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EXPLORING THE DETERMINANTS OF PRO-ENVIRONMENTAL BEHAVIOUR IN ECO-TOURISM: A CASE STUDY OF VISITORS TO THE AYAZINI RUINS

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ABSTRACT

This study aims to determine the pro-environmental behaviour influencing factors of tourists within the scope of eco-tourism. The population of the study consists of tourists visiting Ayazini Ruins. In the study, the data were collected using a questionnaire form with a convenience sampling method. 406 questionnaires were administered to the participants. The data were analyzed in the Smart PLS statistical program, and the structural equation model was used to analyze the data. Functional, social, and emotional value significantly positively affects environmental consciousness; conditional value does not positively influence environmental consciousness. Moreover, environmental consciousness significantly positively affects the green image, last chance experience, psychological ownership towards the environment, and pro-environment attitudes. Besides this green image, last chance experience, psychological ownership towards the environment, and pro-environment attitudes significantly positively affect pro-environment behaviour.

Introduction

Environmental Consciousness (EC) refers to an individual's awareness and concern for the natural environment, which can manifest as Pro-Environment Attitudes (PEA) and behaviour (Sharma & Bansal, 2013). Psychological Ownership Towards Environment (POTE) involves a sense of personal responsibility and attachment to the natural environment (Kuo et al., 2021), which can motivate people to protect and preserve it.

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Eco-tourism, which is sustainable tourism that supports conservation efforts (Hawkins, 2004), can be a way to promote both EC and POTE by providing opportunities for people to connect with and learn about the natural environment. To effectively promote ecological consciousness and Pro-Environment Behaviour (PEB) within the framework of eco-tourism, it is essential to consider factors such as education, accessibility, personal value, and social influence (Liu et al., 2014). One way to promote EC and PEB within the framework of eco-tourism is through education and information sharing (Yang et al., 2021). This can include providing information about the natural environment and the impact of human actions on it, as well as offering educational activities and experiences that allow people to learn about and connect with the natural environment (Huang & Liu, 2017). Personal value is also essential in promoting EC and PEB (Xie et al., 2020). Encouraging people to connect with the natural environment on a personal level and align their values with those of conservation can be an effective way to motivate PEB (Paswan et al., 2017). This can involve activities that allow people to experience and appreciate the natural environment and encourage people to think about the long-term consequences of their actions on the environment (Liu et al., 2014). Seeing others engage in PEB can serve as a model and encourage individuals to adopt similar behaviours (Thøgersen & Crompton, 2009). This can involve promoting eco-friendly practices and initiatives within the local community and showcasing successful conservation efforts. Overall, by considering these factors and implementing strategies that promote EC and PEB, eco-tourism can be a powerful tool for protecting and preserving the natural environment while providing economic and social benefits for local communities. This study aimed to identify the factors that influence environmentally friendly behaviour in the context of sustainable eco-tourism for the future of the Ayazini Archaeological Site. The fact that there has been no previous study on eco-tourism in the context of the Ayazini Archaeological Site is one factor that demonstrates this research's originality.

Theoretical framework and hypotheses development

Perceived value and environmental consciousness

Perceived value is the value an individual assigns to an object or experience based on personal beliefs, preferences, and circumstances (Brown, 1984). It is often influenced by factors such as the functional value, social value, emotional value, and conditional value that the object or experience provides, as well as other factors such as the price (Beyari & Abareshi, 2018), availability, and reputation of the entity or experience (Lin et al., 2012). Perceived value can be influenced by marketing and advertising efforts, as companies often highlight their products or services' functional, social, emotional, and conditional value to appeal to potential customers (Hur et al., 2012). However, perceived value can also be influenced by personal experiences, recommendations from friends and family, and other factors (Castellanos-Verdugo et al., 2016). Overall, perceived value is subjective and can vary significantly from one individual to another (Sanchez et al., 2006). From perceived value dimensions, functional value refers to the practical benefits or utility that an object or experience provides (Zhang et al., 2010).

Social value refers to the benefits or positive effects of an object or experience on an individual's relationships or sense of community. Emotional value refers to the feelings or emotional reactions that an object or experience elicits (Lee et al., 2021). Conditional value refers to the knowledge or understanding that an object or experience provides (Jamrozy & Lawonk, 2017).

