprises from the Republic of Serbia. The paper determines the nature of the relationship between defined determinants and profitability by applying a panel regression model on a sample of 189 small, medium, and large food enterprises from Serbia in the period from 2011 to 2021. The analysis results showed that the profitability of food enterprises is positively influenced by liquidity and sales growth rate. On the other hand, the indebtedness, size, and materiality of assets have a negative impact on the profitability of food enterprises. Of all analyzed variables, only liquidity does not affect profitability at a statistically significant level. The results of the analysis should be added to the fact that smaller food enterprises, with a lower degree of indebtedness and a smaller share of fixed in total assets, achieve a higher degree of profitability.

Introduction

A company's profitability implies the ability to achieve maximum profit in relation to invested assets. If the company does not achieve a minimally acceptable profit level, it can be considered that it is not using its funds in a sufficiently efficient manner. However, the funds are necessary for the company to perform activities, innovate business, implement technological changes, etc.

1 Stevan Tomašević, PhD, Lecturer, Novi Sad School of Business, Vladimira Perića Valtera 4, Novi Sad, Republic of Serbia, Phone: +381692009155, E-mail: stevan.tomasevic@vps.ns.ac.rs, ORCID ID (https://orcid.org/0000-0003-3819-9150)

2 Mirela Momčilović, PhD, Lecturer, Novi Sad School of Business, Vladimira Perića Valtera 4, Novi Sad, Republic of Serbia, Phone: +38163280010, E-mail: bizniscentar@gmail.com, ORCID ID (https://orcid.org/0000-0001-5752-6992)

3 Nada Milenković, PhD, Associate Professor, University of Novi Sad, Faculty of Economics in Subotica, Subotica, Republic of Serbia, Phone: +38124628068, E-mail: nada.milenkovic@ef.uns.ac.rs, ORCID ID (https://orcid.org/0000-0001-9810-3021)

4 Dragana Milić, PhD, Professor of Applied Study, Novi Sad School of Business, Vladimira Perića Valtera 4, Novi Sad, Republic of Serbia, Phone: +381638215979, E-mail: dragana.ikonic@vps.ns.ac.rs, ORCID ID (https://orcid.org/0000-0001-8250-0479)

In today's dynamic business environment, understanding the factors that affect a company's profitability is essential to maintaining competitiveness and achieving long-term success. This is particularly important in the food industry, where challenges such as changing market demands, regulatory requirements, and the complexity of resource management can significantly affect financial performance. In defining the determinants of profitability, Tomašević (2020) explains that it is impossible to consider all the determinants of profitability and that the interpretation of such analysis results would be questionable due to complexity. Also, too small a number of determinants cannot be included because the formed model most likely ignores the effect of other determinants with greater influence, and the results of such research are inadequate. Thus, profitability determinants should be selected by the specificity of the enterprise, industry, and geographical area of business and the researcher's ability to evaluate.

This research stems from a clear motivation to examine and understand the profitability of food enterprises in the Republic of Serbia. The motivation lies in recognizing the importance of maintaining competitiveness, achieving long-term success in a dynamic business environment, and identifying shortcomings in existing knowledge. In this context, the key "gaps" that this study aims to fill are the lack of detailed understanding of the factors influencing the profitability of food enterprises in the Republic of Serbia. While there is extensive literature on factors affecting profitability in general, little attention has been paid to the specific characteristics and challenges of the Serbian food industry. Therefore, this study aims to fill those knowledge gaps and explore innovative approaches to analyze the determinants of the profitability of food enterprises. So, this paper aims to identify, evaluate, and analyze critical determinants affecting the profitability of Serbia's food enterprises. In this regard, the relationship between the identified determinants and the profitability of food enterprises will be determined, which will be an adequate basis for improving, growing, and developing food enterprises in Serbia.

Through in-depth analysis of factors such as liquidity, indebtedness, firm size, sales growth, and investment management, the research seeks to provide new insights and contribute to the theoretical understanding of financial performance in the food industry.

Literature review

Various studies have analyzed the determinants of profitability of the agri-food sector in recent times (Chaddad, & Mondelli, 2013; Hirsch et al., 2014; Pindado Tapia, & Alarcón Lorenzo, 2015; Mijić et al., 2016; Nuševa et al., 2017; Andrašić et al., 2018; Dakić & Mijić, 2018; Grau, & Reig, 2018; Tomašević, 2020).

Different researchers examine the influence of internal and external factors on the profitability of the company (Abey, & Velmurugan 2018; Milošević-Avdalović, 2018; Dakić, & Mijić, 2018; Nanda, & Panda, 2018). Some papers examine only internal factors of profitability that are specific to the company (e.g. firm size, growth, age, indebtedness), while others investigate the influence of external factors (e.g. business and economic environment, market). The third group of papers examines how internal and external factors impact a company’s profitability.

Bhayani (2010) uses both internal and external variables, such as the size and growth of the company, liquidity, and inflation rate, to determine a company’s profitability. By trying to identify the variables that best assess the profitability of enterprises in cement production in India, he found that liquidity, enterprise growth, and inflation rates played a crucial role in determining profitability. Pervan and Višić (2012), when analyzing the relationship between firm size and profitability, include other internal and external variables in regression. They concluded that the firm size has a positive and weak statistically significant impact on profitability, the company’s indebtedness records a negative statistically significant impact on profitability, and liquidity was not an important variable in explaining the set model, i.e., profitability.

Nuševa, Mijić, and Jakšić (2017) found the existence of a number of independent variables with an insignificant statistical impact on the profitability of the company (such as liquidity, indebtedness, company size, and sales growth). On the other hand, a positive statistical impact on the company’s profitability had an inventory turnover, and a negative statistical impact had a degree of concentration of coffee processors in Serbia.

Pathirawasam and Knápková (2013) explored the relationship between profitability and different variables of enterprises in the Czech Republic. They concluded that size and sales growth have a statistically positive relationship with profitability, while indebtedness, inventory turnover, and capitalization rate have a negative and statistically significant impact on profitability. However, liquidity and company age have a statistically insignificant and positive relationship with profitability.

By examining the impact of factors on the profitability of small and large agricultural enterprises, Andrašić et al. (2018) have formed a model in which they determine the influence of company size, liquidity, debt, insurance, and export on the dependent variable. The result showed a significant positive impact of independent variables on the profitability of medium and large agricultural enterprises in the area of Vojvodina.

The article by Denčić-Mihajlov (2014) found that larger and more liquid companies have a higher level of profitability. Statistically significant and positive contributions are noted in the size of the company, liquidity, growth in sales, and turnover of assets, while negative contributions are noted in the ownership of the company. An insignificant contribution is noted in the indebtedness of the company. The analysis of the real sector in Serbia during the recession found that there is a need for additional ways to achieve profitability and improve its performance. Also, the recession period in Romania was examined by Vătava (2014), whose regression results show that profitable companies operate with limited loans. A statistically significant, positive contribution to profitability is observed with the variable of company size, while a negative contribution is noted in indebtedness, materiality, liquidity, and inflation. Similar research results were presented by Tomašević (2020), who concludes that liquidity, indebtedness, gross domestic product, and inflation have a negative and statistically significant contribution to the profitability of food companies, while only the size of the company makes a positive contribution to the profitability.

To determine which internal factors have a significant impact on the profitability of the meat processing industry, Mijić, Zekić, and Jakšić (2016) showed that companies with a high liquidity ratio and sales growth achieve a higher degree of profitability. On the other hand, they found that high indebtedness has a negative impact on profitability. Also, their results show that the size of the enterprise does not affect the profitability of the meat processing industry.

Examining the determinants of the profitability of Greek enterprises, Asimakopoulos, Samitas, and Papadogonas (2009) stated that the size of the enterprise, working capital, and the growth of sales and investments positively impact profitability. Food and beverage companies in Indonesia are the most resilient to crisis conditions compared to other sectors, and Fatmawati (2019) is trying to uncover the effect of sales growth and working capital, as well as liquidity, on the profitability of food and beverage companies. He concluded that liquidity has a statistically insignificant positive relationship with profitability, as Wibowo and Wartini (2012) confirmed. For Indonesia, analyzing the profitability of production companies, Tarihoran and Endri (2021) examined the impact of independent variables, such as liquidity, working capital, company size, growth, world oil prices, and exchange rate, on the dependent variable, i.e., profitability.

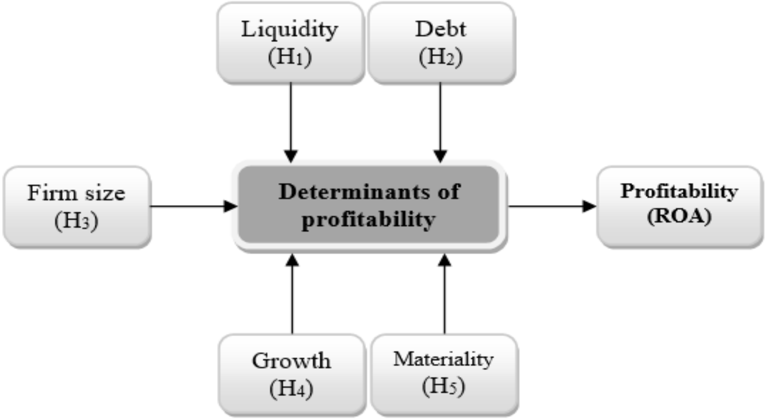
A number of research papers use size, age, and market share as factors that determine company's profitability (Chaddad, & Mondelli, 2013; Hirsch et al., 2014; Pindado Tapia, & Alarcón Lorenzo, 2015; Grau, & Reig, 2018; Yameen, Farhan, & Tabash 2019). Size, as an internal determinant of the company's profitability, is often the subject of various studies, and in addition to the aforementioned authors, numerous others have pointed out its importance (Pathirawasam, & Knápková, 2013; Denčić-Mihajlov, 2014; Vătavu, 2014; Andrašić et al., 2018; Tomašević, Jović, & Vlaović Begović, 2019).

Ratajczak, Szutowski and Nowicki (2024) indicate that the literature often emphasizes the influence of liquidity as a key factor that determines the short-term performance of companies. In this context, numerous authors investigate the impact of liquidity on the profitability. Some authors have shown the existence of a positive relationship between liquidity and profitability (Nunes et al., 2012; Denčić-Mihajlov, 2014; Andrašić et al, 2018), others that there is no statistically significant relationship between these variables (Pervan, & Višić, 2012; Pathirawasam, & Knápková, 2013; Kurniawati, & Apollo 2018), while the third group of authors indicates that there is a negative relationship between liquidity and profitability (Eljelly, 2004; Vătavu, 2014).

Hawawini et al. (2003) indicate that the performance of the company is decisively influenced by internal factors, as a result of which this study will examine the internal determinants of the company's profitability.

Based on the examined theory and literature research model is formed (Figure 1).

Figure 1. Research Model



Source: Authors' illustration

The model serves as the backbone for the development of the research hypothesis that will be tested in this paper:

H_1: Better liquidity of food enterprises positively impacts their profitability.

H_2: The higher level of food enterprises' indebtedness negatively impacts their profitability.

H_3: The size of food enterprises positively impacts their profitability.

H_4: The higher level of food enterprises' sales growth rate positively impacts their profitability.

H_5: The higher share of fixed assets in the total assets of food enterprises positively impacts their profitability.

Materials and methods

This research was conducted on 282 small, medium, and large food enterprises from the Republic of Serbia. The main activity of the sampled enterprises is the production of food products, which includes the processing of agricultural, forestry, and fishery products for obtaining food for humans or animals, as well as the production of various semi-finished products (C – processing industry, area 010 - production of food products). All sample enterprises were active from 2011 to 2021 and have published regular financial statements. The sample was formed based on data collected from the "Amadeus" database, which includes data from the balance sheet and income statement for the observed period. Extreme values and missing data were removed from the sample. The final sample based on which the research was carried out consists of 189 enterprises and refers to the research period of 11 years, i.e., there are 2.079 observations.

A panel regression model was used to identify the main determinants of the profitability of food enterprises from Serbia. The model's dependent variable is the rate of return on assets (ROA), while the independent variables are the internal determinant of profitability are listed in Table 1.

Table 1. Research variables

Variable	Indicator	Definition
ROA	Profitability	Net income/Total assets
LIQ	Liquidity	Current assets/Current liabilities
DEBT	Indebtedness	Total liabilities/Total assets
SIZE	Firm size	Natural logarithm of the value of the total assets
GROWTH	Sales growth rate	(Sales of current period – Sales of previous period) / Sales of previous period
FIXED	Materiality	Fixed assets/Total assets

Source: Authors' illustration

For empirical testing of the association between profitability and selected independent variables, the following model was used:

$$ROA_{it} = \beta_0 + \beta_1 LIQ_{it} + \beta_2 DEBT_{it} + \beta_3 SIZE_{it} + \beta_4 GROWTH_{it} + \beta_5 FIXED_{it} + \varepsilon_{it}$$

where: ROA_{it} – the value of the rate of return on assets of the *i* enterprise from the sample for the year *t*; β_0, β_1,..., β_5 – unknown regression parameters; LIQ_{it} – the value of the current ratio of the *i* enterprise for the year *t*; $DEBT_{it}$ – the value of the total debt ratio of the *i* enterprise for the year *t;* $SIZE_{it}$ – the value of the natural logarithm of the value of total assets of the *i* enterprise for the year *t*; $GROWTH_{it}$ – the value of the growth rate of sales of the *i* enterprise for the year *t*; $FIXED_{it}$ – the value of the fixed-to-total asset ratio of the *i* enterprise for the year *t*; ε_{it} – a random error with a normal distribution.

To analyze the profitability determinants of food enterprises in Serbia, the model of ordinary least squares, the model with a fixed effect, and the model with a stochastic (random) effect were used. The selection of the most appropriate models was based on the F, Breusch-Pagan LM, and Hausman tests. The VIF test was used to test the presence of multicollinearity between independent variables of the regression models.

Results

The descriptive statistics of all variables of the analyzed model are shown in Table 2.

The average value of the rate of return on the assets (ROA) of the sampled enterprises was 6.50% in the analyzed period. Suppose the obtained value is compared with the expected reference value of the rate of return on the assets, i.e., the theoretically recommended rate of 10%. In that case, the analyzed enterprises in the observed period have a relatively low level of profitability and did not achieve a satisfactory rate of return on the assets. The rates of return on the assets (ROA) of the enterprises from the sample vary from -64.03% to 71.20%. Due to the significant level of variation between the values of the rates of return of individual enterprises from the sample, their standard deviation is relatively high and amounts to 9.55.

Table 2. Descriptive statistics of Serbian food enterprises

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
ROA	2,079	6.5004	9.5539	-64.0300	71.2000
LIQ	2,079	1.6893	1.2655	0.0800	21.4100
DEBT	2,079	52.9925	21.2429	2.5600	112.7800
SIZE	2,079	13.2916	1.6160	8.0892	17.8831
GROWTH	2,079	0.1388	0.4911	-0.8028	10.9770
FIXED	2,079	0.4790	0.1868	0.0119	0.9679

Source: Authors' calculations based on STATA 15

In the observed period, the average value of the current ratio of food enterprises from the sample was 1.69, which is below the theoretically recommended value of 2.00 and indicates that the average current ratio of the sampled enterprises is slightly below the satisfactory level. The current ratio of the analyzed enterprises varied from 0.08 to 21.41, as a result of which the value of the standard deviation of this ratio was relatively low (1.27).

The average value of the total debt ratio of food enterprises was 0.5299, indicating that an average of 52.99% of the asset value of the analyzed enterprises was financed from debt, while the remaining 47.01% was financed from equity. The result is approximately in line with the traditional financing rule, according to which the acceptable debt-equity ratio of the enterprises is 1:1.

Based on the conducted analysis, it can be concluded that the firm size, measured by the natural logarithm of the value of the company's assets, has moderate variability, i.e., that the enterprises from the sample in most cases have assets with a value that is at the level of the average assets of the examined enterprises from the sample.

The average value of the sales growth rate from the sampled food enterprises is 13.81%, which indicates that enterprises, on average, achieved growth of the sales compared to the previous year. The growth rate varied from -8.03% to 10.98%. The negative value of the sales growth rate of some sample enterprises shows that these enterprises recorded a decrease in sales compared to the previous period. The standard deviation of the growth rate is high and amounts 49.11, indicating a significant deviation in the sales growth rate of individual enterprises from the average sales growth rate.

The average value of the fixed-to-total assets ratio was 47.90%, indicating that fixed assets, on average, accounted for 47.90% of the total assets of the sampled food enterprises. The ratio value varied from 1.19% to 96.79%, depending on the examined enterprise.

The correlation matrix (Table 3) shows the Pearson correlation coefficients between ROA and the selected independent variables. The correlation results show a positive relationship between ROA on one side and the current ratio, sales growth rate, and fixed-to-total asset ratio on the other. There is a negative link between ROA and total debt ratio and between ROA and the size of sample enterprises.

Table 3. Pearson correlation analysis of profitability and its determinants

	ROA	LIQ	DEBT	SIZE	GROWTH	FIXED
ROA	1.0000					
LIQ	0.1598	1.0000				
DEBT	-0.2867	-0.5363	1.0000			
SIZE	-0.1883	0.1219	-0.0716	1.0000		
GROWTH	0.1183	-0.0663	0.0557	-0.1157	1.0000	
FIXED	0.0167	-0.3247	-0.0498	-0.0556	0.0227	1.0000

Source: Authors' calculation based on STATA 15

From Table 4, it can be seen that the VIF test results confirm no problem with multicollinearity because none of independent variables used has a VIF value greater than the theoretical reference value of 5. The results indicate that all independent variables can be used in the regression panel model.

Table 4. Results of the multicollinearity test

Variable	VIF	1/VIF
LIQ	1.71	0.5841
DEBT	1.52	0.6558
SIZE	1.03	0.9731
GROWTH	1.02	0.9833
FIXED	1.21	0.8238

Source: Authors' calculation based on STATA 15

In the next step of the analysis, an adequate regression model was selected using the selected tests, the results of which can be seen in Table 5.

Table 5. Results of tests for the selection of an adequate regression model

Test	Test value	Probability
F test	$F_{(188, 1885)}=11.73$	$p(F)=0.0000<\alpha=0.05$
Breusch-Pagan LM test	$\chi^2_{(01)}=2,346.50$	$p(\chi^2)=0.0000<\alpha=0.05$
Hausman test	$\chi^2_{(5)}=25.55$	$p(\chi^2)=0.0001<\alpha=0.05$

Source: Authors' calculation based on STATA 15

The F-test value showed that there are individual effects, as a result of which it can be concluded that the fixed effects model (FE) is more adequate than the ordinary least squares model (OLS). The Breusch-Pagan test also showed individual effects, suggesting that a random effects model (RE) is more suitable for use than the ordinary least squares model. Therefore, both tests confirmed the statistical significance of individual effects, implying that the application of the ordinary least squares model is inadequate within the conducted research. Finally, by applying the Hausmann test when determining the nature of individual effects, it can be concluded that in this study, a fixed effects model is more suitable for application compared to a random effects model, and therefore it will be used for further analysis and evaluation of regression coefficients with independent variables.

Table 6. The results of the fixed-effect model (FE)

ROA	Coefficients	Standard Error	t Stat	p>|t|
LIQ	0.0381	0.1762	0.22	0.829
DEBT	-0.8696	0.0143	-13.08	**0.000**
SIZE	-1.0918	0.3378	-3.23	**0.001**
GROWTH	2.2855	0.3069	7.45	**0.000**
FIXED	-11.6021	1.5973	-7.26	**0.000**
Const	36.0959	4.4976	8.03	**0.000**
F(5,1885)	65.62			
Prob>F	0.0000			
R-Ad (overall)	0.1095			

Source: Authors' calculation based on STATA 15

The results of the panel regression model with fixed effects are presented in Table 6, and based on them, it can be concluded that the factors of indebtedness, firm size, sales growth rate, and materiality of assets have a significant impact on the profitability of food enterprises from the sample in the analyzed period. On the other hand, the results show that in the observed period, the liquidity of food enterprises is not associated with profitability at a statistically significant level. From the previous table, it can also be seen that liquidity and sales growth rate have a positive, while indebtedness, firm size, and materiality of assets have a negative impact on the profitability of food enterprises.

Discussions

Previous studies on the relationship between profitability and liquidity produced varying results and conclusions. On the one hand, multiple studies have found that liquid companies are often more profitable. On the other side, some argue that too much liquidity might harm a company's profitability. Specifically, it is considered that increasing the enterprise's liquidity increases its profitability, but only to a certain extent. After this level, any further increase in liquidity reduces profitability because the company does not invest surplus funds. This research showed a positive relationship between liquidity and profitability of food enterprises from the sample, and the fact that this relationship is not at a statistically significant level ($p = 0.829 > \alpha = 0.05$). If the other variables in the model remain constant, it is possible to conclude that increasing enterprise liquidity by one ratio point does not result in a significant gain in profitability for Serbian food enterprises (Table 6). The results are in line with the results of studies done by other authors who have engaged in similar research (Nuševa, Mijić, & Jakšić, 2017; Dakić, & Mijić, 2018; Fatmawati, 2019), as a result of which the first hypothesis can be confirmed.

The majority of research studies on the relationship between profitability and indebtedness have found that companies with more debt are less profitable than those with less debt. Accordingly, this research showed a negative and statistically significant relationship between the indebtedness and profitability of food enterprises from Serbia in the observed period ($p = 0.000 < \alpha = 0.05$). Furthermore, the data showed that a 1%

increase in overall debt reduces food enterprise profitability by 0.87%, with all other conditions remaining constant. The same conclusion regarding the ratio of profitability and indebtedness was made by numerous authors who conducted similar research (Pervan, & Višić, 2012; Pathirawasam, & Knápková, 2013; Vătavu, 2014; Mijić, Zekić, & Jakšić, 2016; Andrašić, Mijić, Mitrović, & Kalaš, 2018; Dakić, Mijić, & Jakšić, 2019; Tomašević, 2020; Stoijljković, Balaban, & Simić, 2023), which is the basis for acceptance of the second hypothesis.

Several authors have explored the relationship between profitability and firm size. Based on the results obtained, some concluded that there is a negative and statistically significant relationship between the size and profitability of the company, while others that the relationship is positive and statistically significant. At the same time, the third group of authors showed that there is no statistically significant relationship between firm size and profitability. The results of this research indicate that between the firm size (measured by the natural logarithm of the value of total assets) and the profitability of food enterprises in the analyzed period, there is a negative and statistically significant relationship ($p = 0.001 < \alpha = 0.05$), which means that smaller enterprises are more profitable compared to larger enterprises. The results obtained are in accordance with the results of various studies (Andrašić, Mijić, Mirović, & Kalaš, 2018; Mijić, Nuševa, & Jakšić, 2018; Tarihoran, & Endri, 2021; Yadav, Pahi, & Gangakhedkar, 2022). According to everything that is presented, the third hypothesis is rejected.

Intuitively, it can be predicted that the rise in sales compared to the prior period will raise the company's profitability, which the results of this research supported. Namely, the obtained results indicate that between the sales growth rate and profitability of food enterprises from Serbia in the analyzed period, there is a positive and statistically significant relationship ($p = 0.000 < \alpha = 0.05$), which is in line with the results of numerous studies (Asimakopoulos, Samitas, & Papadogonas, 2009; Denčić-Mihajlov, 2014; Mijić, Zekić, & Jakšić, 2016; Andrašić, Mijić, Mirović, & Kalaš, 2018; Dakić, Mijić, & Jakšić, 2019; Fatmawati, 2019; Tarihoran, & Endri, 2021) and represents the basis for confirming the fourth research hypothesis.

It would be expected that companies with a higher level of materiality of assets, i.e., with a higher fixed-to-total asset ratio, have a higher degree of profitability because fixed assets can lead to an increase in operating income. However, this research shows that the rise in materiality results in a decrease in the profitability of food enterprises in Serbia. Namely, along with other unchanged conditions, an increase in the share of fixed assets in total assets by 1% leads to a decrease in the profitability of food enterprises by 11.60%. The obtained results showed a negative and statistically significant relationship between profitability and materiality of assets ($p=0.001<\alpha=0.05$). This may be due to insufficient funding sources and food enterprises' inability to employ or manage fixed assets efficiently. The results obtained are in line with the results of other authors who have conducted similar research (Vătavu, 2014; Mijić, Nuševa, & Jakšić, 2018). Accordingly, the fifth hypothesis is rejected.

Conclusion

In this article, the profitability of food enterprises from the territory of Serbia was investigated based on data related to the period from 2011 to 2021 to identify the fundamental determinants of profitability and determine their impact on the company's profitability level. The research analyzed the influence of five independent variables, namely liquidity, indebtedness, firm size, sales growth rate, and asset materiality, on the profitability of food enterprises. As a dependent variable, profitability was measured by the rate of return on assets. The research was based on the use of panel regression analysis. The research hypotheses were tested based on a fixed effect model, which proved to be the most appropriate.

The research results showed that the level of profitability of food enterprises from the territory of Serbia in the analyzed period is positively influenced by liquidity and sales growth rate. On the other hand, the indebtedness, firm size, and materiality of assets have a negative impact on the profitability of food enterprises. Of the mentioned variables, only liquidity does not affect profitability at a statistically significant level.

Based on the results obtained, it can be concluded that smaller food enterprises, with a lower level of indebtedness and a smaller share of fixed assets in total assets, achieve a higher degree of profitability because they are flexible, unburdened by the need to repay high loans and interest, as well as inefficient and insufficiently employed fixed assets, and can adequately respond to market demands.

The conducted research and obtained results can facilitate the adoption of sound business decisions by the company's management and thus lead to an increase in the profitability of food enterprises. Also, the research's results can be used to create and adopt systemic measures to support food enterprises in Serbia and accelerate their growth and development.

The significance of this research lies in its ability to improve business strategies and the sustainability of food enterprises in the Republic of Serbia. Understanding the key determinants of profitability and identifying effective management strategies can enable better decision-making and achieve a competitive advantage in this sector.

Theoretical implications

These findings carry significant theoretical implications for understanding the determinants of profitability in the food industry of the Republic of Serbia. Firstly, the identified relationship between liquidity, indebtedness, firm size, sales growth, and profitability contributes to enriching existing theoretical frameworks in financial management and firm performance. It underscores the importance of these factors in shaping the financial health and competitive advantage of food enterprises. Moreover, the findings suggest that the impact of specific determinants on profitability may vary depending on the industry context and geographical location. This highlights the need for nuanced theoretical models that account for sector-specific dynamics and regional variations in business environments. It encourages researchers to develop more tailored theoretical frameworks that capture the intricacies of profitability determinants in different sectors and regions.

Additionally, the observed patterns of profitability determinants offer insights into the underlying mechanisms driving financial performance in the food industry. Scholars can refine existing theories of firm behavior and economic decision-making by understanding how liquidity, indebtedness, enterprise size, and sales growth influence profitability. This could lead to developing more comprehensive models that better capture the complexities of business operations and financial management in the food sector.

Practical implications

The practical implications of this research point to several key strategies managers of food enterprises in Serbia can employ to enhance profitability and achieve sustainable growth. Firstly, effective liquidity management can ensure business stability and facilitate access to financial resources. Additionally, optimizing indebtedness can reduce financial risk and increase the company's ability to generate profit. Furthermore, managers should direct efforts toward growing sales volume and achieving stable growth, which can be crucial for improving company performance. Analyzing the size of the enterprise can provide insights into optimal operational models and scaling strategies. At the same time, careful management of investments in fixed assets can optimize production capacities and ensure adequate returns on investment. Following these practical guidelines can give food businesses a competitive advantage and pave the way for sustained success in the market.

Limitations

While the results of this research are helpful, it is important to consider a few limitations. First, the paper focuses exclusively on the food industry in the Republic of Serbia, which can limit the generalization of results to other sectors or states. Secondly, although panel regression analyses have been used, there is a possibility of the influence of other factors not covered in this model. Third, the data used in the research was collected from publicly available sources, which may limit the accuracy and completeness of the information. Finally, this survey covers the period from 2011 to 2021, so the results may be subject to the impact of economic and market changes over that time period.

Framework for future research

Future research could deepen the understanding of the determinants of the profitability of food businesses through additional analysis of factors such as technological innovation, market competition, and regulatory framework. Also, research involving international comparisons or longitudinal studies could provide valuable insights into long-term trends and factors affecting profitability in the food sector.

Conflict of interests

The authors declare no conflict of interest.

References

1. Abey, J., & Velmurugan, R. (2018). Determinants of Profitability in Indian Automobile Industry. *International Journal of Pure and Applied Mathematics*, 119(12), 15301-15313.
2. Andrašić, J., Mijić, K., Mirović, V., & Kalaš, B. (2018). The modelling factors of agricultural companies performances. *Custos e Agronegocio on line,* 14(4), 223-240.
3. Asimakopoulos, I., Samitas, A., & Papadogonas, T. (2009). Firm-specific and economy wide determinants of firm profitability - Greek evidence using panel data. *Managerial Finance,* 35(11), 929-940. DOI: 10.1108/03074350910993818
4. Bhayani, S. J. (2010). Determinant of profitability in Indian cement industry: An economic analysis. *South Asian Journal of Management,* 17(4), 6-20.
5. Chaddad, F. R., & Mondelli, M. P. (2013). Sources of firm performance differences in the US food economy. *Journal of Agricultural Economic*, 64(2), 382–404. DOI: 10.1111/j.1477-9552.2012.00369.x
6. Dakić, S., & Mijić, K. (2018). A panel analysis of profitability in the fruit and vegetable processing industry in Serbia. *Economics of Agriculture,* 65(1), 307-321. DOI: 10.5937/ekoPolj1801307D
7. Dakić, S., Mijić, K., & Jakšić, D. (2019). Multiple regression approach to modeling determinants of business success based on financial statements: Evidence from food processing companies in the Republic of Serbia. *Custos e agronegocio on line*, 15(4), 485-501.
8. Denčić-Mihajlov, K. (2014). Profitability during the financial crisis - Evidence from the regulated capital market in Serbia. *South-Eastern Europe Journal of Economics*, 12(1), 7-33.
9. Eljelly, A. M. (2004). Liquidity-profitability tradeoff: An empirical investigation in an emerging market. *International Journal of Commerce and Management*, 14(2), 48-61. DOI: 10.1108/10569210480000179
10. Fatmawati, E. (2019). The effect of working capital round, sales growth and liquidity on corporate profitability. *Journal of Research in Business, Economics, and Education*, 1(2), 204-213.
11. Grau, A. J., & Reig, A. (2018). Trade credit and determinants of profitability in Europe. The case of the agri-food industry. *International business review*, 27(5), 947-957. DOI: 10.1016/j.ibusrev.2018.02.005
12. Hawawini, G., Subramanian, V., & Verdin, P. (2003). Is performance driven by industry-or firm-specific factors? A new look at the evidence. *Strategic management journal*, 24(1), 1-16. DOI: 10.1002/smj.278

13. Hirsch, S., Schiefer, J., Gschwandtner, A., & Hartmann, M. (2014). The determinants of firm profitability differences in EU food processing. *Journal of Agricultural Economics*, 65(3), 703–721. DOI: 10.1111/1477-9552.12061
14. Kurniawati, E., & Apollo, D. (2018). The Effect of Working Capital, Liquidity, Leverage on Profitability: Empirical Study of Manufacturing Companies in Indonesia Stock Exchange 2012-2016. *International Journal of Science and Research,* 7(12), 336-342.
15. Mijić, K., Nuševa, D., & Jakšić, D. (2018). The Determinants of SMEs profitability in the wholesale and retail sector in Serbia. *Teme*, 42(1), 97-111. DOI: 10.22190/TEME1801097M.
16. Mijić, K., Zekić, S., & Jakšić, D. (2016). Profitability analysis of meat industry in Serbia. *Facta Universitatis: Economics and Organization,* 13(4), 379-386. DOI: 10.22190/FUEO1604379M
17. Milošević-Avdalović, S. (2018). Impact of Firm Specific Factors on Profitability of Industrial Grinding Companies. *Economics of Agriculture,* 65(2), 493-501. DOI: 10.5937/ekoPolj1802493M
18. Nanda, S., & Panda, A. K. (2018). The determinants of corporate profitability: an investigation of Indian manufacturing firms. *International Journal of Emerging Markets*, 13(1), 66-86. DOI: 10.1108/IJoEM-01-2017-0013
19. Nuševa, D., Mijić, K., & Jakšić, D. (2017). The performances of coffee processors and coffee market in the Republic of Serbia. *Economic of Agriculture,* 64(1), 307-322. DOI: 10.5937/ekoPolj1701307N
20. Pathirawasam, C., & Knápková, A. (2013). Firm-specific factors and financial performance of firms in the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 61(7), 2183-2190. DOI: 10.11118/actaun201361072183
21. Pervan, M., & Višić, J. (2012). Influence of firm size on its business success. *Croatian Operational Research Review,* 3(1), 213-223.
22. Pindado Tapia, E., & Alarcón Lorenzo, S. (2015). Factores de rentabilidad en la industria cárnica de Castilla y León. *Revista Española De Estudios Agrosociales y Pesqueros*, 240, 39–75.
23. Ratajczak, P., Szutowski, D., & Nowicki, J. (2024). Exploring the Dynamics of Profitability–Liquidity Relations in Crisis, Pre-Crisis and Post-Crisis. *International Journal of Financial Studies*, 12(1), 16. DOI: 10.3390/ijfs12010016
24. Stoiljković, B., Balaban, S., & Simić, M. (2023). Uticaj likvidnosti na profitabilnost preduzeća prerađivačkog sektora u Republici Srbiji. *Oditor,* 9(2), 155-177. [*in English*: Stoiljković, B., Balaban, S., & Simić, M. (2023). The influence of liquidity on the profitability of companies in the processing sector in the rural Serbia. *Oditor,* 9(2), 155-177]. DOI: 10.5937/Oditor2302155S

25. Tarihoran, D. V., & Endri, E. (2021). Analysis of factors affecting the profitability in consumer goods sector companies listed on the Indonesia Stock Exchange in 2015-2020 period. *Journal Research of Social Science, Economics, and Management,* 1(5), 545-558. DOI: https://doi.org/10.59141/jrssem.v1i5.59

26. Tomašević, S. (2020). *Determinante profitabilnosti poljoprivrednih preduzeća u Republici Srbiji* (doktorska disertacija). Univerzitet Singidunum, Beograd. [*in English*: Tomašević, S. (2020). *Determinants of profitability of agricultural enterprises in the Republic of Serbia* (doctoral dissertation). Singidunum University, Belgrade].

27. Tomašević, S. M., Jović, Z. D., & Vlaović Begović, S. M. (2019). The impact of enterprise size on the profitability of agricultural enterprises in the Republic of Serbia. *Journal of Agricultural Sciences (Belgrade)*, 64(3), 293-302. DOI: 10.2298/JAS1903293T

28. Vătavu, S. (2014). The determinants of profitability in companies listed on the Bucharest Stock Exchange. *Annals of the University of Petrosani: Economics,* 14(1), 329-338.

29. Wibowo, A., Wartini, S. (2012). Efisiensi modal kerja, likuiditas dan leverage terhadap profitabilitas pada perusahaan manufaktur di BEI. *Jurnal Dinamika Manajemen*, 3(1), 49-58.

30. Yadav, I. S., Pahi, D., & Gangakhedkar, R. (2022). The nexus between firm size, growth and profitability: new panel data evidence from Asia–Pacific markets. *European Journal of Management and Business Economics*, 31(1), 115-140. DOI: 10.1108/EJMBE-03-2021-0077

31. Yameen, M., Farhan, N.H., & Tabash, M.I. (2019). The Impact of Liquidity on Firms' Performance: Empirical Investigation from Indian Pharmaceutical Companies. *Academic Journal of Interdisciplinary Studies*, 8(3), 212-212. DOI: 10.36941/ajis

COMPARING THE ECONOMIC EFFECTS OF OPEN FIELD AND PROTECTED AREA ORGANIC TOMATO CULTIVATION SYSTEMS

Vasili Vasilije Ostojić[1], Riste Elenov[2], Zorica Sredojević[3]
**Corresponding author E-mail: vasilije.ostojic@agrif.bg.ac.rs*

ARTICLE INFO

Original Article

Received: *14 April 2024*

Accepted: *15 May 2024*

doi:10.59267/ekoPolj2402535V

UDC 635.64:631.544

Keywords:

Organic tomato, production in a protected area, open field production, economic indicators

JEL: *Q12; Q13; D13*

ABSTRACT

To compare the economics of different systems of organic tomato production, two models were created, one assuming outdoor production, and the other representing production in a protected area under a greenhouse, based on the data obtained through interviews with organic tomato producers from Vojvodina. The cost and sensitivity analysis revealed that the greenhouse model yields better results overall (a financial result of €273/100 m2 compared to €58/100 m2), despite the higher costs due to amortization, interest and costs related to the higher yield obtained. The production model also showed less dependence on the change in organic tomato yield and price, as well as key cost groups and post-harvest losses, which in both cases were mediated by growing coriander as an intercrop. This research improves the knowledge of the economics of organic tomato cultivation and at the same time proposes a methodology to analyze the economic impact of other organic productions.

Introduction

Tomatoes grown in a protected area are more regular in shape, size and color, which make them more attractive on the market than tomatoes cultivated in open field conditions (Engyndenyz & Tuzel, 2002). Greenhouse production ensures a higher yield per unit area, the possibility to produce outside the peak season and an overall higher added value of the product (Mohammed and Al Dulaimi, 2021, Gül et al., 2021). However, more favorable production conditions also promote the faster spread of diseases and

1 Vasili Vasilije Ostojić, PhD student, Assistant, University of Belgrade - Faculty of Agriculture, Nemanjina 6, 11080 Zemun, Serbia, Phone: +381 11 441-3215, E-mail: vasilije.ostojic@agrif.bg.ac.rs, ORCID ID (https://orcid.org/0009-0003-6736-1193)

2 Riste Elenov, Ph.D., Assistant Professor, Ss. Cyril and Methodius University of Skopje - The Faculty of Agricultural Sciences and Food, Str. 16-ta Makedonska brigada No 3 1000 Skopje, North Macedonia, Phone: +389 2 325-5100, E-mail: relenov@fznh.ukim.edu.mk, ORCID ID (https://orcid.org/0000-0003-1005-358X)

3 Zorica Sredojević, PhD, Full Professor, University of Belgrade - Faculty of Agriculture, Nemanjina 6, 11080 Belgrade-Zemun, Serbia, Phone: +381 11 441 3297, E-mail: zokas@agrif.bg.ac.rs, ORCID ID (https://orcid.org/0000-0001-7224-1573)

pests (Engyndenyz & Tuzel, 2002). This production risk is particularly pronounced in organic farming given the limited options for yield protection. There is a gap in the existing literature regarding the analysis and comparison of the economic impact of organic tomato production in the open field and in the greenhouse (Santos Neto et al., 2017). The literature search conducted revealed a few papers that considered the economics of organic tomato production. Previous research has mainly focused on comparing the economic effects of organic and conventional cultivation (Engyndenyz & Tuzel, 2002, Luz et al., 2007, Santos Neto et al., 2017, Abebe et al., 2022), while only two papers were found analyzing the economics of organic tomato cultivation in a protected area (Engyndenyz & Tuzel, 2002, Nian et al., 2022).

The aim of this work is to compare the economics of the two systems of organic production which is done by analyzing the results obtained in terms of the level and structure of costs, production value, net profit and other indicators from the compiled analytical calculations. By simulating income and costs under different conditions of organic production, it is investigated whether the quantitative and qualitative yield increases of tomatoes in a protected area exceed the cost increases and whether these conditions are economically more advantageous for the producer compared to open field cultivation. Sensitivity analyzes were used to determine the effects of changes in yield, organic tomato price, the proportion of post-harvest losses and the main cost groups of the two production systems. This paper aims to fill the identified research gap, but also proposes a methodology for analyzing the economics of other organic productions.

Materials and methods

Based on literature research, analysis of available data on organic tomato production under different production conditions and interviews with organic tomato producers in Vojvodina, two production models were simulated on an area of 100 m^2.

A total of 32 producers (from the districts of North Bačka, West Bačka, South Bačka, North Banat and Central Banat of Vojvodina) were surveyed, of which 15 farms grew tomatoes only in the open field, six farms organized part of their production in the open field and in protected areas and 11 farms grew tomatoes only in protected areas in the 2022/2023 season.[4] In this sense, the analysis of the economic effects includes the data from 21 farms in the case of outdoor production, i.e. 17 in the case of greenhouse cultivation. Model 1 assumes open field production with a drip irrigation system. Model 2 considers production in a greenhouse covering the entire area and a drip irrigation system. While the main objective of the research is to further develop empirical knowledge on the economics of organic tomato production by comparing these two production systems, the results will also improve the basis for analyzing the impact of investments in the construction of greenhouses according to the recorded

4 All the farms surveyed have a certificate for organic production issued by the Ministry of Agriculture, Forestry and Water Economy of the Republic of Serbia and have undergone the conversion period.

production conditions in the Vojvodina region, where a significant part of organic tomato production in the Republic of Serbia is realized (Sredojević, 2014).

The production models assume that the entire yield of tomatoes is sold. Sale to a retailer is assumed as the most common marketing channel in the case of organic tomato production (Abebe et al., 2022), while possible government incentives are neglected given their relatively small share in the value of this production (Radović et al., 2023). The need for human labor is covered by the work of farm members, i.e. there is no need to hire seasonal workers, even during the harvest period, as the total yield of organic tomatoes is relatively low. At the same time, the tomato harvest extends over a period of four to six weeks, which allows for a more even distribution of labor compared to other productions (Santos Neto et al., 2017, Vanitha et al., 2018). Machine requirements are minimal for the defined models.

When preparing the analytical calculations, the total costs were divided into two basic groups: production costs and marketing costs. Production costs are divided into five groups: costs of materials (which include all materials used in production, the cost of technical maintenance of fixed assets and the cost of soil and leaf analyzes performed), labor costs (man and machine), amortization, and interest (on the total initial invested funds and variable production costs) and non-material costs and common costs. The last group includes, in addition to the common costs attributed to organic tomato production, the costs of production certification, inspection, yield insurance, land lease and various administrative costs. Marketing costs include all costs incurred after production, such as packaging materials and human and machine labor for various operations. The calculations refer to a production cycle. Some similar works in the past have overestimated the financial result by not considering parts or whole groups of fixed costs, especially amortization (Zárate et al., 2009, Assi et al., 2010, Nastić et al., 2020). In the existing literature, there are also examples of the same type of research considering total costs, where fixed costs have been presented and analyzed as a single general group (Demirtaş et al., 2016, Oruç and Gozener, 2020) or in a detailed way with multiple groups (Engyndenyz & Tuzel, 2002, Santos Neto et al., 2017, Vanitha et al., 2018, Dorogi and Apáti, 2019, Souza e Souza, et al., 2023), which is the approach adopted in this paper.

When compiling the analytical calculations, most of the results and costs in production were calculated as an average of the values recorded in the individual farms for the two production systems. This approach was applied to material and labor costs, a portion of interest costs (on variable costs), a portion of intangible and other production costs and marketing costs. For the other costs, as they are largely fixed, only the data from five farms (two for outdoor production and three for greenhouse production) were used, which grow tomatoes on an area similar to the 100 m2 assumed in the models created. This is the amortization (and valuation of the initial investment) of the greenhouse and the irrigation system, the interest on investments in the acquisition of fixed assets and the land rent, administrative and common costs. It is also pointed out that almost all of the farms that took part in the survey do not specialize in growing tomatoes, but also grow other vegetables and crops or raise livestock.

The basic additional cost groups generated by production in a protected area are the cost of greenhouse amortization and the cost of materials used and consumed in a given production cycle (e.g. sticky traps). In addition, different conditions lead to differences in the amount of material used. The above explanations provide an overview of the basic general differences between the individual cost groups resulting from the different production conditions assumed by the models (*Table 1.*).

Table 1. Organic tomato production models and the main causes of differences in costs and results between the two models

Element	Model 1	Model 2
Irrigation system	**YES**	**YES**
Greenhouse	**NO**	**YES**
Causes of differences in costs and results	A somewhat larger volume of material input, given the outdoor production (Duhan, 2016)	Increasing the quantity and quality of yields through production in a protected area
	Higher demand for human labor in outdoor production	Additional costs for the amortization of the greenhouse
	Higher demands on the use of machinery in outdoor production	Higher interest costs for the funds invested in the purchase and construction of the greenhouse as well as interest on a larger proportion of the variable costs
	Higher fixed costs, as it is possible to organize only one production per year on the same plot of land	Higher costs for insurance, packaging and human labor due to a higher yield

Source: The authors' own systematization based on Wehinger T., 2011.

In the subsequent evaluation of the results from the analytical calculations, the costs were divided into variable and fixed costs according to their change depending on the production volume. The variable costs include the costs for all materials and labor (machinery and human labor) as well as the costs for certification, inspection, insurance and marketing, as they are predominantly variable. The rest are fixed costs. Production in a protected area enables the organization of at least two productions per year (Vanitha et al., 2018). Therefore, this analysis assumes the possibility of realizing two productions in a protected area per year, which means that half of the annual fixed costs in the case of model 2 are attributed to the analytical calculation for one production cycle.

By analyzing the cost differences presented, the economic efficiency of different production conditions are finally compared. The initial investment for the purchase and installation of the greenhouse and the irrigation system are calculated and presented separately in order to estimate the annual amortization costs that will be included in the production costs of both models.

Organic production requires a lower sowing density compared to conventional production, primarily to prevent the development and spread of diseases (Lopez-Marin et al., 2019). This results in a lower tomato yield, but at the same time creates additional space for sowing intercrops. In this paper, following the approach of Santos Neto et al., it is assumed that sowing coriander is a suitable intercrop for organic tomatoes that increases income and improves the sustainability of this production (Miles and Peet, 2000, Santos Neto et al., 2017). In the case of open field production, a tomato yield of 3.2 kg per m^2 (total 320 kg) is assumed, i.e. 4.4 kg/m^2 (total 440 kg) for the greenhouse production model. It is estimated that yields in organic tomato production are 60% to 75% lower compared to conventional production (Tüzel, 2001, Engyndenyz & Tuzel, 2002, Abebe et al., 2022). When calculating the production value, the total yield of the main product is divided into two quality classes with different market prices (€2.55/kg and €1.49/kg). For outdoor production, the class structure is 60:40 in favor of the first class. With the construction of the greenhouse, in addition to a higher yield of organic tomatoes, an improvement in the quality structure in favor of the first class of 70:30 was assumed. The yield of coriander is 0.95 kg/m^2 (model 1) and 1.25 kg/m^2 (model 2) at a market price of €0.8/kg.

Organic tomato cultivation is also characterized by significant post-harvest losses (Abebe et al., 2022). This refers primarily to the impact of pests, but also to the portion of production that is returned to growers due to insufficient quality before it reaches the market. Most authors have not considered yield reduction on this basis. Abebe et al. estimate that these losses reach up to 25% of the production value (Abebe et al., 2022). In this paper, a 10% yield reduction in organic tomatoes is assumed, while the impact of different levels of loss on the result is subsequently investigated through a sensitivity analysis.

Based on the data from the calculations made, the following indicators were further calculated:

$$\text{Gross margin} = \text{Production value} - \text{Variable costs} \tag{1}$$

$$\text{Net result} = \text{Gross margin} - \text{Fixed costs} \tag{2}$$

$$\text{Return per euro of expenditure} = \frac{\text{Production value}}{\text{Variable costs} + \text{Fixed costs}} \tag{3}$$

$$\text{Natural productivity of work} = \frac{\text{Yield}}{\text{Human labor}} \tag{4}$$

$$\text{Valued productivity of work} = \frac{\text{Net result}}{\text{Human labor}} \tag{5}$$

The gross margin and net profit are first used to examine the economic justification of production under the given conditions, while the return per unit of expenditure and the productivity indicators are used to compare the models. The return per euro of expenditure reduces different production results and costs to a comparable basis (Vanitha et al., 2018, Pavlović et al., 2010). The inclusion of labor productivity indicators was subsequently influenced by the initial research findings after a significant share of human labor costs was identified.

The differentiation of certain cost groups with a significant share finally made it necessary to carry out a sensitivity analysis of the financial results of both models. In contrast to previous studies (Engyndenyz & Tuzel, 2002, Dorogi and Apáti, 2019, Nastić et al., 2020, Abebe et al., 2022), this part examined not only the effect of the change in the yield and price of organic tomatoes on the financial result, but also how the result changes depending on the increase or decrease of the most represented cost groups, as well as in the case of a decrease in production value due to post-harvest losses. In this way, insight was gained into the stability of financial results in relation to changes in the main economic conditions, that are determined by internal (yield, material consumption, labor or protection against diseases) and external influences (prices of products, materials, labor, etc.).

Results and Discussion

The initial investment for the purchase and installation of the greenhouse and the irrigation system for the assumed area of 100 m^2 are shown in *Table 2*. When calculating the annual amortization costs, different lifetimes were assumed for the individual parts of the greenhouse and the drip irrigation system. In other words, the elements of the greenhouse and the irrigation system as well as the transportation and installation services were considered as separate assets with their own planned useful lives. The initial investment value for the purchase and construction of the greenhouse and irrigation system was calculated at €2,379 and €671 respectively. More than two-thirds of the initial investment value of the greenhouse is the cost of purchasing the basic structure, while in the case of the irrigation system; one-third of the investment is the price of the water pump. The transportation and installation costs accounted for a significant share of 24.5% in the case of the greenhouse and 30.7% in the case of the irrigation system. By dividing the initial investment by the assumed useful life of the individual elements, the total annual amortization costs of the greenhouse and the irrigation system were calculated at €181.0 and €44.5 respectively.

Table 2. Initial investment funds for the construction and installation of the greenhouse and irrigation system with amortization calculation (area of 100 m^2)

Element	Initial investment funds		Amortization	
	Value (€)	%	N (years)	Value (€)
Greenhouse				
Frame and kit	868	36.5	25	34.7
Basic locking rail	737	31.0	25	29.5
Foil - Polyethylene (covering material) and ground cover	152	6.4	2	76.0
Roof sprinkler	38	1.6	20	1.9
Transportation and installation	583	24.5	15	38.9
Total (greenhouse)	**2,378**	**100.0**	**1**	**181.0**
Irrigation system				
Main pipe	36	7.8	15	2.4

Element	Initial investment funds		Amortization	
	Value (€)	%	N (years)	Value (€)
Water pump	158	34.5	10	15.8
Filters	45	9.7	8	5.6
Tank for pressure regulation	38	8.4	15	2.6
Other elements of the system	41	9.0	10	4.1
Transportation and installation	141	30.7	10	14.1
Total (irrigation system)	**459**	**100.0**	**1**	**44.5**

Source: Calculation by the authors. Systematization of costs based of Bodiroga et al., 2018.

In view of the fact that the entire area is irrigated, the amortization of the irrigation system was included in the cost structure of both models 1 and 2. Half of the annual amortization amount was attributed to the calculation of production in the protected area (model 2), based on two productions during the year. The direct fixed assets in this production also include the tomato sticks that are used during several cycles and whose amortization costs were indicated in the analytical calculation (*Table 3.*).

The value of organic tomato cultivation increased by the value of intercrops and reduced by the assumed losses of 10% amounted to €689/100 m^2 and €985/100 m^2 for models 1 and 2 respectively. It should be noted that the losses in both models were offset by the value of the coriander.

Table 3. Production value and cost calculation of organic tomato production in the open field (model 1) and in the greenhouse (model 2)

Model		Model 1	Model 2
Irrigation system		**YES**	**YES**
Greenhouse		**NO**	**YES**
Yield per 100 m² (kg)	**Organic tomato**	**320.0**	**440.0**
	Coriander	**95.0**	**125.0**
Value of production			
I) Organic tomato	I class of product (price: €2.55/kg)	490	786
	II class of product (price: €1.49/kg)	191	197
	Post-harvest losses (10% of I and II class)	68	98
II) Coriander (price: €0.8/kg)		76	100
A. Total value of production (I+II)		**689**	**985**

Type of costs	€ per 100 m²		Share in total costs (%)	
	Model 1	**Model 2**	**Model 1**	**Model 2**
Costs of production				
a) Costs of materials	*173*	*237*	*27.4*	*33.3*
1) seedlings	29	26	4.6	3.7
2) crop protection	27	24	4.3	3.4
3) fertilizers	54	62	8.6	8.7
4) electricity	2	2	0.3	0.3
5) bumblebees	37	19	5.9	2.7

Model	Model 1		Model 2	
6) technical maintenance (greenhouse and irrigation system)	13	61	2.1	8.6
7) soil and leaf analysis	6	7	1.0	1.0
8) other material costs (threads, sticky traps and irrigation pipes)	5	36	0.8	5.1
b) Labor costs	*174*	*114*	*27.6*	*16.0*
1) human labor	167	109	26.5	15.3
2) machinery labor	7	5	1.1	0,7
c) Amortization	*58*	*121*	*9.2*	*17.0*
1) greenhouse	0	91	-	12.8
2) irrigation system	45	23	7.1	3.2
3) sticks	13	7	2.1	1.0
Type of costs	**€ per 100 m²**		**Share in total costs (%)**	
	Model 1	**Model 2**	**Model 1**	**Model 2**
d) Interest	*25*	*34*	*4.0*	*4.8*
1) interest on total initial investment funds	14	31	2.2	4.4
2) interest on total variable costs	11	3	1.8	0.4
e) Non-material costs and common costs	*96*	*93*	*15.2*	*13.1*
1) certification	29	27	4.6	3.8
2) inspection	9	8	1.4	1.1
3) insurance	21	34	3.3	4.8
4) land rent	15	12	2.4	1.7
5) administrative costs	9	4	1.4	0.6
6) common costs	13	8	2.1	1.1
B. Total costs of production (a+b+c+d+e)	**526**	**597**	**83.4**	**83.8**
Marketing costs				
Type of costs	**€ per 100 m²**		**Share in total costs (%)**	
	Model 1	**Model 2**	**Model 1**	**Model 2**
a) Packaging and nylon	61	80	9.7	11.2
b) Human labor	23	16	3.6	2.2
c) Machinery labor	21	19	3.3	2.7
C. Total marketing costs (a+b+c)	**105**	**115**	**16.6**	**16.2**
D. Total costs (B.+C.)	**631**	**712**	**100.0**	**100.0**
Average price of organic tomato (€/kg)[5]	2.13	2.23	/	/
Break-even average price of organic tomato (€/kg)[6]	**1.73**	**1.99**	/	/
Break-even yield of organic tomato (kg/100 m²)[7]	**261**	**274**	/	/

Source: Authors' calculation.

5 (Production value + Post-harvest losses - Value of coriander)/Total yield of organic tomato

6 The calculation of the break-even average price and yield for organic tomatoes requires the assumption of the share of total costs for organic tomato production (excluding the production costs for the intercrop). In our calculation, we assume that the value and costs of coriander production are approximately the same, i.e. the share of the costs of organic tomato production can be calculated by subtracting the total production costs and the value of coriander. Therefore, the average break-even price is calculated as follows: (Total costs – Value of coriander)/Yield of organic tomato

7 (Total costs –Value of coriander)/Average price of organic tomato

Material costs include organic tomato seeds, special certified organic pesticides and fertilizers, the consumption of which were approximately the same in both models. The use of organic fertilizers contributes significantly to improving the fertility and other properties of the soil, and unlike mineral fertilizers, they have a long-lasting effect, i.e. they increase the yield and quality of the cultivated plants several years after fertilization (Ferguson et al., 2005, Bogdanović et al., 2014). In model 2, the costs for technical maintenance were higher, as the maintenance of the greenhouse is included in addition to the irrigation system, while bumblebees are less effective in the open field, which lead to higher costs in the case of model 1. The share of costs of materials in the total costs was 27.4% in the open field and 33.3% in the protected cultivation of tomatoes.

The open field production system had a higher demand for human labor. The share of these costs in model 1 was more than a quarter of the total costs, while the share in model 2 was slightly more than 15%. The possibility of spreading the fixed costs over two production processes per year in the case of production in a protected area significantly reduced the production costs in model 2. A realization of three cycles a year, as noted by Vanitha et al., would further reduce the burden of fixed costs, but would also incur additional costs for preventive protection under conditions of repeated production on the same area, which justifies a separate analysis (Vanitha et al., 2018). Overall, amortization and interest costs increased by around €70/100 m^2 in case of production in protected area, which is mainly due to the construction and use of the greenhouse. The share of other production costs was around 15% for model 1 and 13% for model 2 and included the costs of organic certification and inspection, which vary widely and depend on numerous factors (Santos Neto et al., 2017, Abebe et al., 2022), insurance costs, that were higher in the protected area given the higher yield of organic tomatoes, land rent, and the administrative and general costs of the farm attributed to this production. The total costs of organic tomato production in the open field was estimated at €526 (€5.26/m^2), while the costs of production in the protected area was €597 (€5.97/m^2), accounting for more than 83% of the total costs, with the remainder being marketing costs. If the total costs are deducted from the production value, the financial result is €58/100 m^2 and €258/100 m^2 for model 1 and model 2 respectively (*Table 4*.). The return per euro of expenditure was also significantly higher in model 2, as €1.38 of production value was achieved for €1 of total costs, compared to €1.09 in the case of open field production.

Table 4. Indicators for organic tomato cultivation in the open field (model 1) and in the greenhouse (model 2)

Indicator	Model 1			Model 2		
	Value (€)	Value per 100 m^2	Share (%)	Value (€)	Value per 100 m^2	Share (%)
I) Production value	**689**	**6.89**	**100.0**	**985**	**9.85**	**100**
1) Variable costs	511	5.11	74.2	535	5.35	54.3
II) Gross margin (I-1)	**178**	**1.78**	**25.8**	**450**	**4.50**	**45.7**
2) Fixed costs	120	1.20	17.4	177	1.77	18.0
III) Net result (II-2)	**58**	**0.58**	**8.4**	**273**	**2.73**	**27.7**

Indicator	Model 1			Model 2		
	Value (€)	Value per 100 m^2	Share (%)	Value (€)	Value per 100 m^2	Share (%)
a) Return per euro of expenditure	**1.09**			**1.38**		
b) Natural productivity of work	**6.50**			**13.70**		
c) Valued productivity of work	**1.18**			**8.50**		

Source: Authors' calculation.