EC refers to the awareness and concern individuals have for the natural environment and the impact of their actions on it (Lin & Niu, 2018). In the tourism industry, EC is becoming increasingly important as the negative impacts of tourism, such as pollution and resource depletion, have come to light (Sharma & Bansal, 2013). Tourism can positively and negatively impact the environment (Runge et al., 2020). On the one hand, it can benefit local communities economically and support conservation efforts (Ahmad et al., 2020). On the other hand, it can also lead to overcrowding, pollution, and resource depletion if not appropriately managed. EC tourism, also known as eco-tourism or sustainable tourism, aims to minimize traditional tourism's negative environmental and social impacts (Ramaswamy & Kumar, 2010). At the same time, it maximizes local communities' positive economic and cultural benefits (Kreps, 2008). When the studies are examined, it has been determined that the perceived value affects EC (Tsai et al., 2012; Souza et al., 2020). Accordingly, the following hypotheses have been developed.

H_1: *Functional value has a significant positive effect on EC.*

H_2: *Social value has a significant positive effect on EC.*

H_3: *Emotional value has a significant positive effect on EC.*

H_4: *Conditional value has a significant positive effect on EC.*

Green image

Image is the impression formed in the receiver's memory of feelings or thoughts about something. It can be stated that these impressions are shaped by information obtained from various sources or by the experiences of other people or the individual themselves (Yükselen & Güler, 2009: 22). Destination imagery is a group of beliefs, thoughts, and impressions that individuals have about a place or destination (Baloğlu & McClearly, 1999: 871). Eco-tourism, also known as sustainable tourism, minimizes negative environmental and social impacts while maximizing the positive contributions to local communities and the environment (Lee et al., 2010). On the other hand, a Green Image (GI) refers to the perception that a company or destination has a positive environmental impact and is committed to sustainable practices (Namkung & Jang, 2013). When the studies conducted within the framework of eco-tourism are examined, it has been determined that EC affects the GI.

H_5: *EC has a significant positive effect on the GI.*

Last-chance experience

Last Chance Experience (LCE) is a type of tourism that arises from believing that a place, person, or object will not exist or be visitable in the future (Fisher & Stewart, 2017). Lemelin et al. (2010) have described LCE as a niche market based on the opportunity to see disappearing places. This type of tourism is based on the belief that an area that interests' tourists will disappear. During the LCE, tourism offers the opportunity to see disappearing places, and it can also contribute to the conservation of these places. Visitors' interest in these places can encourage locals to show more interest in conservation efforts. Additionally, LCE does not only encompass places at risk of disappearing due to natural events. Some places risk disappearing due to no longer being used as residential areas for a city or village (Piggott-McKellar & McNamara, 2017).

H_6: *EC has a significant positive effect on the LCE.*

Psychological ownership towards environment

POTE refers to the sense of personal responsibility and attachment an individual feels toward the natural world (Kuo et al., 2021). This concept has gained increasing attention in recent years as the need for environmental conservation and sustainability becomes more pressing. Research has shown that individuals with a high level of POTE are more likely to engage in PEB, such as reducing their environmental footprint and advocating for environmental policies (Süssenbach & Kamleitner, 2018). POTE creates a sense of responsibility and a desire to protect and preserve the natural world (Jiang et al., 2019). It can be influenced by various factors such as personal values, beliefs, knowledge, and identity (Pierce et al., 2001). It can also be affected by an individual's level of involvement and attachment to the environment (Afsar & Umrani, 2020). Other factors influencing POTE include an individual's cultural background, social norms and expectations, and past experiences (Avey et al., 2012). To promote POTE, it is important to encourage individuals to develop a personal connection with nature through outdoor recreation, environmental education, and volunteering (Dresner et al., 2015).

H_7: *EC significantly positively affects POTE.*

Pro-environment attitudes

Attitudes are evaluative statements or judgments people hold about objects, people, issues, or events. Attitudes can be positive, negative, or neutral, often influenced by a person's values, beliefs, and experiences (Eiser & Van Der Pligt, 2015). Attitudes can significantly impact an individual's behaviour, shaping how a person thinks about and reacts to various situations (Glasman & Albarracín, 2006). PEA refer to a positive or supportive perspective toward the natural environment and a commitment to protecting it (Chen & Chai, 2010). People who hold PEA may be concerned about the effects of human activities on the earth's environment and may advocate for policies and practices

that help to conserve natural resources, reduce pollution, and protect biodiversity (Stefănica & Butnaru, 2015). These attitudes may be motivated by various factors, such as a love of nature, a belief in preserving the environment for future generations, or a desire to protect the earth's natural systems for their own sake (Dunlap et al., 2000). There are many ways in which individuals can express their PEA, such as by reducing their environmental impact through their consumption and lifestyle choices, supporting environmentally friendly businesses and organizations, or advocating for policies that protect the environment (Yu & Yu, 2017). PEA are essential for creating a more sustainable and healthier planet (Chen & Chai, 2010). PEA and behaviours can also have personal benefits, such as improving one's health and well-being (Crookes et al., 2022; Chen & Chai, 2010). Spending time in nature and outdoor activities can positively impact mental health and help reduce stress and improve overall well-being. As a result of these arguments, the following hypothesis was developed.

H_8: *EC has a significant positive effect on PEA.*

Pro-environment behaviour

The intention is the goal state in a person's mind, planning according to that goal, thinking about the future, making decisions for oneself, and implementing one's thoughts and dreams (Lange & Dewitte, 2019). On the other hand, behaviour can be defined as a series of attitudes and actions people take within society (Thøgersen, 2014). Behavioral intentions predict tourists' needs in the tourism industry (Lien et al., 2011) and measure tourists' preferences to value time and place (Lin, 2017: 390). PEB protect and preserve the natural environment (Blok et al., 2015). In tourism, PEBs of tourists can be defined as actions that minimize harm to the destination's environment and actively contribute to its preservation and enhancement (Miller et al., 2015). Tourists' PEBs can vary depending on various factors, such as their values, attitudes, and knowledge about environmental issues and the destination's social and cultural context. The studies that have been done have been examined, and the following hypotheses have been developed for the related research (Miller et al., 2020; Jiang et al., 2019; Xu et al., 2022).

H_9: *GI has a significant positive effect on PEB.*

H_{10}: *LCE has a significant positive effect on PEB.*

H_{11}: *POTE has a significant positive effect on PEB.*

H_{12}: *PEA has a significant positive effect on PEB.*

Materials and methods

Study site: Ayazini Ruins

The study site is the Ayazini Ruins, a protected archaeological and natural area in the Frig Valley within the district of Ihsaniye, Afyonkarahisar. The Frig Valley is known

for its rich history and immovable cultural heritage. The Ayazini Ruins are listed on the Turkish Cultural Heritage list and protected by the Ministry of Culture and Tourism (İçlek & Gül, 2021). The study also notes that many unregistered immovable cultural assets in the area are not protected. The site is also known for its rock monuments reflecting the Frig culture, and the Oyma Church, a rock church from the Byzantine period, is one of the most notable works in the area (İçlek & Gül, 2021). The research aims to determine the factors that affect environmentally friendly behaviour within the framework of eco-tourism for a sustainable future.

Research instrument

This study applied a questionnaire to the tourists visiting the Ayazini Ruins. The survey used in the research consists of two sections. The first section includes categorical questions on the demographic characteristics of the participants. The second section of the survey includes statements for measuring perceived value dimensions, EC, LCE, POTE, PEA, GI, and PEB. The research used the perceived value scale developed by Suki & Suki (2015), which consists of 16 items and four dimensions. The scale developed by Huang et al. (2014), composed of 8 items, was used for the variable of EC. The scale developed by Huang et al. (2014) consisting of 3 items was used for the variable of GI. The scale developed by Piggott-McKellar and McNamara (2017), composed of five things, was used for the variable of LCE. The scale developed by Kirk et al. (2018) consisting of 5 items was used for the variable of POTE. Finally, the PEB (3) and PEA (6) scales developed by Ajzen (1991) consisting of items were used.

Sampling and data collection

Since it is not easy to touch the universe in terms of the research process, time, place, cost, etc., this study adopts a sampling method. In this study, convenience sampling, one of the non-probability sampling methods, was preferred. The data collection was conducted between November 1-26, 2022, and 450 surveys were administered to participants. However, only 406 surveys were considered suitable for analysis. The participants were tourists visiting the Ayazini Ruins, Afyonkarahisar. The survey was administered in person to the tourists visiting the Ruins. The researcher collected the data in person, and the survey was administered in Turkish. The sample size was calculated using the G*POWER 3.1.9.4 software program (Faul et al., 2007; Rashid et al., 2020). It was determined that the sample size required was 100 (power = 0.80, $f2 = 0.15$, $\alpha = 0.05$).

Data analysis

The collected information was encoded in the SPSS software to analyze the data and study the structural equation modelling technique. Using the Smart PLS statistical program, measurement and structural models were evaluated in a two-stage approach (Hair et al., 2022). After the measurement model analysis for the reliability and validity of the scale, the structural model was evaluated. In the analysis stage, demographic

survey results, reliability and validity analysis (Cronbach Alpha, rho_A, rho_C, AVE, VIF), discriminant validity analysis (Fornell Larcker, HTMT, cross-loadings), model fit value (SRMR, d_ULS, d_G, X^2, NFI, GoF), model effect sizes (InnerVIF, f^2, Q^2, R^2) and structural equation model results are listed in the table.