The differences in terms of labor input between the two models of organic farming could be seen by comparing the values of the productivity indicators. A higher yield and a lower labor input led to a twice as high value of the natural productivity indicator in the case of production in protected areas (13.70 versus 6.50). If the yield of organic tomatoes was replaced by the net profit, the value of the indicator in model 2 was more than seven times higher than in model 1 (values of 8.50 and 1.18 respectively).

It is obvious that the result of the open field production model was sensitive to the change in tomato yield and price (*Table 5.*). Under the given conditions, the model was almost unprofitable. A 10% decrease in yield or price would already result in the production value being lower than the total costs.

Table 5. Sensivity analysis – Model 1 (open field cultivation)

Element		Model 1				
		Yield (320 kg/100 m^2)				
		-20%	-10%	0%	10%	20%
Average price (€2.13/kg)	-20%	-162	-113	-64	-15	34
	-10%	-113	-58	-3	52	108
	0%	-64	-3	58	120	181
	10%	-15	52	120	187	255
	20%	34	108	181	255	328
Element		Amortization (€58)				
		-20%	-10%	0%	10%	20%
Costs of materials (€173)	-20%	104	98	93	87	81
	-10%	87	81	75	70	64
	0%	70	64	58	52	46
	10%	52	47	41	35	29
	20%	35	29	23	18	12
Element		Post-harvest losses (% of organic tomato production value)[8]				
		0%	5%	10%	15%	20%
Costs of human labor (€167)	-20%	159	127	95	62	30
	-10%	143	109	76	43	10
	0%	126	92	58	24	-10
	10%	109	74	40	5	-30
	20%	93	57	21	-15	-50

Source: Authors' calculation.

8 Initially assumed 10%.

The sensitivity analysis carried out also showed a high dependency of the open field model on changes in costs of materials. The change in labor costs also significantly determined the financial result, which is important considering that the production models assume that seasonal workers are not represented, whose wages per labor unit would be proportionally higher compared to the wages of farm members. This represents a restriction on the conditions for carrying out production on a larger area or, more generally, for hiring additional labor. If the loss of value in the production of organic tomatoes were to increase to 20% compared to the originally assumed 10%, model 1 would have been unprofitable. It was also found that the profitability of the production model in a protected area was sensitive to the change in yield and average price of organic tomatoes, although the risk was lower on this basis, considering that production would have been only unprofitable if the price and yield decreased by 10% and 20% (*Table 6*.). Compared to model 1, model 2 was less dependent on the change of costs of materials. The financial result achieved was also not overly influenced by the level of amortization costs, although the value of the greenhouse was also being amortized. Under the given conditions, the production model in protected area was almost free from the risk of changing labor costs, which creates an opportunity for possible additional hiring.

Table 6. Sensivity analysis – Model 2 (cultivation in a protected area)

Element		**Model 2**				
		Yield (440 kg/100 m²)				
		-20%	**-10%**	**0%**	**10%**	**20%**
Average price (€2.23/kg)	**-20%**	-83	-4	74	153	232
	-10%	-4	84	174	261	350
	0%	74	174	273	369	468
	10%	153	261	369	477	586
	20%	232	350	468	586	704
Element		**Amortization (€121)**				
		-20%	**-10%**	**0%**	**10%**	**20%**
Costs of materials (€237)	**-20%**	345	333	320	308	296
	-10%	321	309	297	285	273
	0%	297	285	273	261	249
	10%	274	261	249	237	225
	20%	250	238	226	214	201
Element		**Post-harvest losses (% of organic tomato production value)**[9]				
		0%	**5%**	**10%**	**15%**	**20%**
Costs of human labor (€109)	**-20%**	393	344	295	245	196
	-10%	382	333	284	234	185
	0%	371	322	273	224	174
	10%	360	311	262	213	164
	20%	349	300	251	202	153

Source: Authors' calculation.

9 Initially assumed 10%.

Finally, model 2 was more resilient to the growth of value loss in organic tomato production. With unchanged conditions and a 20% loss in the value of organic tomatoes, a profit of €153/100 m^2 would still have been achieved.

The considered change of price of organic tomatoes is decisively determined by the marketing channel. This was particularly considered by Abebe et al. who found that by shortening the chain of marketing intermediaries, three to four times the price of organic tomatoes can be obtained when considering direct sales and the most common way of selling organic tomatoes, namely selling to an intermediary who assumes all (or part of) the post-harvest risks and seeks a buyer to sell the tomatoes to the final customer (Abebe et al., 2022).

Obviously, in addition to assuming the aforementioned risks, the direct sale of products also generates new costs, such as market entry costs, advertising measures and others. With this in mind, subsequent studies should first define any additional costs incurred by the chosen marketing channels and then examine the profitability at different prices for organic tomatoes resulting from the chosen realization model.

Conclusions

The production of organic tomatoes is profitable under the conditions of the analyzed farms in Vojvodina in case of both production systems. Organic tomato production in a protected area achieves more favorable economic results overall than open field cultivation. In addition to a higher financial result (€273/100 m^2 compared to €58/100 m^2 in the case of outdoor production), the model was less sensitive to the change in the main cost groups and to the increase in subsequent yield losses. The profitability of the production model in a protected area is directly determined by the possibility of realizing two productions per year. Otherwise, all fixed costs would be attributed to one production cycle, as is the case with open field the open field model. Production in a protected area still does not eliminate the price and yield risks and some of the production risks that can significantly determine the results in this production.

However, it is undeniable that growing in a protected area, apart from the significant investment for the construction and installation of a greenhouse, estimated at €2,378 for a 100 m^2 production area, increases and to a certain extent stabilizes the yield of organic tomatoes, and that intercropping improves the sustainability of this production. It should also be pointed out that the yields observed in both cases were obtained under conditions of irrigation of the entire plot area.

Acknowledgements

This paper is a research result within the "Treaty on the transfer of funds for financing the scientific research work of teaching staff at accredited higher education institutions in 2024 between the Ministry of Science, technological development and innovation of the Republic of Serbia and the Faculty of Agriculture, University of Belgrade" No. 451-03-65/2024-03/200116.

Conflict of interests

The authors declare no conflict of interest.

References

1. Abebe, G. K., Traboulsi, A., & Aoun, M. (2022). Performance of organic farming in developing countries: a case of organic tomato value chain in Lebanon. *Renewable Agriculture and Food Systems*, *37*(3), 217-226. doi:10.1017/S1742170521000478
2. Assi, L., Stangarlin, J. R., & Portz, R. L. (2010). Disease control in strawberry plants in different cropping systems: a study on sustainability. Sci. Agrar. Parana, 9, 58-67.
3. Bodiroga, R., Sredojević, Z., & Subić, J. (2018). Economic efficiency of investment in greenhouse vegetable production without heating. *Economics of Agriculture*, *65*(4), 1383-1393. doi:10.5937/ekoPolj1804383B
4. Bogdanović, D., Ilin, Ž., Čabilovski, R., Marijanušić, K., & Adamović, B. (2014). Effect of direct and residual fertilization with organic and mineral fertilizers on tomato yield. *Annaly of Agronomy, 38*(1), 59-68. doi:10.5937/lnrpfns1401059B
5. Demirtaş, B., Dağistan, E., & Subaşi, O. S. (2016). A comparison of profitability and cost analyses of tomato cropping systems in greenhouses. *Custos e Agronegocio 12*(1), 139-152.
6. Dorogi, D. A., & Apáti, F. (2019). Economic analysis of forced tomato production with regard to the intensity of production. *International Journal of Horticultural Science*, *25*(1-2), 15-21. doi:10.31421/IJHS/25/1-2./2911
7. Duhan, P. K. (2016). Cost-benefit analysis of tomato production in protected and open farm. *International Journal of Advanced Research in Management and Social Sciences*, *5*(12), 140-148.
8. Engyndenyz, S., & Tuzel, Y. (2002). The economic analysis of organic green house tomato production: A case study for Turkey. *Agro Food Industry Hi-Tech*, *13*(5), 26-30.
9. Ferguson, R. B., Nienaber, J. A., Eigenberg, R. A., & Woodbury, B. L. (2005). Long-term effects of sustained beef feedlot manure application on soil nutrients, corn silage yield, and nutrient uptake. *Journal of Environmental Quality, 34*(5), 1672-1681. doi:10.2134/jeq2004.0363
10. Gül, M., Topçu, F., Kadakoğlu, B., & Şirikçi, B. S. (2021). Cost and profitability analysis of tomato production in the greenhouse in highland conditions: a case study of Burdur Province, Turkey. *Custos e Agronegocio, 17*(3), 160-175.
11. Lopez-Marin, J., Rodriguez, M., Amor, F. D., Galvez, A., & Brotons-Martinez, J. M. (2019). Cost-benefit analysis of tomato crops under different greenhouse covers. *Journal of Agriculture, Science and Technology, 21*(2), 235-248.
12. Luz, J. M. Q., Shinzato, A. V., & Silva, M. D. (2007). Comparison of conventional and organic tomato growing under protected cultivation. *Acta Alimentaria, 41*(4), 486-493. doi:10.1556/AAlim.41.2012.4.10

13. Miles, J.A. and M. Peet. (2000). *Organic Greenhouse Vegetable Production*. North Carolina State University, Department of Horticultural Science, Raleigh.
14. Mohammed, I. A., & Al Dulaimi, M. A. K. (2021). An Economic analysis of the costs of producing tomato under greenhouse in Anbar Governorate for the agricultural season 2019-2020, *3rd Scientific and 1st International Conference of Desert Studies-2021 (ICDS-2021),* Anbar, Iraq. *IOP Conference Series: Earth and Environmental Science*, 904(1). doi:10.1088/1755-1315/904/1/012061
15. Nastić, L., Jeločnik, M., & Subić, J. (2020). Analiza varijabilnih troškova u proizvodnji paradajza u zaštićenom prostoru. *Agroekonomika, 49*(86), 43-53. [*in English:* Nastić, L., Jeločnik, M., & Subić, J. (2020). Analysis of variable costs in the production of tomatoes in a protected area. *Agroekonomika, 49*(86), 43-53.].
16. Nian, Y., Zhao, R., Tian, S., Zhao, X., & Gao, Z. (2022). Economic analysis of grafted organic tomato production in high tunnels. *HortTechnology*, *32*(5), 459-470. doi:10.21273/HORTTECH05101-22
17. Oruç, E., & Gozener, B. (2020). Economic analysis of tomato cultivation in plastic greenhouses of Antalya Province in Turkey. *Custos E Agronegocio OnLine, 16*(3).
18. Pavlović, N., Ugrinović, M., & Zdravković, M. (2010). Economic and agronomic analysis of organic production of tomato and pepper. *Economics of Agriculture*, *57*(Spec. No. 2), 153-157. doi:10.5937/ekoPolj1404895P
19. Radović, G., Zejak, D., & Pejanović, V. (2023). Agricultural budget in the function of organic agriculture development in Serbia and Montenegro. *Economics of Agriculture*, *70*(2), 645-659. doi:10.59267/ekoPolj2302645R
20. Santos Neto, J. D., Schwann-Estrada, K. R. F., Sena, J. O. A. D., & Telles, T. S. (2017). Economic viability of tomato cultivation in organic farming system. *Brazilian Archives of Biology and Technology*, *60*, e17161229. doi: 10.1590/1678-4324-2017161229
21. Souza e Souza, L. G. D., Ferreira, R. L. F., Araújo Neto, S. E. D., Uchôa, T. L., Silva, N. M. D., & Francisco, W. D. M. (2023). Profitability of organic carrot cultivation under weed interference and sowing methods. *Pesquisa Agropecuária Tropical*, *53*, e74735. doi: 10.1590/1983-40632023v5374735
22. Sredojević, Z. (2014). Analiza lanca vrednosti organskih proizvoda specifičnih za regione u Srbiji. Assistance to the Development of Capacity and Support Services for Organic Agriculture in Serbia. GCP/SRB/001/HUN. *Food and Agriculture Organization of the United Nations Project.* [*in English:* Sredojević, Z. (2014). Analysis of the value chain of organic products specific to regions in Serbia. Assistance to the Development of Capacity and Support Services for Organic Agriculture in Serbia. GCP/SRB/001/HUN. *Food and Agriculture Organization of the United Nations Project*.].
23. Tüzel, Y. (2001). Organic Vegetable Growing in the Greenhouses. Regional WG Greenhouse Crop Production in the Mediterranean Region, Newsletter No: 8, 7-17. doi:10.12691/ajams-5-4-4

24. Vanitha, S. M., Reddy, B. C., & Gajanana, T. M. (2018). Economic analysis of profitability in tomato production at different seasons and market prices: a study in Kolar district of Karnataka. *International Journal of Agriculture Sciences, 10*(16), 6961-6966.

25. Wehinger T. (2011). Ekonomija organske poljoprivrede u: Priručnik za organsku proizvodnju – za osoblje savjetodavne službe. (ed. Mirecki N., Wehinger T., Repič R.) Podgorica, Biotehnički fakultet. [*in English:* Wehinger T. (2011). The economics of organic farming in: Handbook for organic production - for extension staff. (ed. Mirecki N., Wehinger T., Repič R.) Podgorica, Biotechnical faculty.].

26. Zárate, N. A. H., Vieira, M. D. C., de Sousa, T. M., & Ramos, D. D. (2009). Yield and net income of unripe corn in function of the hilling dates. *Semina: Ciencias Agrárias (Londrina)*, *30*(1), 95-100.

UNLOCKING POTENTIAL: GEOGRAPHICAL BRANDING AS A POSSIBLE FACTOR OF REVITALIZATION OF SERBIAN VILLAGES – A CASE STUDY OF THE VISOK MICROREGION

Aleksandar R. Radivojević[1], Rastko Marković[2], Ksenija Marković[3], Ana Langović [4], Miloš Marjanović [5], Filip Stojilković [6], Ivan Filipovic [7], Tin Lukić [8]

**Corresponding author E-mail: rastko.markovic@pmf.edu.rs*

ARTICLE INFO

Original Article

Received: *16 April 2024*

Accepted: *24 May 2024*

doi:10.59267/ekoPolj2402551R

UDC 659.11:711.3 (497.11 Visok)

ABSTRACT

The objective of this paper is to emphasize, branding as one of the possible ways to take concrete steps towards reaffirming the local values and traditional knowledge of rural populations in Serbia. Based on information gathered in the field, as well as from existing literature sources, the main goal of this study is to promote products from the Visok microregion.

1 Aleksandar R. Radivojević, Full professor, Department for Geography, Faculty of Sciences, University of Niš, Višegradska 33, 18000 Niš, Serbia, Phone: +381 63 8159096, E-mail: aleksandar.radivojevic@pmf.edu.rs, ORCID ID (https://orcid.org/0000-0002-8176-5165)

2 Rastko Marković, Teaching assistant, Department for Geography, Faculty of Sciences, University of Niš, Višegradska 33, 18000 Niš, Serbia, Phone: +381 60 5509997, E-mail: rastko.markovic@pmf.edu.rs, ORCID ID (https://orcid.org/0000-0002-6357-9481)

3 Ksenija Markovič, Research associate, Center for Political Research and Public Opinion, Institute of Social Sciences, Kraljice Natalije 45, 11000 Belgrade, Serbia, Phone: +381 64 3250617, E-mail: kmarkovic@idn.org.rs, ORCID ID (https://orcid.org/0000-0002-3785-7169)

4 Ana Lanogovic, Full professor, Faculty of Geography, University of Belgrade, 10 Studentski Trg 3/III, 11000, Belgrade, Serbia, Phone: +381648134010, E-mail: analangovicmilicevic@gmail.com, ORCID ID (https://orcid.org/0000-0003-3610-1332)

5 Miloš Marjanović, PhD, Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia, Phone: +38162878001, E-mail: milosm2305@gmail.com, https://orcid.org/0000-0003-0412-6615;

6 Filip Stoiljković, MSc, Department for Geography, Faculty of Sciences, University of Niš, Višegradska 33, 18000 Niš, Serbia, Phone: +38163325819, stolkovicfilip@gmail.com;

7 Ivan Filipović, Full professor, Department for Geography, Faculty of Sciences, University of Niš, Višegradska 33, 18000 Niš, Serbia, Phone: +381641194947, E-mail: roza@ptt.rs, ORCID ID (https://orcid.org/0000-0002-6973-6142)

8 Tin Lukić, Associate professor, Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia, Phone: +381600540499, E-mail: tin.lukic@dgt.uns.ac.rs, ORCID ID (https://orcid.org/0000-0001-5398-0928)

Keywords:

The Republic of Serbia, Visok, Stara Planina Mountain, Branding

JEL*: D10*

Due to very alarming demographic data, this may be the last chance for revitalizing this region. In this study, we highlighted the following products: Pirot kilim (Pirot rug), Pirot/Stara Planina lamb, Pirot Kachkaval cheese, Stara Planina honey, and Stara Planina potato. Besides agriculture, micr oregion Visok also has exceptional tourist potential. The conclusion of this paper emphasizes that the only viable path to revitalization is through planned investment. Such investment would facilitate the development of local infrastructure and help restore the population, thus enabling the creation of sustainable development.

Introduction

The results from the 2022 Census of the Republic of Serbia reveal that Serbia is faced with an alarming demographic inventory (Cenus, 2022). It has brought to light a plethora of crucial social indicators, encompassing data on population growth, birth rate, age structure, and more. However, the most significant changes are notably observed in rural areas. Rural settlements in the Republic of Serbia are profoundly impacted by depopulation, deagrarization, and devitalization. Over the years, these trends have resulted in substantial population aging across rural areas on a broad social scale, especially in Eastern Serbia. (Krstić, 2007). The very fact that at the end of the first decade of the 21st century, Serbia had a record of 1,961 villages with zero population, i.e. of every fourth village (out of the total of 4,800) in a die-off phase, speaks for itself about the seriousness and stunningness of the current trends (Census, 2011; 2022). The reasons for such a situation are multi-dimensional and cannot possibly be fully reviewed in a paper of this scope. However, the most significant factors include the typical dispersion of Serbian rural areas, characterized by a high number of miniature villages and hamlets, as well as the general economic situation in the country, which leads to a high outflow of population, predominantly young and highly educated and highly skilled individuals, to urban centers and foreign countries. The main reason for this migration is the search for chances for further education, better job offers, working and life conditions, economic underdevelopment of rural areas, lack of quality traffic and communal infrastructure, low level of mechanization, lack of prospects regarding the intensification of agriculture, etc. (Rašević, 2017; Milić, 2017; Lukić, 2021).

Serbia's pollution is driven by fossil fuels and inefficient agricultural practices, including heavy fertilizer use. To leverage its agricultural strengths and promote rural development, a targeted green transformation is necessary. (Vukelić et al., 2023). However, agriculture remains the predominant economic activity in rural areas (Pejanović et al., 2017). In the pursuit of effective solutions, it is imperative to adopt a paradigm of creative reinterpretation of the essence and role of rural communities, grounded in a holistic, synergistic approach aligned with the dynamics of the contemporary global society in the 21st century. Concurrently, it is essential to uphold the foundational principles traditionally underpinning the social fabric of agrarian societies and serve as the cornerstone of cultural identity for rural residents. These principles encompass family-based agriculture, land cultivation, animal husbandry, and the preservation of distinctive traditional practices. Rather than undermining these elements, they should be leveraged as inherent strengths in redefining the socioeconomic status of rural communities and reducing their historical reliance on urban centers of influence.

The importance of branding in agricultural domestic products cannot be overstated, particularly in today's competitive market environment. Effective branding serves as a powerful tool for enhancing the visibility, credibility, and marketability of agricultural products originating from domestic sources. Firstly, branding provides a means of differentiation in a crowded marketplace. With an abundance of similar products available, a well-crafted brand identity sets domestic agricultural products apart, enabling consumers to recognize and distinguish them from competitors. This differentiation fosters brand loyalty and encourages repeat purchases. Secondly, branding facilitates trust and confidence among consumers. A strong brand conveys reliability, quality, and consistency, reassuring consumers about the origin and standards of the agricultural products they purchase. By associating positive attributes with domestic agricultural products, branding builds trust and fosters a positive reputation in the market. Furthermore, effective branding enables agricultural producers to command premium prices for their products. A well-established brand communicates value and justifies higher price points, allowing producers to capture greater margins and enhance profitability. Consumers are often willing to pay a premium for products with a recognized brand that aligns with their preferences and values (Pay et al., 1996; Butova et al., 2019).

It's worth mentioning that the territorial brand, alongside its geographic positioning defining natural and climatic conditions, significantly influences the success of product brands (Butova et al., 2019). Moreover, branding plays a crucial role in opening new market opportunities and expanding market reach. A recognizable brand facilitates market entry by creating awareness and generating interest among consumers. It also enables agricultural producers to access niche markets and cater to specific consumer segments with unique preferences or dietary requirements. In addition, geographical branding contributes to the overall development and sustainability of rural economies. By establishing strong brands for domestic agricultural products, rural communities can capitalize on their natural resources and cultural heritage, creating economic opportunities and preserving local traditions. Branding initiatives can also attract investment, tourism, and support for rural development initiatives. Overall, branding is essential for enhancing the competitiveness, profitability, and sustainability of agricultural domestic products. By investing in branding efforts, agricultural producers can unlock the full potential of their products, differentiate themselves in the market, and build lasting relationships with consumers (Murphy, 1988; McDowell, 2006).

In this study, we present the main agricultural brands in Serbia. The main focus will be on the development of agriculture in the Visok microregion and the heritage of livestock breeding on Stara Planina Mountain.

Materials and methods

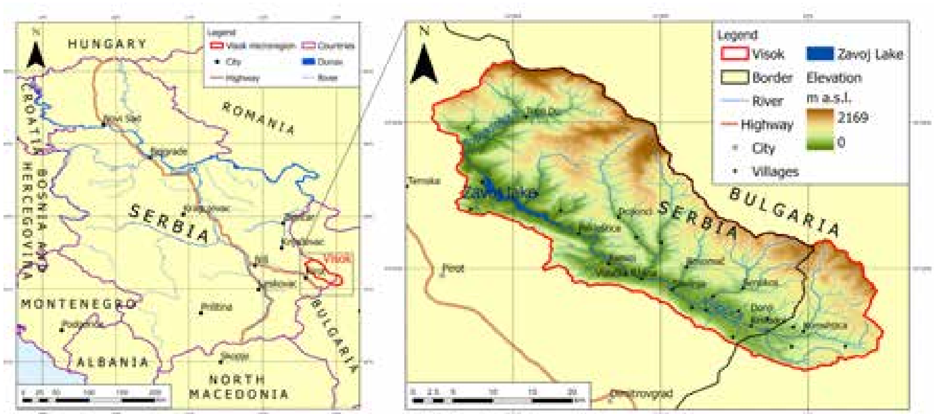
Demographic data was obtained from Censuses from 1953 to 2022 and existing literature (Krstić, 2007; Velojić & Radovanović, 2017). The authors spent a significant amount of time in the field collecting information from local inhabitants between 2017 and 2024. Most of the data for the Visok microregion is part of the research process for the PhD thesis titled "Geoecological and Functional Changes in the Visok microregion." As part of this thesis, a survey was conducted to identify motives and sustainable solutions for intensive depopulation and to determine the most effective methods of revitalizing villages. While specific details about this survey will be included in forthcoming papers, the knowledge obtained in the field was utilized to provide crucial information about brands in this region.

For cartographic visualization in this study ArcGIS Pro 2.5.0. was used. We used Digital Elevation Model (DEM) data in Figure 1. with horizontal resolutions from 1 arc-second (30 m) (SRTM) to 12.5 m (ALOS PALSAR RT1) (Das et al., 2014; Marković et al., 2024).

Study area

The Visok microregion is delineated by the Visočica River basin and Toplodolska River watershed. Situated in the southeastern region of Serbia. It lies between the Stara Planina and Vidlič mountains (Vidanović, 1955). The section of the basin located in Serbia falls within the administrative jurisdictions of the municipalities of Pirot and Dimitrovgrad. Within the Visok microregion, there are a total of 26 villages, 22 of which are situated in Serbia. All of them are experiencing a significant decline in population. The population decreased from 13,914 (Census, 1953) to 504 (Census, 2022). None of these villages have a population exceeding 100 inhabitants (Census of 2022) (Marković et al., 2024). The population is in the final stage of demographic transition, and in almost all rural areas, the process of biological reproduction is at the minimum level of sustainability.

Figure 1. Geographical position of the microregion Visok



Source: The map utilized in this study was created by Rastko Marković and modified according to Marković et al, 2024

The morphology of the investigated area is predominantly represented by the Stara Planina Mountain, which has great potential and a long tradition as a livestock breeding region. The average height of the Visočica basin is ~1146.47 m a.s.l. (Marković et al, 2024). The highest point of the Visok microregion is represented with peak Midžor (2169 m a.s.l.). Interestingly, it is located approximately in the middle of the Adriatic, Aegean and Black Sea. All the big aquatic surfaces are farther than 300 km from the investigated region, which means it doesn't get as much moisture as other mountains with this elevation in the Balkans (Milovanović, 2010).

Visok, as well as the whole Stara Planina Mountain, is well known for its milk and wool products. In the past, Visok microregion had around 1.000.000 sheep (Vidanović, 1955). Unfortunately, nowadays we witness that this number is negligible. Due to the old age structure of inhabitants, depopulation, and deagrarization, all sectors of agriculture are decreasing rapidly. There is only one active farm "Bele Vode" close to Slavinja and Rosomač villages with a capacity of around 5000 sheep and goats.

In addition to its great agricultural potential, Stara Planina is also distinguished by its exceptional geoheritage (Marjanović et al., 2022a, 2022b). Every season on Stara Planina is suitable for tourists. In the spring, the biggest attraction is represented by over 60 waterfalls, fueled by melted snow and rain, offering an exceptional experience (Stojadinović. 2013; Marković, 2024). In summer, this region represents one of the few places of untouched nature in Serbian, with exceptional locations for swimming and bathing tourism, such as Zavoj lake, Ogorelica, Topilnica and others. In winter, visitors most often spend time in the "Stara Planina" ski center. While it may not be the largest ski center in Serbia, it is considered the most affordable option.

Geographical Branding – EU Experience

The World Intellectual Property Organization (WIPO) defines a geographical indication (GI) as "*a sign used on goods that have a specific geographical origin and possess qualities, reputation or characteristics that are essentially attributable to that place of origin.*"(WIPO – World Intellectual Property Organization: http://www.wipo.int/geo_indications/en/about.html) Much in the same spirit, the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) qualifies GIs as "*indications which identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin*."(Article 22(1) of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)).

Hence, „geographic labeling is motivated by the notion that there are unique characteristics implicit in a product (such as food) attributable to certain production methods and location-based attributes based on where the product is made" (Moran, 1993; Barham, 2003; Bowen & Zapata, 2009; Bowen & De Master, 2011). Thus, geographic labeling typically tries "to establish a link between the production characteristics and the characteristics of the location and/or method or production" (Verhaegen & Van

Huylenbroeck, 2001). The whole concept is based on the idea of creating products different from standardized industrial outputs by emphasizing the producer's personal touch and the "little secrets" involved in traditional ways of preparing, producing, processing or breeding in a specific geographic microenvironment, i.e. on a unique combination of natural and human factors of a particular locality.

GI products play an increasingly significant role in the world market as an effective value-creating tool, i.e. means of upturning and affirming the micro localities which have their own traditional high-quality products as a specific combination of unique geographical traits and local population expertise. In 2009 there were more than 10,000 protected GIs in the world with billions worth of trade value, although about 90% of them come from only 30 most industrialized countries (Giovannucci, et al., 2009).

Results

Geographical Branding in Serbia

Up to March 2015, 52 Serbian products obtained recognition and registration by the Intellectual Property Office of the Republic of Serbia on account of their geographical origin (11 as geographical indications – GI, and 41 as appellations of origin – AO), out of which only three (Homolje honey, "Bermet" wine and Leskovac homemade ajvar) have so far obtained international labels of quality under the Lisbon Agreement, which made opportunity to the mentioned products to be present on the markets of 28 countries – signatories of the mentioned Agreement. For the remaining 46 products from the list of the Intellectual Property Office protected geographical origin is limited to the Serbian market (Table 1).

Table 1. List of all the products that have so far been registered with the Intellectual Property Office of the Republic of Serbia as geographical indications (GI) or appellations of origin (AO).

Cheeses	Sjenica sheep milk cheese (AO), Sjenica cow milk cheese (AO), sheep milk cheese from Homolje (AO), Homolje goat cheese (AO), Homolje cow milk cheese (AO), Sombor cheese (AO), Zlatar cheese (AO), Svrljig hard cheese (kashkaval) (AO), hard cheese (kashkaval) from Stara Planina (AO), cow milk hard cheese (kashkaval) from Pirot (AO), hard cheese (kashkaval) from Krivi Vir (AO), Svrljig belmuž[9] (AO)
Meat and meat products	Sjenica lamb meat (AO), Užice beef prosciutto (AO), Užice pork prosciutto (AO), Užice bacon (AO), Srem kulen[10] (AO), Srem home sausage (AO), Srem salami (AO), Požarevac sausage (AO), Petrovska sausage[11](AO), Leskovac barbeque meat (AO), „tobacco" pork cracklings from Valjevo (AO), pepper sausage from Lemes (AO), Vršac ham (AO)

9 A cheesy dish of the Balkan cattle breeders made from young sheep's milk cheese and corn flour

10 Paprika flavored sausage made of minced pork

11 Traditional dry-fermented flavored sausage from Bački Petrovac

Other agricultural products	Leskovac homemade ajvar[12] (AO), Homolje honey (AO), lime-tree honey of Fruška Gora (AO), Kačer honey (GI), Kladovo caviar (AO), Rtanj tea, Ečka carp (GI)
Wines and beers	Bermet – Sremski Karlovci (AO), Banat Riesling[13] (AO), Jagodina pink wine[14] (GI), Karlovac Riesling[15] (AO), Island of Pearl (Muskat krokan wine) (AO), Kosovo Polje (Amselfeld, Field of the black bird, Champ de merle) (AO), Kosovo wine (Amselfelder) (AO), Prizren wine (AO), Metohija (Metohy) wine (AO), Apatin Jelen beer (GI), Vršac Champion Beer (GI)
Water	Vrnjci water (GI), AQUA HEBA mineral water from Bujanovac (GI), Duboka mineral water (GI), Knjaz Miloš mineral water - Bukovička banja (GI)
Fruits and vegetables	Fresh and pickled cabbage from Futog (AO), Arilje raspberry (AO)
Non-food products	Pirot kilim rugs (AO), Sirogojno handmade knitwear (GI), bezdan hand-woven silk damask (nepkins, table toppers, tablecloths, pillow cases, bedclothes...) (GI)

Source: Republic Statistical Office. (2017,2020,2023). Annual Report on Population Statistics. Republic Statistical Office.

Out of 29 districts, 19 have at least one product registered on account of quality attributable to geographical origin. The districts that have not shown any initiative for geographical branding are Mačva, Podunavlje, North Banat, North Bačka, Toplica, Rasina, Kosovo, Kosovska Mitrovica, Kosovo-Pomoravlje and Peć districts. Some districts have shown comparatively high activity in searching for solutions for economic stimuli in the domain of products branding on account of their geographical origin (Zlatibor, Braničevo and South Bačka Districts), mainly in synergy with other incentive measures (primarily tourism in various forms) (Table 2).

Table 2. Agricultural brands classified by geographical region.

District	**Geographical indications/Appellations of origin**
Bor District (1)	Kladovo caviar
Braničevo District (6)	Homolje honey, Homolje sheep milk cheese, Homolje goat cheese, Homolje cow milk cheese, Požarevac sausage, Duboka mineral water,
City of Belgrade (1)	Kačer honey/(shared with Kolubara, Moravica, Šumadija districts)
Zaječar District (2)	Rtanj tea, hard cheese (kashkaval) from Krivi Vir
West Bačka District (4)	Apatin Jelen beer, bezdan hand-woven silk damask, Sombor cheese, pepper sausage from Lemeš
Zlatibor District (9)	Užice beef prosciutto, Užice pork prosciutto, Užice bakon, Sjenica sheep milk cheese, Sjenica cow milk cheese/(shared with Raška District), Sirogojno handmade knitwear, Arilje raspberry, Sjenica lamb meat /(shared with Raška District), Zlatar cheese
Jablanica District (2)	Leskovac homemade ajvar, Leskovac barbrque meat
South Banat District (3)	Banat Riesling. Vršac Champion Beer, Vršac ham

12 A paprika delicacy made from indigenous and domesticated varieties of red peppers

13 Dry white table wine

14 Dry pink table wine

15 Quality dry white wine

District	Geographical indications/Appellations of origin
South Bačka District (5)	Bermet, petrovska klobasa, Karlovac Riesling, fresh and pickled cabbage from Futog, lime-tree honey of Fruška Gora
Kolubara District (2)	„tobacco“ pork cracklings from Valjevo, Kačer honey /(shared with Belgrade, Moravica, Šumadija districts)
Moravica District (1)	Kačer honey/(shared with Beograd, Kolubara, Šumadija districts)
Nišava District (2)	Svrljig belmuž, Svrljig hard cheese (kashkaval)
Pirot District (3)	Pirot kilim rugs, hard cheese (kashkaval) from Stara Planina, cow milk hard cheese (kashkaval) from Pirot
Pomoravlje District (1)	Jagodina pink wine
Prizren District (4)	Kosovo Polje (Amselfeld, Field of the black bird, Champ de merle), Kosovo wine (Amselfelder), Prizren, Metohija
Pčinja District (1)	AQUA HEBA mineral water from Bujanovac
Raška District (4)	Vrnjci water, Sjenica sheep milk cheese, Sjenica cow milk cheese /(shared with Zlatibor district), Sjenica lamb meat /(shared with Zlatibor district)
Central Banat District (2)	Island of Pearl (Muskat krokan wine), Ečka carp
Srem District (3)	Srem kulen, Srem home sausage, Srem salami
Šumadija District (2)	Knjaz Miloš mineral water - Bukovička banja, Kačer honey/(shared with Belgrade, Kolubara, Moravica districts)

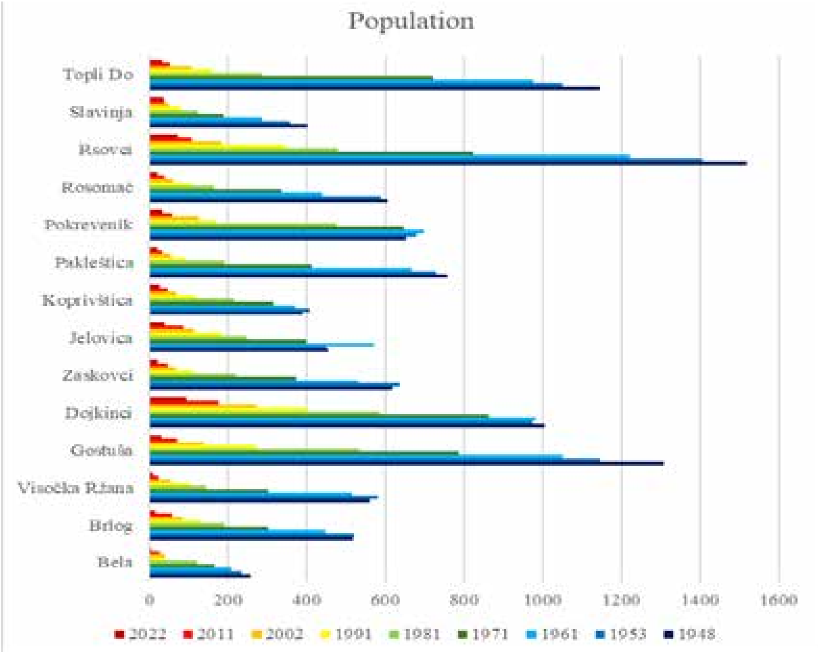
Source: Republic Statistical Office, Municipalities in Republic of Serbia

Although it is still rather early to analyze the real and full effects of these measures on the revival of economic activities of the local population (living mainly in the rural areas which have been most severely struck by depopulation), being that this process has been initiated only recently (the first products registered for quality attributable to geographical origin were registered in 1990 in the Zlatibor District, and the first international certification occurred in 2010), it is already possible to talk about the first signals of good practice and significant potentials for change that can be expected in the future. The first Serbian products with international registration based on their geographical origin – Leskovac handmade ajvar, Homolje honey and „Bermet“ wine from Sremski Karlovci (Chever et al., 2012).

The potential of the Visok microregion products for branding

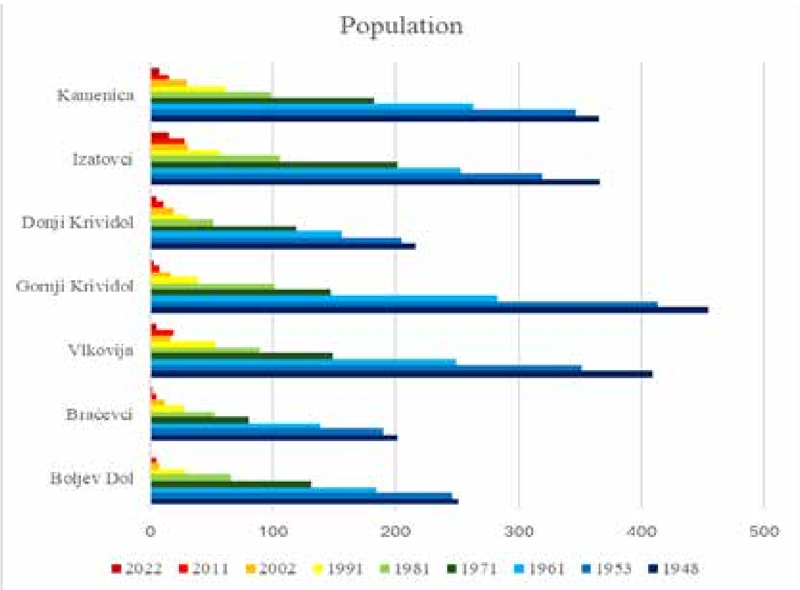
The demographic trend for the Visok microregion is alarming. There has been a consistent trend of depopulation across all villages of Visok microregion since 1961, persisting until 2022 (see Figures 2 and 3). In the mid-20th century, five villages had populations exceeding 1000: Topli Do, Rsovci, Dojkinci, Gostuša, and Zavoj. However, Zavoj village no longer exists. It had been submerged in a catastrophic event in February 1963. Afterward, the villages of Velika Lukanja and Mala Lukanja were also submerged following the construction of an artificial dam at the location where a natural dam had appeared (Marković et al., 2024). For this reason, these villages are not included in this study. Today, migrations to Pirot and other big cities left behind a population of 504, mostly elderly residents. This demographic shift is starkly evident in the Population Aging Index, highlighting almost the complete absence of young people in the region since the 1990s (Table 5). The aging population, initiated by war, migrated to city centers and sealed any natural revitalization chances within these villages.

Figure 2. Population Changes Across Census Cycles in Settlements of the Visok Region 1948-2023 (Pirot Municipality)



Source: Republic Statistical Office, Census Data (1948-2022)

Figure 3. Population Changes Across Census Cycles in Settlements of the Visok Region 1948-2023 Dimitrovgrad Municipality)



Source: Republic Statistical Office, Census Data (1948-2022)

By using the Population Aging Index, it is evident that Serbia is experiencing an aging population, primarily due to the departure of young people from the country between 1991 and 2022 (RZS, 2022). Table 3 illustrates that the Pirot district has a significantly older population than the Serbian average, although the numbers are not alarming. However, the Visok microregion exhibits a Population Aging Index more than twenty times higher than the Serbian average, indicating a severe lack of young individuals residing there. The decline in the Population Aging Index over the last decade is attributed to the passing out of the oldest residents rather than an influx of young people migrating to the Visok microregion.

Table 3. Population Aging Index in Serbia, Pirot district and Visok microregion

	Population Aging Index			
Year of Census	**1991**	**2002**	**2011**	**2022**
Serbia	0,44	1,05	1,22	1,54
Pirot district	0,92	1,59	1,87	2,39
Visok	10	36,57	39,93	32

Source: Republic Statistical Office, Census Data (1948-2022)

The cultural heritage of the local community in the Pirot municipality once hung in the balance. Pirot kilim (Pirot rug), Pirot/Stara Planina lamb, and Pirot/Stara Planina Kachkaval cheese are all precious products made using rural traditional recipes, linked to Visok microregion sheep breeding (Figure 4). Their continued existence hinges upon the preservation of the unique breed originating in this geographical region (Stevanović et al., 2016b).

A meticulous examination of 51 ewes and two rams reveals the Pirot sheep's distinctive features are compact, slightly rectangular body frame, with a body length averaging 115.40 percent of height at withers. The studied population displays remarkable homogeneity, with morphological variations confined to the parameters of this research. However, significant differences among age groups hint at the breed's late maturation and slow growth. These sheep represent the last vestiges of their breed, and their evaluation serves as a crucial step in preservation efforts (Stevanović et al., 2016a).

Pirot School for Milk Products is well-known using only traditional ways of making products with the famous brand Pirot Kashkaval from Stara Planina mountain (Đorđević, 1955). Nowadays the biggest problem is the lack of young people, as well as rapidly decreasing number of livestock in the rural areas. Young people are migrating constantly mostly to Pirot, Niš, Belgrade and other bigger cities since 1953. The decrease of the inhabitants of the Visok microregion in Pirot and Dimitrovgrad municipalities is visible in Figure 2 and Figure 3.

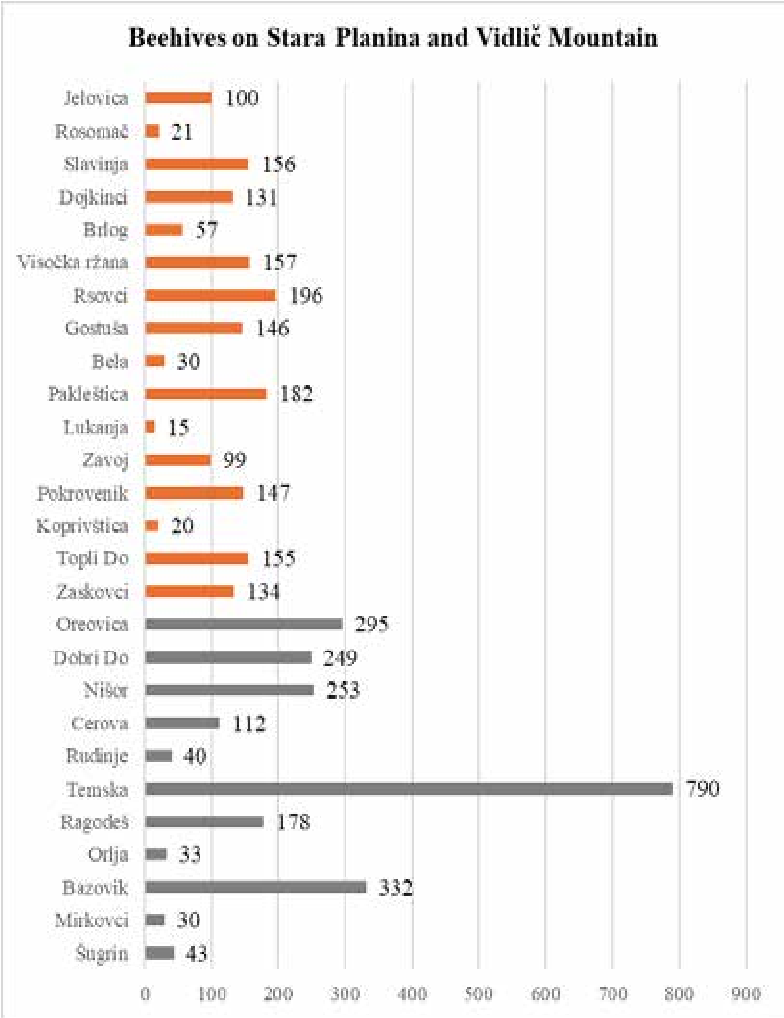
Figure 4. Farmer with sheep and goats

Source: Photo by Rastko Marković (2017)

According to data gathered in the field, domestic potatoes are also highly regarded in this region. The primary reason for this is the high altitude, which prevents damage from potato beetles. Additionally, the soil structure is favorable for cultivating potatoes. There was also a plan for a potato product industry in Dojkinci village, but this never materialized due to political reasons, as stated by locals.

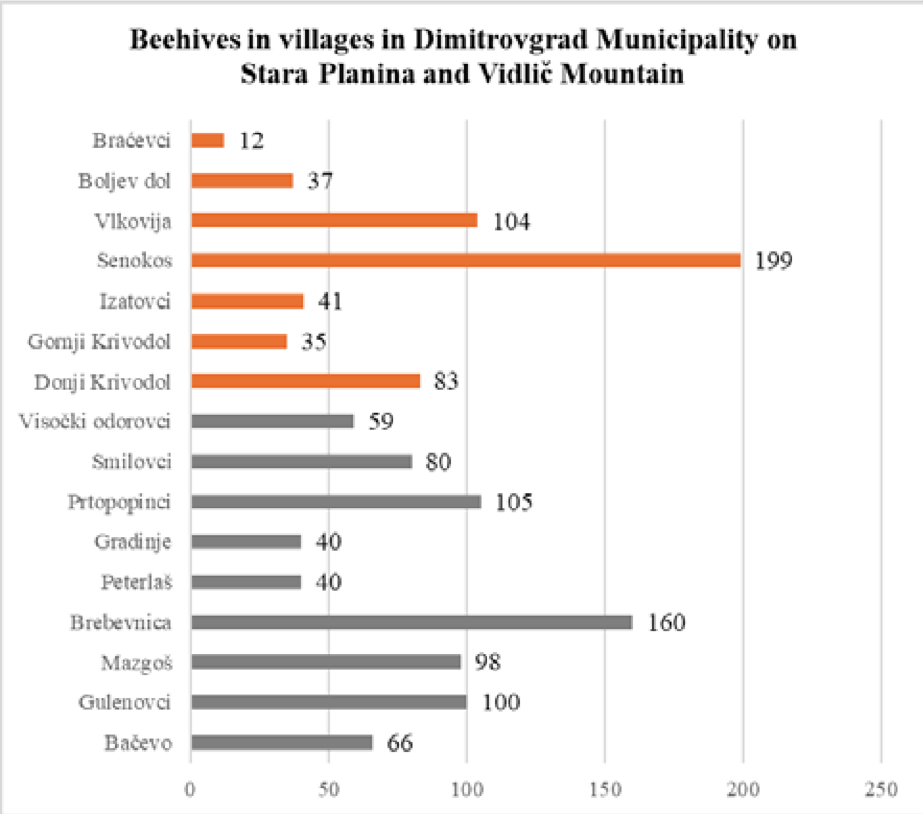
Beekeeping is widely represented and is one of the last branches of agriculture that still survives in this area. There are more than 10,000 beehives in the municipalities of Pirot and Dimitrovgrad. Specifically, there are 4,101 (1,746 in Visok) beehives in Pirot and 1,259 (511 in Visok) in Dimitrovgrad, all within the area of the Stara Planina Mountain and Vidlič Mountain (Figure 5 and Figure 6).

Figure 5. Number of beehives for villages in Pirot Municipality within the area of the Stara Planina Mountain (2024). Villages from the Visok microregion are represented with orange color.



Source: Veterinary Station Pirot. (2023).

Figure 6. Number of beehives for villages in Dimitrovgrad Municipality within the area of the Stara Planina Mountain (2024). Villages from Visok microregion are represented with orange color.



Source: Veterinary Station Pirot. (2023).

The average beehive in Serbia produces around 12 kg of honey per year (Ignjatijević et al., 2015), and in the Vojvodina region from 11 kg to 23 kg of honey per year (Marinković & Nedić, 2010). Based on the presented numbers in Figure 5 and Figure 6 we can assume that on average Visok is producing more than 27 t, while the region of Stara Planina and Vidlič mountains are producing more than 64 t of honey. Temska village represents the highest number of beehives and it is the only village with some potential for revitalization. Temska lies outside the Visok microregion, yet it serves as the primary connection point between Visok and other parts of Serbia. For instance, it stands as the sole crossroad for Zaskovci and Topli Do. Additionally, Temska boasts a functional school and is home to several children within the village. Most of these children (aged 0-18) are of Romani ethnicity, and any potential revitalization efforts should consider their distinct way of life. According to the veterinary services of Pirot and Dimitrovgrad, all the beekeepers gather in the different beekeeper societies. Through such societies, they get help from the state or local governments.

Discussion and conclusion

Branded objects and branding processes are deeply intertwined with spatial and historical contexts, contributing significantly to economic and social disparities of whole regions (Pyke, 2009). The brand is created with prescribed technology that cannot be changed. It reflects the style of living and tradition of the specific area.

The most famous brands from Serbia over the world are “Plazma”, “Krem bananica”, “Jafa”, Knjaz Miloš”, “Smoki”,””vacuumed sauerkraut from Futog”, “Karneks” pate, “Štark”, “Začin C”, “Medeno srce”, “Negro” bonbons and “Eurokrem” (Đuričanin et al., 2012). Unfortunately, none of those brands include traditional ways of preparation, so there is an open niche in the market for some new brands that represent Serbian culture and tradition, as essential parts of the brand. In this study, we suggest the following products originating from the Visok microregion: Pirot kilim (Pirot rug), Pirot/Stara Planina lamb, Pirot Kachkaval cheese, Stara Planina honey, and Stara Planina potatoes.

Recognition of products based on their geographical origin for quality is a relatively new trend in Serbia. The first “geographical brands” were registered in 1990, and by early 2015, their number had reached 52, with only three products holding international certification. Products with registered geographical origins can provide reaffirmation and stimulus for rural area development. This is due to their favorable geographical positions in specific micro-locations and the utilization of traditional methods in preparation, processing, or production, ensuring certain value-added products with guaranteed quality that can gain national and, more importantly, international recognition (Stevanović et al, 2016a, 2016b). Examples such as Homolje honey, Leskovac homemade ajvar, and “Bermet” wine, which have obtained international quality labels, have already validated this assumption (Gorjanović et al, 2020).

Geographical branding can become one of the main solutions in the struggle against the depopulation of rural areas. However, it definitely is a good and efficient way of revitalization which, in synergy with some additional stimuli and incentive strategies (development of tourism in various formats, strengthening of the public sector, organic farming, etc.) can lead to much better results in the battle against the severe demographic crisis that Serbia is currently facing.

Young people migrated from the Visok microregion due to various factors, such as the industrialization of Pirot, rather poor job offers, bad infrastructure and communal service, low salaries, unemployment, etc. This resulted in a catastrophic age pyramid and led to the closing of almost all schools in this region. At this point, revitalization can’t come naturally. If current demographic trends continue, it is most likely that in 30 years there will be more waterfalls than people in the Visok microregion.

In conclusion, the study highlights the potential of seasonal residences for the tourism season, with the micro-region predominantly inhibited during the summer season. Given the natural conditions, the entire micro-region holds potential for the development of agriculture and complementary activities. This primarily involves the integrated development of agriculture and tourism. Excursion tourism, active leisure, mountain tourism, and ski tourism are just some of the motivating forms of movement that can complement and enhance the tourism product of this region. On the other hand, an increase in tourist traffic would lead to increased sales and placement of agricultural products authentic to this region. Consequently, greater economic effects would be realized from agriculture, leading to increased employment levels, and ultimately initiating demographic revitalization.

At this juncture, it is unrealistic to expect the villages in the micro-region to regain the function they held in the mid-twentieth century. However, the potential of villages for seasonal residency should be considered. The villages should be specialized and influenced by the modern style of living. Without state intervention and a detailed development plan, rural revitalization cannot be expected. However, it is worth mentioning that this region represents one of the most preserved natural ecosystems in Serbia, which is crucial in organic production and the modern trends in tourism.

Acknowledgments

This research is supported by the Ministry of Science, Technological Development and Innovation, Republic of Serbia (No. 451-03-65/2024-03/200124); Ministry of Science, Technological Development and Innovation, Republic of Serbia (No. 451-03-68/2020-14/200091).

Conflict of interests

The authors declare no conflict of interest.

References

1. Barham, E. (2003). Translating terroir: the global challenge of French AOC labeling. Journal of rural studies, 19(1), 127-138. https://doi.org/10.1016/S0743-0167(02)00052-9
2. Bowen, S., & De Master, K. (2011). New rural livelihoods or museums of production? Quality food initiatives in practice. Journal of Rural Studies, 27(1), 73-82. https://doi.org/10.1016/j.jrurstud.2010.08.002
3. Bowen, S., & Zapata, A. V. (2009). Geographical indications, terroir, and socioeconomic and ecological sustainability: The case of tequila. Journal of rural studies, 25(1), 108-119. https://doi.org/10.1016/j.jrurstud.2008.07.003
4. Butova, T. G., Bukharova, E. B., Morgun, V. N., Pantyukhov, I. V., & Shmeleva, Z. N. (2019). The issues of territorial branding of agricultural products in modern conditions. In IOP conference series: earth and environmental science (Vol. 315, No. 2, p. 022097). IOP Publishing. https://doi.org/10.1088/1755-1315/315/2/022097

5. Census, 1948-2022, Republic Statistical Office - National Affiliation, Book 1. (2023) Available online: https://popis2022.stat.gov.rs/sr-Latn/5-vestisaopstenja/news-events/20230428-konacnirezpopisa (accessed on 27 October 2023).
6. Das, A., Agrawal, R., & Mohan, S. (2015). Topographic correction of ALOS-PALSAR images using InSAR-derived DEM. Geocarto International, 30(2), 145-153. https://doi.org/10.1080/10106049.2014.883436
7. Đorđević, D. (1955). How to Solve the Problem of the Dairy School in Pirot? Dairy Farming: Journal for the Advancement of Milk Production and Processing, 5(8), 177-179.
8. Đuričanin, J., Đurović, J., & Radojcic, S. M. (2012). SERBIAN BRANDS. EMoNT 2012, 164.
9. Verhaegen, I., & Van Huylenbroeck, G. (2001). Costs and benefits for farmers participating in innovative marketing channels for quality food products. Journal of Rural Studies, 17(4), 443-456. https://doi.org/10.1016/S0743-0167(01)00017-1
10. Giovannucci, D., Josling, T. E., Kerr, W., O'Connor, B., & Yeung, M. T. (2009). Guide to Geographical Indications: Linking products and their origins (p. 232). Geneva: International trade centre. https://dx.doi.org/10.2139/ssrn.1736713
11. Gorjanović, S., Pastor, F. T., Loupassaki, S., Veljović, S., Vukosavljević, P., Zlatanović, S., & Pezo, L. (2020). Serbian aromatized wine "Bermet": Electrochemical, chemiluminescent and spectrophotometric determination of antioxidant activity. *Journal of the Serbian Chemical Society*, *85*(4), 517–529. http://dx.doi.org/10.2298/JSC190404139G
12. Chever, T., Renault, C., Renault, S., & Romieu, V. (2012). Value of production of agricultural products and foodstuffs, wines, aromatised wines and spirits protected by a geographical indication (GI). AND International.
13. Ignjatijević, S., Ćirić, M., & Čavlin, M. (2015). Analysis of honey production in Serbia aimed at improving the international competitiveness. Custos Agronegocio On Line, 11(2), 194-213.
14. Krstić, V. (2007). The Population of the South-East Serbia, Comparative Study of Demographic Development. Niš.
15. Lukić, V. (2021). Migration and Mobility Patterns in Serbia Serbia. In The Geography of Serbia: Nature, People, Economy (pp. 157-167). Cham: Springer International Publishing.
16. https://doi.org/10.1007/978-3-030-74701-5_12
17. McDowell, W. S. (2006). Issues in marketing and branding. In Handbook of media management and economics (pp. 237-258). Routledge.
18. eBook ISBN9781410615589

19. Marković, R., Mudelsee, M., Radaković, M. G., Radivojević, A., Schaetzl, R. J., Basarin, B., Nikolić, J., Marković, S. B., Spalević, V., Antić, A., Marjanović, M., & Lukić, T. (2024). An index for Snowmelt-Induced Landslide Prediction for Zavoj Lake, Serbia. *Atmosphere*, *15*(3), 256. https://doi.org/10.3390/atmos15030256
20. Marinković, S., & Nedić, N. (2010). Analysis of production and competitiveness on small beekeeping farms in selected districts of Serbia. APSTRACT: Applied Studies in Agribusiness and Commerce, 4(3-4). http://dx.doi.org/10.19041/APSTRACT/2010/3-4/10
21. Marjanović, M., Milenković, J., Lukić, M., Tomić, N., Antić, A., Marković, R. S., ... & Marković, S. B. (2022a). Geomorphological and hydrological heritage of Mt. Stara Planina in SE Serbia: From river protection initiative to potential geotouristic destination. Open Geosciences, 14(1), 275-293. https://doi.org/10.1515/geo-2022-0340
22. Marjanović, M., Radivojević, A. R., Antić, A., Peppoloni, S., Di Capua, G., Lazarević, J., ... & Marković, S. B. (2022b). Geotourism and geoethics as support for rural development in the Knjaževac municipality, Serbia. Open Geosciences, 14(1), 794-812. https://doi.org/10.1515/geo-2022-0388
23. Milić, B. (2017). Rural in-Migrations in Serbia. An Assessment of Social and Economic Implication on Rural Communities. https://doi.org/10.6092/unibo/amsdottorato/7915.
24. Milovanović, B. (2010). Climate of Stara Planina (Vol. 75). Geographical Institute „Jovan Cvijić “SANU.
25. Moran, W. (1993). Rural space as intellectual property. Political geography, 12(3), 263-277. https://doi.org/10.1016/0962-6298(93)90057-E
26. Murphy, J. (1988). Branding. Marketing Intelligence & Planning, 6(4), 4-8. https://doi.org/10.1108/eb045775
27. Pay, C. J., White, M. R., & Zwart, A. C. (1996). The role and importance of branding in agricultural marketing.
28. Pejanović, R., Trbić, D. G., & Tomaš-Simin, M. (2017). Problems of agricultural and rural development in Serbia and necessity of new agricultural policy. Економика пољопривреде, 64(4), 1619-1633.
29. Pike, A. (2009). Geographies of brands and branding. Progress in Human Geography, 33(5), 619-645. https://doi.org/10.1177/0309132508101601
30. Rašević, M. (2017). Serbia: The migration issue in key national strategies.
31. Stevanović, O. N., Stojiljkovic, M., Trailovic, R., Ivanov, S., & Nedic, D. N. (2016a). Primary phenotypical characterization of the Pirot sheep from Stara Planina, Republic of Serbia: can we save the forgotten zackel?. Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales, 59, 63-72. https://doi.org/10.1017/S2078633616000187

32. Stevanović, J., Okanović, Đ., Stevanetic, S., Mirilović, M., Karabasil, N., & Pupavac, S. (2016b). Traditional products: Base for the sustainable development of Serbian animal origin products. *Food & Feed Research*, *43*(2), 127–134. http://dx.doi.org/10.5937/FFR1602127S
33. Stojadinović Sule, D. (2013). Waterfalls of Srbija; National library "Vuk Karadžić": Kragujevac, Serbia. (In Serbian)
34. Velojić, M., & Radovanović, O. (2017). Visok. Zaječar–Bor: Tercija.
35. Vidanović, G. (1955). Visok. SAN, Special ediotion, Geographical Institute, book, 6.
36. Vukelić, I., Milošević, S., Đurđević, D., Racić, G., & Tot, V. (2023). Sustainable transition of the Republic of Serbia: measuring capacity for circularity in agriculture and rural areas. Energy, Sustainability and Society, 13(1), 34. https://doi.org/10.1186/s13705-023-00413-4
37. Article 22(1) of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)
38. Portal Makroeconomics, Economic Analyses, Serbia, Environment and International Economy, http://www.makroekonomija.org
39. Intellectual Propertz Office of the Republic of Serbia, http://www.zis.gov.rs
40. WIPO – World Intellectual Property Organization: http://www.wipo.int/geo_indications/en/about.html

ECONOMIC ASPECTS OF THE USE OF FORESTRY PRODUCTS FOR COMMERCIAL PURPOSES

Milica Marčeta[1], Ljiljana Keča[2], Sreten Jelić[3]
**Corresponding author E-mail: milica.marceta@sfb.bg.ac.rs*

A R T I C L E I N F O

Original Article

Received: *16 April 2024*

Accepted: *23 May 2024*

doi:10.59267/ekoPolj2402569M

UDC 339.13:630*8

Keywords:

non-wood forest products, wood assortments, trend, marketing mix, companies

JEL: *Q570*

A B S T R A C T

Forestry together with the industry based on wood and non-wood forest products (NWFPs) represents an important activity and branch of the national economy. In accordance with that, the work is divided into two chapters, one of which analyzes wood, and the other of NWFPs. Therefore, the aim of the research is to examine the market trends and potential of forestry in the part of central Serbia (Central forest area). The purpose of the research is to identify trends in the categories of felling, production and sale of wood assortments of beech, oak and poplar and to analyses the commercial aspect and the way of organizing the marketing mix in companies that deal with the purchase, processing and placement of NWFPs. The Mann-Kendall test was used for the analysis of trends in wood products, while a survey was created for the analysis of companies in the field of NWFPs, which included 29 open and closed questions, with conceptual units related to the marketing mix. For the purposes of the research, primary and secondary data were used and the time period 2008-2017 was covered.