Maximum likelihood estimation is a common method used in SEM research. This method assumes that the collected data follow a multivariate normal distribution. To assess this assumption, kurtosis and skewness coefficients were calculated using SPSS and Smart PLS software as recommended by Hair et al. (2022). The results of this analysis indicated that the data under investigation satisfied the requirement of multivariate normality, with kurtosis and skewness coefficients falling within the acceptable range of -1.5 to +1.5. To further confirm the normality assumption, Mardia's normality test was conducted. The results of this test revealed that the data had multivariate skewness ($\beta = 7$; $p>0.01$) and multivariate kurtosis ($\beta = 76$; $p >0.05$) values, indicating that the data were normally distributed.

When the results of the CTA analysis are examined, it is determined that the structure has a "reflective" design considering that the confidence intervals of the other variables are 0. In this context, the covariance-based Smart PLSc method was used in the research analysis stages of the Smart PLS statistical program. Principal component factor analysis was performed for all items, and Harman's univariate test was applied (Fuller et al., 2016). It was found that none of the things could explain 50% of the variance with a single factor (42%), and there was no common method bias across the study. The results also confirmed that the correlations between the variables were low. To confirm the absence of multicollinearity among the variables, tolerance values, variance inflation factor (VIF), and correlations among variables were examined. According to Hair et al. (2022), multicollinearity is not confirmed since the bivariate correlation between variables is below 0.70, and the VIF is below 3.0.

Results

When the participants' genders are examined, 48% are male, and 52% are female. When the age range is reviewed, it is seen that 32% are concentrated between 35-44. Regarding the participant's marital status, 49% are married, and 51% are single. 44% of the participants are graduates of undergraduate programs, 31% are associate degree holders, 20% are high school graduates, and 5% are postgraduate degree holders. When the participants' perceived income is examined, 58% report having a middle-level income (Türkiye income 8500-11000 TL).

Outer model

Table 1. Results of validity and reliability analysis for scales

Indicator	Factor	CA	rho_A	rho_C	AVE
Functional Value-quality (FV)					
FV1	0.802	0.769	0.771	0.852	0.591
FV2	0.717				
FV3	0.756				
FV4	0.797				
Social Value (SV)					
SV1	0.818	0.820	0.827	0.881	0.650
SV2	0.817				
SV3	0.834				
SV4	0.752				
Emotional Value (EV)					
EV1	0.753	0.826	0.834	0.885	0.658
EV2	0.789				
EV3	0.860				
EV4	0.838				
Conditional Value (CV)					
CV1	0.745	0.763	0.771	0.847	0.580
CV2	0.744				
CV3	0.753				
CV4	0.804				
Environmental Consciousness (EC)					
EC1	0.909	0.959	0.960	0.965	0.777
EC2	0.868				
EC3	0.907				
EC4	0.900				
EC5	0.908				
EC6	0.862				
EC7	0.857				
EC8	0.840				
Green Image (GI)					
GI1	0.870	0.868	0.872	0.919	0.792
GI2	0.924				
GI3	0.875				
Last-Chance Experience (LCE)					
LCE1	0.851	0.949	0.950	0.961	0.833
LCE2	0.941				
LCE3	0.939				
LCE4	0.941				
LCE5	0.887				
Psychological Ownership Towards Environment (POTE)					

Indicator	Factor	CA	rho_A	rho_C	AVE
POTE1	0.891	0.951	0.952	0.962	0.836
POTE2	0.914				
POTE3	0.930				
POTE4	0.918				
POTE5	0.919				
Pro-Environment Attitudes (PEA)					
PEA1	0.863	0.921	0.922	0.939	0.719
PEA2	0.897				
PEA3	0.862				
PEA4	0.884				
PEA5	0.841				
PEA6	0.732				
Pro-Environment Behaviour (PEB)					
PEB1	0.937	0.918	0.918	0.948	0.859
PEB2	0.918				
PEB3	0.926				

According to Nunnally and Bernstein (1994), Cronbach's alpha and rho_A values above 0.7 can be considered satisfactory. In the study, these values were found in an acceptable range. Convergent validity analysis is evaluated with two tests; factor loads, AVE and rho_C. Fornell and Larcker (1981) have posited that achieving values of at least 0.50 for the AVE and rho_C indicates good validity and reliability for scales employed in a study. Upon conducting an evaluation, it has been found that all variables have fulfilled the criteria above. Hence, the first phase of establishing the scales' validity and reliability has been accomplished.

Table 2. Fornell Larcker criterion and HTMT ration

Fornell Larcker Criterion										
	PEA	PEB	CV	EC	EV	FV	GI	LCE	POTE	SV
PEA	**0.848**									
PEB	0.557	**0.927**								
CV	0.346	0.458	**0.762**							
EC	0.670	0.683	0.461	**0.882**						
EV	0.367	0.524	0.862	0.469	**0.811**					
FV	0.438	0.638	0.389	0.609	0.376	**0.769**				
GI	0.527	0.713	0.418	0.716	0.454	0.626	**0.890**			
LCE	0.519	0.735	0.418	0.725	0.461	0.625	0.859	**0.913**		
POTE	0.376	0.550	0.394	0.510	0.434	0.396	0.511	0.529	**0.914**	
SV	0.404	0.521	0.381	0.527	0.354	0.676	0.588	0.550	0.307	**0.806**
HTMT Ration										
PEA										
PEB	0.594									
CV	0.397	0.536								
EC	0.703	0.721	0.524							

EV	0.412	0.599	0.987	0.520						
FV	0.507	0.757	0.498	0.701	0.469					
GI	0.578	0.797	0.498	0.777	0.532	0.765				
LCE	0.541	0.787	0.481	0.753	0.517	0.731	0.945			
POTE	0.398	0.588	0.457	0.528	0.486	0.465	0.562	0.556		
SV	0.452	0.598	0.466	0.586	0.423	0.848	0.692	0.618	0.346	

The study analyzed two tests to measure discriminant validity, the Fornell-Larcker criterion and the HTMT ratio. This method is based on the view that latent variables should better explain the item variable than other latent variables.

The standardized root means square residual (SRMR) value was examined for the fit indices of the research model. According to Henseler et al. (2016) and Cho et al. (2020), the SRMR value should be less than 0.08. Thus, a meaningful model fit was determined for this study.

Inner model

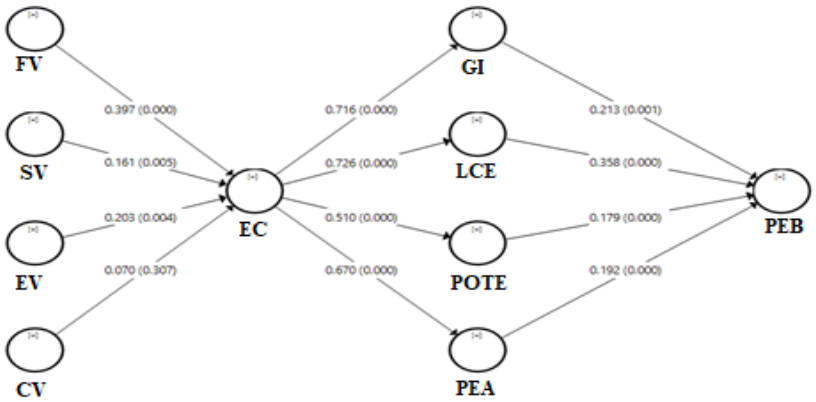
Based on the results obtained in the study, it was determined that the VIF values had appropriate values. If the R^2 value is 0.5 indicates a medium effect; 0.25 or less means a weak effect (Hair et al., 2016). The R^2 values in the current research show that the independent variables generally significantly impact the dependent variables. If the f^2 value is below or equivalent to 0.02, it means a common effect. Suppose the f^2 value shows 0.15 or higher. In that case, it indicates a medium result; if it shows 0.35 or higher, it means a strong effect (Cohen, 1988). In the current research, the f^2 generally indicates that the latent variables have a substantial impact. Prediction power analysis is a method that calculates the prediction power of the model with the Q^2 (Blindfolding) method, and if it is 0.15 or higher, it is regarded as medium prediction power; if it is 0.35 or higher, it is considered ample prediction power (Hair et al., 2022). As a result of the analyses, the Q^2 values obtained show that the prediction power is at the level of ample prediction power.

Table 3. Path analysis result

HYPOTHESES		ß	X	S.d.	t	p	Result
H1	FV -> EC	0.397	0.396	0.053	7.521	0.000	Supported
H2	SV -> EC	0.161	0.162	0.057	2.827	0.005	Supported
H3	EV -> EC	0.203	0.205	0.070	2.891	0.004	Supported
H4	CV -> EC	0.070	0.069	0.068	1.023	0.307	Not Supported
H5	EC -> GI	0.716	0.716	0.029	24.307	0.000	Supported
H6	EC -> LCE	0.726	0.726	0.030	23.826	0.000	Supported
H7	EC -> POTE	0.510	0.505	0.046	11.097	0.000	Supported
H8	EC -> PEA	0.670	0.670	0.039	17.017	0.000	Supported
H9	GI -> PEB	0.213	0.213	0.065	3.255	0.001	Supported
H10	LCE -> PEB	0.358	0.358	0.076	4.696	0.000	Supported
H11	POTE -> PEB	0.179	0.177	0.051	3.511	0.000	Supported
H12	PEA -> PEB	0.192	0.191	0.044	4.321	0.000	Supported