Introduction

Forests are a renewable resource, and wood and other forestry products represent a valuable and sustainably usable product, which makes an economic contribution to national economies (Kalamárová et al., 2014; Sadanandan-Nambiar, 2015; Rikalović, Molnar, 2017; Zastocki et al., 2021).

1 Milica Marčeta, Research Associate, University of Belgrade, Faculty of Forestry, Kneza Viseslava street 1, Belgrade, Republic of Serbia, Phone: +381113053938, E-mail: milica.marceta@sfb.bg.ac.rs, ORCID ID (https://orcid.org/0000-0002-7961-0690)

2 Ljiljana Keča, Full professor, University of Belgrade, Faculty of Forestry, Kneza Viseslava street 1, Belgrade, Republic of Serbia, Phone: +381113053829, E-mail: ljiljana.keca@sfb.bg.ac.rs, ORCID ID (https://orcid.org/0000-0002-4203-2727)

3 Sreten Jelić, Full professor, University of Bijeljina, Faculty of Agriculture, Pavlovica put bb, Bijeljina, Phone: +381638044778, E-mail: sjelic@agrif.bg.ac.rs, ORCID ID (https://orcid.org/0000-0001-6783-5908)

If forestry is observed in the context of the production process, it is possible to identify significant deviations in relation to other economic areas, which shows a certain similarity with agricultural production (Shmulsky, Jones, 2019; Tsuchikawa et al., 2022). What makes a significant difference is the inability to react quickly (Sabadi, 1986) and adapt to market demands. On the other hand, if we are talking about the market of forest products, it is characterized by a number of specificities of a biological, technical and economic nature (Ranković, 2008).

Such specificities are reflected, among other things, in the spaciousness of production, the relatively large distance between the initial and final stages of work, the distance between the working surfaces and processing, which makes it different from other production branches (Stevanović, Simić, 2014).

In addition, in relation to conventional production, in forestry we are talking about long production cycles, multiple functions of forests, the impossibility to valorize many of its values on the market, natural renewal, afforestation, nurturing, cleaning up to economic effects, which exceeds the lifespan of people (Figurić, 1996; Delić, 2011; Posavec, Beljan, 2013).

The common component for all forestry products is that their production takes place simultaneously in the same production process (Kant, 2011). On the other hand, there is a pronounced difference in product characteristics, where wooden products are distinguished by pronounced voluminousness, which is accompanied by high transport costs (Olofsson, Lundmark, 2016) and homogeneity, then by occasional consumption and intended for further reproduction.

Besides, the realization takes place according to the established price list at the level of the year (Delić, 2011), while there is a limited number of suppliers of raw materials on the market, which means that the market can be characterized as oligopolistic (Kester, Zarić, 2009). Unlike wood products, with NWFPs there is a greater number of actors on the supply side (oligopoly) and demand side (oligopsony), the products are easy to manipulate, in the context of the assortment heterogeneous and intended for final consumption, while the prices are influenced by market trends.

In addition to providing various economic, social, cultural and ecological benefits for society, NWFPs also play an important role in the life of local communities, which use forest resources as one of the sources of income (Keča et al., 2015; Weiss et al., 2020; Zhu, Lo, 2021). In such areas, forest products are often the main source of income for the local population (Yadav, Kalpana, 2013; Simić et al., 2021; Pandey et al., 2016). In addition, forestry enterprises have a very important role for increasing employment, better living standards and long-term development of rural areas (Ticktin, 2004; Pantić et al., 2022; Shackleton et al., 2015).

On the other hand, the quantitative limitation of the supply of wood on the market is linked to the permitted felling volume, which is generated from the forest inventory and based on the yield calculation. In this sense, the wood market has a unique character, since the supply of this natural resource is strictly limited by the requirements of appropriate forestry practices (Adamowicz et al., 2008). Through the given types of restrictions, a difference is manifested in relation to conventional types of production, because forestry, in addition to striving to satisfy the economic interests of the economy, takes as its starting point the principle of sustainable management (Medarević et al., 2008).

It is estimated that more than 4,500,000 m3 are cut in the territory of Serbia, which accounts for about 70% of the planned yield, i.e. 50% of the annual increase, where the representation of hardwoods is about 85%. Of the total volume of wood cut, about 45% is firewood, while 42% is technical wood, and 13% is wood residue.

Based on the importance of forestry and products that are commercialized on the market, the goal of the research was aimed at examining market trends and potential in the part of central Serbia (Central forest area). The purpose of the research was to identify trends in the categories of felling, manufacturing and sale of wood assortments and examination of the commercial aspect and ways of organizing the marketing mix in companies dealing with purchase, processing and placement of NWFPs.

Materials and methods

In the first part of the research, annual data on sales (volume of wood in m³), price of wood (in dinars) of beech, oak and poplar in the Central forest area, for the period 2008-2017, were used. These species were taken into consideration, because they are recognized as commercially important according to their distribution in the forest fund of Serbia. The analyzed forest area, according to the Law on Forests (2018), includes forests and forest lands of forest areas of Šumadija, Posavina and Podunavlje and Podrinje and Kolubara (*Figure 1*). The territory of this forest area includes the forest estates of PE "Srbijašume" Belgrade, Kragujevac, Loznica.

Figure 1. Forest areas in Serbia

Source: original

The data was collected from internal databases and reports of the company PE “Srbijašume”. The price of wood was adjusted using annual price indices, in order to achieve comparability of prices during the observed time period. In this way, the so-called the real price of wood. Also, the gross annual income for each of the three types of wood was calculated, as a product of sales and the real price of wood.

Table 1. Assortment structure of beech, oak and poplar

<table>
<tr><th>FOREST AREA</th><th colspan="2">SPECIES</th><th>ASSORTMENTS</th></tr>
<tr><td rowspan="6">CENTRAL</td><td colspan="2">Beech (Fagus)</td><td>➢ fire wood
➢ log (1, 2, 3, K, L class)</td></tr>
<tr><td rowspan="4">Oak (Quercus)</td><td>Turkey oak (Quercus cerris)</td><td>➢ fire wood</td></tr>
<tr><td>Sessile oak(Quercus petraea)</td><td rowspan="2">➢ fire wood
➢ log (1, 2, 3 class)</td></tr>
<tr><td>Pedunculate oak (Quercus robur)</td></tr>
<tr><td>Hungarian oak (Quercus frainetto)</td><td>➢ fire wood</td></tr>
<tr><td colspan="2">Poplar (Populus)</td><td>➢ fire wood
➢ log (1, 2, F, L class)</td></tr>
</table>

Source: original

Table 1 shows the assortment structure of the analyzed wood species. A trend analysis was performed for the categories of felling, production and sale of wood assortments, with a preliminary examination of the existence of autocorrelation (Wang, 2008). Autocorrelation means the existence of correlation between observations in time or space, and in regression analysis autocorrelation refers to the existence of correlation between random errors. In regression models, it most often occurs when evaluating the dependence of time series data, where the effect of a random error from one period manifests itself in the next (Mladenović, Petrović, 2003).

In the second stage, to test the significance of the trend, the Mann-Kendall test was applied (Mann, 1945; Kendall, 1975; Kulkarni, von Storch, 1995; Yue, Wang, 2004). Research shows that the method most often used for trend detection is the non-parametric Mann-Kendall test (Hamed, Rao, 1998; Ghalharia et al., 2012; Guhathakurta et al., 2010), which assumes independence of data in the time series (Yue, Wang 2004; Pohlert, 2016). However, in many real-world situations, data are automatically correlated, which can result in misinterpretation of trend test results (Fathian et al., 2016).

In the second part of the research, 7 companies were analyzed, which deal with the purchase, processing and placement of NWFPs in the area of the Central forest area, of which 4 are from the Belgrade area and 3 from Kragujevac. The criteria for the selection of companies that were included in the analysis were based on the database of the Agency for Business Registers (APR) and the internal documentation of the Institute for Nature Protection (list of companies in the field of purchase, processing and placement of NWFPs for commercial use):

- private property

- the average annual quantity of purchased raw materials is higher than 100 t (Keča et al., 2015);

- belonging to the category of micro- and small enterprises, according to the classification given in the Law on Accounting (2021).

For the purposes of the research, a survey was created (Hanić et al., 2010), which included 29 open and closed questions, with conceptual units related to the marketing mix (Petrochilos, 2004; Barjaktarović, 2023; Lamb et al., 2013), and therefore and issues related to product, price, promotion and distribution (Kotler et al., 2007; Marčeta et al., 2014; Keča et al., 2015).

In this way, a database was created, which served as a basis for further analysis using appropriate methods and techniques. On the basis of the obtained qualitative-quantitative data, an effort was made to present the structure of the NWFPs, which is commercialized within the analyzed area (forest area). The products taken into consideration are classified as: mushrooms, medicinal herbs, forest fruits, honey (Mitchell, Hobby, 2010; Sorrenti 2017).

In the part related to the product, a bar diagram shows the representation of certain products (category of NWFPs) in the analyzed companies. Pie charts illustrate the representation of certain standards, as well as the participation of certain promotional activities. In the same way, the forms of product billing and the problems that companies face in business and on the market are presented. The prices are given schematically, where the process of price formation is presented, from the moment of the initial phase of collecting raw materials in nature, to the placement of the final or semi-final product. Distribution is also shown in the form of a scheme, starting with the purchase of raw materials, delivery to the premises of the company, storage, internal transport, warehousing and placement on the market through various types of distribution channels.

In the last part, the flows and quantities of purchase, placement on the domestic market and export of NWFPs were analyzed by determining the average annual growth rate for all three categories. The growth rate was calculated by obtaining chain indices in the first phase according to the following pattern:

$$\overline{Y}c = \frac{Y}{Y-_1} * 100$$

In this way, the value of the change in occurrence in the current year compared to the previous year (expressed in %) was obtained (Krstić, Šoškić, 2016). From the values thus obtained, the geometric mean was calculated (Excel function “geomean”). The obtained value was reduced by 100, which determined the average annual growth rate for quantities, purchases, placement on the domestic market and exports.

Results

Table 2 presents the total logging, sales, gross income, as well as the average price and standard deviation of the price in the Central forest area in the period 2008-2017. In this way, an effort was made to show the dynamics in the domain of felling volume and placement of wood assortments, as well as average prices and gross income based on their realization on the market.

Table 2. Descriptive statistics for the Central forest area

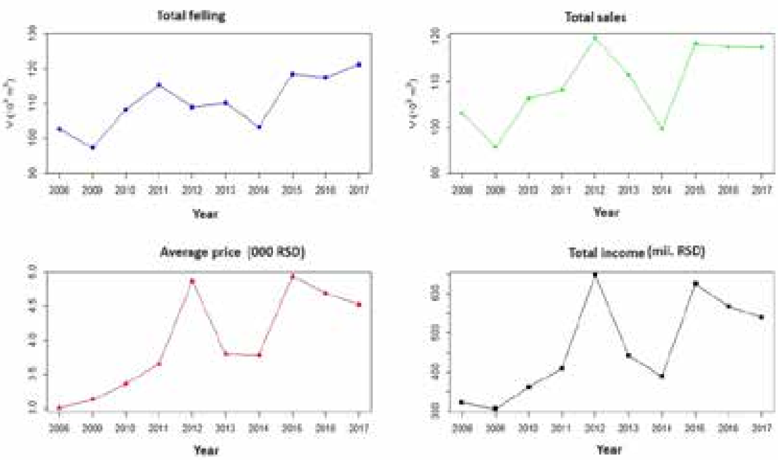
Year	Feeling		Sale		Price		Gross income	
	Total (m^3)	%	Total (m^3)	%	Mean value (RSD)	Standard deviation	Total (RSD)	%
2008	102,628	9.1	103,129	9.5	3,005	335	322,216,650	10.7
2009	97,264	8.8	95,711	9.0	3,123	273	307,577,428	10.3
2010	108,210	9.2	106,354	9.3	3,354	149	361,532,546	10.1
2011	115,430	9.5	108,338	9.4	3,646.5	358.5	408,572,094	10.6
2012	109,089	9.0	119,651	9.7	4,868.5	1,416.5	648,750,299	13.9
2013	110,160	8.6	111,620	8.8	3,794.5	454.5	442,620,632	10.3
2014	103,298	8.1	99,587	7.9	3,782.5	401.5	389,238,181	8.5
2015	118,615	8.8	118,490	8.8	4,937.5	1,011.5	624,912,245	11.8
2016	117,568	8.7	117,588	8.8	4,690	424.0	567,581,724	10.0
2017	121,103	7.7	117,552	8.5	4,519.5	154.5	539,148,457	9.0

Source: original

The felling volume ranged from 97,264 to 121,103 m3, which is in line with the realized quantities. As for prices, the highest value was reached in 2015, which means that, compared to the other years of the analyzed time interval, more valuable assortments were realized. The highest gross income was achieved in 2012, which is the result of the ratio of prices and realized quantities (*Table 2*). In comparison to the others, the proportion of poplars is significantly higher in the Central Forest Area, where artificially raised plantations of poplar clones are dominant, with minimal participation of autochthonous communities. All this indicates that participation in sales fully follows the representation of specific species in forest areas, as well as income from their realization (Marčeta, 2023).

Graph 1 presents data for total felling (in thousands of cubic meters), total sales (in thousands of cubic meters), average price of wood (in thousands of dinars) and total gross income (in millions of dinars) in the Central forest area during the observed period.

Figure 2. Trend of total cutting, total sales, average price and total income

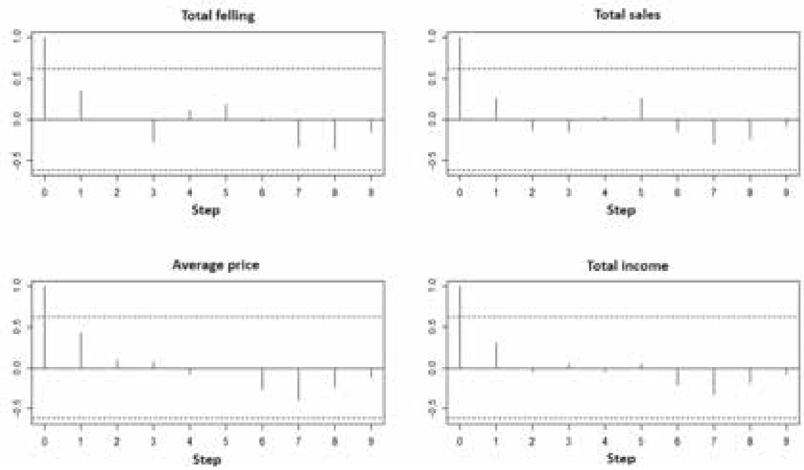


Source: original

A slight increasing trend can be observed on the graph of total felling. Total sales have also seen growth over the years, however, there was a big jump in 2012 and a big drop in value in 2014, which deviate from the overall profile of the growing trend. An increasing trend can be observed for the average price and total income, with a big jump in 2012. That is, for total sales, average price and total income, there was a big jump in 2012, which deviates from the pattern followed by most other values, which can be linked to the realization of stocks from previous years. Unlike products whose demand depends on the disposable income of consumers, in the case of wood it can be conditioned by the volume of production of finished and semi-finished products of wood processing companies, whose demand depends on the needs of customers or further processing (Brodrechtova et al., 2014).

Accordingly, Zastocki et al. indicate that the market for wood raw materials is influenced by numerous factors (Zastocki, et al., 2021), where one group refers to the availability of raw materials, assortments, felling and the situation on the forestry services market (Malinen, Kilpeläinen, 2013; Gejdoš, Danihelová, 2015; Malinen et al., 2015; Wysocka-Fiorek, Lachowicz, 2018), while, in the second group of factors, forestry policy, nature protection or natural disasters (Sikora, 2017; Lundholm et al., 2019; Toth, et al., 2020).

Figure 3. Autocorrelation coefficients



Source: original

Figure 3 presents the autocorrelation coefficients of total felling, sales and gross income and average prices in the Central forest area. There are no statistically significant autocorrelation coefficients, so the unmodified Mann-Kendall trend test was applied in all cases.

Table 3. Mann-Kendall test results for the Central forest area

Variables	Test	Statistics	*p*-value	Trend
Total felling	Mann-Kendall	2.504	0.012	Yes
Total sales	Mann-Kendall	1.610	0.107	No
Average price	Mann-Kendall	2.504	0.012	Yes
Total gross income	Mann-Kendall	1.968	0.049	Yes

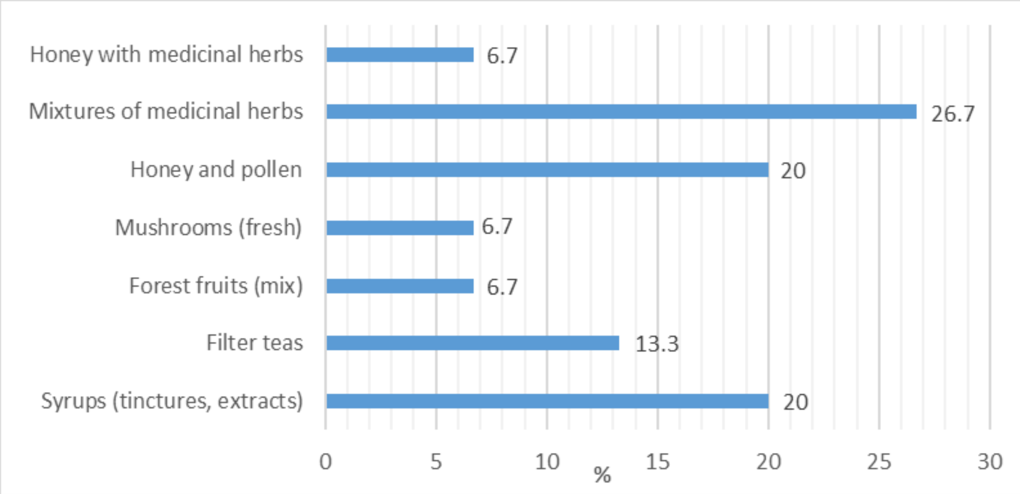
Source: original

It was determined that there is a statistically significant growing trend of total felling, average price and total income in the Central Forest Area in the period 2008-2017 (*table 3*). Based on this, it can be concluded that oscillations in the realized quantities of wood assortments contributed to the appearance of extreme values in certain years (under the influence, primarily of the sale of stocks from previous years), which there was no verification of the statistical significance of the trend.

Analysis of NWFPs

The survey was conducted in 7 companies, 4 in Belgrade and three companies in Kragujevac. Three of the analyzed companies are business-oriented on medicinal plants, two on the production and marketing of honey and one company each for the purchase, processing and marketing of only forest fruits, that is, combined forest fruits and mushrooms.

Figure 4. Representation of certain NWFPs in the assortment of analyzed companies



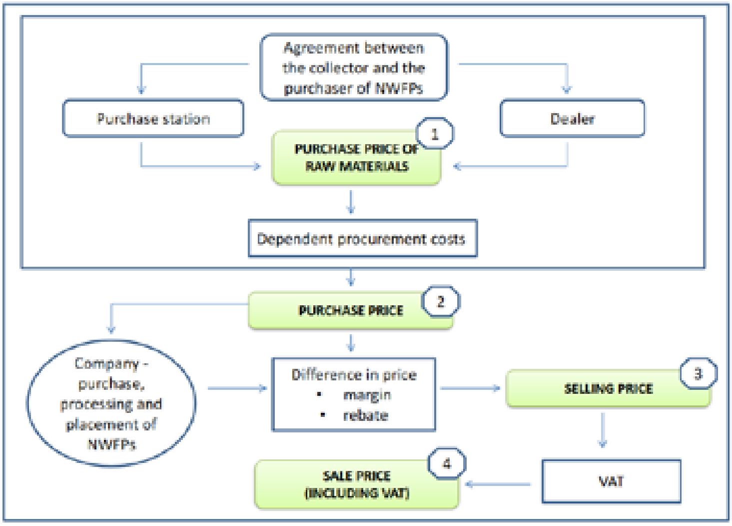
Source: original

The analyzed companies in their assortment are mostly oriented towards medicinal herbs and products based on medicinal herbs and honey. In this sense, medicinal herb mixtures (26.7%), syrups and tinctures based on medicinal herbs (20%) and honey and pollen, with the same share, stand out (*Figure 4*).

The dominant products (Milisavljević et al., 2004; Vasiljev, 2005; Gligorijević, 2007; Kotler et al., 2007; Singh, 2012; Lamb et al., 2013) marketed by the analyzed companies are mostly in raw or partially processed state (medicinal herbs, mushrooms, forest fruits, etc.), although there are also products of a higher level of processing (marmalades, syrups, extracts, etc.) (Marčeta, Keča, 2014).

Analogous to the situation in Croatia (Posavec et al., 2018), NWFPs market in Serbia is not organized, where the prices (Milisavljević et al., 2004; Kotler et al., 2007; Lamb et al., 2013) of these products depend on the buyers, supply and demand ratio, but also weather conditions and quality of raw materials (Keča, 2013; Keča et al., 2014), which, in general, creates a favorable climate for the development of the "gray" market.

Figure 5. Formation of retail price of NWFPs

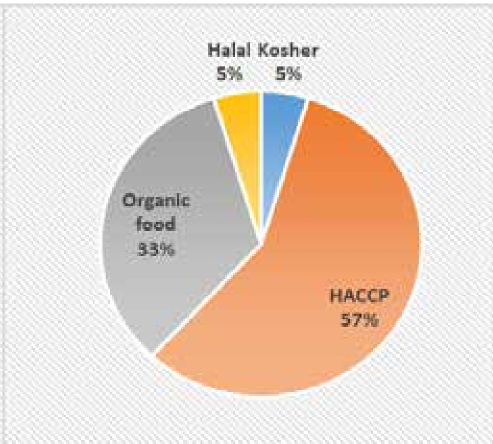


Source: original

As in previous researches (Keča et al., 2014, Marčeta et al., 2014), all analyzed companies form the price according to the “costs plus” model, which includes: purchase price, as well as costs processing, packaging, transport and promotion (*Figure 5*).

Figure 6. Forms of promotional activities at surveyed companies

Figure 7. Representation of certain standards in surveyed companies

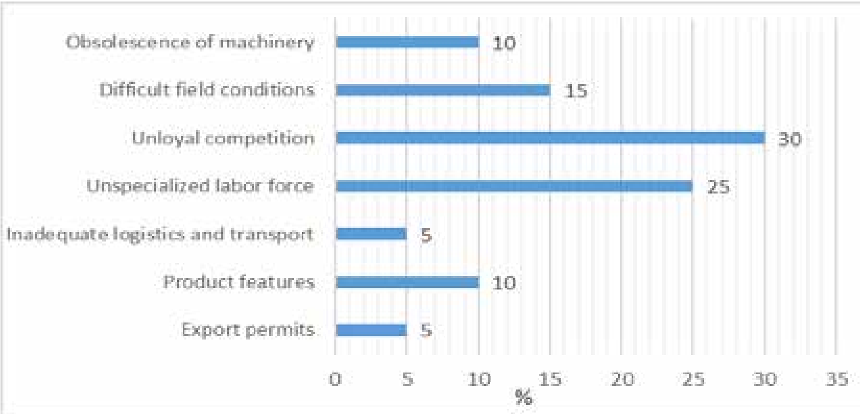


Source: original

The most represented form of promotion, among surveyed companies in the Central forest area, are fairs with 35%, followed by advertisements in the form of printed material (leaflets, posters, flyers, etc.) with a share of 31%, while other forms of promotional activities have a smaller representation (*Figure 6*).

Of the companies surveyed, 57% have so far adopted the HACCP standard, while the representation of the Organic food standard is 33%. Kosher and Halal standards were adopted by 5% of analyzed companies (*Figure 7*). The improvement in business after the adoption of the standard was emphasized by 81% of respondents. Fairs are one of the most common forms of promotion among the analyzed companies (Nedeljković, Keča, 2010), which is an effective way to present the product on the spot to a large number of potential consumers.

Figure 8. Problems in the business of the company

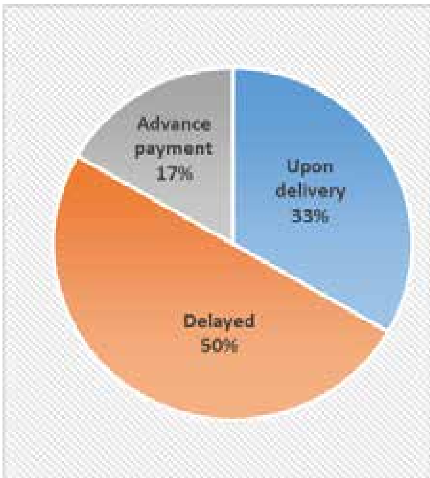


Source: original

The problem in the form of unfair competition was pointed out by 30% of the respondents, while in the case of unspecialized labor the share is slightly lower (25%) (*Figure 8*).

Figure 9. Problems on the market

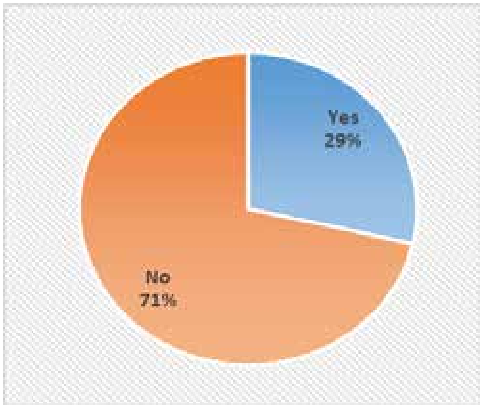
Figure 10. Forms of payment



Source: original

Billing was recognized by 65% of respondents as a problem in business, while the underdevelopment of the market was emphasized by 30% of respondents (*Figure 9*). 50% approve "postponed" payment, while "on delivery" payment is implemented by 33% of companies. Advance payment, as a form of payment, is the least represented and participates with 17% in the total payment structure (*Figure 10*).

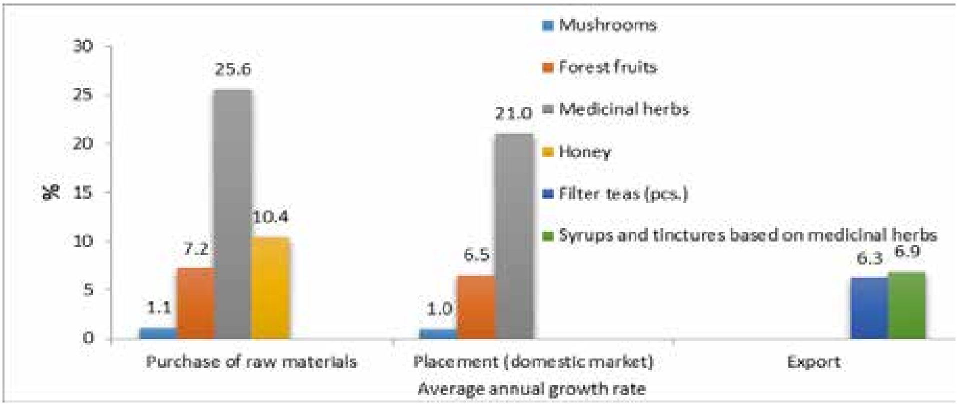
Figure 11. State support



Source: original

The largest number of companies (71%) did not use any form of state support and subsidies in their operations (*Figure 11*).

Figure 12. Average annual growth rates of purchase of raw materials, placement on the domestic market and export of NWFPs in the Central forest area

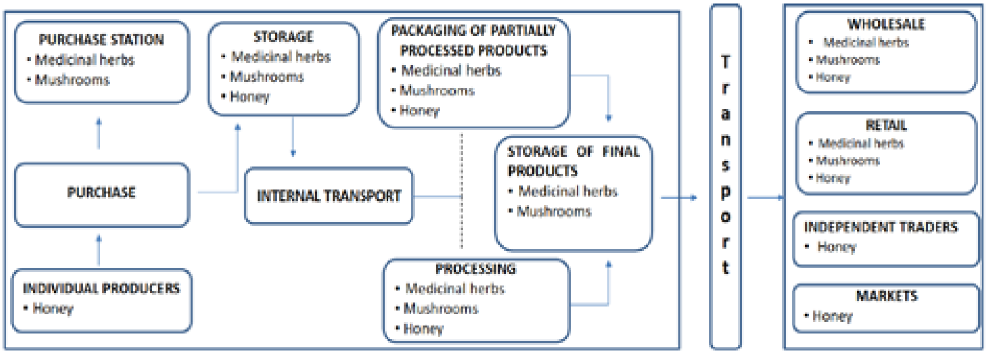


Source: original

According to the average annual growth rate, medicinal plants and products based on medicinal plants stood out, with a growth of 25.6% in purchase and placement on the domestic market of 21%. Filter teas and tinctures based on medicinal herbs achieved export growth of 6.3% and 6.9%, respectively. Forest fruits, in purchase, recorded a growth of 7.2%, while placement on the domestic market increased by 6.5%.

Mushrooms purchased and placed on the domestic market grew by 1.1% and 1% respectively (*Figure 12*). A significant increase in the dynamics of the purchase of raw materials and the placement of medicinal plants can be linked to the increasing orientation of the population towards natural products in the form of dietary supplements and for medical purposes.

Figure 13. Distribution of NWFPs



Source: Marčeta, 2023

In the specific case, the collected NWFPs are directed to purchase stations and organized points, where the purchase and sale of the raw product is carried out, where, after quantitative and qualitative control, the raw material is further distributed to companies that deal with their processing and placement.

Enterprises then store the raw material, then clean it and classify it according to certain qualitative categories. About one half of the analyzed companies, after such primary processing, place the NWFPs in the form of a semi-finished product further on the market. Other companies continue the process of creating additional value by subjecting these semi-products to various types of processing, then the final product is packed in individual, and then in collective (transport) packaging and deposited in the warehouse (*Figure 13*).

Conclusions

Based on the results of the research, it was determined that there is a statistically significant growing trend of total felling, average price and total income in the Central forest area in the period 2008-2017. Based on this, it can be concluded that oscillations in the realized quantities of wood assortments contributed to the appearance of extreme values in certain years (under the influence, primarily of the sale of stocks from previous years), which is why there was no verification of the statistical significance of the trend.

As for the NWFPs, the following conclusions stand out:

- the analyzed companies in their assortment are mostly oriented towards medicinal herbs and products based on medicinal herbs and honey, while the final products stand out as: mixtures of medicinal herbs (26.7%), syrups and tinctures based on medicinal herbs (20%) and honey and pollen, with the same proportion;

- the most represented form of promotion, among surveyed companies, are trade fairs with 35%, followed by advertisements in the form of printed material (31%);
- of the companies surveyed, 57% have so far adopted the HACCP standard, Organic food 33%, while Kosher and Halal standards have been adopted by 5% of the analyzed companies;
- as a problem in business, respondents mostly emphasized unfair competition (30%);
- 65% of respondents recognized payment as a problem in business, while 30% of respondents emphasized the underdevelopment of the market;
- "postponed" payment is approved by 50%, while "on delivery" payment is realized by 33% of companies;
- the largest number of companies (71%) did not use any form of state support and subsidies in their business;
- according to the average annual growth rate, medicinal plants and products based on medicinal plants were singled out, with a growth of 25.6% in purchase and placement on the domestic market of 21%;
- filter teas and tinctures based on medicinal herbs achieved a growth in exports of 6.3% and 6.9%, respectively;
- forest fruits, in purchase, recorded a growth of 7.2%, while placement on the domestic market increased by 6.5%;
- mushrooms purchased and placed on the domestic market grew by 1.1% and 1%, respectively.

Based on the previously presented research, it can be concluded that the wood market is under the intense influence of the growing demand for wood as a product of certain properties. Analogous to the situation on the wood products market, growth trends are also present in the NWFPs. The reason for this is reflected in the global expansion of organic production and consumption of products of natural origin. The analyzed companies that deal with the purchase, processing and placement of natural resources are predominantly small family-owned and, as such, are to a significant extent the driving force behind the development of rural areas.

Precisely because of pronounced migrations of the population to more developed parts of the country and increasingly pronounced depopulation of rural areas, future development strategies should be directed towards the development of local entrepreneurship and sustainable use of natural resources. In such constellations, NWFPs represent a strategically important category, where through the education of the local population on the commercial importance of these products, along with training on the method of collection and processing and the possibilities of placement, awareness of the possibilities that these products provide would be created in the future.

Conflict of interests

The authors declare no conflict of interest.

References

1. Adamowicz, V., Boyda, A. & McFarlane, P. (2008). *Global Forest Products Markets and Canadian Wood Supply – ERA*. Report #2 in the Series on "Drivers of Change in Canada's Forests and Forest Sector", prepared for the Forest Futures Project of the SFM Network, University of Alberta. Retrieved from: https://era.library.ualberta.ca/items/a688b04e-6a5d-4077-8ccc-261ed1fd4f32/view/5fcc6918-9590-469b-a2f6-e2b3d2e38b9b/FF_GlobalMarkets_Adamowicz.pdf.
2. Barjaktarović, S. (2023). Annual costs of dysfunctional fluctuation on the example of a manufacturing company in Serbia. *Oditor*, *9*(2), 78-109. https://doi.org/10.5937/Oditor2302078B
3. Brodrechtova, Y., Trenčiansky, M. & Halaj, D. (2014). Dynamics of Slovakian Timber Market in Retrospect. *Proceedings of the 57th International Convention of Society of Wood Science and Technology*, Zvolen, 89-96.
4. Delić, S. (2011). Osnove ekonomike šumarstva, Šumarski fakultet Univerziteta u Sarajevu, Sarajevo. [in English: Delić, S. (2011). Basics of forestry economics, Faculty of Forestry, University of Sarajevo, Sarajevo].
5. Fathian, F., Dehghan, Z., Bazrkar, M.H. & Eslamian, S. (2016). Trends in hydrological and climatic variables affected by four variations of the Mann-Kendall approach in Urmia Lake basin, Iran, *Hydrological Sciences Journal*, 61(5), 892–904. DOI: 10.1080/02626667.2014.932911.
6. Figurić, M. (1996). *Uvod u ekonomiku šumskih resursa*. Šumarski fakultet u Zagrebu, Zagreb. (244) [In English: Figurić, M. (1996). *Introduction to the economics of forest resources*. Faculty of Forestry in Zagreb, Zagreb].
7. Gejdoš, M. & Danihelová, Z. (2015). Valuation and timber market in the Slovak Republic. *Procedia Economics and Finance*, 34, (697–703). DOI: 10.1016/S2212-5671(15)01688-3.
8. Ghalharia, G.F., Dastjerdib, J.K. & Nokhandan, M.H. (2012). Using Mann Kendal and t-test methods in identifying trends of climatic elements: A case study of northern parts of Iran. *Management Science Letters*, 2(3), 911–920. DOI: 10.5267/j.msl.2011.10.015.
9. Guhathakurta, P., Preetha, M., Mazumdar, A.B. & Sreejith, O.P. (2010). *Changes in extreme rainfall events and flood risk in India during the last century*. National Climate Centre, Research Report No.3, Retrieved from: DOI: http://www.environmentportal.in/files/changes%20in%20extreme%20rainfall.pdf.

10. Hamed, K.H. & Rao, R.A. (1998). A modified Mann-Kendall trend test for autocorrelated data. *Journal of Hydrology*, 204(1–4), 182–196. DOI: 10.1016/S0022-1694(97)00125-X.

11. Hanić, H., Vićentić, M. & Đurica, M. (2010). *Istraživanje tržišta*. Visoka poslovna škola strkovnih studija, Valjevo. [In English: Hanić, H., Vićentić, M. & Đurica, M. (2010). *Market Research*. College of Business Studies, Valjevo].

12. Kalamárová, M., Parobek, J., Loučanová, E. & Trebuňa, P. (2014). Competitiveness evaluation of the Slovak forest industry. *7th International Scientific Conference on Position and Role of the Forest Based Sector in the Green Economy Location*, Zvolen, 58-62.

13. Kant, S. (2011). Market, timber pricing and forest management. *The Forestry Chronicle*, 86(5), 580-588. DOI: 10.5558/tfc86580-5.

14. Keča, Lj., Keča, N. & Marčeta, M. (2015). Nedrvni šumski proizvodi, Socio-ekonomski i ekološki aspekti, Univerzitet u Beogradu, Šumarski fakultet, Beograd. [In English: Keča, Lj., Keča, N. & Marčeta, M. (2015). Non-wood forest products, Socio-economic and ecological aspects, University of Belgrade, Faculty of Forestry, Belgrade].

15. Keča, Lj. & Marčeta, M. (2015). Export as Market Component and Development Perspective of NWFPs Sector in Central Serbia. *Baltic Forestry*, 21(2), 315-325.

16. Kendall, M. (1975). Multivariate analysis. Charles Griffin, Londres.

17. Kester, U. & Zarić, V. (2009). *Trgovina poljoprivredno-prehrambenim proizvodima-principi i politika, Univerzitet u Beogradu*. Poljoprivredni fakultet, Beograd. [In English: Kester, U. & Zarić, V. (2009). *Trade in agricultural and food products - principles and policy.* University of Belgrade, Faculty of Agriculture, Belgrade].

18. Kotler, F., Vong, V. Sonders, Dž. & Armstrong, G. (2007). *Principi marketinga*. Gospodarska misao, Mate d.o.o., Zagreb, (932). [In English: Kotler, F., Vong, V. Sonders, Dž. & Armstrong, G. (2007). *Principles of Marketing*, Gospodarska misao, Mate d.o.o., Zagreb].

19. Krstić, G. & Šoškić, D. (2016). *Ekonomska statistika*. Centar za izdavačku delatnost Ekonomskog fakulteta u Beogradu, Beograd. [In English: Krstić, G. & Šoškić, D. (2016). *Economic statistics*. Center for publishing activities of the Faculty of Economics in Belgrade, Belgrade].

20. Kulkarni, A. & von Storch, H. (1995). Monte Carlo experiments on the effect of serial correlation on the Mann-Kendall test of trend. *Meteorologische Zeitschrift*, 4(2), 82–85. DOI: 10.1127/metz/4/1992/82.

21. Lamb, C.H., Hair, J.F. & McDaniel, C. (2013). Marketing-MKTG, Datastatus, Beograd.

22. Law on Forests (2018). Retrieved from: https://www.paragraf.rs/propisi/zakon-o-sumama-republike-srbije.html.

23. Law on accounting (2021). Retrieved from: https://www.paragraf.rs/propisi/zakon-o-racunovodstvu-2020.html
24. Malinen, J., Haring, M., Kilpeläinen, H. & Verkasalo, E. (2015). Comparison of alternative roundwood pricing systems–A simulation approach. *Silva Fennica*, 49(3), 1-14. DOI: 10.14214/sf.1293.
25. Malinen, J. & Kilpeläinen, H. (2013). Price systems for standing sales of industrial roudwood in Finland. *Baltic Forestry*, 19, 307–315.
26. Mann, H.B. (1945). Nonparametric Tests Against Trend. *Econometrica*, 13(3), 245–259. DOI: 10.2307/1907187.
27. Marčeta, M. (2023). *Socio-ekonomska kretanja u sektoru šumarstva Srbije: Analiza tržišta šumskih proizvoda i njegovih dinamičkih elemenata*. Doktorska disertacija, Univerzitet u Beogradu, Šumarski fakultet. [In English: Marčeta, M. (2023). *Socio-economic trends in the forestry sector of Serbia: Analysis of the forest products market and its dynamic elements*. Doctoral dissertation, University of Belgrade, Faculty of Forestry].
28. Marčeta, M., Keča, Lj. & Jelić, S. (2014). Perspectives and Possibilities for Development of Rural Areas in Vojvodina Through the Sector of Non-Wood Forest Products, *Bulletin UASVM Horticulture*, 71(2), 402-407. DOI: 10.15835/buasvmcn-hort:10656.
29. Medarević, M., Banković, S. & Šljukić, B. (2008). Sustainable forest management in Serbia - state and potentials. *Bulletin of the Faculty of Forestry*, 97, 33-56. DOI: 10.2298/GSF0897033M.
30. Mitchell, D. & Hobby, T. (2010). From rotations to revolutions: Non-timber forest products and the new world of forest management. *BC Journal of Ecosystems and Management*, 11(1-2), 27–38.
31. Mladenović, Z. & Petrović, P. (2003). *Uvod u ekonometriju*, Ekonomski fakultet u Beogradu, Beograd. [In English: Mladenović, Z. & Petrović, P. (2003). *Introduction to econometrics*, Faculty of Economics in Belgrade, Belgrade].
32. Olofsson, E. & Lundmark, R. (2016*). Competition in the Forest Sector: An extensive review*. Paper presented at the Swedish Association for Energy Economics (SAEE) conference 2016, Luleå. Retrieved from: http://urn.kb.se/resolve?urn=urn:nbn:se:ltu:diva-60935.
33. Pantić, N., Mikulič, K., & Lekovič, M. (2022). The influence of claims payments on the investment portfolio of insurance companies. *Oditor*, *8*(3), 42-71. https://doi.org/10.5937/Oditor2203042P
34. Pandey, A., Tripathi, Y. & Kumar, A. (2016). Non timber forest products (NTFPs) for sustained livelihood: Challenges and strategies. *Research Journal of Forestry*, 10, 1–7. DOI: 10.3923/rjf.2016.1.7.
35. Petrochilos, G.A. (2004). *Managerial Economics: a European Text-Teories, Policies and Problems*. Palgrave Macmillan, New York.

36. Pohlert, T. (2016). Non-parametric trend tests and change-point detection. Retrieved from: http://cran.stat.upd.edu.ph/web/packages/trend/vignettes/trend.pdf.
37. Posavec, S. & Beljan, K. (2013). *Forest Products Production and Sale Trends in Croatia*. In: Jelačić D. (ed.), WoodEMA, Zagreb.
38. Ranković, N. (2008). *Ekonomika šumarstva*. Univerzitet u Beogradu, Šumarski fakultet. [In English: Ranković, N. (2008). *Forestry Economics*. University of Belgrade, Faculty of Forestry].
39. Rikalović, G. & Molnar, D. (2017). Srbija-područje sa posebnim prirodnim pogodnostima, *Ekonomski vidici*, 22(2-3), 77-88. [In English: Rikalović, G. & Molnar, D. (2017). Serbia - an area with special natural advantages, Economic prospects, 22(2-3), 77-88].
40. Sabadi, R. (1986). *Ekonomika šumarstva*. Liber, Zagreb. [In English: Sabadi, R. (1986). *Economics of Forestry*. Liber, Zagreb].
41. Sadanandan-Nambiar, E.K. (2015). Forestry for rural development, poverty reduction and climate change mitigation: we can help more with wood. *Australian Forestry*, 78, 55–64. DOI: 10.1080/00049158.2015.1050776.
42. Shackleton, C.M., Pandey, A.K. & Ticktin, T. (2015). *Ecological Sustainability for Non-Timber Forest Products: Dynamics and Case Studies of Harvesting*. Routledge, New York.
43. Shmulsky, R. & Jones, P.D. (2019). *Forest products and wood science: An introduction*. 7th Ed. Hoboken, NJ: Wiley– Blackwell.
44. Sikora, A.T. (2017). The effect of natural disasters on the timber market, *Forest Research Papers*, 78(4), 277–284. DOI: https://doi.org/10.1515/frp-2017-0031.
45. Simić, M., Vassileva, A., & Aničić, A. (2021). Economic aspects of the integration processes of the Republic of Serbia. *Oditor*, *7*(2), 83-93. https://doi.org/10.5937/Oditor2102083S
46. Sorrenti, S. (2017). *Non-wood forest products in international statistical systems*. Rome, FAO. Retrieved from: https://www.fao.org/3/i6731e/i6731e.pdf.
47. Stevanović, S. & Simić, J. (2014). Nacionalna ekonomika i privredni sistem, Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd. [In English: Stevanović, S. & Simić, J. (2014). National Economy and Economic System, University of Belgrade, Faculty of Agriculture, Belgrad].
48. Ticktin, T. (2004). The Ecological Implications of Harvesting Non-Timber Forest Products. *Journal of Applied Ecology*, 41(1), 11–21. DOI: 10.1111/j.1365-2664.2004.00859.x.
49. Tsuchikawa, S., Ma, T. & Inagaki, T. (2022). Application of near-infrared spectroscopy to agriculture and forestry. *Analytical Sciences*, 38, 635–642.

50. Wang X.L. (2008). Accounting for Autocorrelation in Detecting Mean Shifts in Climate Data Series Using the Penalized Maximal *t* or *F* test. *Journal of Applied Meteorology and Climatology*, 47(9), 2423–2444. DOI: 10.1175/2008JAMC1741.1.
51. Weiss, G., Emery, M.R., Corradini, G. & Živojinović, I. (2020). New values of non-wood forest products. *Forests*, 11, 165. DOI: 10.3390/f11020165.
52. Wysocka-Fiorek, E. & Lachowicz, H. (2018). Changes in prices, volume and value of wood raw material sold by the State Forests. *Sylwan*, 162, 12–21.
53. Yadav, M. & Kalpana, B. (2013). *Status of Forest Products Production and Trade*. Working Paper Series 1. Bhopal, India: Centre for Sustainable Forest Management and Forest Certification, Indian Institute of Forest Management. Retrieved from: http://iifm.q4hosting.com/wp-content/uploads/2016/06/IIFMWP-13-10-01.pdf.
54. Yue, S. & Wang, C.Y. (2004). The Mann-Kendall Test Modified by Effective Sample Size to Detect Trend in Serially Correlated Hydrological Series. *Water Resources Management*, 18(3), 201–218. DOI:10.1023/B:WARM.0000043140.61082.60.
55. Zastocki, D., Oktaba, J. & Lachowicz, H. (2021). Changes in the Market of Precious Wood: A Case Study of Submission System in Poland. *Forests*, 12(4), 421. DOI: 10.3390/f12040421.
56. Zhu, L. & Lo, K. (2021): Trees, Forests and People Non-Timber Forest Products as Livelihood Restoration in Forest Conservation: A Restorative Justice Approach. *Trees Forests and People* (6), 100130. DOI: 10.1016/j.tfp.2021.100130.

SLOW TOURISM AS A CONTEMPORARY TENDENCY IN THE TOURISM MARKET: IMAGE CONTENT AND GEOTAG ANALYSIS ON INSTAGRAM

Sonja Lazarević[1], Tanja Stanišić[2], Raluca Andreea Ion[3]
**Corresponding author E-mail: tanja.stanisic@kg.ac.rs*

ARTICLE INFO

Original Article

Received: *23 April 2024*

Accepted: *24 May 2024*

doi:10.59267/ekoPolj2402589L

UDC 338.48-6:641/642

Keywords:

slow tourism, slow food, Instagram, social media analysis

***JEL**: Z32*

ABSTRACT

Although it originated from the Slow Food and Cittaslow movements, slow tourism has spread to many spheres of tourism. The purpose of the paper is to investigate what people associate with slow tourism, and how and where they engage in slow tourism. Social media content analysis on Instagram, using hashtag #slowtourism, was performed in the research. The general conclusion is that people mostly associate slow tourism with different forms of architecture and landscape, and to lesser extent with transport and food. Also, there was significant content variation within the architecture and landscape categories, suggesting that people associate different types of architecture and tourism destinations with slow tourism. When it comes to location, the majority of photos were taken in Italy, which is not surprising, considering that Slow Food and Cittaslow movements originated in this country.

Introduction

The slow tourism is a relatively new concept. It originates from the Slow Food and Cittaslow movements that appeared in Italy in the eighties and nineties of the last century. The concept of slow food was initiated by Carlo Pertini in the 1980's in Italy, as a response to the market oversaturation with fast-food restaurants, and today it has spread throughout Europe and to a smaller degree USA (Hall, 2006). This concept arose

1 Sonja Lazarević, Associate Professor, University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Vojvođanska 5A, 36210 Vrnjačka Banja, Serbia, Phone: +381648198998, E-mail: sonja.milutinovic@kg.ac.rs, ORCID ID (https://orcid.org/0000-0001-9913-4495)

2 Tanja Stanišić, Associate Professor, University of Kragujevac, Faculty of Hotel Management and Tourism in Vrnjačka Banja, Vojvođanska 5A, 36210 Vrnjačka Banja, Serbia, Phone: +381644941542, E-mail: tanja.stanisic@kg.ac.rs, ORCID ID (https://orcid.org/0000-0001-5809-794X)

3 Raluca Andreea Ion, Professor, The Bucharest University of Economic Studies, Department of Agro-food and Environmental Economics, Bucharest, Romania, Phone: +40722959353, E-mail: raluca.ion@eam.ase.ro, ORCID ID (https://orcid.org/0000-0001-7182-5809)

as a response to the worldwide standardization of food production and hospitality, which is typical of fast-food production (Miele & Murdoch, 2002). In slow food restaurants, traditional recipes are used to prepare dishes, all food is organic and always served fresh, and ingredients are sourced from local suppliers to avoid stockpiling that may spoil or change in flavor due to long storage (Dickinson & Lumsdon, 2010; Simonović, 2019). As it refers to food that is linked to local culture and heritage, the concept of slow food contributes to the maintenance of customs inherent in each community (Jones et al., 2003). Slow Cities, better known as Cittaslow, is a movement founded by Paolo Saturnini in 1999 "with the aim of improving the quality of life in cities by slowing down their overall pace" (Cittaslow International, 2024). Slow tourism is a travel approach that emphasizes connection with local community, culture, architecture, food and music. It relies on the idea that travel should educate and have an emotional impact, while remaining sustainable for the local community and environment.

There is currently no consensus definition for the term slow tourism, although many authors have tried to define it. It can be said that slow tourism represents such tourism concept, where the focus is on the journey itself, rather than on the destination, with an emphasis on a reduced tourism footprint. Pécsek (2014) argues that slow tourism should include four dimensions: local (local gastronomy, culture, workforce, shops); sustainable (profitability, environmentally friendly investments, small ecological footprint, longer stay in the destination); social well-being (consensual decision-making, population retention, growing well-being, community cohesion); and experiential (non-standard offer, selective attractions, active program, collective experience).

Various social platforms provide users with the ability to share and promote information important for making travel decisions (Filipović et al., 2023). These posts can affect tourists' choice (Fatanti & Suiadnia, 2015; Sofronijević & Kocić, 2022), but in the same time be a very abundant data source for the scientific public when analyzing contemporary tourism trends (Zeng & Gerritsen, 2014). The Instagram platform, which is based predominantly on images, is particularly significant and aligned with the tourism industry due to "the particularly visual nature of tourism content" (Smith, 2019, p. 2). La Busque et al. (2021) conducted an image content analysis on Instagram to investigate how tourists relate to slow tourism. A similar analysis, albeit of the "fitspiration" trend, was conducted by Tiggeman and Zaccardo (2018) and Boepple and Thompson (2016).

Taking into account the importance of social networks content and its influence on tourists' travel decisions, as well as the small number of papers dealing with the research of slow tourism on social networks, the paper aims to determine how social networks portray slow tourism, more specifically Instagram. Therefore, using social media content analysis, the paper aims to determine: 1) with which activities tourists associate slow tourism; and 2) which locations, i.e., countries, tourists associate with slow tourism.

Theoretical background

Many authors have tried to define slow tourism, but considering that it is still in the early stages of evolution, no generally accepted definition of this term still exist. Slow tourism is a conceptual framework that includes people who travel to destinations more slowly and by land, stay longer and travel less. This concept emphasizes the importance of the traveling experience to and within a destination, consuming slow food, exploring historical and cultural sites at a slower pace, and supporting the environment (Dickinson & Lumsdon, 2010). Slow tourism has many parallels with slow food, which implies the consumption of homemade food prepared according to a traditional recipe, using local ingredients. Authors Babou and Callot (2009) claim that slow tourism refers to slowing down the travel rhythm and rediscovering oneself (naturally and psychologically). This includes "not only a low carbon footprint, but also patience, peace of mind, enjoyment of deeper experiences, enhanced understanding and familiarity with the host country's culture" (Moira et al., 2017, p. 4).

Some authors (Dickinson et al., 2010; Heitmann et al., 2011; Conway & Timms, 2012; De Salvo et al., 2013) define slow tourism as an aggregation of four dimensions: environmental (reduced carbon footprint, environmentally friendly transport, travel closer to the place of residence and at shorter distances, longer stay in the destination); experiential (quality time, meaningful experience, slower pace, pleasant way of spending free time); economic (selection of local suppliers, economic contribution to local communities); and ethical (giving something back to the local community and places visited, conscious and thoughtful choices, conscious and informed travel, slow and sustainable consumption, awareness and care).

A slow tourist is an environmentally friendly and responsible tourist, who stays longer in one place, gets to know the culture of the country and the lifestyle of its population, gains an authentic experience, treats the environment and its diversity responsibly, and discovers attractions unknown to other travelers. During his trip, the slow tourist will learn more about the natural and cultural heritage, local cuisine, traditions and special attractions of the destination. With a tour of the local market, the surrounding village, a meal in a traditional restaurant, as well as a conversation with the local population, the slow tourist absorbs the atmosphere and engage in a more authentic experience on his trip (Caffyn, 2022). Slow tourism can also have an element of relaxation and re-creation, as it involves spending quality time with loved ones, sharing experiences and seeking peace and tranquility during a break from everyday life. In contrast, mass tourism involves visiting popular and commercialized destinations for a short and limited period of time. Mass tourism does not give tourists the opportunity to enjoy the destination, get in touch with the inhabitants, try the local gastronomy or get to know the culture.

One of the main components of slow tourism is the opportunity for the tourists to actively participate in the local community and establish a connection with the locals, strengthening their memories of the journey and the destination (Moira et al., 2017). Slow tourists stay in the chosen destination as long as it takes to experience and engage with the local community's daily activities. They would rather use accommodation that is in balance with the natural and social surroundings; they avoid all-inclusive resorts and hotel chains. Generally speaking, slow tourists would rather experience personalized or small-scale services and local goods. Additionally, they travel more independently and exhibit greater option flexibility, as they try to experience the authentic dimension of local culture.

It is essential to consider the idea of slow tourism within a larger sociocultural framework (Fullagar et al., 2012). The intention to "slow down" life's routine is evident in the effort to discover ways for stress reduction. Choosing a slow destination could be one of them. The slow tourism ideology holds that getting to know one small area in-depth is more significant than getting to know a large number of destinations quickly (Georgica, 2015). Mainly, slow travel offers a way out of the hectic, daily life. Also, this type of travel is less expensive. Specifically, slow travelers choose to stay in less expensive lodging than hotels, prepare meals using local ingredients, or sample local cuisine. In this sense, slow tourism enables visitors to engage with the destination, people, and culture by integrating them into the daily activities of the local community.

Increasing the variety of value added to the location where this activity is taking place is one advantages of slow tourism. By fostering a genuine interest in, respect for, and concern for the customs and culture of the area, slow tourists enhance the economic value and preserve the social and natural environment. Communities that are remote from major cities or political hotspots and are more vulnerable to depopulation and/or political power loss (rural or mountainous areas) are considered to benefit from this type of tourism. The promotion of community cohesion and a stronger sense of entrepreneurship are two important aspects of any thriving community that can be fostered through the slow tourism. On the other hand, tourists enjoy destinations where the local population is satisfied and proud of their tourism values.

Materials and methods

In order to achieve the research goals, social media content analysis was used in the paper. For the purpose of analyzing the content of slow tourism on Instagram, the pictures shared by the users of this social network were used. Images containing the hashtag #slowtourism were found using the hashtag search feature.