The present study examined the relationships between various constructs, including practical, social, emotional, and conditional value, EC, GI, LCE, POTE, PEA, and PEB. The structural model evaluation was conducted after the measurement model evaluation to ensure the validity and reliability of the constructs. The study's results indicate that practical, social, and emotional value have a significant positive effect on EC, while conditional value does not positively influence EC. Thus, the H_1, H_2, and H_3 hypotheses were supported, and the H_4 hypothesis was also supported. Moreover, the study found that EC has a significant positive effect on GI, LCE, POTE, and PEA, thus empirically supporting the H_5, H_6, H_7, and H_8 hypotheses. Additionally, GI, LCE, POTE, and PEA significantly positively affect PEB, thus supporting the H_9, H10, H_{11}, and H_{12} hypotheses. The study's findings suggest that practical, social, and emotional value can enhance individuals' environmental consciousness, leading to positive outcomes such as a green image, last-chance experience, psychological ownership towards the environment, pro-environment attitudes, and, ultimately, pro-environmental behaviour. These results have been visually presented in Figure 1.

Figure 1. Research Model



Conclusion and implications

The present study aimed to investigate the factors that influence EC and PEB and to explore the relationships between these constructs and other environmental attitudes and behaviours. The study's results suggest that functional, social, and emotional values positively influence EC, whereas conditional value does not. This implies that individuals who value the practical, social, and emotional benefits of engaging in PEB are likelier to exhibit higher levels of EC. Therefore, interventions promoting PEB should highlight the practical, social, and emotional benefits of engaging in environmentally friendly behaviours. In addition, this study's findings demonstrate that EC positively impacts other environmental attitudes and behaviours, including GI, LCE, POTE, and PEA. These variables, in turn, have a positive influence on PEB. Therefore, individuals with higher levels of EC are more likely to exhibit more positive attitudes and behaviours

towards the environment, increasing the likelihood of engaging in PEB. The implications of these findings are twofold. Firstly, they suggest that promoting EC is a critical factor in promoting PEB, and highlighting the practical, social, and emotional benefits of engaging in PEB may be more effective in promoting EC than relying on conditional rewards or incentives. Secondly, the results of this study indicate that interventions aimed at promoting PEB should focus on increasing EC and promoting a positive image of the environment, a sense of urgency regarding environmental issues, a sense of ownership and accountability for the environment, and PEA.

Theoretical implications

The theoretical implications of this study are that it adds to the existing literature on EC and PEB by showing the importance of functional, social, and emotional values in shaping EC and the role of EC in driving PEB. It also highlights the importance of considering the influence of conditional value and other variables in efforts to promote PEB (Ahmad et al., 2021; Xu et al., 2022). This study contributes to understanding how the different values influence EC and how EC influences PEB (Fu et al., 2017; Zheng, 2010). It also underlines the importance of considering the interplay of these different variables when designing interventions and campaigns to promote PEB. Additionally, the study provides a new perspective on the role of intrinsic motivation in shaping PEB, suggesting that focusing on the inherent benefits of PEB, rather than external rewards, may be more effective in promoting PEB.

Practical implications

The practical implications of this study are that it provides insight into promoting PEB effectively. Specifically, the study suggests that efforts to promote PEB should focus on increasing EC by highlighting PEB's functional, social, and emotional benefits rather than relying on rewards or incentives. Additionally, the study suggests that encouraging a positive image of the environment, a sense of urgency about environmental issues, a sense of ownership and responsibility for the environment, and PEA may also be effective in promoting PEB. One practical implication of the study is that policymakers can use organizations and businesses to design effective campaigns that promote PEB by focusing on the intrinsic motivations for PEB, such as the emotional and social benefits and the sense of ownership and responsibility for the environment (Muralidharan & Sheehan, 2018; Ramkissoon, 2020). Another practical implication is that organizations and businesses can use it to improve their sustainability by creating and promoting a positive image of the company as environmentally friendly and encouraging a sense of ownership and responsibility among employees, stakeholders, and customers (Ren et al., 2023).

Limitations and recommendations for future research

This study's limitations include using a specific research design and sample, which may limit the generalizability of findings to other populations and environments. Additionally, the study relied on self-reported measures, which may be subject to social

desirability bias. Another limitation is that the study only examines a specific set of variables and their relationships. It does not consider other potential factors influencing EC and PEB. To resolve these limitations, future research should replicate the study with different samples and research designs to increase the generalizability of the findings. Additionally, future research could use other methods, such as experiments or observational studies, to investigate the causal relationships between the variables further. The study has limitations, and further research is needed to replicate and generalize the findings. Future research should use different samples, research designs, and methods and investigate other potential factors influencing EC and PEB.

Conflict of interests

The authors declare no conflict of interest.