Taking into account the subject of the paper, that is to investigate what people associate with slow tourism, and how and where they engage in slow tourism, the hashtag #slowtourism was used in the analysis. Following similar research (Boepple & Thompson, 2016; Tiggemann & Zaccardo, 2018; Le Busque et al., 2021), the first 600 images, under 'top posts' category were subject to coding. The research was conducted on 28th March, 2024. Pictures were classified under a general content category: Architecture, Landscape, Transport, Food/Beverage and People, and further into subcategories where suitable. Further analysis involved determining the location of the pictures, using Instagram Geotag.

Results and discussion

In March 2024, the hashtag #slowtourism had about 183,000 posts, while hashtag #tourism that had 1.2 million posts. Only 1.2% of the posts did not include geotag. Table 1 shows the percentage of countries represented as the location of Instagram posts with the hashtag #slowtourism. It is noted that about 87% belong to European countries. Italy (33%) and France (30.2%) have the highest percentages.

The Slow Food and Slow Cities movements originated in Italy, so it is not surprising that the majority of photos are from this country. These two movements spread outside of Italy, especially across Europe (Perano et al., 2019), which can explain the fact that the most images are from Europe. Also, the common border of Italy and France can explain the largest number of photos from France, right after Italy. It is interesting to note that tourists began to associate the United Kingdom, South Africa and the USA with slow tourism, which was not the case with earlier research (Le Busque et al., 2021). This indicates that new countries are positioning themselves on the slow tourism market and that they have recognized its importance.

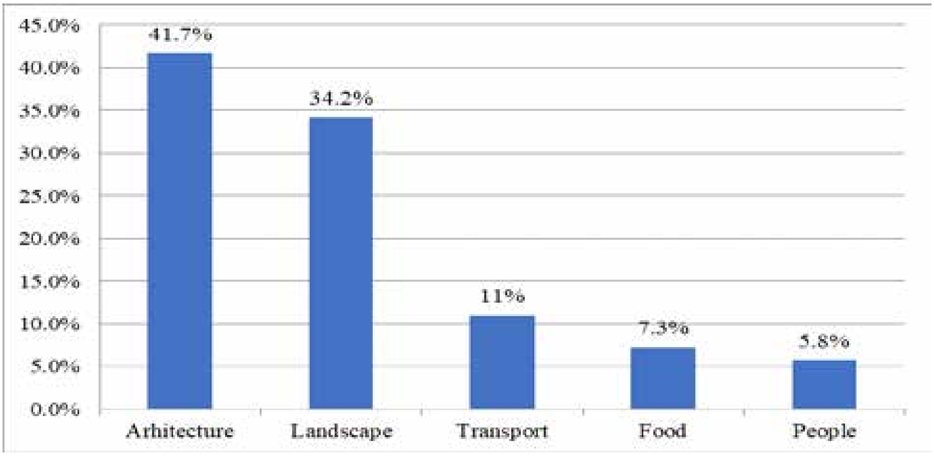
Table 1. Location of Instagram posts

Percent of posts	Country
33%	Italy
30.2%	France
9.3%	Spain
6.5%	Portugal
3.2%	Greece
2.3%	UK
1.2%	Ireland
1%	Scotland
0.8%*	Marocco, Mexico, South Africa
0.7%	Belgium, Croatia, Germany, India, USA
0.5%	Switzerland
**	Argentina, Austria, Brazil, Finland, Holand, Kenya, Romania, Vietnam
***	Australia, Bali, Chile, Columbia, Columbia, Costa Rica, Czech, Denmark, Estonia, Guinea, Hungary, Mauritius, Malaysia, Nepal, Norway, Pakistan, Poland, San Marino, Seychelles, Turkey
1.2%	Did not include a geotag

*Legend: * means percent of posts for each country; ** means 2 Instagram posts for each country; *** means 1 Instagram post for each country*

Source: Authors' research

Figure 1. Key categories of images



Source: Authors' research

Most of the images (Figure 1) include various forms of architecture (41.7%), followed by landscape (34.2%) and various forms of transport (11%). Although it is considered an important part of slow tourism, especially since slow tourism originated from the Slow Food movement, few photos are related to slow food, only 7.3%. Out of the total number, 5.8% of the photos contain people. The resulting categories, people excluded, were further divided into subcategories, as shown in Table 2.

Although the first association of slow tourism is nature or food, the majority of Instagram photos contained some form of architecture (41.7%), which is dominated by some type of accommodation or residentials, as much as 50.4%. This can be explained by the fact that many accommodations are advertised or associated with slow tourism. The following are photos that included some form of architecture in smaller areas, i.e. villages (19.2%), thereafter urban areas (11.2%). Photos of cultural and historical objects and heritage that people associated with slow tourism follows, such as castles (10.4%), churches (4.8%), and lighthouses (2.4%). It is interesting to note that all the lighthouses, except for one, were photographed in France, more precisely in the Brittany region.

Table 2. Subcategories of image content analysis

Architecture (total 41.7%)		Landscape (total 34.2%)		Transport (total 11%)		Food/Beverage (total 7.3%)	
Of the 41,7%		Of the 34.2%		Of the 11%		Of the 7.3%	
Accommodation/ Residential	50.4%	Sea/Beach	36.6%	Cycling	30.3%	Food	68.2%
Village	19.2%	Greenery	22.4%	Trekking	30.3%	Wine	31.8%
Urban	11.2%	Mountain	16.1%	Hiking	16.7%		
Castle	10.4%	Flowers	8.8%	Boat	13.7%		

Architecture (total 41.7%)		**Landscape (total 34.2%)**		**Transport (total 11%)**		**Food/Beverage (total 7.3%)**	
Of the 41,7%		**Of the 34.2%**		**Of the 11%**		**Of the 7.3%**	
Church	4.8%	Lake	5.9%	Van	4.5%		
Lighthouse	2.4%	River	4.9%	Train	3%		
Other	1.2%	Forest	2.4%	Horse	1.5%		
		Cave	0.97%				
		Other	1.93%				

Source: Authors' research

There was a wide range of landscape shown in the Instagram photos, indicating that slow tourism is not only about one kind of landscape. The most frequently portrayed landscapes were the sea or the beach (36.6%), some type of greenery (22.4%), mountains, with or without snow (16.1%), flowers (8.8%), lake (5.9%), river (4.9%), forest (2.4%), and cave (0.97%).

Transport is an important aspect of slow tourism, emphasizing the need to use a greener, more sustainable, and slower form of transport in order to experience the destination at a slower pace and thus more fully. Cycling and trekking were the most common form of transport shown in the Instagram posts (30.3% each), followed by hiking (16.7%), boat (13.7%), van (4.5%), train (3%), and horse (1.5%). This indicates that tourists have recognized the importance of transportation as part of slow tourism and are using more sustainable ways to get around destinations. Electric scooters are a form of transport that did not appear in the analysed pictures, but belong to a greener form of transport, and a chance for tourists to experience destination in a slower and more detailed way, especially cities. Taking this into account, it may be expected that, in the future, tourists will start to associate this form of transport with slow tourism.

As for the Food/Beverage category, 68.2% of the images portrayed some type of food, while 31.8% contained wine or/and vineyard. This is a surprisingly small percentage considering that slow tourism originated from the concept of slow food, and that one important aspect of slow tourism is using local food and buying local ingredients.

Conclusions

The concept of slow tourism is relatively new and originated from the Slow Food and Slow Cities movements. It is a tourism concept that promotes sustainable and slow travel, enjoying the nature and cultural heritage in a slower pace, staying in local accommodation rather than in large hotel chains, trying local food, buying local ingredients, giving something back to the local community and places visited, etc. From the above, it can be concluded that slow tourism is associated with many aspects of tourism travel. Applying social media content analysis, the paper aimed to determine how slow tourism is portrayed on Instagram, and which countries people most often associate slow tourism with. Using hashtag #slowtourism, first 600 photos under 'top category' were used in the analysis. Images were classified under following categories: Architecture, Landscape, Transport, Food/Beverage and People, and further into subcategories where suitable. Analysis also involved determining the location of the pictures, using Instagram Geotag. The results showed that people mostly associate slow tourism with various forms of architecture (41.7%), landscape (34.2%), transport (11%), food/beverage (7.3%), and people (5.8%). The results are surprising considering that slow tourism is most often associated with nature, but also with food, taking into account that it originated from the Slow Food movement. Further analysis of subcategories reveled interesting facts, given that over 50% of the architecture contained some form of accommodation or residentials. Other subcategories included some form of architecture in smaller areas, i.e. villages (19.2%), urban areas (11.2%), castles (10.4%), churches (4.8%), and lighthouses (2.4%). Of the 34.2% images that contained landscape, the majority portrayed sea or beach (36.6%), some type of greenery (22.4%), mountains (16.1%), flowers (8.8%), lake (5.9%), river (4.9%), forest (2.4%), and cave (0.97%). The most common form of transport shown on Instagram images were cycling and trekking (30.3% each), followed by hiking (16.7%), boat (13.7%), van (4.5%), train (3%), and horse (1.5%). Even though it is considered as important aspect of slow tourism, food/beverage was associated with only 7.3% of the images - 68.2% of the images portrayed some type of food, while 31.8% contained wine or/and vineyard.

When it comes to the location analysis, about 87% of images belong to European countries, with Italy (33%) and France (30.2%) leading. These results were not surprising given that Slow Food and Slow Cities movements on which slow tourism is based originated from Italy. The analysis also showed that several new destinations are associated with slow tourism, such as United Kingdom, South Africa and the USA, which was not the case in the earlier research (Le Busque et al., 2021).

Social media analysis provides rich insight into tourist preferences, and can identify tourism trends and serve as an important tool for more detailed analysis. The contribution of the paper is in the theoretical coverage of the slow tourism concept, as well as in empirical knowledge about where and in what way people get engaged in slow tourism. However, the paper has certain limitations. It is unclear whether people who share images on Instagram choose to post architecture and landscape photos more than food and transport, because they are more appealing or because they associate it in larger extent with slow tourism. In order to obtain more valid conclusions, future research should also include a survey of tourists' opinions about what they associate slow tourism with.

Acknowledgment

This research is supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia by the Decision on the scientific research funding for teaching staff at the accredited higher education institutions in 2024 (No. 451-03-65/2024-03/200375 of February 5, 2024).

Conflict of interests

The authors declare no conflict of interest

References

1. Babou, I., & Philippe, C. (2009). Slow tourism, slow (r)évolution?. *Cahier Espaces*, *100*(56), 48-54.
2. Boepple, L., & Thompson, J.K. (2016). A content analytic comparison of fitspiration and thinspiration websites. *International Journal of Eating Disorders*, *49*(1), 98-101. https://doi.org/10.1002/eat.22403
3. Caffyn, A. (2012). Advocating and implementing slow tourism. *Tourism Recreation Research, 37*(1), 77-80. https://doi.org/10.1080/02508281.2012.11081690
4. Cittaslow International (2024), https://www.cittaslow.org/ (March 23, 2024)
5. Conway, D., & Timms, B. F. (2012). Are slow travel and slow tourism misfits, compadres or different genres?. *Tourism Recreation Research*, *37*(1), 71-76. https://doi.org/10.1080/02508281.2012.11081689
6. De Salvo, P., Mogollón, J. M. H., & Di Clemente, E. (2013). "Repellent" tourists versus "slow" tourists. *European Journal of Tourism, Hospitality and Recreation*, *4*(2), 131-148
7. Dickinson, J. E., & Lumsdon, L. (2010). *Slow travel and tourism*. Earthscan Ltd, London
8. Dickinson, J. E., Lumsdon, L.M., & Robbins, D. (2010). Slow travel: issues for tourism and climate change. *Journal of Sustainable Tourism*, *19*(3), 281-300. https://doi.org/10.1080/09669582.2010.524704
9. Fatanti, M. N., & Suyadnya, I. W. (2015). Beyond user gaze: How Instagram creates tourism destination brand?. *Procedia-Social and Behavioral Sciences*, *211*, 1089-1095. https://doi.org/10.1016/j.sbspro.2015.11.145
10. Filipović, J., Šapić, S., & Dlačić, J. (2023). Social media and corporate image as determinants of global and local brands purchase: Moderating effects of consumer openness to foreign cultures. *Hotel and Tourism Management*, *11*(1), 79–94. https://doi.org/10.5937/menhottur2301079F
11. Fullagar, S., Markwell, K., & Wilson, E. (2012). Starting slow: thinking through slow mobilities and experiences. In Fullagar, S., Markwell, K., & Wilson, E. (Eds.) *Slow tourism: experiences and mobilities* (pp. 15-26). Channel View Publications, United Kingdom
12. Georgica, G. (2015). The tourist's perception about slow travel – a Romanian perspective. *Procedia Economics and Finance, 23*, 1596-1601. https://doi.org/10.1016/S2212-5671(15)00557-2

13. Hall, C. M. (2006). Introduction: Culinary tourism and regional development: from slow food to slow tourism. *Tourism Review International*, *9*(4), 1-4. https://doi.org/10.3727/154427206776330580
14. Heitmann, S., Robinson, P., & Povey, G. (2011). Slow food, slow cities and slow tourism. In Robinson, P., Heitmann, S., & Dieke, P. U. C. (Eds.) *Research themes for tourism* (pp. 114-127). CABI, Wallingford. https://doi.org/10.1079/9781845936846.0114
15. Jones, P., Shears, P., Hillier, D., Comfort, D., & Lowell, J. (2003). Return to traditional values? A case study of slow food. *British Food Journal*, *105*(4-5), 297-304.
16. Le Busque, B., Mingoia, J., & Litchfield, C. (2021): Slow tourism on Instagram: an image content and geotag analysis. *Tourism Recreation Research*, *47*(5-6). https://doi.org/10.1080/02508281.2021.1927566
17. Miele, M., & Murdoch, J. (2002). The practical aesthetics of traditional cuisines: Slow food in Tuscany. *Sociologia Ruralis*, *42*(4), 312-328. https://doi.org/10.1111/1467-9523.00219
18. Moira, P. Mylonopoulos, D., & Kondoudaki, A. (2017). The application of slow movement to tourism: is slow tourism a new paradigm?. *Journal of Tourism and Leisure Studies*, *2*(2), 1-10. https://doi.org/10.18848/2470-9336/CGP/v02i02/1-10
19. Pécsek, B. (2014). Gyorsuló idő, lassuló turizmus: a lassú turizmus modellezése. *Turizmus Bulletin*, *16*(1), 3-10.
20. Perano, M., Abbate, T., La Rocca, E. T., & Casali, G. L. (2019). Cittaslow & fast-growing SMEs: Evidence from Europe. *Land Use Policy*, *82*, 195-203. https://doi.org/10.1016/j.landusepol.2018.12.018
21. Simonović, Z., Miletić, S., & Popović, V. (2019). Some features of development in the agricultural policy Western Balkan candidates for market access in the EU. *Economics of Agriculture*, *66*(2), 541-557. https://doi.org/10.5937/ekoPolj1902541S
22. Slow Food (2024), https://www.slowfood.com/ (March 23, 2024)
23. Smith, S. P. (2021). Landscapes for "likes": capitalizing on travel with Instagram. *Social Semiotics*, *31*(4), 604-624. https://doi.org/10.1080/10350330.2019.1664579
24. Sofronijević, K., & Kocić, M. (2022). The determinants of the usefulness of online reviews in the tourist offer selection. *Hotel and Tourism Managemen*t, *10*(2), 25–37. https://doi.org/10.5937/menhottur2202025S
25. Tiggemann, M., & Zaccardo, M. (2018). 'Strong is the new skinny': A content analysis of #fitspiration images on Instagram. *Journal of Health Psychology*, *23*(8), 1003-1011. https://doi.org/10.1177/1359105316639436
26. Zeng, B., & Gerritsen, R. (2014). What do we know about social media in tourism? A review. *Tourism Management Perspectives*, *10*, 27-36. https://doi.org/10.1016/j.tmp.2014.01.001

PLACE AND ROLE OF MARKETING COMMUNICATION IN RURAL AREAS IN CENTRAL SERBIA

Dejan Dašić[1], Biljana Vitković[2], Marija Ilievska Kostadinović [3], Gruja Kostadinović [4], Milijanka Ratković [5]

**Corresponding author E-mail: drddasic@gmail.com*

ARTICLE INFO

Original Article

Received: *06 May 2024*

Accepted: *27 May 2024*

doi:10.59267/ekoPolj2402599D

UDC 339.138:316.334.55(497.11)

Keywords:

Social media, markenting communication, Networks, Farmers, Agricultural, Serbia

JEL: *P25, Z32*

ABSTRACT

Social media is a new emerging field in agricultural marketing, and its use is rapidly evolving, upgrading, and expanding. The aim of this study is to determine the attitudes of agricultural product producers in central Serbia regarding the use of social media in their business, with a focus on identifying the perception of the promotional potential of social networks themselves. The research included a final sample of 200 respondents. The basic hypothesis in this paper is that the internet as a technology for e-commerce, information, and advertising has great potential to improve the position of farmers and producers, but it is not fully utilized. The majority of agricultural producers still use Facebook as one of the main promotional channels.

Introduction

The importance of communication, both at the individual and business entity levels, is reflected in the fact that social acceptance is precisely based on the successful conduct

1 Dejan Dašić, PhD., Full Professor, Faculty of Law, Security and Management "Constantine the Great", University Union "Nikola Tesla", Zetska 2-4, mezanin, 18000 Ниш, Phone:+381 018 423 82 88, drddasic@gmail.com, ORCID ID (https://orcid.org/0000-0002-8245-1117)

2 Biljana Vitković, PhD., Associate proferssor, Faculty of Sport, University ''Union – Nikola Tesla'',Narodnih heroja 30, New Belgrade, Serbia, Phone:++381 11 404 40 50, E- mail: biljana.vitkovic@fzs.edu.rs, ORCID ID (https://orcid.org/0000-0001-5312-0979)

3 Marija Ilievska Kostadinović, PhD., Associate proferssor, Faculty of Law, Security and Management "Constantine the Great", University Union "Nikola Tesla", Zetska 2-4, mezanin, 18000 Ниш, Phone:++381 018 423 82 88, E-mail marija.ilievska@konstantinveliki.edu.rs, ORCID ID (https://orcid.org/0000-0001-7137-6177)

4 Gruja Kostadinović, PhD., Full Professor, Faculty of Law, Security and Management "Constantine the Great", University Union "Nikola Tesla", Zetska 2-4, mezanin, 18000 Ниш, Phone:++381 018 423 82 88, E-mail, gruja.kostadinovic@konstantinveliki.edu.rs, ORCID ID https://orcid.org/0000-0002-6049-0916

5 Milijanka Ratković, PhD., Full Professor, Faculty of Sport, University ''Union – Nikola Tesla'', Narodnih heroja 30, New Belgrade, Serbia, Phone:++381 11 404 40 50, E-mail, milijanka.ratkovic@fzs.edu.rs, ORCID ID (https://orcid.org/0000-0002-8245-1117)

of the communication process, and in the context of a business entity, successful market performance. In order for a business entity to ensure that its products and services are successfully sold, it must communicate with its current and potential customers, offering its products through messages that must be informative and substantive, tailored to each specific target group in order for the products and services to meet the needs and desires of customers.

The role of social media in agribusiness and advertising agricultural products is becoming increasingly significant in today's digital age (Dašić, et al, 2023a;). Social media enables direct communication with consumers, brand expansion, and product promotion on a global level (Felix, et al., 2016). Social media allows agribusiness to communicate directly with consumers. This is particularly important for small producers and local farmers who can use platforms like Instagram, Facebook, and Twitter to promote their products, share information about their origin, quality, and production methods, thus building trust with consumers (Raketić, 2022). Through active presence on social media, agribusiness can increase the visibility of its brand among consumers. Regularly publishing content such as product images, recipes, usage tips, or stories about farms and producers can attract the attention of new consumers and raise awareness about the brand. Social media has transformed the marketing landscape, as businesses leverage social media to educate, engage, and entice their current clientele. Social media marketing empowers business firms to generate perceived brand equity activities and build the notion among consumers to continue using the firms' products and services (Yang, et al., 2022).

Additionally, they offer various opportunities for advertising and promoting agricultural products. Through targeted advertising on platforms like Facebook and Instagram, agribusiness can target specific demographic groups and target markets, increasing advertising efficiency and return on investment. Social media also allow agribusiness to educate consumers about the importance of healthy eating, sustainable production, environmental protection, and other topics relevant to the agricultural industry. By publishing informative articles, video content, and interactive posts, agribusiness can raise consumer awareness and promote its values. Finally, but not less importantly, social media enable agribusiness to track current industry trends, consumer reactions to new products and campaigns, and to receive direct feedback from consumers through comments, ratings, and surveys. This allows agribusiness to quickly respond to market needs and improve its products and services. The digital economy has its own set of business characteristics that necessitate the creation of new company models in order to attain strategic marketing excellence. It has been confirmed that half of all people on the planet use social media. Businesses may enhance their business intelligence and obtain market insights with the use of social media. Businesses may utilize social media as a flexible tool for marketing strategies, to increase engagement, to create a communication plan, and to track results.Marketing strategies in social media is a strategy to communicate brands, services, products, and ideas (Rosário & Dias, 2023).

Literature review

Marketing communication encompasses all promotional activities including advertising, personal selling, sales promotion, the Internet, public relations, and communications with the functional elements of the marketing mix. Marketing communication comprises all elements of the organizational marketing mix that encourage exchange by establishing common significance with consumers or clients (Cheng Chu Chan, et al., 2023; Pantić et al., 2022; Meliawati, et al., 2023). Global agriculture is expanding and becoming more intensive, which are significant developments. In every industry, including agriculture, firms need to communicate strategically (Ruban &Yashalova, 2022). The way farmers obtain information and interact with customers has been greatly impacted by the Internet. Agriculturalists may now interact with their audience members through free, almost immediate channels because to the usage of user-generated media, particularly social media (White, et al., 2014).

Social media technologies have given rise to influencers who shape the purchasing behaviors of their followers (peer consumers), thus enabling consumer-initiated social commerce (Wu,et al., 2022). Social media and social networks are often associated terms but have several significant differences. The term “social media” encompasses a broader spectrum of digital platforms and tools that enable interaction, content sharing, and communication among users (Ibáñez-Sánchez, et al., 2022). This includes social networks like Facebook, Twitter, Instagram, LinkedIn, as well as blogs, forums, video-sharing websites like YouTube, and other online platforms for information exchange. The term “social networks” specifically refers to online platforms or applications designed to allow users to connect, communicate, share content, and interact with other users. Social networks typically have a profile for each user, enable friend connections (following, being followed), posting status updates, sharing photos, videos, and messaging. In summary, while social media is a general term that encompasses various online platforms for interaction and content sharing, social networks are a specific type of social media that allows users to connect and communicate in a personalized manner (Varela-Neira, et al.. 2023).

The Internet has proven its capabilities to many individuals and organizations in the promotion of their products, but also in other business segments (Mihić,et al., 2023). Among other things, the goals of the Internet in any business are to expand the business to the goal of reaching the largest number of customers currently possible and find the best distribution channels (Razaque Chhachhar & Hassan, 2013; Dašić & Jeličić, 2016). Putting the Internet into the function of e-business implies exactly the aforementioned. Promotion, that is, presentation of the offer of the goods in a way that will attract customers (Tasić & Đokić, 2022) is directly related to this. Social networks have taken the central role in modern society during the last two decades. They are part of the basic communication, entertainment and various other online activities (the Covid-19 era has enhanced this even more), and as such, have become an integral part of marketing strategies for companies (Dašić, et al., 2024).

In the study performed by Kocan and associates (2017), the factors that have a great impact on (un)successful business of agricultural households in Serbia were analyzed. The authors emphasize how crucial it is to implement preventative measures in order to shield crops from the damaging consequences of climate change. Apart from the aforementioned, it is necessary to give small and medium-sized farming households access to more finance, expertise, and technology.

Serbia has all the natural, cultural and social preconditions for healthy food development and production, such as various biodiversity, noticeable agricultural resources, a large percentage of active agricultural origin, traditional farming methods, limited use of chemicals, etc. (Dašić et al., 2020; Ilić et al., 2022; Leković, et al., 2022). The reasons why this potential has not yet been used to this day may be found in the inadequate and insufficient Internet promotion of domestic agricultural products (Dašić, et al., 2022).

The agriculture industry may use a variety of techniques to promote its products and services on social media. One tactic is sponsored content, when ads are shown prominently next to users' normal browsing activities. Because they are made for shorter content and have sizable user populations, social media platforms like Facebook, Instagram, and Twitter are frequently utilized for sponsored content advertising (Ju, et al., 2021).

Similarly, social media can be used to interact directly with customers and potential customers (Pikelj, 2020; Li, et al., 2021). When consumers express interest in their goods and services, the industry may respond quickly by posting comments and answering questions. The use of social media and the internet has changed consumer behavior as well as corporate operations. Social and digital marketing offers significant opportunities to organizations through lower costs, improved brand awareness and increased sales (Bushara, et al., 2023 ; Dwivedi, et al., 2021; Dašić, et al, 2023b).

Research Methodology:

Descriptive research on social media was used as the foundation for this study since the researcher was interested in learning how people who fit the study's criteria used social media. The study framework is defined by the terms social networks and Internet marketing. These days, social media plays a significant role in online marketing. The purpose of the relationship between these crucial terms and the previous section is only to emphasize how significant they are; the study's main objective is to find out how Central Serbian farmers see social media marketing in general. In keeping with the foregoing, the main goal of this essay is to show how social networks may be used to promote agricultural products.

Our objectives were to ascertain the extent to which respondents were aware of the benefits of using social networks for Internet promotion, the specific social networks they utilized for product marketing and sales, and their level of familiarity with these platforms. Two hundred agricultural farm owners and holders made up our sample group. In 2024, the research was conducted in Central Serbia in the months of February and March. Both primary and secondary data sources were employed, and the degree of presentation of the study results was built around a descriptive analysis.

H1: Agricultural producers from central Serbia are not utilizing social media platforms to their full potential for marketing.

H2: Agricultural producers from central Serbia mostly use the social network Facebook to promote their products

The Sample

A total of 200 respondents—180 men and 20 women—submitted the right form of replies to the survey, which was distributed to 226 addresses. This means that there were 90% more men than women among the 200 respondents. From Table 1, we can see that the largest number of respondents, 43%, are between 30 and 40 years old, while only 6 respondents, or 4%, are over 50 years old.

Table 1. Sociodemographic characteristics of the respondents

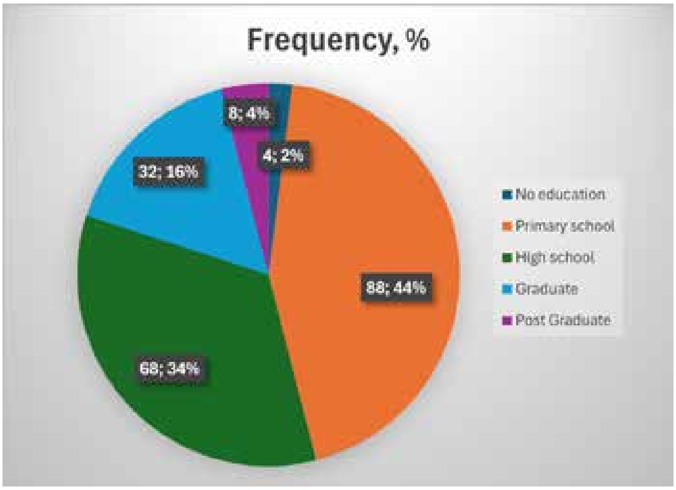
Age (Yrs)	Frequency	%
20 – 30	58	29
30 – 40	86	43
40 – 50	50	25
≥ 50	6	4
Gender		
Male	180	90
Female	20	10

Results and discussion

Education and training play a crucial role in the success and sustainability of agricultural producers. By investing in education, farmers gain the knowledge and skills needed to adopt modern techniques, improve productivity, and mitigate risks. From Figure 1, we notice that 4 respondents, or 2%, answered “no education,” which is a disappointing statistic. The largest number of respondents, 88 or 44%, completed primary school. On the other hand, it is encouraging to see that 68 respondents, or 34%, completed high school, while 32 respondents, or 16%, completed college or university.

Furthermore, education fosters a deeper understanding of sustainable farming practices, environmental stewardship, and efficient resource management, contributing to long-term agricultural viability and resilience. Overall, continuous education and training are key drivers of growth and competitiveness in the agricultural sector, ensuring a brighter future for producers and sustainable food production for generations to come.

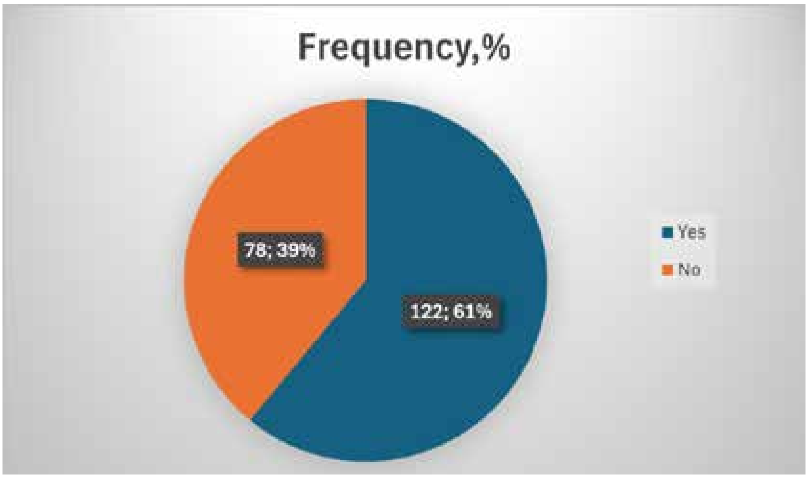
Figure 1. The education of the respondents



Source: Authors

The phenomenon of social networks refers to the pervasive impact of online platforms that enable people to connect, interact, and share information virtually. Social networks offer a multitude of benefits, such as enhancing communication, fostering collaboration, and promoting cultural exchange. They provide platforms for expressing opinions, sharing experiences, and building relationships with like-minded individuals. Businesses leverage social networks for marketing, customer engagement, and brand promotion, tapping into vast audiences and targeting specific demographics. From Figure 2, we can see that 122 respondents, or 61%, use one or more social networks in their business, while 78 respondents, or 39%, reported that they do not use any social networks for business or promoting their agricultural products.

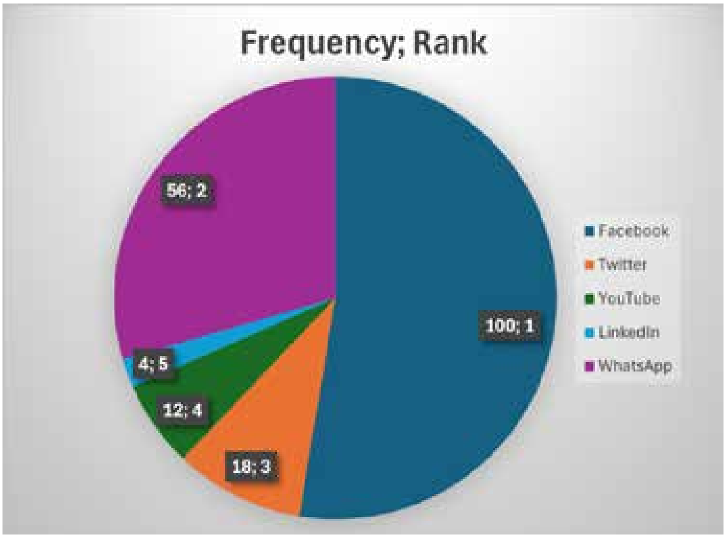
Figure 2. Do you have account on social media?



Source: Authors

Facebook is the most popular social networking site on the planet and a vital tool in the lives of users. Particularly on Facebook, individuals frequently form business groups that enable them to transact business. A marketplace is a type of organization that enables users to engage in consumer-to-consumer business transactions. Facebook users may form marketplace groups in which to sell their goods. Social media platforms are widely used by both developed and developing nations to make purchases of goods. COVID-19 has also had a major effect on consumers' decision to buy things in marketplaces. Moreover, popular social networks, such as Facebook and Twitter, are used by marketers to draw attention to their products and services and reach out to the customers (Ebrahimi, et al., 2022). The social network with the largest number of users in 2024 is Facebook, over 3 billion, followed by Whatsapp, Youtube, Instagram, etc. (Shewale, 2024). And the data from Figure 3 show us that the largest number of agricultural producers from central Serbia, 100 of them, use Facebook.

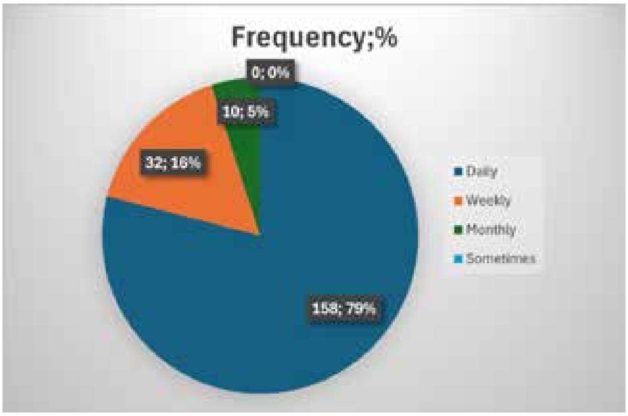
Figure 3. Which social media account do you use?



Source: Authors

Recent research shows that in 2012, people spent an average of 90 minutes per day on social media, while data for 2023 indicates that individuals spend as much as 151 minutes using social networks throughout the day (Statista, 2024). This data is also confirmed by the results from Figure 4, where the vast majority of respondents, 158 or 79%, answered that they use one of the social networks every day.

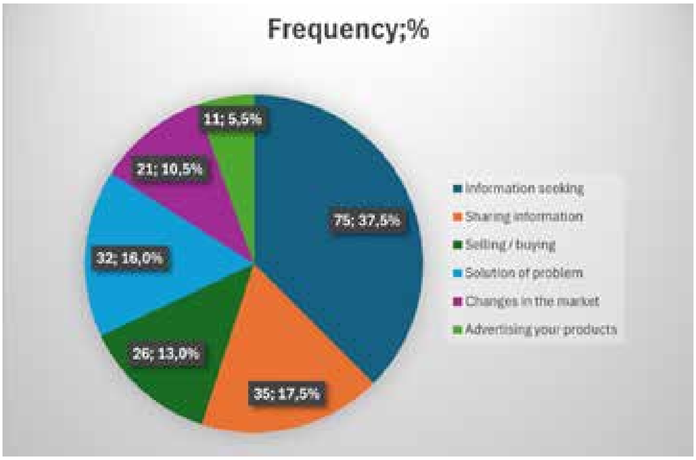
Figure 4. Frequently of visiting Social Media



Source: Authors

Web 2.0 along with user generated content (Kaplan and Haenlein, 2010) allowed for fast spreading of collaboration tools, such as weblogs or social networking sites or collaborative communities among employees all over the world. The question that obviously arises is: what makes users to adopt social media for their work? (Leftheriotis, Giannakos, 2014). One possible answer to this question is: "87% of buyers think that social media helps them make shopping decisions.43% of customers learn about new products through social media networks.66% of customers buy after seeing other people's social media posts.71% of people are more likely to buy something based on social media referrals.A successful social selling program leads to increased pipeline, better win rates, and up to 48% larger deals" (Manich, 2024). From Figure 5, we see that the largest number of agricultural producers use social media to search for or share information about their work, and then to solve some of their problems or to sell and buy.

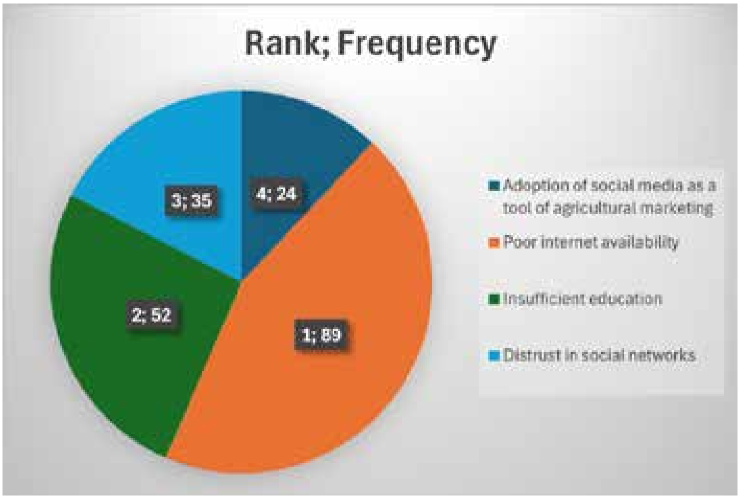
Figure 5. Use of social media in agricultural marketing for:



Source: Authors

The need to follow and integrate modern market communications into business processes is a prerequisite for improving business and providing higher quality services to consumers. The foundation of successful business is innovation, and communication becomes the primary means for profit growth and ensuring a good market position *(Stevanović, et al., 2022).* Media professionals and providers have a special responsibility, being challenged to take on a role as multipliers for awareness raising and human rights education (Bauer, et al., 2024). The use of social media by agricultural producers can bring various challenges and issues. One of the primary concerns is misinformation and the spread of rumors or false information that can harm a producer's reputation or mislead consumers. Privacy and data security are also significant concerns. Sharing too much information about farming practices or personal details on social media can expose producers to risks such as theft, fraud, or misuse of data (Vlajić, 2023). From Figure 6, we observe that 35 respondents answered that they do not use social media in their business due to lack of trust in them.

Figure 6. Issues with social media marketing for agriculture



Source: Authors

Conclusions

Social networks have taken the central role in modern society during the last two decades. They are part of the basic communication, entertainment and various other online activities (the Covid-19 era has enhanced this even more), and as such, have become an integral part of marketing strategies for companies (Dašić, et al., 2021). Maintaining a favorable image for the company is one of the key objectives of communication, which is a purpose-driven, goal-directed activity (Erickson, et al. 2011). Social networks are an appealing option for the marketing and sale of agricultural products because they offer efficient means of swiftly and affordably contacting a large number of potential buyers. The ease with which items could be ordered online and through social media during the Covid-19 outbreak immediately demonstrates how crucial it is to use these channels into marketing plans.

Social media platforms provide direct communication between users and service providers, clients, information exchange hubs, etc. Social media is being used by farmers to boost production at every level. Social media is becoming into a potent instrument that links millions of people worldwide. Social media is being used by farmers because it allows them to communicate virtually with other farmers, agribusiness, and agriexperts. Social media in agricultural marketing helps to solve some of the issues in the field to some level. Social media's primary goals are awareness-raising and information dissemination.

Traditional media and social media are quite different. To exchange information, social media users are starting their own communities, blogs, pages, and organizations. Additionally, they are buying and selling agricultural goods in this group. You may accomplish this by sending links, movies, photographs, and more.The creation of networks and the sale of farmers' goods are made easier by this information exchange. Information on agricultural marketing is covered in a lot of blogs.

As in the previous similar study (Dašić, et al., 2023b), based on the results of the research in this paper, it can be said that agricultural producers from Central Serbia recognize social networks as an important way of promotion, but still not all respondents think so, considering that not all of them have personal or business accounts within these networks, the first hypothesis is confirmed by this. Also, from the results we can see that Facebook is still the most popular social network, thus confirming the hypothesis "agricultural producers from central Serbia mostly use the social network Facebook to promote their products".

Limitations and recommendations

This study's primary limitations are its large dependence on qualitative interpretations and sample size.Furthermore, the findings indicate that just a tiny percentage of central Serbian farmers have a website, which may be one way to enhance future marketing and sales.

Conflict of interests

Authors declare no conflict of interest.

References

1. Bushara, M.A., Abdou, A.H., Hassan, T.H., Sobaih, A.E.E., Albohnayh, A.S.M., Alshammari, W.G., Aldoreeb, M., Elsaed, A.A. & Elsaied, M.A. (2023) Power of Social Media Marketing: How Perceived Value Mediates the Impact on Restaurant Followers' Purchase Intention, Willingness to Pay a Premium Price, and E-WoM? Sustainability, 15, 5331. https://doi.org/10.3390/su15065331

2. Bauer, J., Chakrabarti, J. & Hirschberger, B. (2024) Social Media as a Tool against Populist Appropriation of FoRB and for Promoting FoRB? In: Bernd Hirschberger, Katja Voges (eds.) Religious Freedom and Populism The Appropriation of a Human Right and How to Counter It. Bielefeld: transcript Verlag, pp. 233-246. https://doi.org/10.1515/9783839468272-019
3. Cheng Chu Chan, I., Chen, Z., & Leung, D. (2023)The more the better? Strategizing visual elements in social media marketing, *Journal of Hospitality and Tourism Management*,Volume 54, 268-289. https://doi.org/10.1016/j.jhtm.2022.11.007.
4. Dašić, D., & Jeličić, G. (2016) Marketing of personality and/or sportsmen personal branding. *Sports, media and business*, 2(2), 51–57. Retrieved from http://www.smb.edu.rs/index.php/smb/article/view/90
5. Dašić D, Živković D. & Vujić T. (2020). Rural tourism in development function of rural areas in Serbia. *Economics of Agriculture*, Year 67, No. 3, 719-733; doi:10.5937/ekoPolj2003719D
6. Dašić, D., Stanić, T., & Živković, D. (2022). Market of agricultural and food products in the republic of Serbia: possibilities and implications. *Economics of Agriculture*, *69*(1), 57–74. https://doi.org/10.5937/ekoPolj2201057D
7. Dašić, D., Ratković, M. Marčetić, A., & Tošić, M. (2023b) Promotion on the internet as a function of agribusiness development in central Serbia**.** *Economics of Agriculture*, Vol 70, бр. 2, 479-491- https://doi.org/10.59267/ekoPolj2302479D
8. Dašić, D., Vučić, V., Turčinović, Ž., & Tošić, M. (2023a) Digital marketing - marketing opportunities and the power of virtual consumers. *Economics of Agriculture*, Vol 70, no. 4,- 1187- 1199. doi:10.59267/ekoPolj23041187D
9. Dwivedi, Y., et al., (2021) Setting the future of digital and social media marketing research: Perspectives and research propositions, *International Journal of Information Management*, Volume 59, https://doi.org/10.1016/j.ijinfomgt.2020.102168.
10. Dašić, D., Ilievska Kostadinović, M., Vlajković, M., & Pavlović, M. (2024) Digital literacy in the service of science and scientific knowledge. *International Journal of Cognitive Research in Science, Engineering and Education* (IJCRSEE), *12*(1), 219–227. https://doi.org/10.23947/2334-8496-2024-12-1-219-227
11. Ebrahimi P, Basirat M, Yousefi A, Nekmahmud M, Gholampour A, &Fekete-Farkas M. (2022) Social Networks Marketing and Consumer Purchase Behavior: The Combination of SEM and Unsupervised Machine Learning Approaches. *Big Data and Cognitive Computing*. 6(2):35. https://doi.org/10.3390/bdcc6020035
12. Erickson, S.L., Weber, M., & Segovia, J. (2011) Using communication theory to analyze corporate reporting strategies. *J. Bus. Commun*. 48, 2, 207–223. https://doi.org/10.1177/002194361139972

13. Felix, R., Rauschnabe, P., & Hinsch, C. (2016) Elements of strategic social media marketing: A holistic framework, *Journal of Business Research*, http://dx.doi.org/10.1016/j.jbusres.2016.05.001
14. Ibáñez-Sánchez, S., Flavián, M., Casaló, L.V., & Belanche, D. (2022). Influencers and brands successful collaborations: A mutual reinforcement to promote products and services on social media, *Journal of Marketing Communications*, 28(5), 469-486. DOI: 10.1080/13527266.2021.1929410
15. Ilić, V., Mihajlović, M., & Knežević, M. (2022). The role of social entrepreneurship in modern business conditions. *Oditor*, *8*(2), 75-90. https://doi.org/10.5937/Oditor2202074I
16. Ju, R., Dong, C., & Zhang, Y. (2021) How controversial businesses communicate CSR on Facebook: Insights from the Canadian cannabis industry. *Public Relat. Rev*., 47. https://doi.org/10.1016/j.pubrev.2021.102059
17. Yang Q, Hayat N., Al Mamun A., Makhbul ZKM, & Zainol N.R. (2022) Sustainable customer retention through social media marketing activities using hybrid SEM-neural network approach. *PLoS ONE* 17(3): e0264899. https://doi.org/10.1371/journal.pone.0264899
18. Kočan, E., Pejanović, R. & Cvijanović, S. (2017) *Faktori uspešnog poslovanja poljoprivrednih gazdinstava u Srbiji.* Zbornik radova sa Prve nacionalne naučno-stručne konferenvije sa međunarodnim učešćem - Trendovi u poslovanju, Kruševac, vol. 1, 139-151.
19. Li, F., Larimo, J. & Leonidou, L.C. (2021) Social media marketing strategy: definition, conceptualization, taxonomy, validation, and future agenda. *J. of the Acad. Mark. Sci.* 49, 51–70. https://doi.org/10.1007/s11747-020-00733-3
20. Leković, M., Cvijanović, D., Pantić, N., & Stanišić, T. (2020). Evaluative bibliometric analysis of recent trends in rural tourism literature. *Ekonomika poljoprivrede*, 67(4), 1265-1282. DOI: 10.5937/ekoPolj2004265L
21. Leftheriotis, I. & Giannakos, M.N. (2014) Using social media for work: Losing your time or improving your work? *Computers in Human Behavior*, Volume 31, 134-142 https://doi.org/10.1016/j.chb.2013.10.016.
22. Manich (2024) Social Selling Statistics for 2024 and Why It Matters. https://optinmonster.com/social-selling-statistics/
23. Mihić, S, Dašić, D., & Bogdanova, M., (2023) Promotion of sports and fitness through health in Serbia. In: Dašić, D. (ed.) *SPORTICOPEDIA - SMB*, *1*(1), 239-249. https://doi.org/10.58984/smbic2301239m
24. Meliawati, T., GeraldS. C., & Akhmad Edhy Aruman. (2023). The Effect of Social Media Marketing TikTok and Product Quality Towards Purchase Intention. *Journal of Consumer Sciences*, 8(1), 77-92. https://doi.org/10.29244/jcs.8.1.77-92

25. Pantić, N., Mikulič, K., & Lekovič, M. (2022). The influence of claims payments on the investment portfolio of insurance companies. *Oditor*, *8*(3), 42-71. https://doi.org/10.5937/Oditor2203042P

26. Pikelj, I. (2020) Easier entry into the labor market with new knowledge. *Sports, media and business*, *6*(1), 76-80. https://doi.org/10.58984/

27. Raketić, N. (2022) Transformacija televizije i novinarstva u medijskoj industriji digitalnog doba. *Sports, media and business*, *8*(1), 171-174. https://doi.org/10.58984/smb2201171r

28. Rosário, A. T. & Dias, J. C. (2023). Marketing Strategies on Social Media Platforms. *International Journal of E-Business Research (IJEBR), 19*(1), 1-25. http://doi.org/10.4018/IJEBR.316969

29. Ruban, D.A. & Yashalova, N.N. (2022) CorporateWeb Positioning as a Strategic Communication Tool in Agriculture. *Agriculture*, 12,1101. https://doi.org/10.3390/

30. Razaque Chhachhar, A., & Hassan, S. (2013) Information Communication Technology for Agriculture Development. J Am Sc;9(1):85-91. http://www.jofamericanscience.org.

31. Stevanović, A., Mitrović, S., & Rajković, A. (2022). Primena informacionih tehnologija i interneta u savremenom poslovanju. *Oditor*, *8*(2), 54-74. https://doi.org/10.5937/Oditor2202054S

32. Shewale, R. (2024) Social Media Users 2024 (Global Data & Statistics). https://www.demandsage.com/social-media-users/

33. Statista (2024) Daily time spent on social networking by internet users worldwide from 2012 to 2024. https://www.statista.com/statistics/433871/daily-social-media-usage-worldwide/

34. Tasić , T., & Đokić, A. (2022). External communication of fc radnički Niš on the social network instagram. *Sports, media and business*, *8* (1), 157–169. https://doi.org/10.58984/smb2201157t

35. Varela-Neira, C., Dwivedi, Y.K. & Camoiras-Rodriguez, Z. (2023), Social media marketing system: conceptualization, scale development and validation, *Internet Research*, Vol. 33 No. 4, pp. 1302-1330. https://doi.org/10.1108/INTR-06-2021-0393

36. Vlajić, I. B. (2023) Pravni aspekti suprotstavljanja sajber kriminalu u evropskoj uniji. *Oditor*, *9*(2), 178-207. https://doi.org/10.5937/Oditor2302179B

37. Wu, Y., Nambisan, S., Xiao, J. *et al.* (2022) Consumer resource integration and service innovation in social commerce: the role of social media influencers. *J. of the Acad. Mark. Sci.* 50, 429–459. https://doi.org/10.1007/s11747-022-00837-y

38. White, D., Meyers, C., Doerfert, D., & Irlbeck, E. (2014) Exploring Agriculturalists' Use of Social Media for Agricultural Marketing, *Journal of Applied Communications*: Vol. 98: Iss. 4. https://doi.org/10.4148/1051-0834.1094

INFLUENCE OF PRODUCTION OF PRIMARY PRODUCTS ON THE RATE OF INFLATION IN THE REPUBLIC OF SERBIA

Đorđe Kotarac[1], Simo Stevanović[2]

**Corresponding author E-mail: djordje.kotarac@agrif.bg.ac.rs*

A R T I C L E I N F O

Original Article

Received: *10 May 2024*

Accepted: *10 June 2024*

doi:10.59267/ekoPolj2402613K

UDC 330.123.72:336.748.12(497.11)

Keywords:

Inflation rate, Primary sector, Purchasing power, Volume of production, Republic of Serbia.

JEL: *E23, E31, B23*

A B S T R A C T

The optimization of production processes leads to an increase in the volume of output from the primary sector, as an instrument to protect the population from crossing the border of extreme poverty. The Republic of Serbia is a traditional producer of primary products, as evidenced by the realized surplus in the net export of agricultural crops. In the period after global financial crisis, the Republic of Serbia achieved an above-average inflation rate growth, compared to the countries of the European Union. In this research, we detect a significant participation of products from agriculture, forestry, fishing, mining to reduce the volatility of product prices. The purpose of the research is to prove the causal relationship between the rate of inflation and the volume of production primary products. The methodological part was carried out through the evaluation of the model using econometric methods. The conclusion indicates a high correlation between the production of primary outputs and the rate of inflation in the Serbian economy.

Introduction

In the second half of the 20th century, the neo-classic economic thought was developed, according to which economic growth depends of reallocation of key factors of production, from the primary sector (agriculture, forestry, fishing, mining) to the secondary sector. In accordance with the adopted provision of the economic policy, the process of industrialization was rapidly implemented in developed and developing countries (Anríquez & Stamoulis, 2007). The process of continuous neglect of the primary sector causes the appearance of low productivity, insufficient application of technological innovations, low level of education and low income of the rural population (Lundahl, 2015).

1 Đorđe Kotarac, MSS, teaching assistant, Faculty of Agriculture, Unversity of Belgrade, Nemanjina 6, Republic of Serbia, Phone: 0616730760, E-mail: djordje.kotarac@agrif.bg.ac.rs, ORCID ID: (https://orcid.org/0009-0005-6794-3788)

2 Simo Stevanović, PHD, full professor, Belgrade University, Faculty of Agriculture, Nemanjina 6, Belgrade, Republic of Serbia , Phone: +381114413418, E-mail: simo.stevanovic@agrif.bg.ac.rs, ORCID ID: (https://orcid.org/0000-0002-9188-5929)

According to Kumar and Aithal (2023), insufficient attention is paid to the role of the primary sector in the overall development strategy of national economies. However, the absence of development of the primary sector leads to a scarcity of natural resources and raw materials, as well as basic foodstuffs. As a results, the general level of prices in observed economy increases, which directly affects the decline in the purchasing power of the population (Hałka & Leszczyńska Paczesna, 2023). In his research Brown (2008), claims that the stagnation of the primary sector would potentially threaten the comprehensive development of the national economy of the countries.

The potential of the primary sector of the Republic of Serbia is related to traditional food production, due to the favorable conditions of the natural environment and the high quality of arable land (Mihailović, Cvijanović, and Paraušić, 2013). In this regard, the Republic of Serbia achieves a chronic trade surplus, i.e. an increase in the net export of foodstuffs and agricultural raw materials. After the global Covid 19 pandemic, the growth in the volume of food production in the primary sector of the Republic of Serbia was 16.9% (Akter, 2020).

Through the analysis of production factors, we observe a percentage decrease in the number of employees within the primary sector, for the activities of agriculture, forestry, fishing and mining (Brož & Kočenda, 2018; Gáll, 2023). In the last quarter of 2018, the total number of employees was 1.59%, while the latest calculated data indicate a percentage of 1.29%. Due to the increase in the productivity of the primary sector, the nominal income of employees increase by 8.9% during 2020, as well as the growth of 8.4% during 2021(Ćorović & Gligorijević, 2021).

The neglect of the primary sector in the last couple of decades, affects a significant reduction in the level of education of the workforce, which reduce the application of technological achievements in the direction of the development of this sector (Kumar & Aithal, 2023). In the period June/July 2021, the value of the index of industrial production increases by 7.8%, compared to the same months previous year (Krstić, Jaksić, Mimović and Tadić, 2022).

In previous research, it is emphasized that the maintenance of overall economic development requires investment in activities such as agriculture, forestry, fishing and mining. By calculating the gross added value, we observe reliable data, which represent indicators of market conditions within a economic state of the country (Zakrzewska & Nowak, 2022). The available database indicate a significant contribution of primary outputs (agriculture, forestry, fishing, mining) to the creation of gross added value of the Republic of Serbia.

The total volume of output from the primary sector achieves an increase in participation in the creation of gross added value on the territory of the Republic of Serbia, in the period from 2011 to 2023. In the third quarter 2023, the volume of primary products increased by 1.6 times compared to the volume of primary outputs, which were produced in the same quarter 2011.

In the period after the global Covid 19 pandemic, the production of primary outputs constitutes for 6% of the gross added value of the Republic of Serbia (Demary, Herforth and Zdrzalek, 2022). In the continuation of the research, we present the key factors that influence the quarterly level of production of primary products and regressors that affect the general level of prices in the Republic of Serbia. In the first place, we mention the change in the price of energy sources (coal, oil, gas, oil shale). In addition, we emphasize the change in the condition of the natural environment and temperature oscillations. Finally, the success of the agricultural season is reflected in the level of the annual yield (Turan & Özer, 2022).

The agricultural seasons of 2020 and 2021 are characterized by above-average temperatures, which causes to two dry years in the Republic of Serbia. There is a significant drop in the yield of agricultural production. In the same period, the inflation rate reaches 15.1%, during December 2022 (Tabaković, 2023). As a method of mitigating the growth of inflationary rate, it involves the process of reviving global supply chains, which leads to a decrease in domestic and world energy prices. According to quarterly data, the agricultural season in 2023 was a more successful, in terms of growth in the volume of primary outputs in the Republic of Serbia (Krstić, Jaksić, Mimović and Tadić, 2022).

The method of evaluating the correlation between the described macroeconomics variables is carried out through verified econometric tests. The initial step refers to revealing the direction of causality of the variables, which are the subject of our research (Shojaie & Fox, 2022). In the continuation of this research, we examine the regression between the production of primary outputs and the inflation rate. This type of prediction allows us to forecast further changes in the values of the observed variables and draw conclusions, with the aim of improving the position of the Serbian economy (Mladenović & Petrović, 2007).

In accordance with theoretical concepts, we define and examine research questions and hypothesis, which represent the subject of this research:

1. Does the increase or decrease in the volume of production of primary outputs affect the change in the quarterly inflation rate, in the observed period?
2. Does the increase or decrease in the quarterly prices of primary products cause variation in the level of output production from the primary sector, in the observed period?

Ho: The realized increase or decrease in the volume of production of primary outputs will not affect the change in the quarterly inflation rate in the economy of Serbia.

H1: The realized increase or decrease in the volume of production of primary outputs will affect the change in the quarterly inflation rate in the economy of Serbia.

In their research Przybyla and Roma (2005) conclude that a higher level of production goods and services, along with the growth of market saturation and concentration, provides mitigation of the increase in the inflation rate in modern economic circumstances. Competitive pressure leads companies to improve production performance and capacity, and the saturation process affects the growth of the supply of goods and services in the observed market areas.

Glatzer, Gnan and Vladerrama (2006) point out that the process of globalization, optimization of supply chains and a higher degree of trade openness, ensure a decrease in the prices of production inputs of countries around the world. The trend of increasing the available amount of production factors affects the volume of production placement of companies. The growth of the market supply of goods and services is positively correlated with the reduction in the inflation rate.

According to Baek and Koo (2010), the price of food in the American market has grown rapidly in the last two decades. By examining the causes of the rise in the general price level, the authors identified three key factors. The group of factors includes the volatility of energy prices, the volume of agricultural goods and exchange rate changes. The influence of the mentioned three variables on the general level of prices was carried out through econometric evaluations.

Olatunji, Omotesho, Ayinde and Adewumi (2012) prove the impact of the efficiency of the primary sector on the oscillation of the inflation rate within the Nigerian economy. The quality of the agricultural season is an important factor in the movement of the general price level. The researchers indicated a significant effect of weather conditions and the availability of natural resources on the volume of food items. The results of the study proved a negative correlation between the volume of agricultural production and the inflation rate.

Ali and Ibrahim (2018) examined the effect of the operations of manufacturing companies on the change in the rate of inflation in the Malaysian economy. In this research, they proved that productivity and technological progress affect the growth of market placement, which leads to a decrease in the general level of prices.

According to Jašová, Moessner and Takáts (2020), the domestic and global output gap significantly influence the change in the value of the consumer price index, in countries around the world. The paper confirmed that the domestic and global output gap influence the change in inflation rates, in the period before the world economic crisis (1994-2007), as well as in the post crisis period (2008-2017).

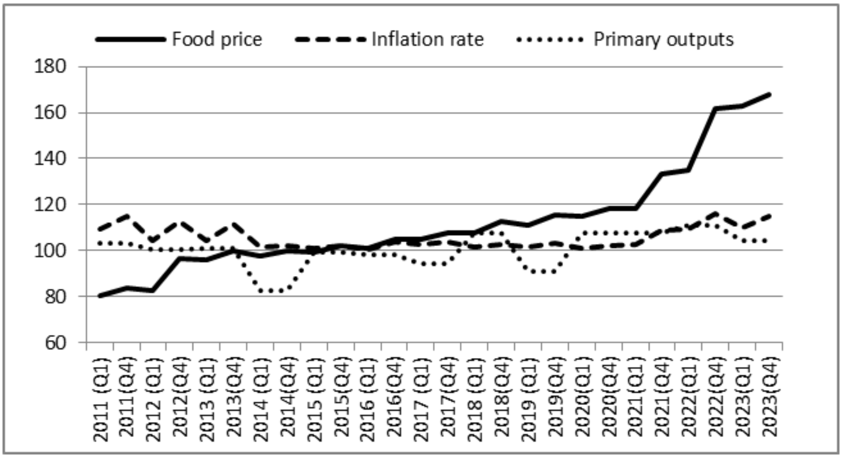
After reviewing the theoretical basis of the influence of the volume of primary production on mitigating the growth of the inflation rate, an analysis of the key characteristics of the primary sector of the Republic of Serbia will be performed. The “Data and Methods” chapter will present the “Granger causality test”, which determines the direction of interaction between variables. In the “Results and Discussion” chapter, the influence of the volume of primary production on the movement of inflation rates will be examined through regression analysis. As part of the conclusion, proposals and economic policy measures will be written to improve the efficiency of the primary sector and the general economic condition.

Key characteristics of the primary sector in Serbian economy

The primary sector represents a strategic component in the process of economic development of countries, with a significant impact on the improvement of performances within the other three sectors (Dimovski, Radivojević and Rađenović, 2023). The production of primary outputs participates in the formation of the value of the gross domestic product, through the creation of added value, with significant employment in the primary sector (Lundahl, 2015). In this sense, the production of primary outputs (agriculture, forestry, fishing, mining) is the basis of the successful economic progress of countries around the world (Cinaroglu & Top, 2021).

The influence of the primary sector on the growth of the gross domestic product is derived through an overview of the trade balance. The key category is net exports of products and services (”Nx”), which is obtained by subtracting imports (”Im”) from exports (”Ex”) of primary outputs, for a period of one year (Šoškić, 2015).

Figure 1. Inflation rate, prices and volume of food production in the Serbian Economy



Source: Author’s calculation, based on data from yearbooks of Serbia (2011-2023)

The primary sector consists mainly of homogeneous products, which in conditions of perfect competition have only price as a differentiating tool on the market. Difficulties in predicting the prices of primary products occur due to the unpredictability of the natural environment and climate changes. As a result, there is a price volatility of primary products on a seasonal level, which can be avoided through the openness of the economy and the removal of trade barriers (Magdalena & Suhatman, 2020).

In developing countries, a significant part of the population earns income through the production within the primary sector. Due to limiting factors, such as: agricultural land area, absence of labour force, high age and lower educational structure, insufficient application of technological innovations, the growth of the primary sector in a short period of time is not achievable. Therefore, increasing total productivity is the strategic orientation of most subject, within the primary economic activity (Brož & Kočenda, 2018).

Data and methods

The source of data for the purposes of this research is the group of ”Statistical Yearbooks”, in the period from 2011 to 2023, which we obtained from the official database of the Statistical Office of the Republic of Serbia. From the publicly available reports of the “World Bank” and “Eurostat”, we conducted an analysis of the trends in inflation rates during the observed period.

Through the review of the statistics of the national accounts of the “Statistical office of the Republic of Serbia”, we find out the participation of primary outputs in the formation of the gross added value. From September 2014, the methodology for calculating “GDP” was changed, in accordance with the “SNA 2008/ESA 2010” implementation plan. The statistical office of the Republic of Serbia has changed the method of calculating national account according to “ESA 2010”. In order to form a regression model, the movement of the inflation rate represents a dependent variable, which was detected in the economy of the Republic of Serbia. In this research, we used quarterly data, obtained through chain indexes, in the period from 2011 to 2023.

The subject of the research refers to the identification of macroeconomic indicators that influence the change in the general level of price in the economic system of the Republic of Serbia. On the other hand, gross added value represents an independent variable in the model, which refers to the primary sector, i.e. activities such as agriculture, forestry, fishing and mining. The added value of production of the primary sector of the Republic of Serbia is the subject of further analysis. The motive for evaluating the regression model is to examine the influence of the volume of production of primary outputs on the movement of the inflation rate.

In the observed model, we included more control variables, in order to achieve a higher degree validity of regression analysis. For the control variable, we use the value of the chain index of nominal wages in the Republic of Serbia. The second control variable implies a change in the nominal exchange rate, in the period from 2011 to 2023. According to the postulates of economic theory, we include energy prices in the country and abroad, as one of the significant factors in changing the general level of prices in the economy. Furthermore, a key part of control variables of the model, which influence the movements of the inflation rate in an economy, refer to the value of the chain indices of the volume of food production, as well as the level of food prices, in the market area of the Republic of Serbia.

In the continuation of the research, we use the method of multiple linear regression to examine the intensity of influence between dependent, independent and control variables in the model. In the empirical part of the research, we conducted an examination of the cause-effect relationship between the dependent variable and six independent variables of this model. Using the method of multiple regression analysis, we identify the direction and intensity of influence between the observed macroeconomic variables (Mladenović & Petrović, 2007).

The process of evaluating the interaction of the variables included in the regression model requires a preliminary examination of the stationary of the time series. Time series with a stochastic trend, which have a unit root, cannot be subject to regression analysis. The mentioned rule is equally used in trend-stationary and difference-stationary types of model (Anderson, 2011). From a statistical point of view, time series with biased and inconsistent estimates and violations of the normality of the distribution cannot be relevant in the process of econometric evaluation. From an economic point of view, the non-stationarity of time series implies a permanent deviation from the trend line, which directly pulls down the values of the time series. The test is carried out on the variables – production of primary outputs ("AQ_t") and inflation rate ("IR_t").

Table 1. Examining the existence of a unit root and stationarity of the included time series in the set regression model

Variables	"ADF" test results		Hypothesis testing	Examining the stationarity of time series
Primary_outputs	1st differences (intercept)	Prob*. (0.0000)	Rejected Ho	The series doesn't have a unit root
Inflation_rate	1st differences (none)	Prob*. (0.0127)	Rejected Ho	The series doesn't have a unit root
Food_prices	1st differences (trend & intercept)	Prob*. (0.0311)	Rejected Ho	The series doesn't have a unit root
Energy_Prices	level (constant)	Prob*. (0.0011)	Rejected Ho	The series doesn't have a unit root
Exchange_rate	level (constant)	Prob*. (0.0048)	Rejected Ho	The series doesn't have a unit root
Nominal_income	1st differences (intercept)	Prob*. (0.0001)	Rejected Ho	The series doesn't have a unit root
Food_outputs	1st differences (intercept)	Prob*. (0.0000)	Rejected Ho	The series doesn't have a unit root

Source: Author's calculation using software Eviews

Note: $p > 0.05$, Null hypothesis: "The time series has a unit roots"

**In the model p < 0.05%, based on which we reject null hypothesis: "the time series has a unit root" and accept the alternative hypothesis: "the time series does not have a unit root". It follows that the dependent, independent and control variables are stationary time series.*

For the purpose of examining the unit root of time series, we use the "ADF test" (extended Dickey Fuller test), with a statistical significance level of $\alpha = 0.05\%$. By logarithming the data and then applying the first difference operator, we transform non-stationary into stationary time series (table 1.). The process of examining the stationarity of the observed series is a necessary requirement for further determining the cause and effect relationship between these two macroeconomic indicators (Shojaie & Fox, 2022). The procedure for applying the "Granger causality test" involves identifying the direction of correlation between the mentioned macroeconomic variables. The “Granger causality test” is used to determine the direction of causality between the total production of primary outputs (agriculture, forestry, fishing, mining) and the movement of the inflation rate in a certain period of time. As a designation for the volume of primary outputs, we use the abbreviation “AQ_t”. Additionally, we use the combination of the letters “IR_t” as a marker for the movement of the quarterly inflation rate.

For the purposes of conducting descriptive statistics and the “Granger causality test” to indentify the interaction between variables, we set the following equations:

$$AQ_t = \sum_{t-1}^{n} C1 * IR_{t-1} + \sum_{t-j}^{n} C2 * AQ_{t-j} + U_{1t} \quad (1)$$

$$IR_t = \sum_{t-1}^{n} C3 * IR_{t-1} + \sum_{t-j}^{n} C4 * AQ_{t-j} + U_{2t} \quad (2)$$

Table 2. Overview of the results obtained through the Granger causality test

Sample	2000 - 2021		
Lags	2		
Null Hypothesis (Ho)	Obs.	F-Statistic	Prob.
The volume of production of primary outputs does not affect the movement of the inflation rate	20	15.9249	0.002
Null Hypothesis (H0a)	Obs.	F-Statistic	Prob.
The movement of the inflation rate does not affect the volume of production of primary outputs	20	1.54563	0.2453

Note: $^{p}P < 0.10$, $^{pp}P < 0.05$, $^{ppp}P < 0.01$.
Sources: Author’s calculation using software Eviews

The result of „Granger causality test” refers to the precise identification of the values of (F) and (T) statistics, which we use to test the statistical significance of hypothesis. Due to prob. (t)=0.002 and prob.(F)=15.9249, with a random error of α=0.05%, we reject the null hypothesis (Ho). Therefore, we conclude that the production of primary outputs affects the movement of the quarterly inflation rate, in the observed economy, for a limited period (table 2.).

Table 3. Results of the cause-and-effect relationship of macroeconomic variables

Variables	(n-r)	Prob.	Direction of influence	Decision
Volume of primary production	20	0.002	AQ_t statistically significantly affects IR_t	Confirmed hypothesis
Inflation rate	20	0.2453	IR_t statistically significantly affects AQ_t	Rejected hypothesis

Note: $^{p}P < 0.10$, $^{pp}P < 0.05$, $^{ppp}P < 0.01$.
Sources: Author’s calculation using software Eviews

In the continuation of the analysis, we calculate the value of the (t) test of prob.=0.2453 and the (F) test of prob.=1.54563, with a random error of α=0.05%. In accordance with the presented results, we accept the "Null hypothesis". The conclusion implies that the movement of the inflation rate does not affect the volume of production of primary outputs in the economy of the Republic of Serbia. On the contrary, the volume of production of primary outputs affects on the movement of the inflation rate in the Serbian economy, for the observed period of time (table 3.)

Results and Discussions

In the direction of a better interpretation of the obtained results, we performed an individual analysis of all positions within the program output of the mentioned econometric model. Therefore, we use the correlation coefficient, the coefficient of determination and the corrected coefficient of determination. The implementation of predictive analytics of this model was carried out by monitoring the value of the standard error of the regression. Testing the statistical significance of the model is provided through assessment of the variables, with the help of various econometric tests. The prerequisite for conducting regression analysis involves determining the equation:

$$Y = \beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \beta_3 * X_3 + \beta_4 * X_4 + \beta_5 * X_5 + \beta_6 * X_6 + \varepsilon_i \quad (3)$$

where Y indicates the value of the dependent variable in the model, and $X_1, X_2, X_3, X_4, X_5, X_6$ represents a set of independent variables in this regression equation. The coefficient β_0 denotes the average initial level of the dependent variable, and the symbol ε_i the random error of this regression model. In addition, regression parameters $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ are partial coefficients, which reflect the influence of a single value of the independent variable on the value of the dependent variable (Mladenović & Petrović, 2007).

The aim of this research is to identify the impact of the volume of output production from the primary sector (agriculture, forestry, fishing, mining) on the trend of the inflation rate in the Serbian economy, in the period from 2011 to 2023. In this sense, we present the results of the multiple linear regression, which we used to analyze the movement of the observed variables, as well as to identify the key factors of their variation.

Table 4. Evaluation of the entire regression model

Model	R- squared	Adjusted R-squared	S.E. of regression	Sum squar. residuals	F statistic	Sig.
Regression Analysis	0.894	0.877	1.725	127.999	52.044	0.0000

Source: Author's calculation using software Eviews

The value of F statistic, with a significance level of α=0.05% is used to evaluate the statistical significance of the entire regression model. Due to the fact that F=52.044 and

Sig.=0.0000, we conclude that the entire regression model is valid. The values of the coefficient of determination (0.89) and the corrected coefficient of determination (0.87), are used to confirm the thesis that independent variables significantly explain the value of included dependent variable in the mentioned econometric model (table 4.).

Table 5. Results of testing the assumptions of the multiple regression model

LM test (Breusch-Godfrey test)		Jarque-Berra test		Breusch-Pagan-Godfrey test	
Prob. (F stat.)	Prob. Chi-Square (2)	JB test	Probability	Prob. (F stat.)	Prob. Chi Square(2)
0.2235	0.1657	4.525091	0.104085	0.2594	0.2468

Source: Author's calculation using software Eviews

In this part of the research, we applied the Breusch-Godfrey test, in order to detect autocorrelation between variables in the econometric model. Based on the Chi-Square (2) probability, which is greater than 0.05%, we reject the null hypothesis (Ho), which implies the absence of autocorrelation between the variables in the specified model. In the presented table number 5, the value of the Jarque-Berra test is 4.52 and the probability is significantly above 0.05%, which leads to the acceptance of the null hypothesis that the residuals have a normal distribution. By examining the results of the Breusch-Pagan-Godfrey test and the Chi-Square probability values, we proved that the residuals are homoscedastic. Finally, the centred VIF values are below 10, indicating that there is no multicollinearity in the model. Therefore, there is no violation of the assumptions of the multiple regression model (table 5.).

Table 6. Results of regression analysis

Regress. Analysis	Model	Unstandardized Coefficient		(T) Statistic	Sig. Toleran.	Collinearity Statistics (VIF)	
Variabl.	1	Beta	Std.Error	Value	p<0.05	Coeff.	Centred
C	(Constant)	34.463	16.500	2.088	0.042	272.250	NA
X1	Energy_Srb	0.389	0.072	5.393	0.000	0.005	2.692
X2	Food_ Prices	0.073	0.020	3.547	0.001	0.000	3.638
X3	Food_Output	-0.001	0.041	-0.027	0.978	0.001	1.670
X4	Exch_Rate	-0.292	0.091	-3.186	0.002	0.008	2.556
X5	Nom_ Income	0.1535	0.056	2.725	0.009	0.003	1.532
X6	Primary_Out	164.66	68.169	2.415	0.0200	4647.04	2.063
Y(-1)	Hicp (-1)	0.277	0.090	3.063	0.0038	0.008	3.142

Note: ^{p}P < 0.10, ^{pp}P < 0.05, ^{ppp}P < 0.01.

Sources: WB datasets, OECD reports, Eurostat, Own calculation using software

Using the results of the regression analysis, we evaluate the regression equation:

$$Y = 34.46304 + 0.389X_1 + 0.073X_2 - 0.001X_3 - 0.292X_4 + 0.153X_5 + 164.663X_6 + \varepsilon$$

$$(16.500) \quad (0.072) \quad (0.020) \quad (0.041) \quad (0.091) \quad (0.056) \quad (68.169)$$

The probability value in the regression model (column Sig.), leads to the conclusion that five independent variables have a statistically significant influence on one dependent variable. The measured prices of domestic and imported energy sources increase inflation rates in the Republic of Serbia. The appreciation or depreciation of the exchange rate and the average nominal wage affect the movement of the general prices in the economy. The research results imply that food prices are directly correlated with the level of inflation in the Serbian economy.

The growth of the output of the primary sector leads to the movement of general level of prices in the economy of the Republic of Serbia (Sig.=0.0002). Based on the principles of economic theory and practice, we conclude that the increase in the supply of primary outputs will reduce the prices on the market, with an emphasis on the reduction of food prices. The drop in food prices by a percentage point leads to a decrease in the inflation rate by 0.07%. The primary sector has an important function in mitigating the inflationary trend in the Serbian economy.

Conclusions

In the modern market economies, it is an increasingly common phenomenon that the rise in the inflation rate is accompanied by a decline in the purchasing power of the population. For this reason, the creators of economic policies especially analyze the trend of population consumption, i.e. analysis of the impact of the general price level on the trend of inflation. By applying the „Granger causality test", the research proves the impact of the growth of production of primary products (independent variable) on the reduction of the general price level (inflation rate as a dependent variable) in the Republic of Serbia. In addition, we confirmed in the research that the change in the inflation rate will not significantly affect the volume of production of primary products. On the contrary, the research confirms that the volume of production of primary products directly affects the movement of the quarterly inflation rate.

In the process of identifying the direction and quantifying the intensity of the relationship between the analyzed variables, through multiple regression analysis, we determine that energy prices on the domestic and world markets participate in the formation of the general price level in the economy of the Republic of Serbia. In this research, we concluded that the movement of average nominal wages and the value of the exchange rate influence the movement of the inflation rate in the observed economy. The production of primary products doesn't have a direct impact on the movement of the inflation rate, but the increase in food prices leads to a statistically significant change in the general price level in the economy of the Republic of Serbia.

In accordance with the basic postulates of economic theory that the development of supply directly causes price movements, we confirm the thesis that the increase in the supply of food products affects the reduction of food prices in country. At the same time, we mention the fact that primary agricultural production is predominantly carried out in open space. Therefore, the supply of primary agricultural products is highly correlated with the general natural conditions of production. In the empirical part of this research, we proved that reducing the prices of food products means a tool for mitigating the rising trend of the inflation rate. Based on econometric and statistical evaluations, we conclude that the reduction in food prices leads to a decrease in the general level of prices in the economy of the Republic of Serbia.

Through the analysis of the obtained results, we confirm the hypothesis that the growth in the supply of products of the primary sector, along with the simultaneous growth of branch productivity, affects the mitigation of the increase in annual inflation rates. Data on the level and extent of the impact of food supply on the reduction of the general level of prices, i.e. the inflation rate, represent an important indicator for economic policy makers, with the aim of adopting specific measures of monetary policy and inflation control, through its introduction into the targeting regime in the Republic of Serbia. The development of the efficiency of the primary sector becomes a quality instrument for controlling the inflationary pressure on the economy of a country. Investing resources to improve the primary sector and reduce the production gap of producers ensures economic growth and comprehensive economic development of countries.

Acknowledgements

The result of the research study is within the frameworks of the scientific-research work implementation and funding in the year 2024 made between the Belgrade Faculty of Agriculture and the Ministry of Education, Science and Technological Development of the Republic of Serbia, Agreement Registration Number: 451-03-65/2024-03/200116

Conflict of interests

The authors declare no conflict of interest.

References

1. Anríquez, G., & Stamoulis, K. G. (2007). Rural Development and Poverty Reduction: Is Agriculture Still Key?. *eJADE: Electronic Journal of Agricultural and Development Economics*, *4*(1), 5-46.
2. Ali, M., & Ibrahim, P. (2018). Inflation and companies' performance: A cross-sectional analysis. *Advanced science letters*, *24*(6), 4750-4755.
3. Brož, V., & Kočenda, E. (2018). Dynamics and factors of inflation convergence in the European union. *Journal of International Money and Finance*, *86*, 93-111.
4. Ćorović, E., & Gligorijević, Ž. (2021). Competitiveness in the Serbian growth strategy. *Acta Oeconomica*, *71*(2), 309-326.
5. Chahad, M., Hofmann-Drahonsky, A. C., Page, A., Tirpák, M., & Meunier, B. (2022). What explains recent errors in the inflation projections of Eurosystem and ECB staff?. *Economic Bulletin Boxes*, *3*.

6. Cinaroglu, S., & Top, M. (2021). The changing pattern of European country groups: Economic, financial, and health indicators, 2000–2015. *Acta Oeconomica*, *71*(4), 609-626.

7. Dimovski, J., Radivojević, V., & Rađenović, T. (2023). Dynamics and intensity of structural changes in agricultural output: The case study of the Republic of Serbia. *Economics of Agriculture*, *70*(2), 493-506.

8. Gáll, J. (2023). Artificial intelligence in the hotel industry in Slovakia. *Hotel and Tourism Management*, 11(2), 117–128. https://doi.org/10.5937/menhottur2302117G

9. Glatzer, E., Gnan, E., & Valderrama, M. T. (2006). Globalization, import prices and producer prices in Austria. *Monetary Policy & the Economy Q*, *3*, 24-43.

10. Demary, M., Herforth, A. L., & Zdrzalek, J. (2022). *The new inflationary environment: How persistent are the current inflationary dynamics and how is monetary policy expected to respond?* (No. 16/2022). IW-Report.

11. Gnan, E., & Valderrama, M. T. (2006). Globalization, inflation and monetary policy. *Monetary Policy & the Economy Q*, *4*, 37-54.

12. Hałka, A., & Leszczyńska-Paczesna, A. (2023). Inflation measurement in times of large consumption shifts–Evidence of the CPI bias from Poland. *Acta Oeconomica*, *73*(3), 383-401.

13. Ješić, M., Mladenović, Z., & Jakšić, M. (2023). Performances of selected European economies in achieving their inflation targets: The non-stationary discrete choice model approach. *Acta Oeconomica*, *73*(2), 183-216.

14. Kumar, S., & Aithal, P. S. (2023). Tech-Business Analytics in Primary Industry Sector. *International Journal of Case Studies in Business, IT, and Education (IJCSBE)*, *7*(2), 381-413.

15. Lundahl, M. (2015). *The Primary Sector in Economic Development (Routledge Revivals): Proceedings of the Seventh Arne Ryde Symposium, Frostavallen, August 29-30 1983*. Routledge.

16. Mihailović, B., Cvijanović, D., & Paraušić, V. (2013). The analysis of performances in primary agricultural production and food industries of Serbia. *Agro knowledge*, *14*(1), 77-85.

17. Mladenović, Z., & Petrović, P. (2007). *Uvod u ekonometriju*. The publishing centre of the Faculty of Economics in Belgrade.

18. Krstić, A., Jaksić, M., Mimović, P., & Tadić, D. (2022). Dynamic analysis of macroeconomic performance of the Balkan countries. *Acta Oeconomica*, *72*(3), 367-391.

19. Roncaglia de Carvalho, A., Ribeiro, R. S., & Marques, A. M. (2018). Economic development and inflation: a theoretical and empirical analysis. *International Review of Applied Economics*, *32*(4), 546-565.

20. Shojaie, A., & Fox, E. B. (2022). Granger causality: A review and recent advances. *Annual Review of Statistics and Its Application*, *9*, 289-319.
21. Šoškić, D. (2015). Inflation impact of food prices: Case of Serbia. *Economics of Agriculture*, 62(1), 41-51.
22. Turan, T., & Özer, H. A. (2022). The impact of oil price shocks on inflation: Do asymmetries matter?. *Acta Oeconomica*, *72*(3), 271-288.
23. Zakrzewska, A., & Nowak, A. (2022). Diversification of agricultural output intensity across the European Union in light of the assumptions of sustainable Development. *Agriculture*, *12*(9), 1370.

OPTIMIZATION OF MILK PROCESSING PROCESSES AND ANALYSIS OF OBTAINED SOLUTIONS

Mersida Jandrić[1]*, Grujica Vico*[2]*, Željko Savić*[3]

**Corresponding author E-mail: mersida.jandric@hotmail.com*

A R T I C L E   I N F O

Original Article

Received:16 *May 2024*

Accepted: *11 June 2024*

doi:10.59267/ekoPolj2402627J

UDC 637.13/.14

Keywords:

milk, optimization, linear programming, net income, production structure, sensitivity analysis

JEL: *C61, Q13, D24, Q10*

A B S T R A C T

This study focuses on the analysis of optimization and sensitivity in dairy production, utilizing linear programming to achieve an optimal production structure and maximize net income. The model identifies key products with the highest revenues and those having the greatest impact on overall revenue and costs. Sensitivity analysis reveals which products are most sensitive to price changes and how these changes affect production structures, providing valuable insights for dairy management in pricing strategies and future investments. Additionally, the research opens opportunities for further improvements and exploring new market avenues and product diversification in the dairy industry.

Introduction

Daily changes in market conditions emphasize the need for thorough planning and organization in agriculture and agribusiness (Nedeljković et al., 2023). Introducing new decisions in the processing sector has become crucial in response to the dynamic market environment and for profit maximization. Stimulating producers and creating added value for consumers represent opportunities for stable revenues (Ivanović and Ćosić, 2023), crucial for maximizing profits in the processing sector, with the possibility of high-quality raw milk for competitive products.

Grujić and colleagues (2023) highlight that in the period from 2012 to 2021, the majority of investments in production amounted to 25.3% in the Republic of Serbia,

1 Mersida Jandrić, Ph.D., Assistant Professor, Faculty of Agriculture, University of Bijeljina, Pavlovića put bb, 76300 Bijeljina, Bosnia and Herzegovina, Phone: +381 63 661 350, E-mail: mersida.jandric@hotmail.com, ORCID ID (https://orcid.org/0000-0002-8785-7052)

2 Grujica Vico, Ph.D., Associate Professor, University of East Sarajevo, Faculty of Agriculture East Sarajevo, Vuka Karadzića no. 30, 71123 East Sarajevo, B&H, Phone: +387 65 728 323 E-mail: vicogrujica@yahoo.com, ORCID ID (https://orcid.org/0000-0003-1719-7412)

3 Željko Savić, Ph.D., Associate Professor, University of Pristina, Faculty of Agriculture, Kopaonička Street nn, 38219 Lesak, Serbia, Phone: +381 6289 30408 E-mail: zeljko.savic@pr.ac.rs, ORCID ID (https://orcid.org/0009-0006-5932-3551)

which encourages support for the production sector, improvement of technology and capacity, and increasing the availability of raw materials for milk processing. Stable and sustainable production requires acquiring new knowledge and applying positive practices (Čekrlija et al., 2023), crucial for successfully facing the challenges of the modern market. Sustainable production contributes to long-term stability and profit maximization in the processing industry, ensuring long-term supply of raw milk.

The continuous decline in the quality of food products throughout the food supply chain, as noted in the studies by Bloemhof and Soysal (2017), along with the challenges posed by the COVID-19 pandemic, such as disruptions in milk supply chains (Abbasian et al., 2023), underscores the need to consider alternative strategies to reduce losses and preserve product quality. In this context, increasing the processing of raw milk in dairies may be one solution. Milk processing in dairies allows for longer preservation of freshness and extends the shelf life of dairy products. Additionally, processing in dairies can provide better product quality control and reduce the risk of losses occurring in the distribution chain of raw milk. This can, in turn, reduce milk waste and enhance the efficiency of the supply chain.

Agriculture is facing a crucial challenge in making food production more sustainable. This requires the implementation of new production systems, technologies, tools, and programs on a large scale, involving significant changes in existing practices of agricultural production, processing, and food markets (Springmann et al., 2018; Möhring et al., 2023). All of this underscores the importance of continuous development and optimization of supply chains, especially in light of the COVID-19 pandemic, as emphasized in the works of Meyer et al. (2021) and Sharma et al. (2023). With the development of information technology, optimization methods are increasingly relying on software packages, becoming fundamental tools with the aid of computers and computer applications, such as the use of Solver tool.

Literature review

Introduction of linear programming into agricultural practices, especially in activities such as transportation, production, and distribution (Kelaba, 2021), has brought about a more efficient resource management strategy. Mathematical optimization, the foundation of linear programming application, is recognized as a key tool for addressing various agricultural problems (Djukić, 2023). This approach enables the minimization or maximization of linear functions while adhering to linear constraints.

Furthermore, research conducted by Maddah and colleagues (2021) indicates that retailers often have multiple priorities beyond profit alone, highlighting the need for a more comprehensive decision-making approach. Consistent with this, Addis and colleagues (2021) emphasize the usefulness of linear programming in identifying optimal solutions for retailers.

The growing attention towards sustainable food supply chains (Qahtan et al., 2023) motivates researchers to explore new approaches, particularly in the context of the 4.0

revolution in agriculture and the food industry. In modern agriculture, where decision-making based on real facts has become imperative (Vico et al., 2017), production optimization is crucial for the sustainable growth of manufacturing enterprises (Dejanović et al., 2019). The application of operational research, including linear programming, enables rational resource utilization (Kelava, 2021), thereby contributing to agricultural growth and increasing GDP contributions (Kamath, 2020). In this context, optimization and simulation models provide the opportunity to understand the optimal structure of production and study system behavior under different conditions (Orović et al., 2015).

Given the assertion that issues in small-scale agricultural production include fragmentation and the lack of connectivity with processing industries (Vico et al., 2022), this paper will further analyse another model addressed by Jandrić (2019), a model for optimizing milk production (processing) in dairy factories, enabling efficient resource and process management to achieve the best results in the quality and quantity of dairy products produced. The model demonstrates potential for further improvements, particularly in integration with quality monitoring and production sustainability systems. The aim is to thoroughly analyse the model, considering various factors affecting processes in the dairy factory, including resources, technologies, and economic feasibility. Through this analysis, the authors seek to identify opportunities for improvement and innovation, offering suggestions for more efficient and sustainable dairy product production. Such a focus allows for a deeper exploration of the complexity of processes in the dairy factory and provides insights into changes that would enhance the milk value chain.

Input prices from 2019 were utilized in this study, reflecting the period when the dissertation was conducted, to maintain consistency in the analysis and highlight the importance of optimization in achieving optimal outcomes. Optimization can help users recognize opportunities to improve resource efficiency, reduce costs, and enhance production quality. Through precise modeling and analysis, this paper emphasizes how linear programming enables flexibility and accuracy in evaluating various scenarios and making decisions in milk production.

According to Jandrić, the development of a model for optimizing milk production (processing) in a dairy is based on technological, organizational, and economic data provided by the surveyed dairy. A systemic approach was applied in creating the model, which includes the development of a logical and mathematical model, taking into account the key characteristics of the observed production system.

Mathematical model of milk production optimization in dairy

Objective function

$$(\max) f = \sum_{i=1}^{p} \sum_{j=1}^{q} c_{ij} x_j$$

Constraints

$$\sum_{i=1}^{p}\sum_{j=1}^{q} a_{ijkl}x_j \le = \ge u_k \quad \text{k=1,2,…,r} \quad \text{l=1,2,…,s}$$

Non-negativity condition: i=1,2,...,p j=1,2,...,q; Indices: p - number of activity groups; q - number of activities in a group; r - number of constraint groups; s - number of constraints in a group; Activities: x_{ij} ; i=1,2,...,p j=1,2,...,q; Constraints: u_{kl} ; k=1,2,...,r l=1,2,...,s; Coefficients in the objective function: c_{ij}; i=1,2,...,p j=1,2,...,q; Coefficients in the constraints: quantity of the j-activity in the i-activity group for the i-constraint in the r-constraint group.

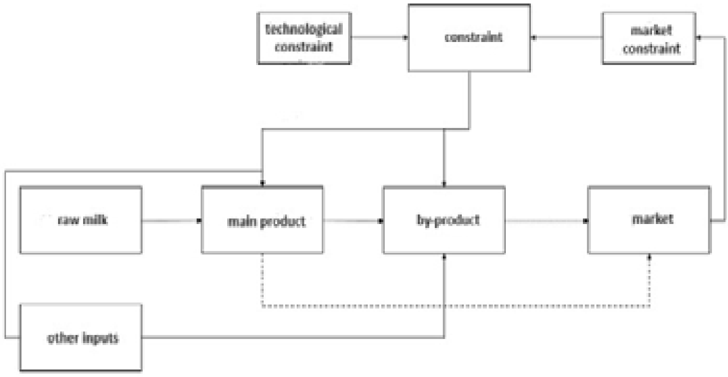
Activity groups: main products; i=1 j=6; by-products i=2 j=1,2,...,5; inputs representing costs, separately listed in the model i=3 j=1,...,14; other costs i=4 j=1; labor expenditure i=5 j=1; finished products i=6 j=1,...,11.

Constraint groups: capacities k=1,l=1,2; market constraints k=2, l=4; raw milk balance k=3, l=1; by-products balances k=4, l=1,...,5; balances of inputs representing costs, separately listed in the model k=5, l=1,...,13; other costs balance k=6, l=1; labor force balance k=7, l=1; finished products balance k=8, l=1,...,11.

Research Results and Discussion

In the process of creating a linear programming model, whether it pertains to primary agricultural production or the food industry, a crucial step is the systemic analysis of the modeled object, as well as the development of a logical model. When constructing a logical model, it is important to define the most important elements of the system being modeled and their interrelationships. The logical model can be represented visually, for example, through a context diagram or other illustrative forms (Vico and Rajić, 2018). Novković and colleagues (1997) emphasize that the logical model should encompass all key elements and relationships that objectively exist in the system and are relevant to the planning process. Figure 2 depicts the parts of the system under analysis, including their interrelationships. Raw milk is a key input for the production of main and by-products, which are marketed. Besides raw milk, other inputs also influence production and appear as activities or constraints in the mathematical model. Market constraints have been identified, defining minimum or maximum levels of finished product production.

Figure 2. Logical model of a dairy



Source: Jandrić, 2019

Activities in the milk processing optimization model: Activities, or independent variable quantities (control variables), must meet the fundamental assumptions for the application of linear programming, which include: proportionality, additivity, divisibility, and certainty (Vujošević, 1997).

The model consists of 38 activities grouped into categories: **Main products;** Pasteurized milk 3.2% fat (X1), White cheese slice 45% fat (X2), Clotted cream 45-50% fat (X3), Yogurt 2.8% fat (X4), Filo cheese pie 20% fat (X5), Sour cream 12% fat (X6), Pepper in cream 35% fat (X7), Fermented whey 0.5% fat (X8), Yogurt 0.5% fat (X9), Bakery cheese (X10), Urda cheese (X11). **Inputs representing costs, separately listed in the model;** Raw milk (X12), Pepper in brine (X13), Packaging for various products (X14-X24). **Other costs;** Labor costs (RSD) (X25), Other costs (RSD) (X26). **Labor expenditure:** Labor expenditure (min) (X27). **Finished products;** Sales of Pasteurized milk 3.2% fat (X28), Sales of White cheese slice 45% fat (X29), Sales of Clotted cream 45-50% fat (X30), Sales of Yogurt 2.8% fat (X31), Sales of Filo cheese pie 20% fat (X32), Sales of Sour cream 12% fat (X33), Sales of Pepper in cream 35% fat (X34), Sales of Fermented whey 0.5% fat (X35), Sales of Yogurt 0.5% fat (X36), Sales of Bakery cheese (X37), Sales of Urda cheese (X38). These activities represent key parts of the model and cover all aspects of the milk and dairy product production process.

Constraints in the milk processing optimization model: Rajić (2002) emphasizes the importance of selecting appropriate constraints, highlighting that this process is crucial for the realism of the obtained solution. The goal and purpose of the research, as well as other relevant factors, influence the selection of constraints to be used in the model. In creating a model for optimizing milk processing in a dairy, eight groups of constraints were defined in the model for milk processing optimization in the dairy: capacities, market constraints, raw milk balance, by-products balances, balances of other inputs representing costs, balances of other costs, labor expenditure balance, and finished product balance. The first two constraint groups in the model use mathematical symbols ≤ or ≥, while the other constraint groups are expressed using the "=" symbol with a value of 0. This is due to the specificity of the task of the last five constraint groups in the model, whose purpose is to link activities in the objective function through technical coefficients. When the solution is obtained, their balance, or the value of the constraint, should be zero.

The milk processing optimization model in the dairy includes numerous constraints expressed within different categories: **Capacities;** Maximum daily capacity of raw milk (Q1), Maximum daily capacity of cheese slices (Q2). **Market Constraints;** Market constraint for sour cream (1,000 units daily) (Q3), Market constraint for yogurt 2.8% fat (maximum 1,200 liters daily) (Q4), Market constraint for yogurt 0.5% fat (maximum 800 liters daily) (Q5), Market constraint for pasteurized milk 3.2% fat (minimum 400 liters daily) (Q6). **Balances;** Balance of raw milk (Q7), Balance of cream 35% fat (Q8), Balance of pepper in brine (Q9), Balance of fermented whey (Q10), Balance of yogurt 0.5% fat (Q11), Balance of bakery cheese (Q12), Balance of urda cheese (Q13), Balance of packaging for various products (Q14-Q24), Balance of other costs (Q25), Balance of labor costs (Q26), Balance of labor expenditure (Q27). **Sales;** Sales of pasteurized milk 3.2% fat (Q28), Sales of white cheese slices 45% fat (Q29), Sales of clotted cream 45-50% fat (Q30), Sales of yogurt 2.8% fat (Q31), Sales of filo cheese pie 20% fat (Q32), Sales of sour cream 12% fat (Q33), Sales of pepper in cream 35% fat (Q34), Sales of fermented whey 0.5% fat (Q35), Sales of yogurt 0.5% fat (Q36), Sales of bakery cheese (Q37), Sales of urda cheese (Q38).

These constraints play a crucial role in ensuring efficient and balanced production of dairy products, with each constraint group contributing to the creation of a realistic and practical optimization model. The maximum daily capacity of raw milk refers to the total amount of raw milk that the dairy can receive in one day, and this capacity is 5,000 liters (Q1). The constraint in the model is expressed as $X12 \leq 5{,}000$. The maximum daily capacity of production of white cheese slices is determined by the capacity of the aging room and amounts to 128 kg per day (Q2). The constraint in the model is expressed as $X5 \leq 128$. The group of market constraints pertains to the minimum and maximum daily quantities of finished products that the dairy can produce. Three products have specified maximum quantities: sour cream (200 units daily), yogurt 2.8% fat (1,200 liters daily), and yogurt 0.5% fat (800 liters daily). Pasteurized milk has a specified minimum daily quantity of 400 liters (Q3-Q6).

Raw milk is the main raw material and is associated with the main products through a specific constraint. The technical coefficients in the equation represent the required quantity of raw milk for one unit of product, which is expressed in the model as: $-1.05042X1 - 7.81250X2 - 20.0000X3 - 1.05042X4 - 10.0000X5 - 3.03030X6 + X12 = 0$ (Q7).

Additional products are generated in the process of producing main products. Except for sour cream, all main products create one or more additional products. In the process of producing clotted cream, yogurt 0.5% fat and bakery cheese are produced. Pepper in cream is produced during the production of pasteurized milk and yogurt 2.8% fat.

The relationship between main and additional products is shown in the constraint group "Balance of additional/by-products". Q8: 0,024002X1 + 0,036019X4 – X7 = 0; Q9: -0,428571X7 + X3 = 0; Q10: 3,90625X2 – X8 = 0; Q11: 8,00X3 – X9 = 0; Q12: 2,00X3 – X10 = 0; Q13: -0,40X5 + X11 = 0.

Balances of other cost inputs include 12 constraints (Q14-Q25): Q14: -X1 + X13 = 0; Q15: -X2 + X14 = 0; Q16: -X3 + X15 = 0; Q17: -X4 + X16 = 0; Q18: -X5 + X17 = 0; Q19: -5X6 + X18 = 0; Q20: -1,42857X7 + X19 = 0; Q21: -X8 + X20 = 0; Q22: -X9 + X21 = 0; Q23: -0,20X10 + X22 = 0; Q24: -X11 + X23 = 0; Q25: -0,24X25 + X27 = 0.

The variable "other costs" represents variable costs per unit of product, including fermentation additives, salt, energy, and similar expenses (Q26): Q26: -5,00X1 - 50,00X2 - 60,00X3 - 6,50X4 - 55,00X5 - 5,50X6 - 26,00X7 - 3,00X8 - 6,00X9 - 12,00X10 - 10,00X11 + X26 = 0.

Labor expenditure per unit of product refers to the labor of direct workers in production (Q27): Q27: -0,11X1 - 3,13X2 - 3,90X3 - 0,15X4 - 4,20X5 - 0,64X6 - 2,81X7 - 0,22X8 - 0,49X9 - 1,40X10 - 3,00X11 + X27 = 0.

The balance of finished products connects production lines with activities of finished products (Q28-Q38): Q28: X1 – X28 = 0; Q29: X2 – X29 = 0; Q30: X3 – X30 = 0; Q31: X4 – X31 = 0; Q32: X5 – X32 = 0; Q33: 5,00X6 – X33 = 0; Q34: 1,42857X7 – X34 = 0; Q35: X8 – X35 = 0; Q36: X9 – X36 = 0; Q37: X10 – X37 = 0; Q38: X11 – X38 = 0.

Criterion function in the milk processing optimization model: When solving managerial problems in the agri-food complex using linear programming, whether it is in primary agricultural production or the food industry, the most common criterion for maximization is net income or gross margin, in line with the works of authors such as Andrić (1969), Mirić and Krstić (1969), Munćan and colleagues (1991, 1998, 2003), Bulatović (1996), Bogavac Violeta (1996), Sredojević Zorica (2002), Mirjanić and colleagues (2008), Vico (2012), and Jandrić Mersida (2019).

Net income is defined as the difference between total revenue and variable costs and is used as the criterion in this research. In this approach, the coefficients in the criterion function for finished products are positive, representing the selling price per unit of product, while the coefficients for inputs are negative, reflecting the purchase price per unit of input. For other activities in the criterion function, the coefficients have a value of zero.

Model solution: Solving a model that includes inputs and outputs in the criterion function has several advantages, such as faster and simpler interpretation of results, enabling separate observation of related products, especially for post-optimal analysis, and facilitating experimentation within the model. By reading the values of activities representing finished products directly from the model, the production structure is obtained.

The optimal production structure of milk in the dairy (Jandrić, 2019) includes eight products, five main and three additional ones. Clotted cream as a main product and two by-products obtained in the process of clotted cream production are not included in the optimal solution. The largest share of revenue comes from filo cheese pie (26.72%), followed by yogurt 2.8% fat (22.11%) and white cheese slices 45% fat (18.15%). The optimal assortment also includes pasteurized milk 3.2% fat, sour cream 12% fat, pepper in cream 35% fat, fermented whey 0.5% fat, and urda cheese. The total revenue is 352,702.93 RSD, while the net income is 145,859.42 RSD. According to Jandrić's analysis (2019), the calculation of input values in the dairy shows the percentage share of each item in total variable costs (VC). The largest portion of costs is attributed to raw milk, accounting for 67.8% of total costs. Other significant costs include "Other costs" (14.4%) and various types of packaging for products. Labor costs account for 3.9% of total costs.

Analysis of the obtained solutions for milk processing optimization: From the optimal solution, managers in the agrofood complex obtain quantitative indicators of inputs and outputs, as well as valuable information from post-optimal analysis. Post-optimal analysis provides insight into the quality of the optimal solution and assists in making future business decisions.

In the optimal solution, pasteurized milk is projected at a quantity of 400 liters per day, which is the minimum set by a specific constraint. Increasing the selling price by more than 3.60 RSD per liter (7.20%) would change the dairy production structure. The selling price of white cheese slices can be increased infinitely without altering the production structure since it is already at the maximum allowed quantity (128 kg/day). Decreasing the price of white cheese slices by more than 82.99 RSD per kilogram (16.60%) would result in a reduction of daily production quantities. The most significant changes in selling prices required to alter the optimal solution are for urda (increase of 119.10%) and pepper in cream (increase of 40.40%). The largest allowable decreases in prices without impacting the optimal solution are for fermented whey (70.82%), pepper in cream (37.70%), and sour cream (36.22%).

Sensitivity analysis of dairy products reveals that products with maximum allowable production, such as white cheese slices, yogurt 2.8% fat, and sour cream, can infinitely increase prices without affecting the optimal solution. Fermented whey, a by-product of white cheese slices, follows a similar pattern. Paprika in cream, a by-product of 2.8% fat yogurt, can only increase prices by up to 40.40% without changing the optimal solution, due to its connection to pasteurized milk production. Products not included in the optimal solution, such as cream cheese and 0.5% fat yogurt, as well as products with minimum required production, will not undergo production changes even if prices decrease.

Table 1- Sensitivity analysis of coefficients for the group of ‘Finished Products’ activities.

Label	Activity Name	Quantity of Activity in Optimal Solution	Value of Coefficient in Criterion Function (RSD)	Permissible Increase (RSD)	Permissible Decrease (RSD)	Permissible Increase (%)	Permissible Decrease (%)
X_{28}	Pasteurized milk 3.2% fat	400,00	50,00	3,60	∞	7,20	
X_{29}	White cheese slices 45% fat	128,00	500,00	∞	82,99		16,60
X_{30}	Clotted cream 45-50% fat	0,00	600,00	6,45	∞	1,08	
X_{31}	Yogurt 2.8% fat	1 200,00	65,00	∞	5,00		7,70
X_{32}	Filo cheese pie 20% fat	171,33	550,00	47,64	3,23	8,66	0,59
X_{33}	Sour cream 12% fat	1 000,00	55,00	∞	19,92		36,22
X_{34}	Pepper in cream 35% fat	75,46	260,00	105,03	97,25	40,40	37,40
X_{35}	Fermented whey 0.5% fat	500,00	30,00	∞	21,24		70,82
X_{36}	Yogurt 0.5% fat	0,00	60,00	0,81	∞	1,34	
X_{37}	Baker’s cheese	0,00	120,00	3,23	∞	2,69	
X_{38}	Urda cheese	68,53	100,00	119,10	8,06	119,10	8,06

Source: Jandrić, 2019

Table 2 - Sensitivity Analysis of Constraints

Label	Name of Constraint	Defined Value	Final Value	Shadow Price	Allowable Increase
O_5	Maximum Daily Capacity White Cheese kg	128,00	128,00	82,99	219,30
O_6	Market Limitation Sour Cream 1000 pcs/day	200,00	200,00	99,61	565,38
O_7	Market Limitation Yogurt 2.8% mm max. 1200 l/day	1 200,00	1 200,00	5,00	1 631,03
O_8	Market Limitation Yogurt 0.5% mm max. 800 l/day	800,00	0,00	0,00	
O_9	Market Limitation Pasteurized Milk 3.2% mm min 400 l/day	400,00	400,00	-3,60	1 631,03

Source: Jandrić, 2019

Conclusion

The optimization results have shown which dairy products should be produced in optimal quantities to achieve the best financial results. This will enable more efficient production planning and resource management. The analysis has highlighted the products that contribute the most to total revenue, as well as those most sensitive to price changes. Management can focus on products with the greatest growth and profit potential. Sensitivity analysis has revealed where products are most sensitive to price and resource changes, allowing for better risk management and exploitation of potential market opportunities. Based on the results, management can make informed decisions about changes in the production program, adjusting pricing strategies, and seeking new markets. The analysis opens up opportunities for further research to improve production processes, reduce costs, and increase profitability. These conclusions can assist management in making strategic decisions and achieving long-term success in the dairy business.

Conflict of interests

The authors declare no conflict of interest.

References

1. Andrić, J., Vasiljević Z., & Sredojević, Z. (2005). *Investments, Fundamentals of Planning and Analysis.* University of Belgrade, Faculty of Agriculture, Belgrade.
2. Addis AH, Blair HT, Kenyon PR, Morris ST, Schreurs NM. (2021) Optimization of Profit for Pasture-Based Beef Cattle and Sheep Farming Using Linear Programming: Model Development and Evaluation. *Agriculture.* 11(6):524. https://doi.org/10.3390/agriculture11060524
3. Abbasian, M., Sazvar, Z., & Mohammadisiahroudi, M. (2023). A hybrid optimization method to design a sustainable resilient supply chain in a perishable food industry. *Environmental Science and Pollution Research*, *30*(5), 6080–6103. https://doi.org/10.1007/s11356-022-22115-8
4. Bloemhof JM, Soysal M (2017). Sustainable food supply chain design. *In Sustainable supply chains.* Springer, Cham, pp 395–412 https://doi.org/10.1007/978-3-319-29791-0_18
5. Bogavac, V. (1996). *Optimal strategy for the development of sheep farming in Serbia.* Doctoral dissertation, Faculty of Agriculture, Belgrade.
6. Bulatović, B. (1996). *Selection of livestock production systems on family farms in the northern part of Montenegro.* Doctoral dissertation, Faculty of Agriculture, Belgrade.
7. Dejanović, P., & Perić, T. (2019). Application of fuzzy multi-criteria linear programming in solving optimization problems of production planning and technological variants. *Proceedings of the Faculty of Economics in Zagreb,* 17(2), 59-74. https://doi.org/10.22598/zefzg.2019.2.59

8. Grujić, Vučkovski, B., Paraušić,. V, Kljajić, N. (2023). Impact of realized investments in new fixed assets on gross domestic product in Serbia, *Economics of Agriculture*, 70, (3), 737-753. doi:10.59267/ekoPolj2303737G
9. Ivanović, LJ., Ćosić, M. (2023). The factors of business efficacy of the food market and their correlation to the marketing in farmers. *Economics of Agriculture,* 70, (3), 829-840. doi:10.59267/ekoPolj2303829I
10. Jandrić, M. (2019). *Organizational-economic characteristics of milk production,* Doctoral dissertation, Faculty of Agriculture, University of Belgrade. https://nardus.mpn.gov.rs/bitstream/id/12842/Disertacija.pdf
11. Kamath, N. (2020). Application of Operation Research Techniques in Agriculture. *Int. J. Res. Appl. Sci. Eng. Technol*, *8*, 734-742. http://dx.doi.org/10.13140/RG.2.2.22645.19683
12. Kelava, L. (2021). *Linear Programming Models and Their Application in Economics: Final Thesis*. Osijek: Josip Juraj Strossmayer University of Osijek, Faculty of Economics in Osijek. Retrieved from Google Scholar.
13. Maddah, B., Ben Abdelaziz, F., & Tarhini, H. (2021). Bi-objective optimization of retailer's profit and customer surplus in assortment and pricing planning. *Annals of Operations Research.* https://doi.org/10.1007/s10479-019-03265-4
14. Meyer, B. H., Prescott, B., & Sheng, X. S. (2022). The impact of the COVID-19 pandemic on business expectations. *International Journal of Forecasting, 38*(2), 529-544. https://doi.org/10.1016/j.ijforecast.2021.02.009
15. Mirjanić, S., Krstić, B., Mrdalj, V., Drinić, L., Rokvić, G., Ž., Vaško, & Ostojić, A. (2008). Economic valuation of organizational-technological solutions in production and marketing of agricultural products. *Agroznanje,* 9(3), 55-73.
16. Mirić, S., & Krstić, B. (1969). Problems of determining the optimal production structure using linear programming. *Economics of Agriculture, 6*, 391-411.
17. Munćan, P. (1991). *Influence of production structure on rational use of mechanization resources in agricultural organizations of crop production direction.* Doctoral dissertation, Faculty of Agriculture, Belgrade.
18. Möhring, N., Huber, R., & Finger, R. (2023). Combining ex-ante and ex-post assessments to support the sustainable transformation of agriculture: The case of Swiss pesticide-free wheat production. *Q Open, 3*(3), qoac022. https://doi.org/10.1093/qopen/qoac022
19. Nedeljković, M., Bajagić, M., & Dimitrijević, L. (2023). Selection of the location of the distribution center for agricultural products. *Economics of Agriculture, 70*(4), 1075–1087. https://doi.org/10.59267/ekoPolj23041075N
20. Orović, D., Ljubanović Ralević, I., & Anokić, A. (2015). Assessment of Business Efficiency of Agricultural Holdings with Different Productions. *Economics of Agriculture*, 3/2015, 781-799. UDC: 631.115.11:519.23 (62). http://dx.doi.org/10.5937/ekoPolj1503781O

21. Rajić, Z. (2002). *Model for optimizing the production structure of industrial slaughterhouses.* Doctoral dissertation, Faculty of Agriculture, Novi Sad.
22. Sharma, M., Antony, R., & Tsagarakis, K. (2023). Green, resilient, agile, and sustainable fresh food supply chain enablers: Evidence from India. *Annals of Operations Research.* Advance online publication. https://doi.org/10.1007/s10479-023-05176-x
23. Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B. L., Lassaletta, L.,... & Willett, W. (2018). Options for keeping the food system within environmental limits. Nature, 562(7728), 519-525. https://doi.org/10.1038/s41586-018-0594-0
24. Vujošević, M. (1997). *Operational management - Quantitative methods*. Society of Operations Researchers, Belgrade.
25. Vico, G., & Rajić, Z. (2018). *Models of agricultural households as a basis for agroeconomic research using linear programming*. Monograph, Faculty of Agriculture, University of East Sarajevo.
26. Vico, G., Mijić, D., & Bodiroga, R. (2017). Two-phase approach to multicriteria decision making in plant production. *Proceedings, XXII Conference on Biotechnology, Čačak, 1*, 413-417.
27. Vico, G., Mijić, D., & Bodiroga, R. (2022). A few examples of good practice from Bosnia and Herzegovina in the field of digital agriculture. *Research Journal of Agricultural Science, 54*(3), 2022. ISSN: 2668-926X.
28. Čekrlija, S., Đuričić, Z., Jovanović, R., & Pešević, S. (2023). Managing the productivity process in agriculture, a framework for improving the market position of agriculture of the Republic of Srpska. *Economics of Agriculture, 70*(3), 855-865. https://doi.org/10.59267/ekoPolj2303855C
29. Đukić, K. (2023). *Optimization of the Composition of 500 g Pastry Flour Mixture using Linear Programming in MS Excel* [Doctoral dissertation, Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology, Department of Process Engineering, Sub-department of Modelling, Optimization and Automatization]. Retrieved from Google Scholar.
30. Qahtan, S., Alsattar, H. A., Zaidan, A. A., Deveci, M., Pamucar, D., Delen, D., & Pedrycz, W. (May 2023). Evaluation of agriculture-food 4.0 supply chain approaches using Fermatean probabilistic hesitant-fuzzy sets based decision making model. *Applied Soft Computing, 138*, 110170. ISSN: 1568-4946. https://doi.org/10.1016/j.asoc.2023.110170

SELECTION OF MARKETING COMMUNICATION CHANNELS IN AGRIBUSINESS

Miroslav Nedeljković[1], Radomir Jovanović[2], Goran Maksimović[3]
**Corresponding author E-mail: miroslavnedeljkovic2015@gmail.com*

ARTICLE INFO

Original Article

Received: *17 May 2024*

Accepted: *11 June 2024*

doi:10.59267/ekoPolj2402639N

UDC 339.138:338.439

Keywords:

Agribusiness, marketing, multi-criteria decision-making, MABAC method, Entropy method.

JEL: *Q13; M31; D30.*

ABSTRACT

The aim of this study was to select the best marketing communication channel for a medium-sized agricultural company in the area of the city of Bijeljina by applying multi-criteria decision-making methods. Eight criteria were used for the research, and five communication channels were selected. The research on the importance of individual criteria was influenced by the commercial management of the company in question with their common attitude, i.e. assessment. The Entropy - MABAC method of multi-criteria decision-making was used for the methodology. The results show that the criterion of diversity of new information is the most significant. The best-rated communication channel is the company's good image. The second-best rated alternative is the use of the internet, specifically social media. The results provide a good basis for further research in this area with the aim of determining the factors that influence the choice of future promotion methods and obtaining useful information.

Introduction

Agribusiness plays an important role in the development of a country. To stimulate economic growth, development, and employment, agribusiness needs a well-functioning market. For this reason, the promotion of agricultural products must be encouraged by good marketing strategies. Part of this certainly includes choosing the optimal marketing channel through which the procurement and distribution of final products run smoothly. As Kuzyk (2023) observes, every business today faces the need

1 Miroslav Nedeljković, Ph.D., Research Associate, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 65 447 1201, E-mail: miroslavnedeljkovic2015@gmail.com, ORCID ID (https://orcid.org/0000-0002-7393-2146)

2 Radomir Jovanović, Ph.D., Associate Professsor, University of Pristina, Faculty of Agriculture, Kopaonička Street nn, 38219 Lesak, Serbia, Phone: +381 65 56 139 40, E-mail: radomir.jovanovic@pr.ac.rs, ORCID ID (https://orcid.org/0000--0001-7966-2768)

3 Goran Maksimović, Ph.D., Full Professor, University of Pristina, Faculty of Agriculture, Kopaonička Street nn, 38219 Lesak, Serbia, Phone: +381 63 419 757, E-mail: goran.maksimovic@pr.ac.rs, ORCID ID (https://orcid.org/0000-0001-5420-4293)

to organize effective collaboration with its marketing environment, especially with targeted consumers. According to him, various marketing communication tools, which are actively developing, aim to help the company grow. With the help of these modern marketing tools, promotion can effectively highlight all the advantages of a new product and clearly position it in the target market, leading to long-term collaboration with the end consumer. Today, functional production is not enough. Additional marketing efforts are needed to ensure the future brand, reputation, and image of a company, especially when it comes to a sensitive economic sector like agriculture. In support of this, Reznik et al. (2020) argue that modern consumers are under constant informational pressure and are not ready to comprehend every piece of information sent to them. According to them, all this limits the demand for products from the agribusiness sector. This is precisely why the choice of marketing channel is one of the most important decisions faced by an agribusiness participant. Well-established marketing channels allow companies to maximize profits and create unique value chains that minimize input costs and other risks.

What is important to emphasize, as noted by Jiuhardi et al. (2022), is that agricultural products have a short shelf life, and to retain their nutritional values, these products need to be delivered to the end consumers as soon as possible (Ndori Queku et al., 2024). For this purpose, various sales channels must be included, involving all stakeholders from the producer to the consumer (Milford et al., 2021). Choosing such an adequate channel helps farmers achieve higher income and maintain economic stability in their operations (Vitković, 2015; Pantić et al., 2022; Khan et al., 2022; Vitković, 2023).

In their earlier research, many authors have dealt with the importance of marketing in agribusiness and agriculture (Hsu, 2012; Jakšić, 2022; Gumirakiza et al., 2014; Kim et al., 2014; Liao et al., 2017; Bauman et al., 2018; Park et al., 2018; Vujanić et al., 2021; Kuzyk, 2019). However, recent studies increasingly incorporate multi-criteria decision-making in the selection of marketing channels. According to Zheng et al. (2021), the choice of marketing communication channel falls under decision-making problems, where the best alternative that meets the given criteria must be chosen. Petković and Užar (2020) research factors affecting the sales channel structure in agriculture using cheese as an example, while Oe and Yamaoka (2023) focus on improving olive oil sales channels in Tunisia. Nedeljković et al. (2023) use the TOPSIS method of multi-criteria decision-making to select marketing channels for a farming company. Ristanović et al. (2022) use the AHP method to analyse sales marketing channels, finding that farmers most often distribute their products through green markets, with price and quality being the dominant factors influencing channel choice. Earlier, using the same methodology, Tošović-Stevanović et al. (2020) found that selling through processing capacities is the best option.