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CHALLANGES AND PROSPECTS FOR TOMATO PRODUCTIVITY IN RESPONSE TO CLIMATIC VARIATIONS: EVIDNECES FROM KHYBER PAKHTUNKHWA-PAKISTAN

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ABSTRACT

Climate change is the momentous and persisting change in the world's temperature, precipitation, humidity, and other climatic variables. This study, therefore estimated the impact of climatic variations on tomato productivity across agro ecological zones of Khyber Pakhtunkhwa, Pakistan. Panel data for 28 years (1991-2018) across the six districts of the agro ecological was used due to availability of data on tomato productivity and climatic variables. Yield of tomato, area, maximum temperature and rainfall were included in the final estimated model. The results indicate that the average maximum temperature and average maximum temperature square have a significant impact on tomato yield. Average maximum temperature has positive coefficient while the average maximum temperature square has a negative coefficient. This demonstrates that, at first, the tomato yield increases as the temperature rises. It reaches the maximum at the critical temperature (34.95ºC) but shows a decline once the temperature rises from the critical value.

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Introduction

Climate change is a serious global issue faced by the mankind (Auffhammer, 2018). It is the momentous and persisting change in the world's temperature, precipitation, humidity, and other climatic variables (Birtahl et al 2021). Studies have identified several human activities, industrial waste, vehicles' emissions, and overall global pollution, among others, as driving forces behind global climate change (Lough, 2008). The world's economy depends on three major sectors; agricultural, industrial, and services. Out of these three sectors, agriculture is the most vulnerable to climate change (Parry, 2019) because of its strong dependence on weather patterns. Climatic variations in the globe have a significant impact on this sector of the world economy. Crop yields, net farm revenue, and agricultural land productivity have all been found to be declining in various parts of the world. Global institutions on climate change aim at conducting research on climate change and ensuring a sustainable global environment. The IPCC being a responsible institution for climate change has forecasted that the global temperature will rise to 3°C by the beginning of the next century (IPCC, 2007). According to reports from the IPCC climate change has caused damage on a global scale. It is responsible for an increase in cyclone activity, an increase in areas facing drought, and an increase in heat waves (Bouwer, 2011). From 2007-2016, global agricultural activities have polluted the earth by emitting 13% of CO2 and more than 80% of nitrous oxide. These emissions rise to about 37% if the emissions from pre- and post-production activities are added to them (IPCC, 2019).

Pakistan ranked the 5th most sensitive country to global climatic variation (Abubakar, 2020). Reasons behind this include lack of policies, less awareness, and increased population (Fahad et al., 2020). Climate change is observed impacting agriculture as temperature and precipitation are inputs for agricultural production (Feres, Reis, and Speranza, 2008) It is more serious issue for farmers of developing countries (Seo et al., 2009). Being an agricultural country climate change impact on the agriculture of Pakistan is a serious challenge for its people and economy. Climate variability has affected the production of major crops in Pakistan. During 2018-19, crops in Pakistan showed a decline in growth by 4.43%. Production of sugarcane, the major cash crop of Pakistan showed a decline of 19.4%. Whereas, production of cotton and rice showed a decline of 17.5% and 3.3%, respectively [Government of Pakistan (GOP), 2019]. This shows that climate change harms the productivity of major crops in Pakistan. The impact of climate change can be reduced by using adaption and mitigation strategies (Chen and Gong, 2021).

Tomato (Solanum Lycopersicum) is one of the climate-sensitive vegetables consumed by people all around the world. The study of the climatic variations' impact on tomato productivity in Pakistan shows that climate change has a significant role in declining the yield and production of this vegetable. Due to this, tomato growing farmers in Pakistan usually prefer subsistence farming. The use of pesticides for growing this crop contributes to a significant share in the emission of gases. These gases boost climate change (Ozkan et al. 2011). The yield of tomatoes in the world was recorded at 38,272.40 kg/ha in 2018. According to Food and Agriculture Organization USA is

the top yielder with estimated yield of 96,807.90 kgha-1, while in Pakistan the yield is 9,441.2 kgha-1 which shows that Pakistan has still the potential to increase its tomato yield per hectare. This higher difference in the yield is because of several factors like choice of farmers for crop and acreage allocation, output prices, rain fall, soil type and temperature (Birthal et al., 2021)

The rise in temperature due to climate change decreases the production of vegetables (Hipro and Gebeyehu, 2019). Changes in climate scenarios also have economic consequences for consumers, such as an increase in commodity prices and a decrease in the utility of consuming commodities. The price rise is strongly felt in the case of vegetables and fruits due to their strong dependence on climatic conditions. Among many other reason climate change is considered as the major one that affect the quality of tomato. The other effects of climate change on tomatoes are; tip burn and reduced fruit set. Since 2010, the yield of tomatoes in Pakistan has been declining. In 2010, a 9% decline in the yield of tomatoes was recorded. In the preceding years, yield kept on showing a decline and failed to recover (GOP, 2018). The above-mentioned decline in tomato yield could be due to many possible reasons but this research attempts to determine the role of climate change in this regard. The decrease in yield is causing an imbalance in the supply and demand of tomatoes in Pakistan. For food security purposes, there is a need to implement effective policies to maintain the yield of tomatoes in the country (Ahmad and Farooq, 2010). The equilibrium in the tomato market would ensure future food security and would bring a fall in the import of tomatoes. This study aims to examine the impact of climate variations on tomato productivity across agro-ecological zones of Khyber Pakhtunkhwa province of Pakistan.