From the foregoing, the application of multi-criteria decision-making in this study emerges, aimed at selecting the most favourable marketing communication channel. This would ultimately lead to an increase in the business success of the subject company and provide a good basis for further similar research on other and similar subjects in agribusiness.

Methodological framework of the research

The previously mentioned multi-criteria decision-making method represents an important tool for selecting the most favourable marketing communication channel for a business entity in agribusiness, and it is also used in this case with a medium-sized agricultural company as an example. The subject company is export-oriented and offers a range of products for planting and plant protection. It is located in the area of the city of Bijeljina in Bosnia and Herzegovina and has about fifty employees, most of whom work in production and packaging. The market is a crucial, decisive segment of its operations, and any irregularity in it directly affects the company's further functioning. In its twenty years of operation, the company has actively used existing communication channels with customers. Trying to follow advertising trends and sources of good practice in procuring necessary raw materials, the company has used and improved a wide range of marketing communications with end users through its commercial department. For this reason, and for the purpose of this research, the following Table 1 shows the currently used marketing channels in the company, whether for procurement or the sale of its final products. These types of communication channels will certainly be used in this work as possible alternatives among which the selection will be made.

Table 1. The method of communication between the company and the market

ID	Type of communication channels	Type of communication
A1	Internet (social media)	Facebook, Instagram, YouTube, Viber groups, WhatsApp groups, other.
A2	TV media	Local, Regional.
A3	Radio media	Local, Regional.
A4	Professional events	International fairs and conferences, Regional fairs and conferences, Local fairs and conferences.
A5	Good image	Direct (personal) promotion and contacts, Previous good cooperation, Recommendations.

Source: Authors

Given the nature of multi-criteria decision-making, it was necessary to formulate, that is, set the criteria on the basis of which the selection will be made. The paper will use 8 criteria based on previous experience in commercial activities. An overview of the criteria is provided in Table 2 below.

Table 2. Criteria used in decision-making

ID	Criteria	Explanation
C1	Accessibility	Giving and receiving information
C2	Reliability	Giving and receiving information
C3	Speed	Time of receiving and giving information
C4	Usability	Possibility of immediate usefulness of obtained information and popularization of given information
C5	Participation	Opportunities in content creation in giving and receiving information
C6	Cost	Cost of obtaining and disseminating information
C7	Variety of new information	Variety of content of new relevant received information
C8	Other	Personal-local devotion to marketing channel

Source: Authors

For the purpose of determining the importance of the given criteria in this paper, we used the Entropy method. The entropy method is an important information weight model and has been extensively used and studied recently (Liu et al., 2010; Zhi-Hong et al., 2010; Durkalić et al., 2019; Pantović et al., 2023). Compared to other similar methods, its biggest advantage is that it greatly reduces the human factor when making a decision, which increases its objectivity. This method estimates value by measuring the degree of differentiation. The greater the degree of dispersion of the measured value, the greater the degree of differentiation of the index and the more information can be derived. According to earlier research in which the Entropy method was used, the results were reliable and effective. (Zhou et al., 2012)

The first step represents the standardization of the measured values based on the following statement (Gorgij et al., 2017; Li et al., 2012):

$$P_{ij} = \frac{x_{ij}}{\sum_{j=1}^{n} x_{ij}}$$

The entropy value of Ei index is defined as (Dong et al., 2018):

$$E_i = \frac{\sum_{j=i}^{n} P_{ij} \cdot \ln P_{ij}}{\ln n}$$

While the final weight by the Entropy method is calculated as (Amiri et al., 2014):

$$w_i = \frac{1 - E_i}{\sum_{i=1}^{m} (1 - E_i)}$$

In the selection of offered alternatives, we use the MABAC method of multi-criteria decision-making (Multi-Attributive Border Approximation area Comparison). He finds confirmation of his successful use of the MABAC method in some of the earlier research (Pamučar et al., 2015; Pamučar et al., 2018; Nedeljković et al., 2021; Puška et al., 2023). The method was developed by Pamučar and Ćirović (2015). It defines the distance of the criterion function of each of the observed alternatives from the limit allowed value. The reason for using this method lies in the fact that it is relatively new, easy to use, but also insufficiently used in this field of research, and in this way, it is aimed at its further popularization. Its use is explained in the following text through its next steps.

Step 1: The initial decision matrix (X)

$$= \begin{array}{c} \\ A_1 \\ A_2 \\ \dots \\ A_m \end{array} \begin{array}{c} C_1 \quad C_2 \quad \dots \quad C_n \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array}$$

Step 2: Normalization of the element of the initial decision matrix (X)

$$N = \begin{array}{c} \\ A_1 \\ A_2 \\ \dots \\ A_m \end{array} \begin{array}{c} C_1 \quad C_2 \quad \dots \quad C_n \\ \begin{bmatrix} n_{11} & n_{12} & \cdots & n_{1n} \\ n_{21} & n_{22} & \cdots & n_{2n} \\ \dots & \dots & \dots & \dots \\ n_{m1} & n_{m2} & \cdots & n_{mn} \end{bmatrix} \end{array}$$

a) For benefits type criteria

$$n_{ij} = \frac{x_{ij} - x_i^-}{x_i^+ - x_i^-}$$

b) For cost type criteria

$$n_{ij} = \frac{x_{ij} - x_i^+}{x_i^- - x_i^+}$$

Step 3: Calculation of the weight matrix element (V)

$$V_{ij} = w_i g(n_{ij} + 1)$$

Step 4: Determination of the matrix of boundary approximate surfaces (G)

$$g_i = \left(\prod_{j=1}^{m} v_{ij} \right)^{\frac{1}{m}}$$

Step 5: Calculation of elements of alternative distance matrices from the limit approximate domain (Q)

$$Q = \begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ q_{21} & q_{22} & \cdots & q_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ q_{m1} & q_{m2} & \cdots & q_{mn} \end{bmatrix} \begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ q_{21} & q_{22} & \cdots & q_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ q_{m1} & q_{m2} & \cdots & q_{mn} \end{bmatrix}$$

Step 6: Ranking of alternatives

$$S_i = \sum_{j=1}^{n} q_{ij} \quad j = 1,2,\ldots,n \quad i = 1,2,\ldots,m$$

Results and discussion

As previously pointed out, the evaluation of the given criteria will be done through the linguistic scale presented in the following table 3, on the basis of which the initial decision-making matrix will be formed (Table 4).

Table 3. Linguistic scale of values

Evaluation of criteria	Linguistic scale
1	VP-Very poor
2	P-Poor
3	M-medium
4	G-Good
5	VG-Very good

Source: Đalić et al., 2020.

Table 4. Decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8
A1	4	3	5	5	4	4	5	3
A2	3	3	3	4	3	2	3	3
A3	4	3	3	3	4	4	3	3
A4	4	3	3	4	4	4	4	5
A5	4	5	2	3	4	4	2	4
SUM	**19**	**17**	**16**	**19**	**19**	**18**	**17**	**18**

Source: Authors

n the next step, after normalization of the initial decision matrix (Table 5), the final weights of the given criteria will be determined. As we can see in the ranking from the following table 6, the most important criterion is the criterion “variety of new information”. Then follows the criteria “speed of obtaining and providing information”, as well as the criterion “price of obtaining and providing information”. The criterion “availability of information” was rated worst.

Table 5. Normalized Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8
A1	0,210526	0,176471	0,3125	0,263158	0,210526	0,222222	0,294118	0,166667
A2	0,157895	0,176471	0,1875	0,210526	0,157895	0,111111	0,176471	0,166667
A3	0,210526	0,176471	0,1875	0,157895	0,210526	0,222222	0,176471	0,166667
A4	0,210526	0,176471	0,1875	0,210526	0,210526	0,222222	0,235294	0,277778
A5	0,210526	0,294118	0,125	0,157895	0,210526	0,222222	0,117647	0,222222

Source: Authors

Table 6. Weights of individual criteria

	C1	C2	C3	C4	C5	C6	C7	C8
A1	-0,32803	-0,30611	-0,36348	-0,35132	-0,32803	-0,33424	-0,35993	-0,29863
A2	-0,29145	-0,30611	-0,31387	-0,32803	-0,29145	-0,24414	-0,30611	-0,29863
A3	-0,32803	-0,30611	-0,31387	-0,29145	-0,32803	-0,33424	-0,30611	-0,29863
A4	-0,32803	-0,30611	-0,31387	-0,32803	-0,32803	-0,33424	-0,34045	-0,35581
A5	-0,32803	-0,35993	-0,25993	-0,29145	-0,32803	-0,33424	-0,25177	-0,33424
$\sum$	-1,60357	-1,58436	-1,56503	-1,59027	-1,60357	-1,58109	-1,56437	-1,58593
$\boldsymbol{E_j}$	0,99635	0,98442	0,97241	0,98809	0,99635	0,98239	0,972	0,9854
$\mathbf{1-E_{ij}}$	0,00365	0,01558	0,02759	0,01191	0,00365	0,01761	0,028	0,0146
$\sum(\mathbf{1-E_{ij}})$	0,12259							
$\boldsymbol{W_j}$	0,029774	0,12709	0,225059	0,097153	0,029774	0,14365	0,228404	0,119096
Rank	8	4	2	6	7	3	1	5

Source: Authors

This research somewhat coincides with the research of Ristanović et al. (2022) who established that price is one of the dominant factors, i.e. the criteria that influence the choice of marketing channel itself.

In the following, after obtaining the weighting coefficients of the criteria and for the purpose of choosing the offered alternatives using the Mabac method, we form an initial decision matrix (Table 7), where by normalizing it and multiplying it with the obtained weighting coefficients (Table 8, Table 9) we determine the distance of the alternatives from the approximate range of limit values (Table 10).

Table 7. Decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8
A1	4	3	5	5	4	4	5	3
A2	3	3	3	4	3	2	3	3
A3	4	3	3	3	4	4	3	3
A4	4	3	3	4	4	4	4	5
A5	4	5	2	3	4	4	2	4
Max.	4	5	5	5	4	*2*	5	5
Min.	3	3	2	3	3	*4*	2	3

Source: Authors

Table 8. Normalized Decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8
A1	1	0	1	1	1	1	1	0
A2	0	0	0,33	0,5	0	0	0,33	0
A3	1	0	0,33	0	1	1	0,33	0
A4	1	0	0,33	0,5	1	1	0,66	1
A5	1	1	0	0	1	1	0	0,5

Source: Authors

Table 9. Weight Normalized Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8
A1	0,059548087	0,12709	0,450118	0,194306	0,059548	0,287299	0,456807	0,119096
A2	0,029774044	0,12709	0,299329	0,14573	0,029774	0,14365	0,303777	0,119096
A3	0,059548087	0,12709	0,299329	0,097153	0,059548	0,287299	0,303777	0,119096
A4	0,059548087	0,12709	0,299329	0,14573	0,059548	0,287299	0,37915	0,238192
A5	0,059548087	0,254181	0,450118	0,194306	0,059548	0,287299	0,456807	0,238192
Gi	0,052	0,145	0,352	0,15	0,051	0,249	0,373	0,157

Source: Authors

Table 10. Distance of the Alternatives from the BBA

	C1	C2	C3	C4	C5	C6	C7	C8
A1	0,007548	-0,01791	0,098118	0,044306	0,008548	0,038299	0,083807	-0,0379
A2	-0,02223	-0,01791	-0,05267	-0,00427	-0,02123	-0,10535	-0,06922	-0,0379
A3	0,007548	-0,01791	-0,05267	-0,05285	0,008548	0,038299	-0,06922	-0,0379
A4	0,007548	-0,01791	-0,05267	-0,00427	0,008548	0,038299	0,00615	0,081192
A5	0,007548	0,109181	0,098118	0,044306	0,008548	0,038299	0,083807	0,081192

Source: Authors

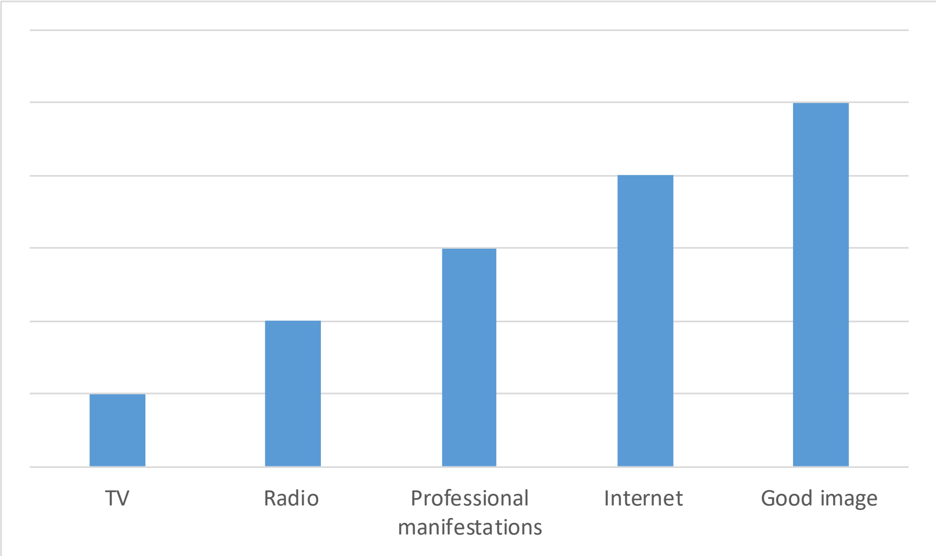
By calculating the coefficient Si, we get the final ranking of the chosen alternatives. (Table 11). We observe that the alternative "good image", which includes previously established relationships and recommendations, is chosen as the best. It is immediately followed by "internet", i.e. social networks as the next important channel of marketing communication. The following Figure 1 gives us a visual representation of the choice of alternatives.

Table 11. Ranking alternatives

Si	Rank
0,224814	2
-0,33078	5
-0,17616	4
0,066886	3
0,471	1

Source: Authors

Figure 1. Marketing Communication Channels Ranking



Source: Authors

Conclusion

Based on the previously presented findings in the study, we can conclude that selecting marketing communication channels in agribusiness is a complex and ongoing task for all companies exposed to dynamic market conditions. In this context, the application of multi-criteria decision-making methods plays a significant role. By applying the Entropy-Mabac decision-making method, we have found that the criterion of greatest importance in this specific case, influencing the choice of marketing channel, is the "variety" of new and relevant information that the company receives and provides. Immediately afterward, great importance is attached to the speed of receiving and providing information, followed by the cost of these services. Considering the importance of these evaluated criteria, "good image," i.e., the company's successful collaboration with clients and service providers, as well as their previous recommendations to others, was selected as the best marketing communication channel in the subject company. Of course, the choice of internet social media as the next important communication channel was expected, given the increasingly advanced technical and technological environment. Surprisingly, TV was rated lower, despite being one of the leading promotion channels for most economic entities until recently. Future research should focus on examining the impact of individual factors influencing the choice of promotion methods and obtaining useful market information, as well as on developing new decision-making methods based on all relevant factors for marketing communication channels.

Acknowledgements

Paper is a part of research financed by the MSTDI RS, agreed in decision no. 451-03-66/2024-03/200009 from 5.2.2024.

References

1. Amiri, V., Rezaei, M., & Sohrabi, N. (2014). Groundwater quality assessment using entropy weighted water quality index (EWQI) in Lenjanat, Iran, *Environmental Earth Sciences*, vol. 72, no. 9, pp. 3479–3490.
2. Bauman, A., McFadden, D., & Jablonski, B. (2018). The financial performance implications of differential marketing strategies: Exploring Farms that pursue local markets as a core competitive advantage. *Agricultural and Resource Economics Review*, *47*(3), pp. 477–504.
3. Durkalić, D., Fedajev, A., Furtula, S., Stanišić, N. (2019), The Measurement of Real Convergence in the EU28 by Using the Entropy Method, *Ekonomický Časopis,* 67 (7), 698 – 724.
4. Đalić, I., Stević, Ž., Erceg, Ž., Macura, P., & Terzić, S. (2020). Selection of a Distribution channel using the Integrated FUCOM-MARCOS model*. International Review*, 3-4: pp. 80-96.
5. Gorgij, A.D., Kisi, O., Moghaddam, A.A., & Taghipour, A. (2017). Groundwater quality ranking for drinking purposes, using the entropy method and the spatial autocorrelation index, *Environmental Earth Sciences*, vol. 76, p. 9.
6. Gumirakiza, J., Curtis, K., & Bosworth, R. (2014). Who attends farmers' markets and why? Understanding consumers and their motivations. *International Food and Agribusiness Management Review*, *17*(2), pp. 65–82.
7. Hsu, W. (2012). Agricultural Marketing. Taiwan, New Taipei City: Cheng Chung Book Co
8. Jakšić, P. (2022). Municipal bonds as an instrument for financing local governments. *Oditor*, *8*(1), 85-110. https://doi.org/10.5937/Oditor2201083J
9. Jiuhardi, J., Hasid, Z., Darma, S., & Darma, D. C. (2022). Sustaining Agricultural Growth: Traps of Socio–Demographics in Emerging Markets. *Opportunities and Challenges in Sustainability*, *1*(1), pp. 13-28. https://doi.org/10.56578/ocs010103
10. Khan, N., Ray, R. L., Zhang, S., Osabuohien, E., & Ihtisham, M. (2022). Influence of mobile phone and internet technology on income of rural farmers: Evidence from Khyber Pakhtunkhwa Province, Pakistan. Technology in Society, 68, 101866. https://doi.org/10.1016/j.techsoc.2022.101866
11. Kim, M., Curtis, K., & Yeager, I. (2014). An assessment of market strategies for small-scale produce growers. *International Food and Agribusiness Management Review*, *17*(3), pp. 187–204.

12. Kuzyk O.V. (2019). The innovative environment of marketing communication in agro-industrial enterprises of Ukraine, Investments: *Practice and Experience*, vol. 11, pp. 20–25, DOI: 10.32702/2306-6814.2019.11.20.
13. Kuzyk, O. (2023). Internet Tools in Marketing Communications of Agribusinesses in Ukraine, *Universal Journal of Agricultural Research 11*(2): pp. 217-229, DOI: 10.13189/ujar.2023.110201
14. Li, X.G., Wei, X., & Huang, Q. (2012). Comprehensive entropy weight observability-controllability risk analysis and its application to water resource decision-making, *Water SA*, vol. 38, pp. 573–579.
15. Liao, P., Chang, H., He, J., & Saeliw, K. (2017). Diversification of marketing strategies among small farms: Empirical evidence from family farms in Taiwan. *Agricultural Economics*, *63*(11), pp. 493–501.
16. Liu, L., Zhou, J., An, X., Zhang, Y., & Yang, L. (2010). Using fuzzy theory and information entropy for water quality assessment in Three Gorges region, China, *Expert Systems with Applications*, vol. 37, no. 3, pp. 2517–2521.
17. Milford, A. B., Lien, G., & Reed, M. (2021). Different sales channels for different farmers: Local and mainstream marketing of organic fruits and vegetables in Norway. *Journal of Rural Studies*, 88, pp. 279-288. https://doi.org/10.1016/j.jrurstud.2021.08.018
18. Ndori Queku, Y., Adibura Seidu, B., Ayine Adaane, L., Carsamer, E., Kofi Sobre Frimpong, F., & Ndori Queku, D. (2024). Market Synchronicity Among African Markets: is IFRS Adoption an Augmentor or Inhibitor? *Economics - innovative and economics research journal*, *12*(1), pp. 29-49. https://doi.org/10.2478/eoik-2024-0006
19. Nedeljković, M., Nastić, L., & Puška, A. (2023). Selection of sales distribution channel in agricultural enterprise. *Western Balkan Journal of Agricultural Economics and Rural Development*, *5*(2), pp. 121-131. https://doi.org/10.5937/WBJAE2302121N
20. Nedeljković, M., Puška, A., Doljanica, S., Virijević Jovanović, S., Brzaković, P., Stević, Ž., Marinković, D. (2021). Evaluation of Rapeseed varieties using Novel Integrated Fuzzy Piprecia-fuzzy Mabac Model, PLoS One, *16*(2)., https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0246857
21. Oe, H., & Yamaoka, Y. (2023). How to support expanding sales channels of agri-food products in new markets: *Healthiness and new experiences of Tunisian Olive oil. Businesses*, *3*(3), pp. 382-401. https://doi.org/10.3390/businesses3030024
22. Pamučar, D., & Ćirović, G. (2015). The Selection of Transport and Handling Resources in Logistics Centers Using Multi-Attributive Border Approximation Area Comparison (MABAC). *Expert Syst. Appl*., 42, pp. 3016–3028.

23. Pamučar, D., & Ćirović, G. (2015). The selection of transport and handling resources in logistics centers using Multi-Attributive Border Approximation area Com- parison (MABAC). *Expert Systems with Applications*, *42*(6), pp. 3016-3028. https://doi.org/10.1016/j.eswa.2014.11.057
24. Pamučar, D., Petrović, I., & Ćirović, G. (2018). Modification of the Best–Worst and MABAC methods: A novel approach based on interval-valued fuzzy-rough numbers. *Expert Syst. Appl*. 91, pp. 89–106.
25. Pantić, N., Mikulič, K., & Lekovič, M. (2022). The influence of claims payments on the investment portfolio of insurance companies. *Oditor*, *8*(3), 42-71. https://doi.org/10.5937/Oditor2203042P
26. Pantović, D., Kostić, M., Veljović, S., Luković, M. (2023). Evaluation Model of Environmental Sustainable Competitive Tourism Based on Entropy, *Problemy Ekorozwoju/ Problems of Sustainable Development,* 18(2), 193-203.
27. Park, T., Paudel, K., & Sene, S. (2018). Sales impacts of direct marketing choices: Treatment effects with multinomial selectivity. *European Review of Agricultural Economics*, *45*(3), pp. 433–453.
28. Petković, G., & Užar, D. (2020). Marketing channels in value creation and delivery of cheese in the Republic of Serbia. *Anali Ekonomskog fakulteta u Subotici*, 43, pp. 101-115. https://doi.org/10.5937/AnEkSub2001101P
29. Puška, A., Štilić, A., Nedeljković, M., Božanić, D., & Biswas, S. (2023). Integrating Fuzzy Rough Sets with LMAW and MABAC for Green Supplier Selection in Agribusiness, *Axioms*, *12*(8), 746, https://doi.org/10.3390/axioms12080746
30. Reznik O., Getmanets O., Kovalchuk A., Nastyuk V., & N. Andriichenko (2020). Financial security of the state, *Journal of Security and Sustainability Issues*, vol. 9, no. 3, pp. 843-852.
31. Ristanović, V., Tošović-Stevanović, A., Maican, S., & Muntean, A. (2022). Economic overview of the distribution channels used by Eastern European small farms for their agricultural products. *Agricultural Economics*, *68*(8), pp. 299-306. https://doi.org/10.17221/168/2022-agricecon
32. Tošović-Stevanović, A., Ristanović, V., Ćalović, D., Lalić, G., Žuža, M., & Cvijanović, G. (2020). Small farm business analysis using the AHP model for efficient assessment of distribution channels. *Sustainability*, *12*(24), 10479. https://doi.org/10.3390/su122410479
33. Vitković, B. (2015). Moć u umreženom društvu i suprotstavljanje toj moći. *CM Komunikacija i mediji*, 10(33), 153-158. [*in English*: Vitković, B. (2015). Power in a networked society and opposition to that power. *CM Communication and media*. 10(33), 153-158.].

34. Vitković, B. (2023). Učesće mladih u medijima i analiza prelivanja informacija o njima od jedne ka drugoj vrsti medija. *CM Komunikacija i mediji*, 18(2), 305–336. DOI: 10.5937/cm18-43849, [*in English*: Vitković, B. (2023). The participation of young people in the media and the analysis of the spillover of information about them from one type of media to another. *CM Communication and media*. 18(2), 305–336.]

35. Vujanić, I., Dabetić, Đ., Erić, I., & Đokić, M. (2021). The effects of state funded support on the survival of start-up companies in Serbia. *Oditor*, *7*(1), 71-100. https://doi.org/10.5937/Oditor2101071V

36. Zheng, B., Chu, J., & Jin, L. (2021). Recycling channel selection and coordination in dual sales channel closed-loop supply chains. *Applied Mathematical Modelling*, 95, pp. 484-502. https://doi.org/10.1016/j.apm.2021.02.022

37. Zhi-Hong, Z., Yi, Y., & Jing-Nan, S. (2006). Entropy method for determination of weight of evaluating indicators in fuzzy synthetic evaluation for water quality assessment, *Journal of Environmental Sciences*, vol. 18, pp. 1020–1023.

38. Zhou, Y., Zhang, Q., Li, K., & Chen, X. (2012). Hydrological effects of water reservoirs on hydrological processes in the East River (China) basin: complexity evaluations based on the multi-scale entropy analysis, *Hydrological Processes*, vol. 26, no. 21, pp. 3253–3262.

EMPIRICAL EVALUATION OF SUSTAINABLE AGRICULTURAL MANAGEMENT IN SOUTHEAST EUROPEAN COUNTRIES USING PANEL DATA ANALYSIS

Lidija Madžar[1], Jasmina Stojiljković[2], Janko Todorov[3]
**Corresponding author E-mail: lidi.madzar@gmail.com*

A R T I C L E I N F O

Review Article

Received: *07 March 2024*

Accepted: *15 March 2024*

doi:10.59267/ekoPolj2402653M

UDC 502.131.1:631(4-12)

Keywords:

sustainability of agricultural development, panel data Fixed Effects Model, renewable energy sources, economic sustainability, environmental and social unsustainability

JEL: *N50, O13, Q01, Q15, Q56*

A B S T R A C T

The purpose of this article is to assess the agricultural development of ten Southeast European (SEE) countries from the aspect of key environmental, economic and social indicators of agricultural sustainability management from 2011 to 2020. The article uses a Cross-section panel data Fixed Effects Model to identify relations between agricultural development in SEE countries and mentioned indicators of sustainable agricultural development management. The common sample of all SEE countries shows the economic sustainability, but also the environmental and social unsustainability of their agricultural systems. At a disaggregated level, the sub-sample of European Union (EU) membership candidate countries also yields the same findings. In contrast, the sub-sample of EU member states indicates all three dimensions of sustainability, with the exception of the aspect of using renewables. Therefore, both groups of countries should use renewables more intensively in order to contribute to the promotion of their efficient, sovereign and sustainable agricultural growth.

Introduction

Sustainability has grown into a key paradigm of connecting ecological, economic and social goals, both in science and practice, and in ongoing economic policies (Janker et al., 2019). Given the rapid growth of the global population, and thus the increase in demand for food, textiles and other agricultural goods, there is an imperative for

1 Lidija Madžar, Associate Professor, Alfa BK University, Faculty of Finance, Banking and Auditing, 3 Palmira Toljatija, 11070 New Belgrade, Republic of Serbia, E-mail: lidi.madzar@gmail.com, ORCID ID (https://orcid.org/0000-0002-1708-5683)

2 Jasmina Stojiljković, Assistant Professor, University of Business Academy in Novi Sad, Faculty of Applied Sciences in Niš, 22a Dušana Popovića, 18000 Niš, Republic of Serbia, E-mail: jasmina.stojiljkovic@fpn.rs, ORCID ID (https://orcid.org/0009-0005-3458-2824)

3 Janko Todorov, Assistant Professor, Faculty of Business Studies and Law, E-mail: janko.todorov@fpsp.edu.rs, ORCID ID (https://orcid.org/0000-0003-2884-7396)

sustainable management of resources in agribusiness. The United Nations (UN) estimates that the global population could grow to about 8.5 billion by 2030 and 9.7 billion people by 2050, if it continues to increase at a rate of less than 1% (United Nations, 2022). That scenario would certainly raise the pressure on the demand for basic life goods. Sustainable agriculture is a flexible and adaptable farming production that meets the needs for food and fiber of current generations, but not at the expense of the similar needs of future generations (SAREP, 2023). Guided by multidimensional sound goals, sustainable agricultural techniques are based on environmental protection, prevention of natural resources and improvement of water, air and soil quality, in their intention to increase the profitability of agricultural business, improve the quality of life on farms, and promote environmentally friendly behavior (National Institute for Food and Agriculture, 2024). The Food and Agriculture Organization (FAO, 2016) defines sustainable agriculture as practices and policies that support the integration of agricultural production with the aim of responsible management and ensuring the long-term availability of natural resources, which is why both the production of nutritious and safe food and good agricultural practices are in its immediate focus.

By relying on organic production, sustainable agriculture helps farmers in use of innovative agricultural practices and sustainable recycling methods such as crop waste and animal manure. It increases the efficiency and effectiveness of agricultural production, has a positive impact on the environment and ecosystems, ensures the long-term use of natural resources and makes its invaluable contribution to the creation of new jobs and the development of local communities (Meena, 2023). Sustainable agriculture, among other things, contributes to the preservation and improvement of natural ecosystems, biodiversity, economic systems and human civilization itself. This concept encourages practices that do not threaten agricultural resources, fosters the sustainability of natural ecosystems and resilience to climate change, preserves soil from degradation and supports agricultural production in the most lucrative and productive way (Coulibaly et al., 2021). However, despite its numerous advantages, there are still many obstacles to the realization of this ambitious concept. They primarily relate to ecological considerations, morality, socially responsible behavior and social expectations regarding the expected productivity and profitability of agricultural production, as well as the application of specific agricultural techniques and the functioning of food supply chains (Dukić et al., 2021).

The region of Southeast Europe (SEE) has a population of 55 million inhabitants, located in as many as ten countries. Although the size and population of this region is relatively small, without encouraging the development of agriculture in the SEE countries, there would also be a decrease in food security in the wider area of Europe (Andrei et al., 2023). This region also represents a special geographically, sociologically and culturally bounded entity that is important for the European Union (EU) itself, bearing in mind that it is made up of some EU members (Bulgaria, Croatia, Greece and Romania), as well as of countries officially candidates for EU membership (Albania, Bosnia and Herzegovina, Moldova, Montenegro, North Macedonia and Serbia).

Today, the countries of Southeast Europe are primarily characterized by accelerated deindustrialization induced by endogenous factors, bad strategic economic decisions, weak human capital, a large wave of emigration and exogenous shocks, as well as stagnant and insufficiently efficient agriculture, low demand and weak capital markets. Along with the slow industrialization of the region and the growth of global prices of agricultural products, there was also a shift of capital and labor force from industry to the agricultural sector, giving the region of South Eastern Europe an explicit comparative advantage in agriculture rather than in industrial production (Kopsidis, Ivanov, 2017). In addition to agriculture and industry, these countries today largely base their development on the perspective service sector. On the other hand, the OECD (2018), by analyzing the agriculture of the Western Balkans' countries, points out that they are abundant in natural resources, which gives them a good basis for the development of agriculture, both in terms of its additional values, as well as in terms of employment and the creation of new jobs. However, these countries still face problems of sustainable growth in agricultural productivity, sectorial competitiveness and rural development. Despite the affordability of basic rural infrastructure and well-established policy frameworks, they still pursue a politics of heavy agricultural subsidies that distort markets and act as a disincentive to agricultural productivity growth.

The significance of this empirical study is reflected in the fact that until now there have been relatively few published research articles devoted to the study of the important issue of sustainable agricultural development management in the SEE countries. Of the published manuscripts dedicated to this topic, they were mainly led by the reports of relevant international organizations. In addition, the findings of many published studies are not mutually comparable since most of them cover heterogeneous countries, most often including the countries of Central Europe. Therefore, the findings of this article will gain significant insights and paint a picture of the SEE agricultural systems' viability, which also gives a significant scientific contribution. This is even truer if one take into account that the previous studies on the assessment of the sustainable agricultural development are still in their infancy, as well as that there is still plenty of room for carrying out research on the sustainability of modern agrarian systems (Yu, Yongtong, 2022). The purpose of this article is to evaluate the agricultural development of the ten mentioned SEE countries at an aggregated level from the aspect of key environmental, economic and social indicators of agricultural sustainability in the period from 2011 to 2020. Following the introductory part, its second section is devoted to a review of the relevant literature sources on the most commonly used indicators of agricultural sustainability, while the third section describes the data and the research methodology applied. The fourth section discusses the obtained results, with the final section concluding the paper.

A brief literature review on sustainable agricultural management indicators

There is a reach body of articles devoted to the study of indicators of sustainable agricultural production. Sustainable agribusiness has emerged as a useful substitute for conventional agriculture that is based on extensive production and mechanization systems, labor and capital intensity, and extensive use of artificial fertilizers and insecticides. Conventional agriculture is often identified with intensive farming systems (Macrì, Perito, 2018), as well as with the practice that insists on the intensive use of agricultural chemicals and land with the aim of maximizing agricultural output (Sumberg, Giller, 2022). Hansen (1996) noted long ago that sustainability is a fundamental characteristic and rudimentary approach to agricultural development that has triggered broad changes and its reform efforts. However, although the interpretation of sustainability in this way is relevant and logical, the idea and practical implications of its conceptualization have limited the usefulness of this approach (Hansen, 1996), which is why there was a need to build a set of more concrete, reliable, quantitatively expressible, systemic and predictable indicators of the sustainable agricultural production.

Smith and McDonald (1998) classified the complex factors of agricultural sustainability into hierarchically organized classes of biophysical, economic and social factors at scientific field, farm, regional and national levels. Bearing in mind the need for adequate information in the decision-making and planning stages of agricultural production, the authors have developed a comprehensive framework for an integrated assessment of sustainable agriculture that includes all analyzed factors and measurement levels. *Table 1* from the Appendix gives a somewhat deeper insight into some of the multitude of indicators used by many authors when constructing the proposed frameworks and indices for assessing the sustainability of agriculture. The tabular representation clearly shows that the proposed indicators of sustainable agricultural management have become more complex over time, both in terms of their number and scope, as well as in terms of the recommended hierarchical determinants and classification levels.

Rao and Rogers (2006) compared and synthesized several formal systems and analytical frameworks for assessing sustainable agriculture at the global, national, regional, village and farming system levels, as basic prerequisites for designing appropriate agricultural policies. By scaling indicators from lower hierarchical levels to higher ones using Geographic Information Systems (GIS) tools, the authors proposed a kind of framework for assessing agricultural sustainability. Yu and My (2022) use an extensive bibliometric analysis of 110 scientific articles published between 2002 and 2022 with the aim of determining the growth trend of sustainable agriculture assessment research. Based on the conducted statistical analysis, the authors conclude that recent studies focused on environmental effects and economic efficiency, mainly using three aggregated groups of a wide range of observed indicators (environmental, economic and social).

Finally, Alaoui, Barão, Ferreira and Hessel (2022) also compare six mutually competing frameworks for assessing the overall sustainability of agricultural holdings in their attempt to summarize sustainability criteria and identify available frameworks for assessing agricultural sustainability. The authors conclude that only the Sustainability Monitoring and Assessment RouTine (SMART) framework simultaneously considers the ecological, socio-cultural and economic dimensions of sustainability in a balanced way, while the other considered frameworks rather focus on only one of these dimensions. While the observed frameworks differ from each other according to the information receivers they are actually intended for, they cover the main ideas and concepts from the environmental, economic and socio-cultural dimensions, concluding that future frameworks should also include the climatic, technological and social dimensions.

This article uses agricultural value added as a dependent variable, bearing in mind that it is a key indicator for measuring the growth of primary sector output and, in general, of national and local rural economic development patterns (Ru et al., 2022; Ceylan, Özkan, 2013). In addition, the agricultural value added is also used as a good indicator of the achieved evolutionary progress in the agricultural sector performance, based on which detailed information could be obtained about the need to change agricultural policies or investment decisions (Olubode-Awosola et al., 2008).

Used data and applied research methodology

Based on the analyzed articles from the Literature Review, the purpose of this article is to assess the impact of some environmental, economic and social sustainability factors on the agricultural development in the observed SEE countries (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Montenegro, Moldova, North Macedonia, Romania and Serbia). All data for analysis comes from the World Bank database, which ensured their full comparability. The sample initially consisted of N=10 cross sections, that is, countries and T=10 time units, that is, years, which made 100 observations of a balanced panel. Preliminary analyzes indicated that there was no possible risk of multicollinearity given that the Pearson correlation coefficients between the regressors ranged up to |0.36|, indicating the absence of multicollinearity. It was also observed that the Agricultural methane emissions indicator had the highest positive and statistically significant correlation with the dependent variable ($\rho = 0.9122$, $p = 0.0000 < 0.05$). The variables used in the analysis are shown in more detail in the following *Table 1*.

Table 1. Indicators used in the analysis

Variable	Variable description	Variable code	Source of data
Agricultural development	Agriculture, forestry and fishing value added (in constant 2015 billion US$)	AGRI	World Bank
Agricultural methane emissions	Agricultural methane emissions (in thousand metric tons of CO_2 equivalent)	METH	World Bank
Renewable energy	Renewable energy consumption (as a % of total final energy consumption)	RENWEN	World Bank
Cereal yields	Cereal yields (in kg per hectare)	CEREAL	World Bank
Unemployment rate	Total unemployment rate (as a % of total labor force)	UNEMPL	World Bank
Education	Total government expenditure on education (as a % of GDP)	EDU	World Bank

Source: Authors

The article applies panel regression analysis in its intention to discover and describe the relationships between the dependent variable Agricultural development and the observed explanatory variables presented in *Table 1*. To this end, the article uses panel data Cross-section Fixed Effects Model (FEM) to identify the mentioned links. The most general and simplest form of the FEM model can be written as follows (Gujarati, 2012):

$$y_{it} = \alpha_i + \beta_i X_{it} + u_{it} \tag{1}$$

where y_{it} represents the dependent variable that is evaluated for each cross-sectional unit i, α_i is the intercept, X_{it} is the matrix of regression variables, β_i is the matrix of coefficients of explanatory variables, while u_{it} is the error term of the regression.

Taking into account *Formula 1* and the variable codes from *Table 1*, the considered research model took the following form:

$$AGRI = \alpha_i + \beta_1 \times METH_{it} + \beta_2 \times RENWEN_{it} + \beta_3 \times CEREAL_{it} + \beta_4 \times UNEMPL_{it} + \beta_5 \times EDU_{it} + u_{it} \tag{2}$$

In this article, the statistical software package Eviews 9 was used for panel data processing.

Results and discussion

Estimation of the entire sample

Initial analyses of the sample data also suggested that all included variables were stationary at their levels. For this purpose, the polled Levin, Lin and Chu (LLC) test was employed, which is suitable for panels of moderate size and provides exceptional estimator consistency compared to its separate unit root test counterparts (Barbieri, 2009). Considering their short length, as well as the detected stationarity, the used variables remained at their levels. Due to the imposed limitations on the length of the article, data on correlation coefficients between the regressors and the results of the conducted LLC test are available upon request from the Authors. The original intention of the authors was to include the variable Gender equality in the analysis, but as it turned out that it was not stationary even in its logarithmic form, it had to be excluded from further analysis.

In the next step, the article approached data diagnostics with the aim of selecting the best panel data regression model. The results of the Likelihood Ratio (LR), i.e. the Chow Test indicated that in the choice between the Pooled OLS model and the Fixed Effects Model, it was necessary to choose the FEM (Cross-section Chi-square = 245.0128, p = 0.0000 < 0.05). On the other hand, the results of the performed Hausman test indicated that the FEM emerged as a preferred solution in relation to the Random Effects Model (REM) (Chi-square = 19.7176, p = 0.0014 < 0.05). The Pesaran CD test also indicated that there was no cross-sectional dependence in the residuals (Pesaran, 2004), which also supported the argument in favor of applying the LLC test of stationarity of the considered variables. Given the observed statistical significance of the cross-sectional effects, but also the heteroscedasticity present in the panel data set, GLS Cross-section weights that allow heteroscedasticity in the cross-sectional dimension (Eviews Halp, 2024) were used, together with White's robust standard errors that correct heteroskedasticity and potential serial correlation. In the continuation of the article, an overview of all three mutually competitive models is presented in order to show the advantages of the selected FEM model in relation to the other two alternatives.

Table 2. Summary overview of three competing models

Variables	Pooled OLS	Random Effects Model	Fixed Effects Model
C	-2.4762* (0.469338)	0.0376 (0.817152)	3.1942* (0.328681)
METH	0.0012* (2.40E-05)	0.0007* (0.000170)	-0.0003* (0.000112)
RENWEN	-0.0092** (0.005227)	-0.0203** (0.011505)	-0.0070 (0.003753)
CEREAL	9.73E-05* (3.70E-05)	0.0004* (6.11E-05)	0.0002* (2.93E-05)
UNEMPL	0.0397* (0.006700)	-0.0067 (0.011198)	0.0003 (0.003654)
EDU	0.4094* (0.059195)	0.0297 (0.094380)	-0.0057 (0.021877)
R-squared	0.8499	0.3768	0.9919
Adjusted R-squared	0.8489	0.3437	0.9906
S.E. of regression	1.0659	0.3637	0.2509
F-statistic	786.1738*	11.3674*	747.2480*
Prob.(F-statistic)	0.0000	0.0000	0.0000

Note: * denotes statistical significance at the level of 0.05, while ** denotes statistical significance at the level of 010; standard errors in parentheses

Source: Authors' calculations

Off all the observed mutually competing models, the proposed Cross-section FEM model also showed the highest Adjusted coefficient of determination (R^2), indicating that it explained as much as 99.06% of the variation in the dependent variable. In addition, this model was characterized by the smallest regression error term (S.E. = 0.2509), while all variables collectively contributed to explaining the dependent variable (F-statistic = 747.2480, p = 0.0000 < 0.05). All of the above indicated that it was a well-fitted and correctly selected model.

The results of the analysis of the proposed Cross-section FEM model unequivocally indicated that the variables Agricultural methane emissions and Cereal yields gave a statistically significant contribution to agricultural development in the countries of Southeast Europe, which was in line with expectations. However, while an increase in Cereal yields by 1 kilogram per hectare leads to an increase in Agricultural value added by 0.0002 billion US$, an increase in Agricultural methane emissions in the amount of one thousand metric tons of CO_2 equivalent causes a decrease in Agricultural value added by 0.0003 billion US$. These findings point to the conclusion that from the perspective of harmful greenhouse gases (GHG) emissions, the development of agriculture in SEE countries is not sustainable. In addition, the growth in the use of renewable energy sources leads to a decrease in agricultural output, suggesting that even from environmental aspect agricultural development in the region is not sustainable. Finally, the negative impact of Total government expenditure on education on the development of agriculture is observable, which probably occurs as a result of the fact that the agricultural production of SEE countries is characterized by weak human capital (Kopsidis, Ivanov, 2017), but also that state allocations for education are likely to be directed towards some other productive sectors.

Estimation of sub-samples

In the next phase of the research, the initial sample was divided into two sub-samples, the first one, which refers to the EU membership candidate countries, and the second one, which consisted of EU member states. By following an almost identical FEM econometric procedure with all previously satisfied conditions, the authors conducted separate analysis on both sub-samples, noting that the sub-sample of EU membership candidates showed significant cross-section effects, while the sub-sample of EU members showed significant time effects. The results of the performed analysis of these two mutually comparative models are shown in the following *Table 3*.

Table 3. Results of sub-samples' Fixed Effects Models

Variables	**Cross-section FEM (EU membership candidate countries sub-sample)**	**Period FEM (EU member states sub-sample)**
C	1.8400* (0.285982)	-1.6172* (0.702027)
METH	-0.0003 (0.000188)	0.0012* (0.001190)
RENWEN	-0.0083* (0.002486)	-0.1106* (0.009537)
CEREAL	0.0001* (2.06E-05)	0.0004* (0.000123)
UNEMPL	0.0005 (0.003544)	0.1955* (0.007916)
EDU	-0.0895* (0.027788)	0.0421 (0.176494)
R-squared	0.9921	0.9965
Adjusted R-squared	0.9905	0.9946
S.E. of regression	0.0805	0.4778
F-statistic	618.7757*	510.3594*
Prob.(F-statistic)	0.0000	0.0000

Note: * denotes statistical significance at the level of 0.05

Source: Authors' calculations

Interesting enough, from this comparative overview, arises the first conclusion that emissions of harmful agricultural methane are negatively correlated with agricultural production in EU membership candidates, while they are positively correlated in EU members. This further suggests that agricultural production in the EU candidates is not sufficiently developed, nor sustainable in terms of methane emissions, while it is sustainable and certainly more developed in EU members. When it comes to renewable energy sources, in both groups of countries a statistically significant negative relationship with agricultural output is observed, indicating the environmental unsustainability of agricultural production, as well as the need for their greater use and more significant investments and employment in this area. As regards the Cereal yields variable, the expected significant positive relationship appeared in both groups of countries, indicating economic viability of their agricultural systems. Finally, it follows from the analysis that allocations for education have positive effects on agricultural development in the EU member states, while this is not the case with the EU membership candidate countries.

Conclusions

This article is dedicated to the research of the influence of some environmental, economic and social factors of sustainable agricultural development management of the countries of Southeast Europe in the period from 2011 to 2020. The research covered ten SEE countries, both official candidates for EU membership (Albania, Bosnia and Herzegovina, Montenegro, Moldova, North Macedonia and Serbia), and EU members (Bulgaria, Croatia, Greece and Romania) with the aim of evaluation the sustainability of their agricultural development. For that purpose, the Cross-section panel data Fixed Effect Model was applied to the aggregate sample, which indicated economic sustainability, but also environmental and social unsustainability of agricultural development in all observed countries. While there is a positive relationship of the economic variables Cereal yields and Unemployment rate with agricultural development, there is also a worrying negative relationship between agricultural methane emissions, the use of renewable energy sources and educational expenditure, on one, and agricultural output on other hand.

After dividing the common sample into two separate sub-samples, the analysis pointed to significant differences between EU membership candidate countries and EU members. Unlike the candidate countries, which again demonstrated the environmental and social unsustainability of their agricultural systems, the situation is completely different in EU members. In EU member states, agricultural development is sustainable from the aspect of harmful methane emissions, cereal yields and allocations for education, while it is unsustainable only from the aspect of using renewable energy sources. This further means that the candidates for EU membership have a long way to go towards consolidating their agricultural sectors, including the greening of their economies and certainly greater and more focused allocations for education purposes. In addition, both groups of countries should focus more intensively on managing the use of renewable energy sources in agricultural production, such as wind, solar and biomass energy, in order to contribute to the promotion of their efficient, sovereign and sustainable agricultural growth. The evidence-based information and findings of this article are useful and informative for researchers, practitioners, decision makers and agricultural policy makers, but also for the wider public concerned with these important issues. The indicators used in this paper can provide useful hints for subsequent research, while further streams of research could be aimed at expanding the scope of the analysis to the countries of Central Europe.

Acknowledgements

This article is a part of the research results on project U 01/2023 Green economy in the era of digitization, realized by Faculty of Finance, Banking and Auditing, Alfa BK University from Belgrade, Serbia.

Conflict of interests

The authors declare no conflict of interest.

References

1. Alaoui, A., Barão, L., Ferreira, C. S. S., & Hessel, R. (2022). An Overview of Sustainability Assessment Frameworks in Agriculture. *Land, 11*(4), 537. 1-26. https://doi.org/10.3390/land11040537
2. Andrei, J. V., Chivu, L., Sima, V., Gheorghe, I. G., Nancu, D., & Duică, M. (2023). Investigating the digital convergence in European Union: an econometric analysis of pitfalls and pivots of digital economic transformation. *Economic research-Ekonomska istraživanja*, 36(2).
3. Barbieri, L. (2009). Panel Unit Root Tests: A Review. Serie Rossa: Economia – Quaderno No. 43. Università Cattolica del Sacro Cuore, Piacenza.
4. Ceylan, R. F., & Özkan, B. (2013). Agricultural Value Added and Economic Growth in the European Union Accession Process. *New Medit, 4*(2013), 62-71.
5. Coulibaly, T. P., Du, J., & Diakité, D. (2021). Sustainable Agricultural Practices Adoption. *Poľnohospodárstvo (Agriculture)*, *67*(4), 166-176. DOI: 10.2478/agri-2021-0015
6. Dukić Mijatović, M., Uzelac, O., & Stoiljković, A. (2021). Agricultural Sustainability and Social Responsibility. *Economics of Agriculture*, *68*(4), 1109-1119. doi:10.5937/ekoPolj2104109D
7. Eviews Help. (2024). Pooled Estimation. Retrieved from https://eviews.com/help/helpintro.html#page/content%2Fpool-Pooled_Estimation.html%23 (January 29, 2024)
8. Food and Agriculture Organization of the United Nations. (2016). Sustainable Agriculture: A tool to strengthen food security and nutrition in Latin America and the Caribbean. UNFAO, Rome.

9. Gujarati, D. (2012). *Econometrics by Example*. Palgrave Macmillan, New York.
10. Hansen, J. W. (1996). Is Agricultural Sustainability a Useful Concept? *Agricultural Systems*, *50*(1996), 117-143.
11. Janker, J., Mann, S., & Rist, S. (2019). Social sustainability in agriculture – A system-based framework. *Journal of Rural Studies*, *65*(2019), 32-42. https://doi.org/10.1016/j.jrurstud.2018.12.010
12. Kopsidis, M., & Ivanov, M. (2017). Industrialization and De-industrialization in Southeast Europe, 1870–2010. In: Kevin Hjortshoj O'Rourke and Jeffrey Gale Williamson (editors), *The Spread of Modern Industry to the Periphery since 1871*. Oxford University Press, Oxford. https://doi.org/10.1093/acprof:oso/9780198753643.001.0001
13. Macrì, M. C., & Perito, M. A. (2018). "Social Agriculture": A Pattern between Farm Innovation, Social Responsibility and Multifunctionality. *Economics of Agriculture*, *57*, *Special No.*(2010), 35-43. Retrieved from https://www.ea.bg.ac.rs/index.php/EA/article/view/1060 (January 27, 2024)
14. Meena, M. (2023). Importance and Approaches of Sustainable Agriculture. *Just Agriculture*, *3*(7), 139-145.
15. National Institute of Food and Agriculture. (2024). Sustainable Agriculture. U.S. Government, Washington, D. C. Retrieved from https://www.nifa.usda.gov/topics/sustainable-agriculture#:~:text=Sustainable%20agricultural%20practices%20are%20intended,Promote%20environmental%20stewardship (January 28, 2024)
16. Olubode-Awosola, O. O., Chilonda, P., Minde, I., & Bhatt, Y. (2008). Indicators for Monitoring and Evaluation of Agricultural Performance and Shared Goals in Southern Africa. ReSAKSS Working Paper No. 24. Regional Strategic Analysis and Knowledge Support System, Addis Ababa, Ethiopia.
17. Organization for Economic Co-operation and Development. (2018). Agriculture in South East Europe. In: *Competitiveness in South East Europe: A Policy Outlook 2018*. OECD Publishing, Paris. https://doi.org/10.1787/9789264298576-en
18. Pesaran, H. M. (2004). General Diagnostic Tests for cross Section Dependence in Panels. IZA Discussion Paper Series No. 1240. Institute for Study of Labor, Bonn.
19. Rao, N. H., & Rogers, P. P. (2006). Assessment of agricultural sustainability. *Current Science*, *91*(4), 439-448.
20. Ru, Y., Blankespoor, B., Wood-Sichra, U., Thomas, T. S., You, L., & Kalvelagen, E. (2022). Estimating Local Agricultural GDP across the World. *Earth System Science Data*, *15*(3), 1-36. https://doi.org/10.5194/essd-15-1357-2023
21. Smith, C. S., & McDonald, G. T. (1998). Assessing the sustainability of agriculture at the planning stage. *Journal of Environmental Management*, *52*(1998), 15-37.
22. Sumberg, J., & Giller, K. E. (2022). What is 'conventional' agriculture? *Global Food Security*, *32*(2022), 1-9. https://doi.org/10.1016/j.gfs.2022.100617

23. Sustainable Agriculture Research and Education Program. (2023). What is sustainable agriculture? August 23, 2023. Agricultural Sustainability Institute, University of California, Davis. Retrieved form https://sarep.ucdavis.edu/sustainable-ag (January 25, 2024)
24. United Nations. (2022). World population to reach 8 billion on 15 November 2022. July 11, 2022. UN Department of Economic and Social Affairs. Retrieved from https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/wpp2022_press_release.pdf (January 25, 2024)
25. World Bank. (2024). World Bank Open Data Portal. Retrieved from https://data.worldbank.org/ (January 26, 2024)
26. Yu, S., & Mu, Y. (2022). Sustainable Agricultural Development Assessment: A Comprehensive Review and Bibliometric Analysis. *Sustainability*, *14*(19), 11824, 1-19. https://doi.org/10.3390/su141911824

Appendix

Table 1. Indicators for agricultural sustainability assessment

Sets of indicators	Smith & MacDonald (1998)	Rao & Rogers (2006)	Yu & Mu (2022)	Alaoui et al. (2022)
Set 1	**Biophysical** (Land and water quality and Productivity)	**Environmental** (Soil loss, Farm size, Water quality, Carbon emissions, Average rainfall, Groundwater use, Soil quality, Livestock etc.)	**Environmental** (Pollution, Acidification, GHG emissions, Energy use efficiency, Healthy agricultural area etc.)	**Environmental** (Water use, quality and pollution, soil quality and land degradation, Air quality, Climate, Plants and fertility, Biodiversity, Energy use, Animal welfare etc.)
Set 2	**Economic environment** (Income, Profitability, Production costs, Consumption, Poverty indices etc.)	**Socio-economic** (National income, Poverty level, Land availability and Food consumption per capita, Debt-service ratio, Labor productivity, Literacy rate, Ownership rights, Household income, Credits and assets etc.)	**Economic** (Agricultural income, Income of farmers, Economic yields, Farm management costs, Agricultural contribution to GDP, Productivity of labor, land and capital, Agricultural productivity, Investment in R&D etc.)	**Economic** (Profitability, Vulnerability, Accountability, Investment, Local economy indicators, Economic risks etc.)

Sets of indicators	Smith & MacDonald (1998)	Rao & Rogers (2006)	Yu & Mu (2022)	Alaoui et al. (2022)
Set 3	**Social environment** (Social justice and equity, Participation, Democratic institutions, Overall policy environment, Access to resources and outputs, Attitudes, Knowledge, Social values etc.)	**Science and technology capacity** (High yielding varieties, Change in fertilizer and water use efficiency, Change in livestock productivity etc.)	**Social** (Agricultural employment and land, Rural development, Education level, Agricultural and environmental subsidies, Income distribution and social inequalities, Agricultural labor intensity, Diversity of products etc.)	**Socio-cultural** (Employment contracts, Workload, Wages, Health safety, Job satisfaction, Decent livelihood, Gender equality, Cultural diversity, Investment in local communities, Employment, Consumer safety, Transparency etc.)
Set 4		**Institutional capacity** (Capacity building, Access to information, financial resources, community services and markets, Infrastructure, Insurance, Financial and agricultural institutions)		

Source: Authors' research

APPLICATION OF A DEFINITE INTEGRAL CALCULUS IN RENT CALCULATION

Ivan Milojević[1], Dalibor Krstić[2], Ivan Božović[3], Dragan Bataveljić [4]
**Corresponding author E-mail: drimilojevic@gmail.com*

A R T I C L E I N F O

Review Article

Received: *18 March 2024*

Accepted: *20 April 2024*

doi:10.59267/ekoPolj2402667M

UDC 517.3:332.858.4

Keywords:

definite integral, rent, method of calculation

JEL: *C60, Q15*

A B S T R A C T

For land rent, it is characteristic that it arises as a consequence of capital investment in the purchase of land, which is not a production investment, because capital is not invested for the reason of organizing agricultural production, the main reason of investing capital is to acquire certain ownership of land areas. In this paper, we will present the possibility of solving the problem of rent calculations using the economic application of the definite integral. First, we will show if the integral calcusus is applied in the rent calculation and then in the domain of its calculation.

Introduction

In the economic literature, rent means the economic form of realization of land ownership, (Ilić, B. 2019) i.e. rent is ownership income derived from the ownership (legally established and sanctioned) of certain land areas. (Avakumović, J., at al. 2021) The functions of rent are multiple:

- at the macro level of the national economy, it is not possible to ensure the unity of the economic and market space, among other things, without the economic function of rent;

1 Ivan Milojević, PhD, Full Professor, Principal Research Fellow, Ministry of Defense, Republic of Serbia, Nemanjina Street No. 15, 11000 Belgrade, Serbia, Phone: +381692702697, E-mail: drimilojevic@gmail.com, ORCID ID (https://orcid.org/0000-0003-3653-3477)

2 Dalibor Krstić, PhD, Assistant Professor, School of economics and manadment studies, Kragujevac, Republic of Serbia, Karadjordjeva Street No. 52, 34000 Kragujevac, Phone: +381601619311, E-mail: dal.krstic@gmail.com, ORCID ID (https://orcid.org/0000-0003-2286-112X)

3 Ivan Božović, PhD, Associate Professor, University of Priština - Kosovska Mitrovica, Faculty of Economy, Kolasinska Street 156, 38220 Kosovska Mitrovica, Republic of Serbia, E-mail: ivan.bozovic@pr.ac.rs, ORCID ID (https://orcid.org/0000-0001-6400-7461)

4 Dragan Bataveljić, PhD., Full Professor, Faculty of Law University of Kragujevac, Jovana Cvijića 1, 34000 Kragujevac, Phone: +38134306544, E-mail: bataveljic@jura.kg.ac.rs, ORCID ID (https://orcid.org/0000-0001-7396-0705)

- rents are important in the field of ecological protection of natural and other assets and their preservation for future generations; (Milošević, I., Stankov, B. 2023)
- at the micro level of individual producers, the economic function of rent conditions the movement of production costs within certain frameworks, and breaking through these frameworks means reducing the producer's income (profit); (Milojević, I., & Mihajlović, M. 2019)
- rent is an important element of establishing market balance, because the supply and demand for resources and production oscillates depending on whether the actual sizes of the manifest forms of rent are greater or less than its amount in a state of equilibrium. (Ilić, B., & Krstić, S. 2013)

Capital is invested in order to obtain income (land rent) and in this sense no distinction should be made between land rent and interest on capital invested as interest-bearing capital. (Chen, C., at al., 2023) By investing capital in the purchase of land, the capitalist, in addition to ownership of that land, also acquires a monopoly on the use of the natural conditions associated with that land. (Miteva, A., & Doitchinova, J. 2022) If the land has special natural advantages (special qualities, special microclimatic conditions, etc.), (Hečková, J., 2019) the landowner acquires a monopoly of a special kind and this gives the capitalist the opportunity to, in addition to differential and absolute rent, also appropriate monopoly rent. (Rothschild, M., & Stiglitz, J. E. 1978) Land rent does not appear only in agriculture, but everywhere where land is the main object of work (mining, forestry, construction, etc.). (Jeločnik, M., at al., 2022)

Here it is important to explain the relationship between rent and ground rent. (Vladisavljević, V. at al., 2023) In the case of rent, the tenant takes from the owner of the land the right to use it and pays rent for it. (Babajanov, A., at al., 2023) Rent is therefore a market category and an economic expression of the relationship between capitalist tenants and capitalist landowners, (Ryazantsev, I., & Ivolga, A. 2021) i.e. it is the fee paid by the tenant to the capitalist landowner for the use of the given land and is equal to the land rent. (Qiao, X., & Feng, T. 2023) This compensation has the character of interest on the fixed capital invested in the land. (Ilić, B., at al., 2022)

On the other hand, ground rent specifically refers to the payment made by the owner of a leasehold property to the freeholder or landlord who owns the land on which the property is built. In this arrangement, the property owner essentially rents the land from the landlord and pays ground rent as a form of leasehold payment. (Ilić, B., at al., 2022)

In summary, while rent is a broader term that encompasses all payments made for the use of a property, ground rent is a specific type of rent that relates to leasehold properties and represents the payment made for the use of the land on which the property is situated. (Bradfield, T., 2023)

Rent calculation plays a crucial role in the real estate industry, influencing both landlords and tenants in determining the monetary value associated with property usage. The traditional methods of rent calculation often involve complex formulas and considerations, making it challenging to arrive at a mutually beneficial rental agreement. (Ilić, B. 2019). However, the integration of mathematical concepts, specifically definite integral calculus, can simplify and streamline the rent calculation process. (Wu, W., & Yuan, X. (2023). By understanding how to apply integral calculus techniques, individuals involved in property rental transactions can optimize rent determinations based on objective and logical criteria. (Qiao, X., & Feng, T. 2023)

Materials and methods

Before delving into the application of definite integral calculus in rent calculation, it is essential to understand the fundamental concepts of this mathematical tool. (Ely, R., Jones, S.R., 2023). Definite integral calculus, also known as the calculus of definite integrals, deals with the computation of integrals with specific limits. These limits, often referred to as the limits of integration, provide a means to determine the area between a curve and the x-axis over a specified interval.

The application of definite integral calculus in rent calculation extends beyond simple scenarios involving time-dependent rental rates. (Denčić Mihajlov, K., 2020) Integration can also be employed to analyze spatial configurations and irregular occupancy patterns. (Oehrtman, M., Simmons, C., 2023) For instance, in cases where the rented area varies over time or is non-uniformly distributed within a property, the total rent can be determined by integrating the rental rate function over the corresponding area intervals. (Qiao, X., & Feng, T. 2023)

Furthermore, definite integral calculus enables landlords and tenants to optimize space utilization and allocate rental costs efficiently. (Ilić, B., 2020) By segmenting the property into distinct rent zones with varying rates, integration can be used to compute the total rent for each zone and derive an equitable distribution of expenses based on usage. (Ćirić, I.,2022)

The application of definite integral calculus in rent calculation can be broken down into several steps: (Ely, R., Jones, S.R., 2023)

Step 1: Identify the Relevant Factors

To begin with, it is crucial to identify the factors that significantly influence rent determination. These factors may include property size, location, market conditions, and maintenance costs. Each of these factors can be represented as a function of the rent, allowing for a more comprehensive understanding of their individual contributions.

Step 2: Establish a Functional Relationship

Once the relevant factors have been identified, a functional relationship must be established between these factors and the rent. This relationship can be expressed as a mathematical equation, where the rent is the dependent variable, and the factors are the independent variables.

Step 3: Integrate the Factors

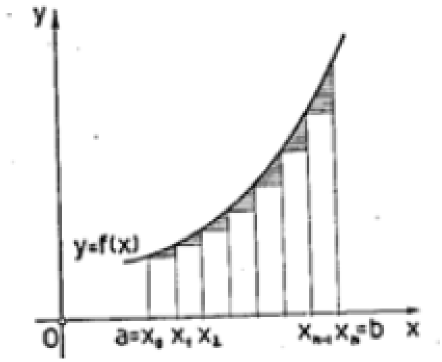
With the functional relationship in place, the next step involves integrating the factors using definite integral calculus. This process enables the computation of the combined effect of these factors on the rent. The definite integral calculus allows for the integration of multiple variables, providing a more accurate and holistic representation of rent determination.

Step 4: Interpret the Results

The final step involves interpreting the results obtained from the integration process. By analyzing the output, one can gain valuable insights into the relative importance of each factor in determining the rent. This information can be used to adjust rent estimates and develop more effective rental strategies.

We will take under consideration function $y = f(x)$ defined on some segment $[a,\ b]$. The interval $[a,\ b]$ is divided into n equal parts $a = x_0 < x_1 < x_2 < \ldots < x_{n-1} < x_n = b$, where $x_1,\ x_2, \ldots,\ x_n$ represents ends of small intervals that belongs to the interval $[a,\ b]$. (Damnjanović, R., at al., 2018) Values of the function $f(x)$ at the ends of those subintervals are: $f(x_1),\ f(x_2),\ f(x_{n-1}),\ f(x_n)$.

Figure 1. Graphic representation of the integral account

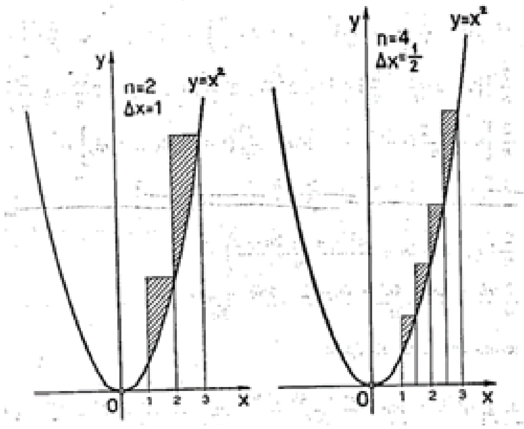


Source: Shekutkovski, N. (2013)

What is the procuct of $f(x_1)(x_1 - x_0) = f(x_1)\Delta x$?

It is the area of the smallest rectangle in the image. In general, the area of an ith rectangle is $f(x_i)\Delta x$, while the area of all those rectangles is $\sum_{i=1}^{n} f(x_i) \cdot \Delta x$. This surface is different from the image surface in Fig. 1 bordered by the curve $y = f(x)$, x axis, and the directions $x = a$ and $x = b$ for the hatched part. (Herceg D., 2009)

Figure 2. Splitting intervals to display partial intervals



Source: Shekutkovski, N. (2013)

When the interval $[a,\ b]$ is divided into an even larger number of partial intervals $x_i - x_{i-1} = \Delta x$, (Fig. 2) the sum of the areas of the rectangles of which these partial intervals are the base will differ even less from the area of that curvilinear picture. (Haq, S., at al., 2022) When is $n \to \infty$, that is $\Delta x \to 0$, the limit value of that sum $\lim_{n\to\infty} f(x_i) \cdot \Delta x$ is completely equal to the area between the curve $y = f(x)$, the line $x = a$ i $x = b$, and the x axis. It is marked with $\int_a^b f(x)\, dx$ i and is called the definite integral of the function $f(x)$ in the limits from a to b. (Huffman Hayes A., 2024) The definite integral is, therefore, the limit value of the sum of the area of the partial rectangles. The sign of the integral, the elongated letter S, is the initial letter of the word "sum". (Sharipova, M. 2024)

Results and Discussions

Let's assume that the land area is R_1, R_2, R_3,..., R_n dinars of rent at the end of the current year, that is, at the end of each of the next $n-1$ years. The present value A of such an annuity is equal to $A = R_1 r^{-1} + R_2 r^{-2} + \ldots + R_n r^{-n} = \sum_{k=1}^{n} R_k r^{-k}$, provided that compound interest is calculated decursively and that the interest rate is constant during that period. If $R_k = const.$, $(k = 1,2,\ldots,n)$, than $A = R \sum_{k=1}^{n} r^{-k} = R \frac{1}{r^n} \frac{r^n - 1}{r-1} = R\ IV_p^n$.

Let's assume that the rent does not arrive discontinuously, in leaps and bounds at the end of each year, but flows continuously throughout the year. (Ely, R., at al., 2023) Let it be received in this way every year at R dinars. Then comes approx. $R\frac{1}{365}$ dinars per day, $R\frac{1}{365\cdot 24}$ dinars per hour etc., that is $R\cdot\Delta t$ dinars per small interval of time Δt. (Kočović, J., Pavlović, M., 2018)

If the rent $R\cdot\Delta t$ is due after t godina, years, starting from today (when $t=0$), i.e. In interval $t,\ t+\Delta t$, then its present value, with continuous interest, is approximately equal $R\cdot\Delta t e^{-\frac{pt}{100}}$.

What is the present value of the annuity in the entire interval from $t=0$ to $t=x$ years?

Obviously, it is approximately equal to the sum: $\sum_{\Delta t\in[0,x]} R\,e^{-\frac{pt}{100}}\cdot\Delta t$.

The mark $\Delta t\in[0,x]$ p indicates that the summation is performed by time intervals Δt from $t=0$ to $t=x$. (J.W.L. Glaisher, 1871)

If $\Delta t\to 0$, the sum converges to the integral $\int_0^x R\,e^{-\frac{pt}{100}}dt$, which represents the exact value of the considered rent at time $t=0$. (Normatov, A. 2023).

In the special case, when the annual interest rate p is fixed, we have

$$\int_0^x R\,e^{-\frac{pt}{100}}dt = R\int_0^x e^{-\frac{pt}{100}}\,dt = R\left[-\frac{100}{p}e^{-\frac{pt}{100}}\right]_0^x = R\left(-\frac{100}{p}e^{-\frac{pt}{100}}+\frac{100}{p}\right).$$

Therefore, the present value of A annuity of R dinars for the year, which flows continuously for x years with continuous interest $p=const.$, is equal

$$A=R\cdot\frac{100}{p}\left(1-e^{-\frac{px}{100}}\right).$$

Obviously, A is a simple function of time x and interest rate p. It is easy to see that A depends on x. (Wu, W., & Yuan, X. 2023) It is evident that A is larger as x is larger, i.e., that the present value of the rent increases when the time interval is wider. (Oehrtman, M., Simmons, C. 2023) What's more, it follows the above relation that it is $\lim_{x\to\infty} A = R\frac{100}{p}$.

This result is interesting, because it shows that the present value of rent in the continuous and discontinuous case is equal. (Shekutkovski, N. 2013) Therefore, the actual or present value of an annuity does not depend on how that annuity flows or how interest is calculated (continuously or discontinuously). (Kočović, J., Pavlović, M., 2018).

It is easy to show that A decreases when p increases (x is fixed), or symbolically

$\lim_{p\to\infty} A = 0$, since it is $\lim_{p\to\infty} A = \lim_{p\to\infty} R\frac{100}{p} \cdot \lim_{p\to\infty}(1 - e^{-\frac{px}{100}}) = 0(1-0) = 0$.

It follows that in the continuous, as well as in the discontinuous case, the present value of the rent decreases when the interest rate increases. (Bradfield, T., at al., 2023) This statement highlights an important relationship between the present value of rent, continuous or discontinuous, and the interest rate. (Kočović, J., Pavlović, M., 2018) In essence, it suggests that as the interest rate rises, the present value of the rent tends to decrease. This can be understood through the concept of time value of money, which states that a dollar today is worth more than a dollar in the future due to its potential earning capacity in the interim. (Vladisavljević, V., 2023)

In the context of continuous and discontinuous cases, it implies that whether the cash flows from rent are received in a steady stream or in discrete intervals, the effect of interest rate changes remains consistent. Higher interest rates make future cash flows less valuable in present terms, leading to a decrease in the present value of rent. This relationship is crucial for financial decision-making, as it helps in evaluating investment opportunities and making informed choices based on the expected interest rate scenario.

In the case of determining the continuity of the rent calculation, that is, whether it is more favorable to receive the rent continuously during the year, rather than all at once at the end of the year in the case where $R = 50000$ dinars for the year, $x = 28$ years and $p = 5$ per year. That's when

$A = 50000 \cdot \frac{100}{5}(1 - e^{-1,4}) = 1\ 000000(1 - 0,246579) \approx 753403$ dinars,

in the event that the rent arrives continuously, assuming that it is working with compound continuous interest. (Popović, G. 2006)

If compounding is discontinuous and decursive (Kočović, J., at al. 2020), and the rent is received at the end of the year, we have

$A = 50000 \cdot IV_5^{28} = 50000 \cdot 14,89812726 = \underline{744906}$ dinars, i.e. now less, because it is more favorable to receive rent continuously throughout the year, than all at once at the end of the year. (Vasiljević, Z., at al., 2006)

This arrangement provides a steady cash flow for the landlord, ensuring financial stability, and allows tenants to manage their expenses more effectively, avoiding potential financial burdens. Additionally, this method fosters a more harmonious landlord-tenant relationship, as it reduces the likelihood of disputes and promotes a sense of responsibility and reliability on both sides.

By extending this methodology to more complex rent structures, such as variable rental rates or lease extensions, property owners and tenants can benefit from a systematic and mathematical approach to rent calculations.

Conclusion

The paper deals with the problem of the possibility of calculating rent using the economic application of a definite integral. The application of definite integral calculus in rent calculation offers a powerful tool for real estate professionals and researchers. By integrating the diverse factors that influence rent determination, this mathematical technique allows for a more accurate and comprehensive understanding of the underlying processes. By leveraging the principles of calculus, property owners and tenants can establish equitable and transparent rent agreements that account for various factors influencing rental costs. As technology advances and computational tools become more accessible, the application of mathematical techniques in rent calculation is poised to enhance the accuracy and efficiency of rental transactions.

As a result, the utilization of definite integral calculus in rent calculation can lead to more informed decision-making and improved outcomes in the real estate market. As the real estate industry continues to evolve, the integration of calculus in rent calculation remains a valuable tool for optimizing financial outcomes and enhancing property management practices.

We came to the conclusion that the present value of the rent increases when the time interval is wider, but that the present value of the rent is equal in the continuous and discontinuous case. Therefore, the actual or present value of an annuity does not depend on how that annuity flows or how interest is calculated (continuously or discontinuously). The present value of an annuity is determined by factors such as the number of periods, the interest rate, and the payment amount, rather than the specific timing or mechanics of the payments. This concept allows for a consistent method of evaluating different types of annuities, regardless of their individual characteristics. It follows that in the continuous, as well as in the discontinuous case, the present value of the rent decreases when the interest rate increases. Furthermore, the next conclusion is that it is more favorable to receive rent continuously during the year, than all at once at the end of the year.

Conflict of interests

The authors declare no conflict of interest.

References

1. Amanda Huffman Hayes. (2024). The Story of Definite Integrals: A Calculus Textbook Narrative Analysis. *International Journal of Education in Mathematics, Science and Technology*, *12*(1), 139–177.
2. Avakumović, J., Marjanović, N., Rajković, A. (2021). Menadžmet cene kapitala u svrhu donošenja investicionih odluka preduzeća. Akcionarstvo, 27(1), 89–106. [*in English*: Avakumović, J., Marjanović, N., Rajković, A. (2021). Capital price management for the purpose of making investment decisions of the company. *Akcionarstvo*, 27(1), 89–106].

3. Babajanov, A., Islomov, U., Umarov, S., Abdiramanov, R., & Inoyatova, M. (2023). Organizational and economic mechanisms of regulating land relations in agriculture. In BIO Web of Conferences (Vol. 65, p. 03005). EDP Sciences.
4. Bradfield, T., Butler, R., Dillon, E. J., Hennessy, T., & Loughrey, J. (2023). Attachment to land and its downfalls: Can policy encourage land mobility?. Journal of Rural Studies, 97, 192-201.
5. Chen, C., Restuccia, D., & Santaeulàlia-Llopis, R. (2023). Land misallocation and productivity. American Economic Journal: Macroeconomics, 15(2), 441-465.
6. Ćirić, I., Tešanović, D., Vujasinović, V., & Ćirić, M. (2022). The impact of food and wine harmonization on the experience and future intentions of the guest. *Ekonomika poljoprivrede*, *69*(2), 331-347. https://doi.org/10.5937/ekoPolj2202331C
7. Damnjanović, R., Đurković, V., & Miljković, M. (2018). Specific integral in economic functions. Oditor, 4(3), 71-81. https://doi.org/10.5937/Oditor1803071D
8. Denčić Mihajlov, K. (2020). Does sustainability matter in mergers and acquisitions?: The case of the Serbian food industry. *Ekonomika poljoprivrede*, *67*(1), 25-36. https://doi.org/10.5937/ekoPolj2001025D
9. Ely, R., Jones, S.R. The Teaching and Learning of Definite Integrals: A Special Issue Guest Editorial. Int. J. Res. Undergrad. Math. Ed. (2023). https://doi.org/10.1007/s40753-023-00214-2
10. Haq, S., Aphane, M., Khan, M. S., & Fabiano, N. (2022). Certain integrals involving generalized Mittag-Leffler type functions. Vojnotehnički glasnik, 70(4), 797-817. https://doi.org/10.5937/vojtehg70-40296
11. Hečková, J., Štefko, R., Frankovský, M., Birknerová, Z., Chapčáková, A., Zbihlejová, L. (2019) Cross-border mergers and acquisitions as a challenge for sustainable business. Sustainability, 11(11): 3130-3130
12. Herceg D., Herceg Đ., The definite integral and computer, The teaching of mathematics, 2009, Vol. XII, 1, pp. 33–44
13. Ilić, B. (2019). Cena zemlje kao faktor održivog razvoja. Održivi razvoj, 1(2), 7-16. https://doi.org/10.5937/OdrRaz1902007I [*in English*: Ilic, B. (2019). The price of land as a factor of sustainable development. Odrzivi razvoj, 1(2), 7-16.].
14. Ilić, B., & Krstić, S. (2013). Politička ekonomija. Etnostil. [*in English*: Ilić, B., & Krstić, S. (2013). Political economy*, Etnostil*].
15. Ilić, B., Đukić, G., & Balaban, M. (2020). Sustainable development directions of rural tourism of Timok region. *Ekonomika poljoprivrede*, *67*(1), 157-174. https://doi.org/10.5937/ekoPolj2001157I
16. Ilić, B., Milojević, I., & Miljković, M. (2022). The role of joint stock company in sustainability of capital development. Održivi razvoj, 4(1), 19-28. https://doi.org/10.5937/OdrRaz2201019I
17. J.W.L. Glaisher B.A. F.R.A.S. F.C.P.S. (1871) XXXII. On a class of definite integrals, The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 42:280, 294-302, DOI: 10.1080/14786447108640568

18. Jeločnik, M., Subić, J., & Zdravković, A. (2022). Economic effects of investment in irrigation systems implementation at the small family farms. Ekonomika poljoprivrede, 69(3), 793-817. https://doi.org/10.5937/ekoPolj2203793J

19. Kočović, J., Mitrašević, M., Rajić, V., (2020). Aktuarska matematika (4. izd.). Univerzitet u Beogradu, Ekonomski fakultet, Centar za izdavačku delatnost. [*in English*: Kocovic, J., Mitrasevic, M., Rajic, V. (2020). Actuarial mathematics*, University of Belgade, Faculty of economy*.

20. Kočović, J., Pavlović, M., (2018). Uvod u finansijsku matematiku (3. izd.). Centar za izdavačku delatnost Ekonomskog fakulteta. [*in English*: Maksimović, G., Sekulić, D., Petrović, A., & Dragičević, D. (2017). Contemporary trends and new competitiveness strategies in hotel industry. *Hotel and Tourism Management, 5*(2), 27-35.].

21. Milojević, I., & Mihajlović, M. (2019). Implementation of the method of assessing investment projects in the public sector. Oditor, 5(1), 19-31. https://doi.org/10.5937/Oditor1901019M

22. Milošević, I., Stankov, B. (2023). Upravljanje prilivima stranih direktnih investicija u Republici Srbiji u kontekstu njihovog uticaja na visinu bruto domaćeg proizvoda. Akcionarstvo, 29(1), 133–149. [*in English*: Milosevic, I., Stankov, B. (2023). Management of inflows of foreign direct investments in the Republic of Serbia in the context of their impact on the gross domestic product, Akcionarstvo, 29(1), 133–149.

23. Miteva, A., & Doitchinova, J. (2022). Agriculture in the Southwestern region of Bulgaria and its impact on rural development. *Ekonomika poljoprivrede*, 69(4), 1003-1016. https://doi.org/10.5937/ekoPolj2204003M

24. Normatov, A. (2023). Some applications of the definite integral. In Proceedings of International Conference on Modern Science and Scientific Studies (Vol. 2, No. 6, pp. 260-263).

25. Oehrtman, M., Simmons, C. Emergent Quantitative Models for Definite Integrals. Int. J. Res. Undergrad. Math. Ed. (2023). https://doi.org/10.1007/s40753-022-00209-5

26. Popović, G. (2006). Macroeconomic efficiency measurement of the invested funds into a rural area or sector with a method of a capital coefficient. *Ekonomika poljoprivrede*, 53(4), 947-961.

27. Qiao, X., & Feng, T. (2023). Land rent theory and rent research of digital platform enterprises. Journal of Digital Economy, 2, 52-63.

28. Rothschild, M., & Stiglitz, J. E. (1978). Increasing risk: I. A definition. In Uncertainty in Economics (pp. 99-121). Academic Press.

29. Ryazantsev, I., & Ivolga, A. (2021). Distribution of agricultural lands and land ownership in Russia. Ekonomika poljoprivrede, 68(4), 961-975. https://doi.org/10.5937/ekoPolj2104961R

30. Sharipova, M. (2024). A is correct of the integral to the economy applications. Solution of social problems in management and economy, 3(1), 116-125.

31. Shekutkovski, N. (2013). Definition of the definite integral. Teaching of Mathematics, 16(1), 29-34.

32. Vasiljević, Z., Sredojević, Z., & Ćejvanović, F. (2006). Model of investments into agricultural land as an element of development program. *Ekonomika poljoprivrede*, 53(2), 403-412.

33. Vladisavljević, V., Mičić, S., Zupur, M. (2023). Analiza kao osnov za donošenje poslovnih odluka. Finansijski savetnik, 28(1), str. 7-35. [*in English*: Vladisavljevic, V., Micic, S., Zupur, M. (2023). Analysis as a basis for making business decisions. *Finansijski savetnik, 28(1), str. 7-35.*].

34. Wu, W., & Yuan, X. (2023). Why Is an Integral an Accurate Value. Applied Mathematics, 14(12), 847-850.

ECONOMIC ANALYSIS OF THE ROLE OF AGRICULTURAL PRODUCTION IN MEETING THE DEFENSE NEEDS OF THE REPUBLIC OF SERBIA

Milan Mihajlović[1], Milan Milunović[2], Uroš Ćeramilac [3]

**Corresponding author E-mail: milan.mih83@gmail.com*

A R T I C L E I N F O

Review Article

Received: *25 March 2024*

Accepted: *20 April 2024*

doi:10.59267/ekoPolj2402679M

UDC 631.16:355/359(497.11)

Keywords:

agricultural production, food products, commodity reserves and the defense system.

JEL: *Q14, H56*

A B S T R A C T

The comprehensive influence and importance of agricultural production on the economy of the Republic of Serbia and its connection with the defense system represent an interesting research topic. This topic has to be researched carefully due to the connection, mutual influence, and mutual intertwining of commodity reserves of food products, the economic system, the defense system, and the army as one of its components, with social and political factors, both internal and external. Since the beginning of the COVID-19 pandemic, global increases in food prices have been noticeable. This problem arose with the beginning of the conflict in Ukraine. It should be understood that the commodity reserve system of food products is a subsystem within a series of higher subsystems and systems, and that this is where its complexity and comprehensiveness lie.

Introduction

In modern society, in which national security and defense are of key importance, the importance of supporting and maintaining stable commodity reserves cannot be underestimated. These reserves represent the basis of the national response to major challenges, including natural disasters, conflicts, and other extraordinary circumstances that may threaten the normal functioning of society and the state. Establishing and maintaining the dynamic stability of the supply and demand relationship and the

1 Milan Mihajlović, assistant professor, Military Academy, University of Defence, Veljka Lukića Kurjaka 33, 11000 Belgrade, Serbia, E-mail: milan.mih83@gmail.com, ORCID ID (https://orcid.arg/0000-0002-4975-9742)

2 Milan Milunović, assistant professor, Military Academy, University of Defense, Veljka Lukića Kurjaka 33, 11000 Belgrade, Serbia, E-mail: 0208luna@gmail.com, ORCID ID (https://orcid.arg/0000-0002-4975-9742)

3 Uroš Ćeramilac, Military Academy, University of Defence, Pavla Jurišića Šturma 33, Belgrade, Republic of Serbia, E-mail: urosc2000@gmail.com, ORCID ID(https://orcid.org/0009-0005-3655-8326)

stability of the production and prices of agricultural products, i.e., the permanent food security of the population, is ensured by the system of market institutions, especially the unique system of agricultural commodity reserves, and primarily those products of vital importance for agro-industrial reproduction. In the context of this, agricultural production plays a vital role. Food is not only the main source of our basic need. It has a deeper and more complex impact on the stability of national security. The production of food and other agricultural products is closely related to the ability of the state to achieve an effective response in the event of a crisis or the needs for defense. Due to the exceptional importance of agriculture in ensuring the stability of the state, including the defense system as part of the national security system, special attention should be paid to the issue of agricultural production. Several questions are very important in light of that. The first question is related to the integration of agricultural production into the supply of commodity reserves. The second is linked to how it affects their readiness and efficiency. The third is connected to its contribution to general national stability.

The aim of this paper is to explore the importance of agricultural production for the economy of the Republic of Serbia and for the national commodity reserves that are of key importance for the defense system. In order to achieve this, we will take into account various dimensions, including the role of agricultural production, recent developments in the agricultural production of the Republic of Serbia, as well as the impact of global events on this important component of national security. A special purpose of this paper is to stimulate discussion about the importance of agricultural production and commodity reserves, with a better knowledge of level of readiness to respond to current and future challenges, risks, and threats from the sphere of food security.

We have not forgotten that the importance of this topic was emphasized even in ancient times, from which comes the sentence attributed to Socrates: “Warriors do not fight only with strong weapons. They also fight with strong food.” In addition, we have a lesson to learn from Serbian history in the Great War and the appeal of Duke Zivojin Misic, who said that a country that does not feed its own army will feed another’s army.”

The importance of commodity reserves in the defense system in modern economic conditions

The institution of commodity reserves was established in Yugoslavia after the Second World War. It has been maintained in Serbia without interruption until today. Commodity reserves are mainly in the function of saving producers and the market. They have a role to calm the market, to mitigate price shocks and shocks in supply, as well as to maintain the guaranteed prices of some goods. Therefore, they are stocks of goods that ensure supply and stability on the market in cases of emergency, war, or market disturbances. They consist of basic agricultural and food products, meat from live cattle, industrial products, medicines and medical supplies, raw materials and reproduction materials for these products.

It should be noted that food is the largest part of the commodity reserves in the Republic of Serbia. It is understandable because war cannot be waged and economic and social policies in peace cannot be implemented if a country does not have food.

Two main facts have to be kept in mind about commodity reserves. The first is that they represent a subsystem of a higher system, the economic system. Second, their role is to ensure the stability of the economic system, especially in crisis, as well as its development and progress. Starting from the definition of a system as a set of elements that constitute it, thus creating a certain structure, they are in mutual interaction that is determined by certain principles and conditions of the way it functions. The economic system can be characterized as a set of institutions and mechanisms for making and implementing decisions that concern production, distribution, exchange, and consumption in a country over a certain period of time (Lindbeck, 1977).

The commodity reserves of the Republic of Serbia represent quantities of goods or raw materials that are purposefully stored on the national level in order to ensure availability in case of shortages, crisis situations, or emergency circumstances in the country. The Republic Directorate for Commodity Reserves performs state administration and professional tasks related to (Leković et al., 2023):

- organization of the commodity reserve system;
- education, accommodation, preservation, and renewal of the national commodity reserves;
- determining the volume, structure, and quality of the balance of commodity reserves;
- managing the flow of quantities with the aim of maintaining reserves at the necessary minimum level;
- construction of storage capacity for the needs of the national commodity reserves;
- financial, material, and record-keeping operations with commodity reserves, as well as other tasks in this area.

The Law on Commodity Reserves (Sluzbeni glasnik RS, 104/13, 145/14, and 95/18) stipulates that the national commodity reserves represent public property and they are managed by the government, and its the Directorate for Commodity Reserves, which has the status of a legal entity. The formation, utilization and renewal of commodity reserves in the Republic of Serbia, the construction and maintenance of storage space for the accommodation and storage of commodity reserves, as well as the manner of dealing with those reserves, are regulated by the Law on Commodity Reserves. Warehouses for the storage of commodity reserves represent a space for temporary storage of material assets in piece, bulk, and liquid form, which should be renewed after a certain period (Regodic, 2011). Commodity reserves are formed and utilized to ensure supply and stability on the market on any occasion (Zupur & Janjetovićc, 2023) such as:

- emergency situations including natural disasters, technical-technological accidents, catastrophes, and other major accidents and calamities as a result of which there is or may be an interruption in the basic supply or an insufficient or unstable basic supply;
- occurrence or immediate danger of the occurrence of serious disturbances on the market;
- state of emergency, or state of the war.

Cities, municipalities, companies, and institutions can create commodity reserves in accordance with their needs and specifics. The act on the establishment of commodity reserves determines the types and quantities of commodities, sources of funding, and other issues of importance for the establishment, preservation, and renewal of commodity reserves. Consent to this act is given by the Republic Directorate for Commodity Reserves (Curakovic, 2023). Commodity reserves consist of basic agricultural and food products, meat in live livestock, industrial products, medicines and sanitary materials, means for maintaining hygiene, as well as raw materials and reproductive material for these products. Additionally, in order to rationalize the operation of commodity reserves and the economy, monetary reserves can be formed. Commodity reserves of food items consist of: mercantile wheat, mercantile corn, wheat flour T-500, milk powder, table salt, sugar, edible sunflower oil, canned fish, permanent canned meat, beans, and rice.

As for the formation, distribution, utilization, and renewal of stocks of commodity reserves, it is carried out on the basis of a medium-term and annual program based on the balances of production, consumption, and foreign trade exchange. The medium-term program of commodity reserves is adopted for a period of five years and it contains of type, name, quantity, and quality of goods, territorial distribution and purpose. It is harmonized with the Development Plan of the Republic of Serbia and the Defense Plan of the Republic of Serbia. The medium-term program is adopted by the National Assembly of the Republic of Serbia on the proposal of the Government of the Republic of Serbia. Commodity reserves are formed by purchasing domestically produced goods and contracting the production of certain products. If there are not enough goods on the domestic market or they are not produced, goods reserves are formed by buying goods from abroad. Commodity reserves are dealt with in the manner and according to the regulations that apply to companies. In dealing with commodity reserves, the Republican Directorate for Commodity Reserves concludes contracts on purchase, sale, accommodation, storage, and renewal of commodity reserves, construction and provision of storage space for accommodation, and storage of commodity reserves, and other tasks within the scope of its work.

During a state of emergency, imminent danger of war or the war, the government of the Republic of Serbia decides on the formation, renewal, and use of commodity reserves (Inđić et al., 2023). Companies that, in accordance with the regulations, are obliged to produce certain goods in the event of war or an imminent threat of war are obliged to, based on an act of the Government of the Republic of Serbia, produce or sell goods for education and replenishment of commodity reserves. Furthermore, Article 9 of the Law on Commodity Reserves (Sluzbeni glasnik RS, 104/13, 145/14, and 95/18) defines that commodity reserves that are kept under the jurisdiction of the Commodity Reserve Directorate can be given a priority loan from the ministries responsible for internal affairs or defense affairs, and the Serbian Armed Forces, in order to ensure the basic necessities of life and the smooth functioning of the defense system in conditions of possible disruptions in the supply system.

The connection between commodity reserves and the defense system can be multiple and crucial for national security. Some of the key points are (Gojković et al., 2023):

- Maintaining supply in emergency situations where commodity reserves play an important role in maintaining the supply of key resources in case of emergencies or crises. This can include food, fuel, medicine, building materials and other basic necessities. Maintaining sufficient commodity reserves allows the defense system to respond quickly and efficiently in the event of natural disasters, conflicts, or in the other crisis situations (Kellerman, 2016). Reserves of food products are one of the most important and safest sources for supplying consumers with food in all situations in which, for any reason, there are certain disruptions in production, distribution, and regular supply. The most common and most pronounced causes of these disorders are war and emergency situations. The main entities providing food products in the Republic of Serbia are the Republic Commodity Reserves (Službeni glasnik RS, 104/13, 145/14, and 95/18) and the Red Cross of Serbia. The international and domestic humanitarian aid, territorial capacities, reserves in households, and army reserves are recognized as alternative sources.
- Commodity reserves for the needs of the defense system require long-term planning and strategies. This includes needs analysis, risk assessment, identification of key commodities, and definition of procedures for management and replenishment of reserves. Effective planning and management of commodity reserves allow the defense system to be prepared for different scenarios and crisis situations (Baldovin et al., 2016).
- The connection between commodity reserves and the defense system may also require international cooperation. This may include information sharing, joint storage, mutual support in emergency situations, and the alignment of strategies. International cooperation can strengthen the defense system's ability to cope with challenges and increase security at the global level (Ngo & Park, 2016).

Analysis of agricultural production in the Republic of Serbia

Agriculture is an activity that deals with the cultivation of plants and animals with the aim of producing products that primarily meet the nutritional needs of the population (Milenković et al., 2023). The task of agricultural production is to produce enough food for all people. Due to the increase in the number of inhabitants on the planet, there was a need for greater food production. The increase and variation in the price of food is the biggest challenge in the last few decades in agriculture, which has greatly changed the structure of production and farms, affected the size and directions of trade in agriculture, food security, significantly increased the income of farmers, as well as the price of resources and inputs in agriculture (Stoiljković et al., 2023). Perhaps the biggest change that the rise in food prices has brought about is a new way of thinking about the importance of agriculture. Nowadays, many people who never saw their future in agriculture have begun to invest in the production and processing of food. The 2001 Food Insecurity Report issued by the World Bank defined the term food security. Food security was defined as a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and habits and enables an active and healthy life. Determining the level of food security is based on the Global Food Security Index (GFSI), which comprehensively examines food security through internationally established dimensions: availability, access, quality, and safety, including the factor called "natural resources and resilience" through which stability is assessed, i.e. the exposure of the country to the effects of climate change, the sensitivity and adaptability of natural resources, and the state of risks (Arsić & Kovač, 2022). The index ranks 113 developing and developed countries in the world according to their degree of food security.

Agricultural production plays a key role in national security, especially in terms of food security and ensuring a sustainable supply the population. The attributes that characterize the importance of agricultural production for national security are:

- It represents a starting point for providing sufficient food for the population. Maintaining stable and sustainable agricultural production is crucial for preventing food shortages, hunger, and social unrest. National security depends on a country's ability to provide enough food for its population (Devereux, 2006).
- Sustainable agricultural practices are important for long-term national security. This includes the application of agricultural techniques that reduce soil degradation, protect water resources, preserve biodiversity, and reduce the use of chemical agents. Sustainable agriculture ensures the long-term ability of the country to produce food and maintain agricultural resources (Tiliman, 2011).
- Stable agricultural production reduces dependence on food imports. In countries that are dependent on food imports, agricultural production plays a key role in reducing this dependence. The development of domestic agricultural production reduces the risk of supply interruptions, price fluctuations on the world market, and external economic shocks (Ruel & Minot, 2012). Reducing dependence on food imports strengthens the country's economic and security independence.
- Diversification of agricultural production, including diversity of crops and livestock, can reduce the risks of disease, pests, and climate disturbances. This helps to maintain stable food production and reduce the vulnerability of the agricultural sector to individual risk factors (FAO, 2017).

The territory of the Republic of Serbia has exceptional geographical, climatic, and pedological predispositions for agricultural production. According to the results of the 2012 Census of Agriculture, the total area of agricultural land in the territory of the Republic of Serbia is 3,861,477 hectares and has 631,552 agricultural holdings (Milošev, 2023). The climate is moderate-continental, and the average temperature during the year is 11 to 12 degrees Celsius. Favorable natural and climatic conditions promote the development of agriculture. The plain regions of Vojvodina, Kosovo Polje, Metohija, Pomoravlje, Posavina, Tamnava, Kruševac, and Leskovac Polje are suitable for mechanized agricultural and vegetable production. Hilly and hilly-mountain areas are favorable for the development of fruit, viticulture, and livestock production. Raspberry production is the most common in western Serbia, followed by the production of plums and apples. The mountainous areas of Zlatibor, Rudnik, Stara Planina, Kopaonik, and Sar-Planina are suitable for the development of sheep farming, cattle breeding, and forestry (Dastjerdi et al., 2022).

Serbia has very favorable natural conditions, such as land and climate, for diverse agricultural production, from plants to livestock, experienced producers, the best experts and scientists, as well as a world-recognized selection of numerous plant crops. The most important agricultural products of Serbia are corn, wheat flour, sunflower oil and meal, sugar beet and sugar, soybeans oil and protein products from the soy, potatoes, raspberries, apples, plums, cherries, grapes, pork, beef and poultry, meat, and milk. In Tables 1, 2 and 3, an analysis of plant production, livestock and meat and milk production in the Republic of Serbia in the period from 2019 to 2023 was carried out.

Table 1. Plant production in the Republic of Serbia

	2019	2020	2021	2022	2023
Production, thousand t t					
Wheat	2276	2 942	2 535	2874	3442
Rye	11	13	13	15	19
Corn	4 018	6 965	7 345	7873	6027
Sunflower	541	734	729	637	608
Tobacco	7	7	8	9	10
Sugar beet	2 513	2 325	2 305	2018	2048
Potato	589	488	702	665	614
Plums	331	430	559	583	413
Apples	379	460	500	489	513
Grapes	166	149	164	160	156

Source: Statistical calendar 2024, Statistical Office of the Republic of Serbia

Table 2. Number of livestock in the Republic of Serbia

	2019	2020	2021	2022	2023
Livestock, thousand pieces					
Cattle	899	878	898	886	860
Pigs	2 911	2 782	2 903	2 983	2 868
Sheep	1 704	1 712	1 642	1 685	1 695
Poultry	16 338	16 232	15 780	15 249	15 348

Source: Statistical calendar 2024, Statistical Office of the Republic of Serbia

Table 3. Production of meat and milk in the Republic of Serbia

	2019	2020	2021	2022	2023
Meat, thousand. T					
Beef	71	76	71	75	77
Pork	307	303	298	299	307
Sheep	30	32	34	31	31
Poultry	95	106	114	115	111
Milk, mil. liters					
Total	1 481	1 475	1 478	1 466	1451

Source: Statistical calendar 2024, Statistical Office of the Republic of Serbia

Production of agricultural goods and services measured by producer prices is an economic measure that includes the value of all goods and services produced in agriculture according to the prices that producers receive for those products. This measure aims to capture the actual value of production without including additional trade margins and other costs incurred in the supply chain from the producer to the end user. Production of agricultural goods and services includes everything produced in agriculture, including different types of crops, livestock, and the production of feed for livestock, but also services related to agriculture, such as land cultivation, production planning and management, etc. Producer prices represent what farmers receive for their products when they sell them on the market. These prices differ from the ratings that consumers pay in the end market because they include trade margins, taxes, transportation costs, etc. (Dimitrijević, 2021). Table 4 shows agricultural goods and services expressed in producer prices in the period from 2013 to 2023.

Table 4. Production of agricultural goods and services in producer prices

Group	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Mil. RSD											
I	519959.5	502684.2	565521.3	584299.7	534779.5	589817.8	543746.5	589704.3	605291.2	667854.8	724332.4
II	509125.4	491597.1	552078.6	569276.2	520965.6	574817.9	529890.4	574703.9	589978.3	651631.7	707213.2
III	359103.1	324451.0	378832.9	390747.7	351927.4	419400.1	357056.3	398513.5	414528.6	473693.3	544202.2
IV	175221.3	138324.7	174602.0	178776.0	139584.0	164831.9	113759.6	157004.2	158628.8	186290.6	216992.9
V	46655.3	52805.6	51487.0	54392.7	48500.6	58939.9	58443.1	62530.5	63157.4	69350.1	89037.3
VI	17183.5	18693.3	16626.0	23688.2	17553.2	27062.5	20984.6	28649.1	33556.5	39973.7	26293.4
VII	27246.3	28985.5	27374.7	28813.2	35588.2	40579.0	32537.9	26097.1	31554.1	28125.3	35756.3
VIII	17870.0	12342.0	19102.0	13024.7	13641.5	13892.3	11686.6	13218.4	11805.3	13001.2	14031.3
IX	50859.5	53932.0	61567.1	56879.7	73669.8	74991.0	76995.0	68815.9	67045.1	89740.6	110217.5
X	23712.7	18.925.0	27534.5	34621.3	22794.7	38568.5	42111.7	41578.5	48249.0	46667.2	51352.1
XI	354.5	442.9	539.6	552.0	595.3	534.9	537.7	619.8	532.5	544.6	521.2
XII	150022.3	167146.1	173245.8	178528.4	169038.2	155417.8	172834.0	176190.4	175449.7	177938.3	163011.0
XIII	102774.2	113462.5	118892.8	123133.0	111012.3	104280.9	120477.8	114530.3	121969.3	123909.1	111828.5
XIV	29058.9	31377.2	32406.8	32114.4	31703.4	30352.6	31039.7	33686.7	32412.0	29158.1	31209.4
XV	48768.0	58641.6	60982.8	65764.6	57097.8	54272.3	66198.5	57503.1	63582.6	65256.8	55812.1
XVI	60.9	377.2	203.2	151.3	77.3	366.8	383.2	35.9	320.4	120.2	493.6
XVII	9314.9	7800.5	8121.4	10107.9	8971.1	5998.2	8415.6	8298.6	10611.7	13856.6	16349.3
XVIII	15571.5	15266.1	17178.6	14994.7	13162.7	13291.1	14440.7	15006.0	15042.5	15517.4	7964.1
XIX	47248.1	53683.5	54353.0	55395.5	58026.0	51136.8	52356.3	61660.1	53480.5	54029.2	51182.6
XX	34212.1	36776.5	38017.9	38459.0	37309.9	35047.9	35387.5	44261.1	37192.3	37350.0	34419.6

Group	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Mil. RSD											
XXI	10809.9	14678.0	13395.1	14970.9	15507.4	13740.5	14504.0	13357.3	13558.5	13619.5	13967.7
XXII	2226.1	2229.0	2940.0	1965.6	5208.7	2348.5	2464.8	4041.7	2729.6	3059.7	2795.2
XXIII	10834.1	11087.1	13442.6	15023.5	13813.9	14999.9	13856.1	15000.5	15313.0	16223.2	17119.2

Note: Agricultural goods and services are categorized as follows: I - Production of agricultural goods and services; II - Production of agricultural goods; III - Plant production; IV - Cereals (including seeds); V- Industrial plants; VI- Fodder plants; VII - Vegetables and horticultural products; VIII - Potatoes (including seeds); IX – Fruits; X – Wine; XI - Other plant products; XII - Livestock production; XIII- Livestock; XIV – Cattle; XV – Pigs; XVI – Horses; XVII - Sheep and goats; XVIII – Poultry; XIX - Production of livestock products; XX – Milk; XXI – Eggs; XXII - Other livestock products; XXIII - Agricultural services;

Source: Statistical calendar 2024. Statistical Office of the Republic of Serbia

By analyzing the processed data from the Statistical Office of the Republic of Serbia, we gain insight into the noticeable growth in agricultural production in most segments of agricultural production in Serbia on the national level. However, the circumstances and aggravating factors in which the agricultural sector has found itself over time are not shown in graphs and tables. One of the recent well-known global circumstances that hit the world market is certainly closely related to the COVID-19 virus pandemic. It has brought a number of challenges to the agricultural sector, including work disruptions, logistical problems, market problems, and price uncertainty. The effects varied from region to region. However, they generally led to significant changes in the agricultural sector. Many countries have had to implement support measures to help farmers facing these challenges and secure food supplies. Comparing the data from 2020, when the crisis occurred, with data from the previous calendar year, 2019, we see that production achieved higher values compared to the previous year. This led to the conclusion that the state had created appropriate mechanisms to overcome the problem and that a series of measures that were undertaken had been successful.

Table 5 shows a comparative quarterly analysis of GDP and other production sides for the period from 2020 to 2022. The analysis showed that in the fourth quarter of 2022, real GDP growth of 0.4% was achieved compared to the same period of the previous year. The positive movement of GDP in this quarter was most significantly influenced by the service sector. Apart from the trade, a significant negative contribution to the movement of GDP was made by the construction sector and the agriculture sector (Golubović & Janković, 2023).

The exports of the agricultural sector in 2022 acccount for a drop of 4.4% compared with the previous year. In the tearms of the share of total exports, this drop was from 6.1% in 2021 to 4.6% in 2022. The cumulative drop of 9.1% was recorded in the export of grain, except rice, legumes, and oilseeds, a group that accounts for 64.9% of the entire sector's exports in the observed period and contributed the most to this result. Exports of apple and stone fruits, the next group in terms of participation with a value of 12.6%, recorded a decrease of 0.4% in 2022 compared to 2021. On the other hand, the growth of exports by 10% in this sector was recorded by the group of growing vegetables, root, and tuberous plants, which contribute 4.3% to the exports of this sector. From the import side, the agriculture, forestry, and fishing sectors recorded a growth of 27.7% in 2022 compared to 2021, as well as a share of 2.4% in total imports. The group with the largest participation in this sector, with a value of 21% was the cultivation of grain, except rice, legumes, and oilseeds, wich records a growth of 64% in 2022. Next in terms of participation, with a value of 15.2%, are the following groups: cultivation of vegetables. root and tuberous plants, which achieved an increase in imports of 78.4%, as well as the cultivation of plants for the preparation of beverages, which recorded an increase in imports of this sector of 64% and participation of 10.9%.

Table 5. Comparative analysis of GDP and other production sides

	2020				2021				2022			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GDP	5.3	-6.2	-1.3	-1.0	1.7	13.8	7.8	7.2	4.1	3.8	1.0	0.4
Agriculture	2.3	2.5	2.4	2.2	-5.9	-5.4	-5.6	-5.8	-8.4	-8.6	-8.5	-7.8
Industry	4.3	-7.5	3.5	1.6	4.4	15.7	2.3	4.0	2.0	4.6	-0.4	1.2
Construction	24.0	-0.2	-14.7	-7.5	19.8	18.3	19.4	14.4	-5.7	-6.9	-12.1	-12.5
Trade	4.1	-8.3	1.8	0.3	8.2	23.4	10.6	10.1	7.5	5.4	2.6	0.3
Services. except trade	5.5	-6.3	-2.7	-1.2	-1.2	11.2	10.1	8.7	5.8	5.9	3.9	3.4
Net taxes	3.3	-7.7	-2.0	-2.5	-0.7	16.7	9.1	8.1	8.2	5.1	2.5	1.1

Note: Q - Quarter

Source: Trends, IV quarter 2022, Statistical Office of the Republic of Serbia

In 2022, the biggest impact on the growth of total consumer prices was the annual increase in the price of meat of 20.3%. The increase in the price of meat was mostly influenced by the increase in the price of boneless pork, boneless beef, beef, and chicken fillet, whose participation in the structure of the annual rate of increase in the price of meat accounted for 43.7%. The increase in the prices of milk, cheese, and eggs has increased its impact on total consumer prices since mid-2022, primarily due to the increase in the prices of yogurt, fruit yogurt, yogurt with the addition of cereals, sour milk, kefir, and fresh cheese of all kinds, and chicken eggs, contributing to the overall structure of the growth rate of consumer prices for 2022 of 9.6%. The mid-2022 drought contributed to the prices of bread and cereal and to overall consumer price growth. The biggest contribution to the annual increase in the prices of bread and cereals, with a value of 18.5%, was the increase in the prices of white bread, wheat flour, pasta made of white flour, and savory pastries, participating in the structure of the overall rate of growth of the prices of bread and cereals with 62.2%. The price of vegetables at 2022 was predominantly determined by the price of potatoes, especially red, tomatoes, and peppers, resulting in an annual growth rate of 21.3% (Bogovac, 2023).

The most important branch of plant products is agriculture and vegetable growing, which in 2022 will contribute 74.5% of the total value of plant production. This is followed by fruit growing, with a share of 23.8%, and viticulture, which counts 1.8% of the share.

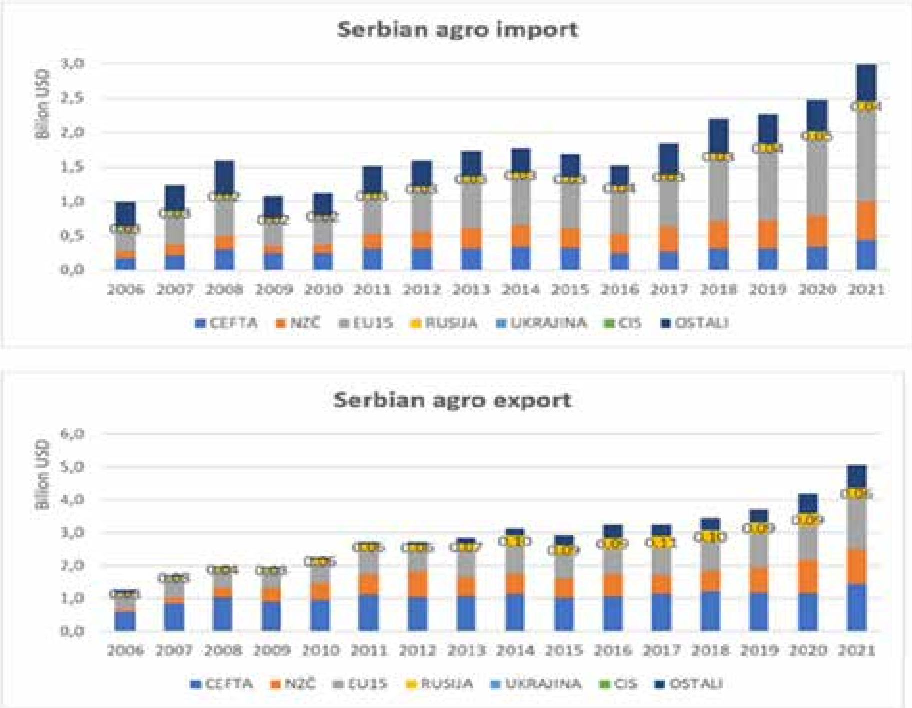
In 2022, plant production was 11.3% lower than in the previous year. This decline was primarily influenced by unfavorable climatic conditions, which led to a 16.7% drop in agricultural and vegetable production. On the other hand, fruit production, whose participation in the total value of plant production is 23.8%, achieved a growth of 9.3% in 2022 compared to the previous year. Although the very beginning of the year gave optimistic results, as time progressed, the weather had a very unfavorable effect on agricultural and vegetable production. Beside the year 2022, we can treat 2000, 2003, 2007, 2012, and 2017 as "dry years" for agriculture, when average yields and total production were also far below average.

Estimates show that farms producing cow's milk distribute about 59% of the total production to purchasing dairy stations (Bogovac et al., 2023). From nearly 41% of the amount of cow's milk that remains on the farm, about 10% is used for feeding members of the farm and livestock on the farm, about 22% is processed into dairy products, mainly cheese and cream, and the rest, about 9%, is sold to direct consumers. According to the same source, losses on the farm are 0.1% and can be treated as insignificant. The representation of cow's milk in the total production of milk on farms is about 97%, and the rest is made up of sheep's and goat's milk. In 2022, the production of drinking cow's milk in dairy is 1.2% higher than in 2021. Observed quarterly, in the IV quarter of 2022, there was a growth in the production of consumer cow's milk of 30.8% compared to the same quarter of the previous year.

The degree of influence of agricultural production on the level of commodity reserves

As we have seen from the attachment, agricultural production and commodity reserves are closely related. An additional challenge for maintaining the level of commodity reserves is represented by crises that can have various complex impacts on Serbian agriculture, including the supply of resources, prices, economic stability, and market conditions. The exact impact depends on the dynamics of conflict development and the reactions of states and markets to such situations. On the February, 24, 2022, armed conflicts began on the territory of Ukraine. The crisis is still current and further complicates the already complex situation of Serbian agriculture. Since the beginning of the COVID-19 pandemic, we have witnessed a global increase in food prices. Agricultural input prices and logistics costs were rising long before the start of the conflict in Ukraine. With the outbreak of conflict in Ukraine, the situation in the food sector became even more complex and complicated. The report of the consulting firm SEEDEV entitled "The impact of the war in Ukraine on the agricultural sector in Serbia" shows that the Russian Federation and Ukraine were two significant markets for Serbian agribusiness.

Figure 1. Import and export of agricultural products of the Republic of Serbia



Source: Report of the consulting firm SEEDEV. Serbian agriculture: The impact of the war in Ukraine, 2022

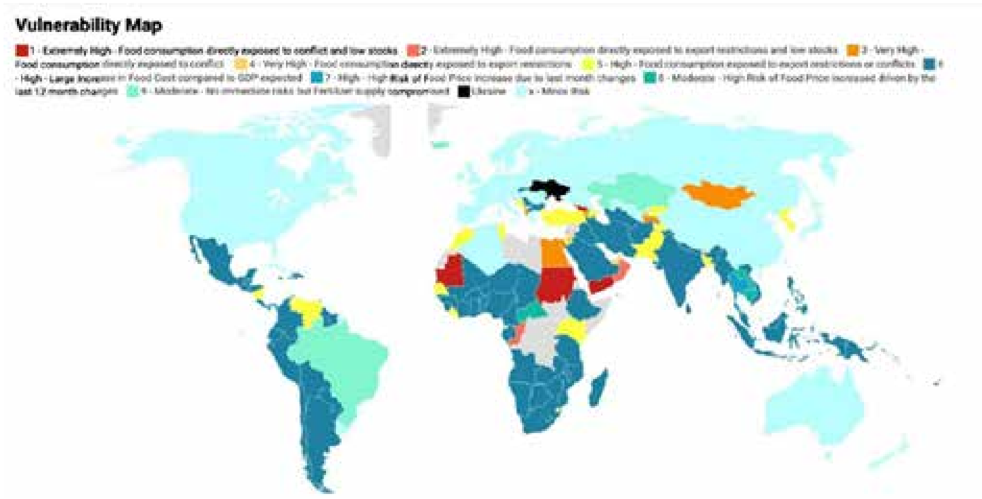
Figure 1 shows the percentage of participation in foreign trade by country. CEFTA countries including Albania, Bosnia and Herzegovina, North Macedonia, Moldova, Serbia and Montenegro, NZC - new member countries of EU, EU15 includes Belgium, Denmark, Germany, Finland, France, Greece, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal, Spain, the United Kingdom and Sweden, Ukraine and Commonwealth of Independent States countries including Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Uzbekistan, as well as others.

According to research (SEEDEV, 2022), the export of agricultural products from Serbia to Russia is less than 10%, and the import is about 2%. For the last five years, Serbian exports to Russia have stagnated, while total exports from Serbia have been growing. The main agricultural export item to Russia is apples. Serbian apple producers were focused on the Russian market because of the high prices of their products. This has changed since local apple production increased and competition from Moldova, Turkey, and Azerbaijan became stronger. Since the beginning of the war, transport and logistics have become very difficult and more expensive. The devaluation of the Russian ruble made Serbian production more expensive for local consumers and, therefore, less competitive. Apart from apples, Serbia also exports strawberries, peaches, and nectarines to Russia. The main import product is tobacco.

Ukraine is a large producer of important agricultural products, which Serbia also exports. This is the reason why Ukraine is not a significant foreign trade partner for Serbia, accounting for only 0.2% of Serbia's agricultural foreign trade. The main agricultural export products to Ukraine were: seeds, mainly sunflower seeds with a value of $2.2 million, corn seeds with a value of $1.1 million, planting material, dairy products, and fruit. The main imports from Ukraine are confectionery products, soy, soy products, and some tobacco products.

The report highlights the inappropriate and unpredictable responses of various governments to the crisis, such as the introduction of export bans and limiting the prices of food products, which can only lead to further disruptions in the market. Figure 2 shows the map of vulnerability (The Russia-Ukraine Crisis, 2022). It was created on March 28, 2022, as a result of an assessment of the current situation, by systematizing available data on the state of agriculture, price changes, and others.

Figure 2. Vulnerability map



Source: The Russia-Ukraine Crisis: Implications for Global and Regional Food Security and Potential Policy Responses, 2022

This, as well as similar research and projections, can be extremely useful in predicting agricultural crises in order to properly manage commodity reserves, reduce the possibility of negative impacts on food supply, and contribute to price stabilization. Considering that the character of economic management is determined by the character of the economic system itself, in order to develop and improve the system of commodity reserves of food products as an essential element of supporting the functioning of the defense system, it is necessary to undertake further activities in the direction of developing an effective system of commodity reserves of food products. These activities include:

1) The development of agricultural and food production and distribution in the forthcoming period has to be better coordinated with consumption. In order to ensure a greater degree of harmony, conformity, and stability in the system of agro-industrial production and the entire economic system is a necessity. It is extremely important to include the production of the individual sector of agriculture in the market system as much as possible.

2) The policy of establishing the prices of food products has an important role in ensuring the harmonious development of food production and the market for food products, too. Simultaneously, it is necessary to strive and encourage prices to be freed from the role of an instrument of economic and social policy that was imposed on them in the previous socio-economic development and to develop their natural function as an accompanying phenomenon of commodity exchange. That is why it is necessary to create conditions for the gradual liberalization of the prices of food products i.e., that the producers themselves decide on the prices depending on the market conditions. Nevertheless, one should be aware that the orientation towards the free formation of prices according to market conditions does not mean absolute freedom of their movement. The art of regulating prices is to allow their free formation, under the influence of supply and demand, and to resort to state interventions only in the event of major disruptions and in order to protect one's own producers and consumers. The mentioned interventions should have a corrective effect and not be a practice. The commodity reserve system is one of the important factors in the protective price system. Therefore, a tighter functional connection between the system of commodity reserves and the system of protective prices appears to be an important prerequisite for maintaining the stable development of agro-industrial production. In order to assess when it is necessary to react through commodity reserves, it is expedient to introduce a protective price category for a certain number of items i.e. the basic food items. The level of protective prices should not be set below the level of the average cost price of that product and should contain the average production costs and the average profit of the economy. Intervention with commodity reserves would be carried out in the event of a large and long-lasting deviation from the protective prices. The main aim of such actions should be the protection of the producer if the selling price is far below the protective price or the consumer if the selling price is far above the protective price.

3) Import and export policies represent significant factors and unique instruments stabilizing the market for food products and development of domestic food production. Import and export of basic food products should be carried out on the basis of a unique balance of production, processing, consumption, reserves, and import, i.e., export of a specific product, and should be for the purpose of both protecting domestic producers and consumers.

4) Improvement of efficiency and rationality in order to ensure a higher degree of efficiency and rationality in the system of commodity reserves is a priority as well. It is necessary to develop, coordinate, direct, coordinate, and control reserves of food products at all levels, in all subsystems, which comprise the national commodity reserves, commodity reserves in production companies, turnover and stocks in households.

5) Improvement of the principle of completeness and uniqueness to ensure the principle of completeness and uniqueness of the system of commodity reserves represents a crucial task, additionally. It is important to enable the system of commodity reserves to act in regular and extraordinary situations. In other words, the integrity of permanent, strategic and marketable commodity reserves should be maintained. It is also important that the system of commodity reserves develop as a functional unity of all forms of commodity reserves, i.e. commodity reserves in raw materials, finished products, spare parts, money, precious metals, and livestock.

Due to all that was previously mentioned and the importance of providing vital life needs that are the first to be hit in crisis situations, within the framework of a comprehensive, unified system of commodity reserves, the relative organizational and functional independence of food product reserves should be ensured. Food reserve products should be set up as a separate sector in the overall system of commodity reserves.

All the mentioned measures are also necessary from the aspect of ensuring the safety and functioning of the defense system, because without the establishment of a safe and functional system of commodity reserves of food products, a defense system capable of responding to the challenges and threats of the modern environment cannot be built.

Precisely from the aspect of ensuring the security of the functioning of the defense system, in the coming period it is necessary to additionally increase the level of stocks, which most countries are doing in order to ensure the stability of supply to their own markets and to ensure the prerequisites for adequate response in crisis situations. Also, it is necessary to establish regular and more frequent inspections of storekeepers to whom commodity reserves are entrusted by the Republic's Directorate for Commodity Reserves to prevent more and more frequent malpractices by which individuals gain illegal profits, and by doing so, they endanger not only the functioning of the defense system, but that act can also be characterized as an "attack on the state."

Conclusion

The importance of agricultural production for the survival of a country, such as the Republic of Serbia, is undeniable. It is not only a source of food but also the foundation of Serbian identity, culture, and economy. Agricultural resources represent a key segment irreplaceable for social progress and stability. In addition, the defense system has deep responsibilities in protecting the security and sovereignty of the state. Stability is key to survival, and that stability rests on the stability of supply.

As we have explored, the dynamic challenges of the modern world can have a major impact on agricultural production. Unfavorable market prices, natural disasters, and geopolitical instability are just some of the factors that can shake the stability of food production. Consequently, they assumed the role of solving pressing problems that were reflected in the lack of raw materials, spare parts, and some vital food products, and precisely because of this, they could not fulfill their basic tasks in terms of functioning as an element of the economic system and an essential factor for establishing and regulating the market economy, which is its function as a factor of economic development. It was shown that commodity reserves for agricultural production became a means of eliminating the consequences of various unfavorable imbalance trends in the supply of certain goods, and they performed their strategic function less within the systems of extended social reproduction, economic development, single market price stabilization, and the simlar. This imposes the need to review and analyze economic trends, especially from the 1970s to today, in order to assess the conditions in which commodity reserves could perform their basic and strategic functions in the economic development and economic system of our country.

Commodity reserves are without a doubt a key mechanism that contributes to the stabilization of supply and supports the defense system in cases of crisis. The synergy between agriculture and defense has the potential to ensure the safety and stability of society in the most necessary moments. This integration can ensure the continuity of the food supply even in the most unpredictable situations. Also, the research of new ways to optimize agricultural production that can meet the needs of the defense system can be encouraged. However, this integration requires fundamental reforms in state policy and institutional structures. The government of the Republic of Serbia should develop strategies that include a coherent vision of both sectors but also invest in supply, education, and research. Cross-sector cooperation and information sharing become crucial to achieving goals. Despite specific challenges, the integration of agriculture and defense can strengthen the structure of the national defense system and provide a basis for stability and progress.

Acknowledgements

This research was carried out as part of the project “Model system for the support of logistic support planning” under the designation VA - TT /1/20-25, which is being implemented at the Military Academy of the University of Defense in Belgrade.

Conflict of interests

The authors declare no conflict of interest.

References

1. Arsić. S. & Kovač. M. (2022). Prehrambena sigurnost kao činilac nacionalne bezbednosti. *Politika nacionalne bezbednosti*. 22 (1). . [*in English*: Arsic. S. & Kovac. M. (2022). Food security as a factor of national security. *National security policy*. 22 (1).].
2. Baldovin. M. et al. (2016). *Stochastic Planning of Emergency Logistics for Critical Infrastructures.* International Journal of Production Economics.
3. Bardžić. Ž. & Miladinović. B. Ž. (2023). Pravno tumačenje savremenih bezbednosnih rizika. *Oditor*. 9 (2). 1-21. https://doi.org/10.5937/Oditor2302001B[*in English*: Bardžić, Ž., & Miladinović Bogavac, Ž. (2023). Legal interpretation of modern security risks. *Oditor*, *9*(2), 1-20. https://doi.org/10.5937/Oditor2302001B.].

4. Bardžić. Ž.. Miladinović. B. Ž.. Prdić. N. & Škrbić. S. (2023). Pravni aspekti međunarodnih odnosa. *Oditor*. 9 (2). 115-138. https://doi.org/10.59864/Oditor32305B [*in English*: Bardzic. Ž.. Miladinović. B. Ž.. Prdić. N. & Škrbić. S. (2023). Legal aspects of international relations. *Oditor.* 9 (2). 115-138. https://doi.org/10.59864/ Oditor32305B.].
5. Curaković. D. (2023). Tržište rada u sektoru turizma kroz prizmu rodne ravnopravnosti. *Oditor*. 9 (3). 1-38. https://doi.org/10.59864/Oditor32301C [*in English*: Curakovic. D. (2023). The labor market in the tourism sector through the prism of gender equality. *Oditor.* 9 (3). 1-38. https://doi.org/10.59864/ Oditor32301C.].
6. Dastjerdi. R.. Hassani. D.. Nadi. S. & Soleimani. A. (2023). Response of some walnut genotypes to Anthracnose attack. *Journal of Agricultural Science and Technology*. 25 (5). 1193-1207.
7. Devereux. S. (2006). *The Impact of Agricultural Policies on Food Security.* IDS Bulletin.
8. Dimitrijević. S.M. (2021). *Implikacije primene inovacija za održivi razvoj u agraru.* Beograd. [*in English*: Dimitrijevic. S.M. (2021). Implications of innovation application for sustainable development in agriculture. Belgrade.].
9. FAO - Food and Agriculture Organization. (2017). *The State of Food and Agriculture.* Leveraging Food Systems for Inclusive Rural Transformation. Rome.
10. Golubović. M. & Janković. G. (2023). Priliv stranih direktnih investicija u funkciji poboljšanja konkurentnosti privrede Republike Srbije. *Održivi razvoj*. 16 (1). 19-31. [*in English*: Golubović, M., & Janković, G. (2023). FDI inflow in the function of improving economy competitiveness of the Republic of Serbia. *Održivi razvoj*, *5*(1), 19-31. https://doi.org/10.5937/OdrRaz2301019G].
11. Inđić. M.. Pjanić. M. & Đaković. M. (2023). Uticaj makroekonomskih faktora na tržšnu kapitalizaciju u bivšim Jugoslovenskim republikama sa moderacijom bivših republika koje ne koriste euro. *Akcionarstvo*. 29 (1). 151-168. [*in English*: Indjic. M.. Pjanic. M. & Djakovic. M. (2023). The influence of macroeconomic factors on market capitalization in former Yugoslav republics with moderation by former republics that do not use the euro. *Akcionarstvo*. 29 (1). 151-168].
12. Kellerman. A. (2016). *Food Security and National Security: The Case of Strategic Food Reserves*. Food Policy.
13. Law on Commodity Reserves („*Službeni glasnik RS*". broj 104 od 27. novembra 2013. 145 od 29. decembra 2014 - dr. zakon. 95 od 8. decembra 2018 - dr. zakon. član 5.).
14. Leković. M.. Pantić. N.. Stanišić. T. & Lazarević. S. (2023). A contemporary bibliometric analysis of culinary tourism literature. *Ekonomika poljoprivrede*. 70 (4). 1101-1122. https://doi.org/10.59267/ekoPolj23041101L

15. Lindbeck. A. (1977). *The Political Economy of the New Left.* New York. Harper and Row.
16. Milenković. N.. Radosavljević. M. & Vladisavljević. V. (2023). Using open licensed applications in the developing programs for businesses. *Održivi razvoj*. 16 (2). 35-50.
17. Milošev. I. (2023). Determinations of profitability in the agriculutral sector in Serbia. *Ekonomika poljoprivrede*. 70 (4). 953-966. https://doi.org/10.59267 / ekoPolj2304953M
18. Ngo. T. A. & Park. N. K. (2016). Evaluating the Effects of International Cooperation on Military Logistics Cost Reductions. *Journal of Defense Modeling and Simulation.*
19. Prdić., N. & Kostić, S. (2022). Poslovanje pojaca u kriznim situacijama sa posebnim osvrtom na komunikaciju sa potrošačima i javnošću. *Akcionarstvo,* 28(1), 63-78. [*in English*: Prdić., N. & Kostić, S. (2022). Business operations in crisis situations with a special focus on communication with consumers and the public. *Akcionarstvo*, 28(1), 63-78].
20. Regodić. D. (2011). *Logistika.* Univerzitet Singidunum. Beograd. [*in English*: Regodić. D. (2011). *Logistics.* University Singidunum. Belgrade.].
21. Ruel. M. T. & Minot. N. (2021). *Potential Impacts of Increasing Food Prices on Poverty and Food Security.* IFPRI Discussion Paper. 01197.
22. SEEDEV. (2022). *The Impact of the War in Ukraine on the Agriculture sector in Serbia.* SEEDEV report.
23. Statistical calendar. (2024). Site of *Republic Institute of Statistics*. https://www.stat.gov.rs/
24. Stoiljković. B.. Balaban. S. & Simić. M. (2023). Uticaj likvidnosti na profitabilnost preduzeća prerađivačkog sektora u Republici Srbiji. *Oditor*. 9 (2). 155-177. https://doi.org/10.5937/Oditor2302155S [*in English*: Stoiljković, B., Balaban, S., & Simić, M. (2023). The influence of liquidity on the profitability of companies in the processing sector in the rural Serbia. *Oditor*, *9*(2), 155-177. https://doi.org/10.5937/Oditor2302155S].
25. The Russia-Ukraine crisis. (2022). *Implications for Global and Regional Food Security and Potential Policy Responses.*
26. Tilman. D. (2011). Global Food Demand and the Sustainable Intensification of Agriculture. *Proceedings of the National Academy of Sciences.* 108 (50). 20260 20264.
27. Trends. IV quarter. (2022). Site of *Republic Institute of Statistics*. https://www.stat.gov.rs/
28. Zupur. M. & Janjetović. M. (2023). Sustainability of personal selling marketing in the modern market. *Održivi razvoj*. 16 (2). 7-20.

ETHNO EVENT IN THE FUNCTION OF DEVELOPMENT OF RURAL TOURIST DESTINATIONS: CASE STUDY “COUNTRY WEDDING“ AT GOSTOLJUBLJE

Leposava Zečević[1], Olgica Zečević Stanojević[2], Dragan Nedeljković[3]

**Corresponding author E-mail: draganedeljkovic62@gmail.com*

A R T I C L E I N F O

Review Article

Received: *03 April 2024*

Accepted: *20 May 2024*

doi:10.59267/ekoPolj2402697Z

UDC 338.48-44(1-22)

Keywords:

rural tourism, ethno event, innovative tourist product, farm, Country wedding

JEL: *Q01, Z32, Z39*

A B S T R A C T

Ethno events have a driving role in the effective development of rural tourism. The goal of the research is to point out the importance of ethno event such as “Country wedding” as an innovative tourist product in enriching the tourist offer of rural areas, in the protection of intangible cultural heritage and affirming rural tourism. The research analyzed the motives, reasons, assessment of stay, sources of information of 346 visitors to the Gostoljublje farm in Kosjerić. Research has shown that in practice, ethno event directly affects the more effective valorization of the tourist potential, image improvement, enrichment and affirmation of the tourism product of the farm, stimulates the increase in employment of the local population and affects the raising of awareness about the importance of tourism in rural areas. Further research should be focused on improving marketing and promotional activities in order to achieve recognition and create a sustainable, professionally designed tourist brand “Country Wedding” in Kosjerić.

Introduction

Tourism represents an important component of integral and sustainable development of rural areas. Rural tourism is type of tourism that has numerous potential benefits for including employment growth, an extended economic base, repopulation, social development and a revival in local crafts (Nicolaides, 2020). Rural tourism directly affects the reduction of

1 Leposava Zečević, Ph.D., Research Associate, Institute of Agricultural Economics, Volgina Street no. 15, 11060 Belgrade, Serbia, Phone: +381 11 697 28 58, E-mail: bekaz70@gmail.com, ORCID ID (https://orcid.org/0000-0002-7103-3577)

2 Olgica Zečević Stanojević, Ph.D., Research Associate, Institute of Agricultural Economics, Volgina Street no. 15, 11000 Belgrade, Serbia, Phone: +381 11 697 28 58, E-mail: olgicazs@gmail.com, ORCID ID (https://orcid.org/0000-0002-0689-4709)

3 Dragan Nedeljković, Ph.D., Research Associate, Institute of Agricultural Economics, Volgina Street no. 15, 11000 Belgrade, Serbia, Phone: +381 11 697 28 58, E-mail: draganedeljkovic62@gmail.com, ORCID ID (https://orcid.org/0000-0002-8391-9703)

migration flows and retention of the local population in the villages, creates new jobs and increases employment, creates additional income for rural agricultural holdings. There are several benefits that arise with introduction of agro-tourism activities and services at the farm. Farm is in position to gain additional profit influencing the long-term farm stability and sustainability. Farm supports the welfare of the wider community (advances the image of the local community, employs local labor, affects the reduction of migration process, especially of youth and female population, empowers the local budget, etc.) or it supports „silent" national export (by hosting the foreign tourists) (Jeločnik et al., 2020). The special importance of rural tourism is reflected in its influence on the preservation of natural resources, ecological protection, preservation of cultural and historical monuments, preservation of customs, old rural crafts as a specific tourist attraction.

Rural tourism is considered not only a type of tourism, but also a kind of instrument for the development of rural areas, their revitalization and increase in attractiveness (Hakkarainen & Tuulentie, 2008). This type of tourism in countries has a significant role in balancing the country's regional development (Mafunzwaini & Hugo, 2005). Rural tourism is considered a source of income for the local community and is one of the directions of diversification of economic activities in rural areas (Clark & Chabrel, 2007). However, countries in their development strategies emphasize the necessity that rural tourism must be based on an efficient management policy and the concept of sustainable development, respecting the basic principles: the principle of economic sustainability, the principle of social and cultural diversity, the principle of ecological sustainability.

Rural tourism is a form of tourism characterized by sustainability (Vesić et al., 2022). Rural tourism is highly correlated with other types of tourism in the Republic of Serbia, and one of them is sustainable tourism – nature-based tourism which has recently gained more and more importance and it is believed that in the future „it will gain even more momentum" and become a trend on a global level (Borović et al., 2022). Rural tourism attracts a smaller number of tourists and tourists are interested in local natural beauty, local culture, customs and traditions. However, sustainability can be questioned if factors such as: seasonal character, insufficiently developed infrastructure, large investments in the construction or adaptation of accommodation facilities, relatively low capacity occupancy are taken into account (Košić, 2009). That is why in contemporary professional literature and practice, the importance of integral rural tourism is increasingly being discussed as an approach that integrates natural and anthropogenic tourism resources, tourist infrastructure and superstructure with the local community, its economy and environment in the most effective way, building, at the same time, a concrete product (Saxena et al., 2007; Bousset et al., 2007). The connection and integration of all interest groups in the use of natural, human and financial resources has a direct impact on the fact that, thanks to tourism, the rural population achieves a better standard of living, and tourists have more varied experiences (Salvatore et al., 2018).

The tourist offer of rural destinations in the Republic of Serbia is relatively similar. In order to achieve coherence, it is necessary to introduce innovations in the enrichment of the tourist product in rural destinations (Vuković & Kljajić, 2023). The demands, motives and interests of tourists have become more complex. This is directly reflected in further directions in the development and improvement of the tourist product in rural areas (Ivloga & Shakharamanian, 2019). Tourist destinations in rural areas offer visitors new experiences: getting to know culture, ethno customs, traditions, gastronomy, old crafts (Cvijanović et al., 2022). Intangible heritage and cultural heritage represent the basis for the development of ethno tourism in rural areas. That is why it is necessary to improve and strengthen promotional activities in the development of rural tourism (Cvijanović et al., 2022). Culture is an indispensable and integral part of the tourist offer of rural destinations through introducing tourists to rural heritage (architecture, history), rural lifestyle (tradition, music, gastronomy) and rural activities (local events, customs) (Lin et al., 2022). Therefore, special ethno events have great popularity because they contribute to destinations sustainability (Noh et al., 2024).

Contemporary research indicates the increasing importance of the terms event tourism, event marketing and event management in the development of various types of tourism, especially in the field of rural and ethno tourism (Getz, 2005; Wood, 2009; Van der Wagen & Carlos, 2005; Kotler & Kelle, 2021). Event tourism represents a specific form of tourism that unites and integrates the needs of tourists for recreation, culture, ethnographic heritage, and entertainment in rural tourist destinations (Bjeljac et al., 2014; Dugalić, 2020). Event marketing is an integral part of organizing tourist destination events. From the point of view of marketing, an event is an activity designed to offer visitors something worthy of their attention, which will attract them to the destination where it is organized, i.e. to gather a certain group of people at a certain time, in a certain place with a special reason (Van Der Wagen & Carlos, 2005). Kotler emphasizes the importance of events as an event designed to convey certain messages to a target group (Kotler & Kelle, 2021). Event marketing influences consumer attitudes towards different brands, consumer behavior and stimulates purchases (Seturi, 2023). Getz believes that the common feature of all events is periodicity and that each manifestation is an exceptional driving force in the mix of management, programs and people (Getz, 2005).

Contemporary trends indicate greater motivation and demand for staying at tourist destinations in rural areas (Christou et al., 2018; Xue et al., 2017). In this sense, in the development and promotion of rural tourism, well-designed and organized events and ethno manifestations are of special importance, which help in the effective affirmation and promotion of tourist products and services and thus enable direct interaction of visitors with the product and service of the tourist destination (Wood, 2009). Today, rural and ethno tourism are accepted in many of countries as the main drivers of development and revitalization of rural areas (Brandth & Haugen, 2011; Gao & Wu, 2017; Raspor et al., 2020; Ranđelović, 2022). Ethno, cultural and event tourism represent the fastest growing forms of tourism in many countries (Pantović et al., 2023). However, in modern literature, relatively little attention is paid to researching the motives of travel in cultural frameworks and the role of ethnic groups in the development of rural tourism (Terkenli & Georgoula, 2021). The aim of this study is to investigate the impact of an event based on local cultural heritage with which tourists have direct contact, as well as the effect that an ethno event has on increasing the attractiveness of a rural tourist destination.

Two research hypotheses were set, according to the available literature:

- Ethno event, as an innovative approach in the development of the tourist product of the rural economy, encourages the development of tural tourist destinations

- Ethno event contributes to raising the quality of the tourist product, expanding the assortment of the tourist offer, valorizing and protecting the intangible cultural heritage and through promotion shapes a new brand of the tourist destination.

Materials and Methods

The structure of the work and conducted research are aligned with the use of relevant data from the internal data of agricultural holding Gostoljublje in Kosjeric, as well as with the use of current scientific and professional domestic and foreign literature.

In order to effectively research tourist supply and demand and determine the market caacity of tourism, a survey was conducted. The instrument used for the research is a survey questionnaire compiled by the authors. The research was carried out in the period from March to October 2023, using the standard procedure of distributing questionnaires among the tourists in agricultural holding Gostoljublje in Kosjerić. The questions were asked in Serbian for domestic and in English for foreign tourists. According to the internal data of the Gostoljublje farm, 1153 visitors participated in the ethnic event “Country Wedding” out of the total number of tourists in the observed period. The questionnaire was conducted on a sample of 346 respondents, which represents 30% of the total number of participants of this event.

The purpose of the questionnaire is to indicate the importance of the ethno event as an innovative tourist product and its influence on the fluctuation of tourists, the reasons and motives of the visit, satisfaction with the stay and sources of information about the tourist destination. These indicators show taking further steps in the affirmation, promotion and further development of the tourist destination. Research should indicate the importance of modern approaches of event marketing in the development of rural tourism on specific example of the agricultural holding Gostoljublje in the municipality of Kosjerić.

In addition to field research, various scientific methods were used, namely the inductive deductive method, the method of analysis and synthesis, the method of description.

Research aims to point out the importance of organizing an ethno event as an innovative tourist product, through the promotion of local customs, old folk Serbian traditions, which contributes to the development and enrichment of the offer in rural tourist destinations.

Results with Discussion

Current trends in tourism indicate that the modern tourist is not satisfied only with the basic products of a tourist destination. That is why it is necessary to affirm new tourist products that complement the content of the tourist destination and fulfill the expected need of tourists, which is to participate in the life and customs of rural areas and to spend their stay at the destination in an active way.

The importance of the development of rural, ethno event and other forms of tourism is also recognized in the sustainable development strategy of the municipality of Kosjerić and contained in the vision: "Kosjerić is a municipality with a preserved population, stable economic development and a healthy environment that provides conditions for a peaceful and quality life of the local community, while the nurturing, the cultural, historical and traditional values makes it an attractive destination for domestic and foreign guests" (Sustainable Development Strategy of the Municipality of Kosjerić, 2018-2028).

Research is focused on the ethno event as a specific tourist product in a rural destination. The ethno project "Country wedding in Kosjerić" was implemented in the tourism offer of the Gostoljublje farm, which recognized the needs of the market and introduced an innovative and authentic tourist product.

This ethno project represents the permeation of the customs, climate and gastronomy of the ethnographic features of the destination as a way of experiencing the cultural essence of Serbia through a touristic ethno event. This represents a significant shift in the tourist offer of rural areas where, in addition to natural beauty and cultural monuments, the target group of tourist consumers realizes directly participates and interacts with the basic product and service of the tourist destination.The ethno event "Country wedding in Kosjerić" is an example of an efficient business venture, but also an increasingly popular form of entertainment and leisure time which, as a specific attraction, contributes to the prosperity of the farm, town and region as a tourist destination in the rural tourism of this region.

The essence of this event, as an innovative tourist brand, refers to the presentation of ethno celebrations and serves the purpose of affirming the local community and its culture. The originality of this event contributes to the protection of intangible cultural heritage, the preservation of traditions, customs, culture, lifestyle and nutrition of this climate and offers direct involvement and interaction to the target group of domestic and foreign tourists to share a new experience through their participation.

In addition, this ethno event expands the activity of the farm as a tourist destination and enables sustainability through an innovative program that provides tourists with an insight into the culture of living of the local residents, familiarization with traditions, customs, people's behavior, clothes, music, song, dance, gastronomy as part of intangible cultural heritage. Local residents, representatives of cultural and artistic societies, the ambience of the ethno farm, artists on old folk instruments are included in the event. Such a specific ethno event has a unique ability to unite people through common goals, interests and experiences and contribute to the development and attractiveness of a tourist destination in a rural area.

Event marketing of this ethno manifestation is based on six stages: the display of customs (planning the theme of the event, event agenda and its phases through display of customs ambience, ethno scenography and costumes, culinary and gastronomic products), promoting the event (through the selection of the appropriate channel of communication with the target groups of visitors), social networks (through specific ways of promoting the event such as Facebook, Instagram), monitoring the progress of the campaign, implementation of the event (in which visitors and tourists are actively involved in the implementation of the event) and evaluation. In order to effectively research supply and demand, the influence of the organization and implementation of ethno events in the affirmation of the market capacity of the Gostoljublje farm, a survey was conducted. The aim of the research was to survey the visitors about their attitudes, preferences, reasons and motives for the visit, evaluation of the stay, sources of information and satisfaction with the trip. The research was conducted on a representative sample of 346 respondents.

Table 1 shows the socio-demographic characteristics of the respondents. From total respondents, 79,77% belong to the domestic and 20,23% belong to the foreign tourists. Also, a total of 42,2% of men and 57,8% of women participated in research. In the research, 47,98% of the age between 18 and 35 years and 52,02% of the age about 35 years participated. In total 54,91% of participants are with completed secondary school, 15,32% with a college degree and 29,77% with university academic degree (Table 1.)

Table 1. Socio-demographic characteristics of respondents

Characteristics	Category	Frequency	Percentage
Type of tourists			
	domestic	276	79,77%
	foreign	70	20,23%
Gender			
	Male	146	42,20%
	Female	200	57,80%
Age (years)			
	18-35	166	47,98%
	>35	180	52,02%
Level of education			
	No formal education	0	0
	Primary	0	0
	Secondary school	190	54,91%
	College degree	53	15,32%
	University degree	103	29,77%

Source: authors' calculation

Table 2. summarize the tourist traffic in the observed five-year period (2019-2023).

Table 2. Number of domestic and foreign tourist arrivals in agricultural holding Gostoljublje

Tourist	2019	2020	2021	2022	2023
Domestic	2500	905	1223	2154	2700
Foreign	1330	0	0	80	754
Total	3830	905	1223	2234	3454

Source: Internal data of agricultural holding Gostoljublje, Annual Report, 2023

The lowest number of tourists was recorded in 2020 and 2021 during the Covid-19 pandemic. This is primarily characteristic of the category of foreign visitors due to the inability to travel. From 2022, there is a constant increase in tourists, which almost doubled in 2022 compared to 2021, and also an increase was recorded in 2023 compared to 2022.

The number of foreign tourists is also increasing, although it has not yet reached the level of 2019. Based on the data presented, an increase in domestic and foreign tourists is evident.

Table 3. Total overnight stays of domestic and foreign tourists in agricultural holding Gostoljublje

Tourist	2019	2020	2021	2022	2023
Domestics	1723	2430	2220	1855	1700
Foreign	150	0	0	65	100
Total	1873	2430	2220	1920	1800

Source: Internal data of agricultural Gostoljublje, Annual Report, 2023

According to the data from Table 3., a total of 1,800 overnight stays were registered, which is about 6,25% less than in 2022. In 2023, domestic tourists had 1,700 overnight stays and domestic tourists accounted for 94.44% of the total number of overnight stays. Foreign tourists make 5.56% of the total number of overnight stays in 2023. The largest number of overnight stays by domestic tourists was realized in 2020 during the pandemic due to the need of tourists to stay in rural areas. With the enrichment of the tourist product and promotion, an increase in the number of overnight stays at this tourist destination can be expected in the coming period.

Table 4. Reasons for the visit and arrival of tourists in agricultural holding Gostoljublje

Reasons for the visit	% answer yes		% answer no	
	Frequency	Percent	Frequency	Percent
Natural attractions	182	52,60%	164	47,40%
Cultural and historical heritage	120	34,68%	226	65,32%
Active vacation, sports, entertainment	81	23,41%	265	76,52%
Hospitality	299	86,41%	47	13,59%
Quality of accommodation	208	60,11%	138	39,89%
Gastronomic offer	230	66,47%	116	33,53%
Ethno event - Country wedding	266	76,88%	80	23,12%
Business events	18	5,20%	328	94,80%
Health reasons	38	10,98%	308	89,02%
Good price-quality ratio	90	26,01%	256	73,99%
Traffic infrastructure	9	2,60%	337	97,40%

Source: authors' calculations

Table 4. presents the motives and reasons for the visit and arrival of tourists to this tourist destination, summarized in the percentage of yes and no answers. The most common reason for choosing the tourist destination "Gostoljublje" is represented by natural attractions (52.60%), hospitality (86.41%) and quality of accommodation (60.11%). In addition, the data indicate that one of the most common motives for the arrival of tourists to this destination is the ethno event, the "Country Wedding" event (76.88%). A high percentage of surveyed visitors (66.47%) stated the excellent gastronomic offer of traditional cuisine.

Other parameters, such as business events (motivational weekends, team-buildings, company get-togethers) (5.20%) or traffic infrastructure (2.60%) are represented with a lower percentage. It can be concluded that one of the defining motives and reasons for visiting this destination is the ethno event “Country Wedding” as part of the specific cultural, ethno and gastronomic heritage of this region.

Table 5. shows the respondents’ answers regarding the assessment of the visitor’s stay at the tourist destination “Gostoljublje” within ten key indicators. The best rated parameters are accommodation quality (4.90), gastronomic offer (4.56) and cleanliness (4.80). An extremely high score (4.86) is characteristic of the ethno event “Country Wedding”, which greatly contributes to the attractiveness of the tourist offer. The price-quality ratio parameter is also high (4.46), as well as the availability of information about the destination (4.65), thanks to the modern approach to promotion at the internet and social networks. The lowest score (3.00) has the parameter that refers to the still inadequate traffic infrastructure.

Table 5. Evaluation of the tourist’s stay at the tourist destination

Residence initiators	**Grade***
Quality of accommodation	4,90
Gastronomic offer	4,56
Natural attractions	4,30
Cultural and historical heritage	4,84
Ethno-event Country wedding	4,86
Fun, going out	3,64
Cleanliness	4,80
Availability of destination information	4,65
Price-quality ratio	4,46
Transport infrastructure	3,00

Source: authors’ calculations, (*the table shows the grades: 1 is minimum and 5 is maximum)

The average rating of satisfaction with the visit and stay of tourists at the tourist destination “Gostoljublje” is very high and amounts to 4.40 out of a possible five.

Conducted research on the assessment of tourists’ satisfaction with a visit to the tourist destination (Table 6.) shows that by far the largest number of tourists, more than two-thirds of the respondents (70.52%) rated the visit to the tourist destination as completely satisfied. A far smaller number rated their stay at this destination as mostly satisfied (19.08%) and partially satisfied (10.40%). Out of the total number of surveyed visitors, none declared themselves dissatisfied.

Table 6. Rating of tourists’ satisfaction with a visit to the tourist destination

Category	**Frequency**	**Percent**
Completely satisfied	244	70,52%
Mostly satisfied	66	19,08%
Partially satisfied	36	10,40%
Dissatisfied	0	0%
Total	346	100%

Source: authors’ calculation

This indicates a high level of visitor satisfaction with the stay and a high level of development of the tourist product of this destination.

Table 7. summarizes respondents' answers about sources of information about this tourist destination. As the main source of information about this tourist destination, the largest number of surveyed visitors (34.97%) used internet sites. A significant percentage of the respondents received the basic source of information about this tourist destination based on experience and recommendations from friends and acquaintances (25.14%).

Table 7. Sources of information about the tourist destination

Source of information	**Frequency**	**Percent**
Internet sites	121	34,97%
Social networks (instagram, twitter...)	52	15,03%
Electronic media (radio, TV...)	35	10,12%
Tourist agencies	32	9,25%
Presentations at fairs	6	1,73%
Print media	11	3,18%
Billboards	2	0,58%
Recommendations from friends	87	25,14%
Total	346	100 %

Source: authors' calculation

In order to better inform tourists, it is necessary to expand promotional activities to other sources that are not sufficiently represented. This primarily refers to more intensive cooperation with travel agencies, promotions at fair events, print and electronic media, and social networks.

In order to plan and direct further activities for the development of farming holding Gostoljublje as a tourist destination, it is necessary to answer two questions: what is the current level of tourism development and what environmental factors affect its future development. The answers to these questions are shown by SWOT analysis (Table 8.). The answer to the first question is obtained by accessing strengths and weaknesses. The achieved level of development of a professionally designed tourist product, the attractiveness of the ethno event "Country Wedding" which has become a brand, the high level of accommodation facilities and gastronomic services, as well as the potential of the local workforce with a positive attitude towards tourists, represent the basic strengths.

Table 8. SWOT analysis

STRENGHT	WEAKNESSES
-good positioning of the destination on the market -achieved level of development of a professionally designed tourist product intended for the domestic and foreign markets - the attractiveness of the “Country Wedding” event, which has reached a level of recognition and has become a brand - High level of accommodation capacity -various gastronomic offer - hospitality and positive attitude of employees and local population towards tourists - local knowledge and skills and potential of the local workforce - positive image of the region	- mismatch of traffic infrastructure with the needs of tourists - lack of greater cooperation between the public and private sectors in the development of products and the establishment of a more efficient value chain - lack of professional staff in tourism and catering - demographic structure, depopulation and unfavorable migration trends - insufficient cooperation between the public and private sectors in marketing and promotional activities - insufficient level of use of information technologies in the promotion of the destination
OPPORTUNITIES	**THREATS**
- creation of new opportunities for employment and education of employees at all levels - improvement of traffic infrastructure (activation of Ponikve airport, highway Belgrade-Sarajevo, Belgrade-South Adriatic) - improvement of existing and development of new tourist products - favorable trends in tourist demand: vacation in preserved nature, tourism, ethno event, short vacations - improvement of marketing and promotional activities adapted to the needs of the destination	-Economic crisis - Delayed implementation of infrastructure facilities (highway, airport) - Negative growth and outflow of professional staff from the hospitality and tourism industry - Mismatch of educational profiles in tourism with market needs - Emergence of new destinations on the tourist market

Source: Authors’ development

Weaknesses relate to the unfavorable demographic structure and depopulation, and thus the lack of professional staff, the lack of meaningful cooperation between the public and private sectors in promotional activities, and especially the mismatch of the transport infrastructure with the needs of tourists.

The assessment of factors from the environment refers to the determination of further opportunities for successful development, but also the assessment of potential threats that can slow down or reduce the development of tourism in this destination.

Conclusion

Research has shown that farms in rural areas in the modern design of the tourist product, in addition to preserved nature and a healthy environment, historical attractions, should especially affirm ethno events that through the interactive participation of visitors and their direct acquaintance with culture, customs and ethnographic heritage enriches the tourist product and stimulates the increase in the attractiveness of the destination. If we analyze the respondents’ answers related to the motives and reasons for staying at the Gostoljublje farm, we can conclude that the ethno event “Country Wedding” has the potential to become a recognizable manifestation in ethno tourism. This is shown by the indicators of the high rating of the tourist stay in the ethno event category (4.86 out of a possible 5), as well as more than two thirds of the visitors in the extremely and completely satisfied category. One of the indicators also refers to the sources of information and demonstrates that, in addition to Internet sites, an important source of information about this tourist destination and event is obtained based on the experience and recommendations of friends, which results in the return of tourists to this destination and the expansion and promotion of this event as an attractive tourist product.

The study was limited by the time frame with regard to seasonal character of this ethno event. Also available literature with specific results and with a large sample is lacking.

Taking into account the current trends in the tourist market, the further development of this tourist destination can be defined through the creation and improvement of the integrated tourist product of the farm "Gostoljublje" (rural tourism, ethno tourism, ethno manifestations) which will enable the satisfaction of the most sophisticated demands of tourists and the achievement of a strategic position that will be competitive in the environment and take a leadership position in the rural tourism of this region. Research confirm hypotheses and has shown that in practice, such an ethno event is an effective way for the local community in rural areas to direct its activities towards certain goals, such as: valorization of capital, change of image, increase in the scope of services and their improvement, increase in employment of the local population, stimulating the economy and at the same time helping the economy to present, improve and affirm its tourist products and services.

Research in the work, through the example of the successful business practice, such as "Country wedding" of the Gostoljublje farm, contributes to the affirmation of further research in the planning, organization and implementation of ethno events in rural tourism. Special steps in further research should be focused on the improvement of marketing and promotional activities in order to achieve a level of recognition and create a sustainable, professionally shaped, positive tourist brand "Country Wedding" in Kosjerić.

Acknowledgements

Paper is a part of research funded by the MSTDI RS, agreed in decision no. 451-03- 66/2024-03/200009 from 5th February 2024.

Conflict of interests

The authors declare no conflict of interest.

References

1. Bjeljac, Ž., Terzić, A.,& Lukić, T. (2014). Tourist events in serbian part of Banat, *Forum Geografic*, vol. XIII, iss 1, 110-117, https://dx.doi.org/10.5775/fg.2067-4635.2014.246.i

2. Borović, S.,Stojanović, K., & Cvijanović, D. (2022). The future of rural tourism in The Republic of Serbia, *Ekonomika poljoprivrede*, vol. 69, iss 3, pp 925-938. https://doi.org/10.5937/ekoPolj2203925B
3. Bousset, J. P., Skuras, D., Tesitel, J., Marsat, J. B., Petrou, A., Fiallo-Pantzion, E., Kušova, I., & Bartoš, M. (2007). A Decision support system for integrated tourism development: rethinking tourism policies and management strategies, *Tourism Geographies*, 9(4), 387-404. https://doi.org/10.1080/14616680701647576
4. Brandth, B., & Haugen, M. (2011). Farm diversification into tourism – Implicastions for social identity?, *Journal of Rural Studies*, 27(1), 35-44. https://doi.org/10.1016/j.jrurstud.2010.09.002.
5. Christou, P., Farmaki, A., & Evangelou, G. (2018). Nurturing nostalgia?: A response from rural tourism stakeholders, *Tourism Management*, 69, 42-51. https://doi.org/10.1016/j.tourman.2018.05.010
6. Clark, G., & Chabrel, M. (2007). Measuring integrated rural tourism, *Tourism Geographies*, 9(4), 371-386. https://doi.org/10-1080/14616680701647550
7. Cvijanović, D., Pantović, D., & Petrović, T. (2022). Costums at an element of enriching the rural tourist offer – a chance for tourism development after the crisis, *11 Scientific Conference with International Prticipation "Jahorina Business Forum 2022: Economic lessons learnt from the 2008 and 2020 crises: Experiances and Recommendations for Enterpreneural Nations*", Faculty of Economics in a East Sarajevo, issue 25, pp 39-47. https://doi.org/10.7251/ZREFIS2225039C
8. Cvijanović, D., Lazović, S.,& Stojanović, K. (2022). The possibility of revitalizing rural areas through the promotion of cultural tourism, *Knowledge – International Journal*, 55(1), 21-26, https://ikm.mk/ojs/index.php/kij/article/view/5678
9. Dugalić, S. (2020). Event turism and sustainable development, *Sport – Science and Practice*, 10(2), 87-98. https://doi.org/10.5937/snp2002085D
10. Gao, J., & Wu, B. (2017). Revitalizing traditional villages through rural tourism: A case study of Yuanjia village Shaqnxi Province, China, *Tourism Management*, 63, 223-233. https://doi.org/10.1016/j.tourman.2017.04.003
11. Getz, D. (2005). Event Management and Event Tourism, Cognizant Communications Corporation, New York, USA
12. Hakkarainen, M., & Tuulentie,S. (2008).Tourism's role in rural development of Finnish Lapland: Interpreting National and Regional Strategy Documents, *Fennia International Journal of Geography*, 186(1), 3-13. http://doi.org/1011143/fenia.127425
13. *Internal data of agricultural holding Gostoljublje*, Annual report (2023)
14. Ivolga, A., & Shakharamanian, I. (2019). Rural tourism as a factor of multifunctional development of rural territories: on materials of Stavropol region, *Western Balkan Journal of Agricultural Economics and Rural Development*, 1(1), 41-50, doi:10.5937/WBJAE1901041

15. Jeločnik, M., Subić, J., & Kovačević, V. (2020). Agriculture practice as support for agro-tourism development at family farms, in innovative aspects of the development service and tourism, Sevastopol State Agrarian University, Faculty of Social and Cultural Service and Tourism, Stavropol, Russia, pp. 49-59.
16. Kotler, Ph., & Kelle, L.K. (2021). Marketing management, Pearson, London, England
17. Košić, K. (2009), Rural tourism in Vojvodina and sustainable development, PhD dissertation, Department of Geography, Tourism and Hotel Management, Faculty of Natural Science, University of Novi Sad
18. Lin, H.H., Chen, I-Y.,Lu, S-Y., Tseng, H., & Lin, J-C. (2022). Can cultural tourism resources become a development feature helping rural areas to revitalize the local economy? An exploration of the perspective of attractiveness, satisfaction, and willingness by the revisit of Hokka cultural tourism, *Open Geosciences*, vol. 14, no. 1, pp 590-606, https://doi.org/10.1515/geo-2022-0358
19. Mafunzwaini, A. E., & Hugo, L. (2005). Unlocking the rural tourism potential of the Limpopo Province of South Africa: Some strategic guidelines, *Development Southern Africa*, 22(2), 251-265. http://doi.org/10.1080/03768500500163048
20. Nicolaides, A. (2020). Sustainable ethical tourism (SET) and rural community involvement, *African Journal of Hospitality, Tourism and Leisure*, 9(1), 1-15.
21. Noh, Y., Coleman A., & Kim, D-Y. (2024). The effects of special events on attendees' diversity, equity and inclusion experience: festival pride, prior experience and Covid-19, *Journal of Convention & Event Tourism*, 25(2) doi:10.1080/15470148.2024.2307006
22. Pantović, D., Cvijanović, D., Cvijanović, G., & Šabić., Lj. (2023). Tradition and culture as the base for the tourism produst: Case of UNESCO intangible heritage, *Facta Universitatis*, 20(2), 103-116. https://doi.org/10.22190/FUEO230130007P
23. Ranđelović, M. (2022). Program activities for sustainable rural development: case study, village Berbatovo, Niš, *Facta Universitatis*, 20(2), 115-130. https://doi.org/10.2298/FUACE220918010R
24. Raspor A., Kleindienst, P., Perišić, T. K., & Mastilo, Z. (2020). A case study of ethno village in Slovenia and Bosnia and Hercegovina, *Economic*s, 8(2), 89-102. doi: 10.2478/eoik-2020-0015
25. Salvatore, R., Chiodo, E., & Fantini, A. (2018). Tourism Transition in Peripheral Rural Areas: Theories, Issues and Srategies, *Annals of Tourism Research*, 68, 41-51. https://doi.org/10.1016/j.annals.2017.11.003
26. Saxena, G., Clark, G., Oliver, T., & Ilbery, B. (2007). Conceptualizing Integrated Rural Tourism, *Tourism Geographies*, 9(4), 347-370. https://doi.org/10.1080/14616680701647527
27. Seturi, M. (2023). About the importance and benefits of event marketing, *Green Blue and Digital Economy Journal*, 4(4):1-16, doi: 10.30525/2661-5169/2023-4-1

28. Terkenli, T. S., & Georgoula, V. (2021), Tourism and cultural sustainability: views and prospects form Cyclades, Greece, *Sustainability*, 14(1), 307. https://doi.org/10.3390/su14010307

29. The Municipality of Kosjerić, (2018). *Sustainable Development Strategy of the Municipality of Kosjeric*, 2018-2028, available at: https://www.kosjeric.rs/wp-content/uploads/2021/09/strategija_odrzivog_razvoja_2018-2028.pdf

30. Van Der Wagen, L., & Carlos, B. (2005). Event management for tourism, cultural, business and sport, Pearson, London, England

31. Vesić, M., Savić, M., Pavlović, S., & Bolović, J. (2022), Sustainability – focused rural tourism development in Western Serbia, *Glasnik srpskog geografskog društva*, 102(1), 87-106. https://doi.org/110.2298/GSGD2201087V

32. Vuković, P., & Kljajić, N. (2023). Rural Tourism Destinations and the Sustainable Development of Tourism in the Republic of Serbia: Analysis of Variables Affecting the Competitiveness, Sustainable Growth and Global Social Development in Competitive Economies*, IGI.Global*, Hershey, USA, pp. 136-156, http:/doi.org/10.4018/978-1-6684-8810-2.ch008

33. Wood, E. (2009). Event marketing measuring an experience, *Journal of promotion management*, 15(1-2), 247-268. https://dx.doi.org/10.1080/10496490902892580

34. Xue, L., Kerstetter, D., & Hunt, C. (2017). Tourism development and changing rural identity in China, *Annals of Tourism Research*, 66, 170-182. https://doi.org/10.1016/j.annals.2017.07.016

PAPER TITLE – USE CAPITAL LETTERS, CENTER, BOLD, TIMES NEW ROMAN, SIZE 12

First Author Name (10pt italic, center align)[1]*, First Co-Author Name (10pt italic, center align)*[2]*, Second Co-Author Name (10pt italic, center align)*[3]

**Corresponding author E-mail: (10pt italic, center align)*

A R T I C L E I N F O

Original/Review Article

Received: *xx May 2018*

Accepted: *xx September 2018*

doi:xxx

UDC xxx

Keywords:

should include 4-6 key words that summarize the contents of the paper /Times New Roman, Italic, 10/

JEL:(www.aeaweb.org/jel/jel_class_system.php) */Times New Roman, Italic, 10/*

A B S T R A C T

The abstract should contain a maximum of 150 words. The abstracts should avoid any abbreviations and mathematical formulas.
The abstract is a summarization of the full report, written in one paragraph, and should include next elements:

1. Purpose
2. Methodology
3. Results
4. Conclusions
5. Recommendations
6. Additional data

/Times New Roman, 10/

Introduction

Page setup: Paper size: width 170 mm x height 240 mm; Margins: top/bottom 20 mm, left/right 18 mm; Layout: header 1,25cm, footer 1,25cm; Orientation: Portrait.

Articles should be written only in English. It is advisable to write the article in the third-person singular or plural with the use of active form. Before paper submission, please check grammatical and spelling mistakes by the spellchecker for the English language.

Paper volume up to 30.000 characters (without spaces) or 15 full pages including the text, figures, tables, references list and appendices. Articles should not be shorter than 10 pages. Depending on papers' quality, Editorial Board could also accept longer articles. Article has to be prepared electronically (on computer), in program MS Word 2003 or some later version of this program.

1 Name, academic position,institution, address, phone number, e-mail, ORCID ID (https://orcid.org/)

2 Name, academic position,institution, address, phone number, e-mail, ORCID ID (https://orcid.org/)

3 Name, academic position,institution, address, phone number, e-mail, ORCID ID (https://orcid.org/)

Introduction is the first section of an IMRAD paper. It purposes is to state clearly the problem investigated and to provide the reader with relevant background information. State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

The purpose of the Introduction should be to supply sufficient background information to allow the reader to understand and evaluate the results of the present study without needing to refer to previous publications on the topic. Much of the Introduction should be written in the present tense. /Times New Roman, 11/

Please define abbreviations and acronyms during their first occurrence within the text, even in case that they were previously defined in article summary. Do not use abbreviations in article title, unless they can not be avoided.

Sub-headings should be written by font **Times New Roman**, **font size 11**, **bold**, **centred**, only first letter capital, interspace between sub-heading and paragraph above 6 pt (**before 6 pt**), and interspace between sub-heading and paragraph below 6 pt (**after 6 pt**). Please use the writing style presented in this template.

Materials and methods

Materials and methods are the second section of an IMRAD paper. Its purpose is to describe the experiment in such retail that a competent colleague could repeat the experiment and obtain the some or equivalent results. Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

For equations and formulas use the Microsoft Equation Editor or addition for equations writing MathType (www.mathtype.com). Use of built-in equation editor within the program Word 2007 is not recommended. Please check if all symbols within the equations/ formulas are defined (forthwith after equation/formula). The equations are written using Microsoft Word (MathType); they are consecutively numbered and centered.

Results

Results are the third section of an IMRAD paper. Its purpose is to present the new information gained in the study being reported. It should be clear and concise. The Results are core of the paper. You shouldn`t start the Results section by describing methods that you inadvertently omitted from the Materials and Methods section. The Results must be writing in past tense.

Discussions

The final section of an IMRAD paper. Its purpose is to fit the results from the current study into the preexisting fabric of knowledge. The important points will be expressed as conclusions. This should explore the significance of the results of the work, not repeat them. A combined *Results and Discussion* section is often appropriate. Avoid extensive citations and discussion of published literature.

Many papers are rejected by journal editors because of a fault Discussion.

Conclusions

The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a *Discussion* or *Results and Discussion* section. Conclusions should provide a summary of important findings and their implicants to the area of research that is the forms of the article.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.). They should be brief.

Conflict of interests

The authors declare no conflict of interest.

References

All manuscripts should be formatted using the American Psychological Association (**APA**) citation style. For additional examples, consult the most recent edition of the Publication Manual of the American Psychological Association.

Reference (author(s) of quotes) has to be entered directly in the text of article in next form (Petrović, 2012; or Petrović, Marković, 2012; or Mirković et al., 2012). Please do not write them as indexes in square brackets [3] or in footnote. Try to use a footnote only in the case of closer explanation of certain terms, or clarification of real and hypothetic situations. ***Do not numerate the pages.***

Reference list should only include works that have been published or accepted for publication. Unpublished works should be only mentioned in the text. Reference list should be with the bibliographic details of the cited books, book chapters, or journal articles.

References in not-English languages should be translated in English, and the English language has to be mentioned in brackets, for example: Максимовић, Г., Секулић, Д., Петровић, А., & Драгичевић, Д. (2017), Савремени трендови и нове стратегије конкурентности у хотелијерству, *Менаџмент у хотелијерству и туризму,* 5(2), 27-35. [in English: Maksimović, G., Sekulić, D., Petrović, A., & Dragičević, D. (2017). Contemporary trends and new competitiveness strategies in hotel industry. Hotel and Tourism Management, 5(2), 27-35.].

Literature units have to be written in font TNR, font size 11, alignment Justified, with mutual interspace of 3 pt - before/after. In all literature units only surnames are written as a whole, while all authors' names has to be shorten on to initial (initials have to be set after surnames). Please, write surnames of all authors (do not use the style Petrović et al.). Do not combine literature units (under each ordinal number can be only one literature unit) and always write complete titles of used literature units. If used/cited literature was taken over from the internet publication, after adequate writing of literature unit, in brackets has to be note complete link from which material was taken over (available at: www.fao.org).

Citation of Books

Author's surname Initial(s) of the given name(s). (Year of Publication) *Title of Book*, Volume number (if relevant), edition (if relevant). Publisher, Place of Publication

Citation of Articles

Author's surname Initial(s) of the given name(s). (Year of publication) Title of article. *Journal Volume number* (and issue number if issues within a volume number are not consecutively paginated): Number of first and last page of article, DOI

If the cited paper is given a DOI number, it should also be included.

Citation of Websites

Author's surname Initial(s) of the given name(s). (if known) title, type of document (if relevant), date of issue (if available), web address and date of access, if the document or the website may be subject to change.

Citing a journal article found online

Author, A. (Publication Year). Article title. Periodical Title, Volume(Issue), pp.-pp. DOI:XX.XXXXX or Retrieved from journal URL

Example:

1. Cvijanović, D., Trandafilović, S., & Imamović, N. (2013). Marketing concept in terms of agricultural enterprises development in transitional countries. *Economics of Agriculture, 60*(1), 113-122.
2. Hjalager, A. M., & Richards, G. (Eds.). (2003). *Tourism and gastronomy*. Routledge, London.
3. Mićović, A. (2017). Tourism Development and Evolution of Tourism Related Rules, *2nd International Scientific Conference – Thematic Proceedings II*, Faculty of Hotel Management and Tourism, Vrnjačka Banja, 181-202. Retrieved from http://www.hit-vb.kg.ac.rs/conference/images/thematic_proceedings/2017_II.pdf
4. Stošić, L., & Stošić, I. (2013). Diffusion of innovation in modern school. *International Journal Of Cognitive Research In Science, Engineering And Education (IJCRSEE),* 1(1), 12-24.

5. Domanović, V., Vujičić, M., & Ristić, L. (2018), Profitability of food industry companies in the Republic of Serbia, *Economic of Agriculture*, 65(1), 11-32. doi:10.5937/ekoPolj1801011D
6. The Food and Agriculture Organization of the United Nations (FAO), Retrieved from http://www.fao.org (July 31, 2018)

TABLES AND FIGURES

All tables are to be numbered using Arabic numerals.

Tables have to be created within the text of article, not taken in the form of images from other documents. Tables should be numerated according to order of their appearance. Titles of the tables have to be given immediately above the table to which they relate. Please use following style during their formatting. Title of the table should be set with the interspace 6 pt - before and 3pt - after, in font TNR, font **size 10**, alignment **Centered**. Text within the table should be written in the font TNR, font size 9. Bold the text in the heading. Start with next paragraph at the interspace of 6 pt from the table source or note (after). During the article writing please mark in the main text all calls to a certain table (*Table 5*.). Try to fit all tables in article within the specified format of the page (Table properties – preferred width – max 97% - alignment: center). Complete text within the table cells has to be entered in next form (paragraph - spacing: before/after 0 pt, line spacing: single). In case when table breaks on next page, broken part of the table on next page has to be accompanied by a table header.

Identify any previously published material by giving the original source in the form of a reference at the end of the table caption.

Footnotes to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data) and included beneath the table body.

For the best quality final product, it is highly recommended that you submit all of your artwork – photographs, line drawings, etc. – in an electronic format.

Example:

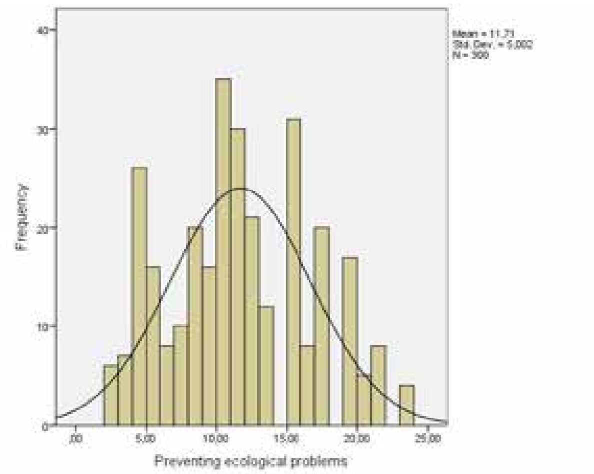
Table 1. The distribution cost of packaged goods from Subotica to retail-store objects

Indicators	Period			Total
	Month 1	Month 2	Month 3	
Distance crossed (km)	12.926	11.295	13.208	37.429
Fuel consumption (litre)	3.231	2.823	3.302	9.356
Value of fuel consumption (RSD)	242.378	211.790	247.653	701.821
Total time spend on touring (hour)	314	266	417	997
Value of total time spend on touring (RSD)	47.048	39.890	62.570	149.508
Number of tours	98	77	102	277
Toll value (RSD)	0	0	0	0
Number of pallets transported (piece)	1.179	976	1358	3.513
Total weight transported (kg)	602.600	429.225	711.116	1.742.941
Vehicle maintenance costs (RSD)	203.858	164.970	224.806	593.634
Lease costs (RSD)	480.938	454.214	565.784	1.500.936
Total sum (RSD)	974.222	870.864	1.100.813	2.945.899

Source: Petrović, 2012

All illustrations whether diagrams, photographs or charts are referred to as Figures. The name and number of figures should be centered on the line above a figure.

Figure 1. Agriculture, value added (% of GDP)



Source: Authors' calculations

Technical preparation, prepress and printing:
DIS PUBLIC D.O.O., Braće Jerković 111-25, Belgrade, phone/fax: 011/39-79-789

Number of copies:
300 copies

The Balkan Scientific Association of Agrarian Economists, Belgrade, Serbia, Institute of Agricultural Economics, Belgrade, Serbia and Academy of Economic Studies, Bucharest, Romania is pleased to announce that journal **ECONOMICS OF AGRICULTURE** has been accepted for indexing in the ***Emerging Sources Citation Index (ESCI)**,* a new edition of Web of Science.

Content in ESCI is under consideration by Clarivate Analytics, the owner of Web of Science, for additional indexing on the platform, including for the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index.

The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of **ECONOMICS OF AGRICULTURE** in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential **economics of agriculture** content to our community.

You may find necessary information on the following link:
http://mjl.clarivate.com/cgi-bin/jrnlst/jlresults.cgi?PC=MASTER&ISSN=0352-3462

Published quarterly

Journal is registered in major scientific databases:

- Web of Science (Clarivate Analytics) – Emerging Sources Citation Index (ESCI)
- EBSCO
- DOAJ
- ERIH PLUS
- AgEcon Search
- Social Science Research Network (SSRN)
- ProQuest
- Library of Congress E-Resources Online Catalog
- Ingenta Connect
- Ulrich’s Periodicals Directory
- CABI
- J-Gate
- The World Wide Web Virtual Library for European Integration
- SCIndeks
- The digital repository of the National Library of Serbia
- doiSerbia
- EconLit
- WorldCat
- Mendeley
- CyberLeninka
- Google Scholar
- CNKI (China National Knowledge Infrastructure)
- ERIH PLUS by Dimensions
- Agora
- Publons
- Internet Archive

EconLit Journal is indexed in major scientific databases:

- Index Copernicus Journals Master List (ICV2013: 5,22).

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

33:63(497.11)

ЕКОНОМИКА пољопривреде = Economics of Agriculture / editor-in-chief Drago Cvijanović. - Год. 26, бр. 5 (1979)- . - Београд : Научно друштво аграрних економиста Балкана : Институт за економику пољопривреде ; Букурешт : Академија економских наука, 1979- (Belgrade : Dis Public). - 24 cm

Тромесечно. - Је наставак: Економика производње хране = ISSN 0352-3454. - Друго издање на другом медијуму: Економика пољопривреде (Online) = ISSN 2334-8453
ISSN 0352-3462 = Економика пољопривреде (1979)
COBISS.SR-ID 27671

The Ministry of Education, Science and Technological Development of the Republic of Serbia provides financial support for publishing of the quarterly journal ECONOMICS OF AGRICULTURE