Materials and Methods

Universe of the Study and Data

The universe of the study of this research was Khyber Pakhtunkhwa (KPK), Pakistan. KPK is the third largest province in the country in terms of population. Most of the people living in KPK are associated with agriculture for earning their livelihood. The province has an influential geographical position that makes it a hub of trade and agriculture. It has Gilgit-Baltistan in its north, Afghanistan in the west, Kashmir in the east, and Punjab in the south. KP is well-known for the production of many agricultural commodities because of different climatic conditions across the province from northern to southern areas. The province is divided into 4 agro-ecological zones by the Environmental Protection Agency of this province [Environmental Protection Agency (EPA), 2016]. These zones are; Northern (A), Eastern (B), Central (C), and Southern (D). Districts from zone A, C, and D are selected based on tomato productivity and availability of data. Panel data for 28 years (1991-2018) was used for the study. Data on climatic variables; average maximum temperature, average maximum temperature square, average rainfall and average rainfall square was gathered from the Regional Meteorological Department (RMD) Peshawar. The data on production, area, and yield of tomatoes in selected districts was taken from Crop Reporting Services (CRS) government of Khyber Pakhtunkhwa Pakistan.

Conceptual framework

Several research studies have analyzed the relationship of climate change with crop choices, acreage response and its influence on crop comparative advantage (Wang et al., 2010; caho and McCarl, 2017; Birthal et al., 2021). To analyze the impact of climate change on the productivity of any cereal crop, fruit, or vegetable, a researcher can use cross-sectional, time series, or panel data as evident from the literature. The selection of the type of data depends on the objectives of the research (Guiteras, 2009). In the current research panel data was used to determine the impact of climate variability on tomato productivity. The general model for panel data can be presented as;

$$Y_{it} = \alpha + \beta_{xit} + \varepsilon_{it} \qquad (1)$$

Where in the model Y is the dependent model, X represents the various variables, i and t represent cross section and time whereas α,β and β are used for intercept, coefficient and error term respectively. Much of the confusion about method of analyzing panel data arises due to the fact that different discipline tend to produce solutions according to their unique features. This resulted in an astonishing series of notational orthodox, terminological variant and various software used. Depending on the researcher's background various models are used for the analyses of Panel data. In literature the most widely used model for the panel data are Fixed effect model and Random effect model (Niekerk et al., 2022). A detailed discussion of the advantages of the both model can be found in (Gujarati, D.N., and D.C. Porter. 2009). Fixed-effects model is also called an unobserved effect model. It can be presented as;

$$yit = (\alpha + \mu i) + \beta Xit + Vit \qquad (2)$$

(α+ μi) in the model shows that the intercept is time-invariant. It means that μi will only change for its district. The purpose of introducing intercepts in this model is to control the time-invariant features (Torres-Reyna, 2007). There are some limitations while using the fixed-effect model. These are; the intercepts created for every section that would require a degree of freedom and creating dummies increases the possibility of strong multicollinearity (Gujarati and Porter, 2009). However, the random effect model doesn't introduce fixed constants for units or sections and considers random parameters as intercepts of sections. The Random-effects model forms with the assumption of non-correlation of error term with independent variables (Wooldridge, 2013). One simple way of understanding the random-effects model is to consider it as a regression model with a random intercept or constant (Elhorst, 2014). The generalized form of random effects model can be written as;

$$yit = \alpha + \beta Xit + (\mu i + Vit) \qquad (3)$$

In this general form of the model, the μi is time-variant. It means that there will be no separate intercepts for districts (Bell, and Jones, 2015). In this paper based on the result of the Durbin Wu Hauman test we will decide to use the fixed effect or the random effect model (Gujarati and Porter, 2009).

Empirical Model

Several studies have examined the effect of climate change on agriculture. In order to find out the impact of climatic variations on tomato productivity across agro ecological zones econometric analysis was performed following the existing literature (Bouwer, L.M. 2011; Cho and McCarl, 2017; Auffhammer, M., 2018; Hipro and Gebeyehu. 2019; Chen, and Gong. 2021). Kuamr and singh (2014) estimated that due to rise in temperature of about 2.3 0C to 4.5 0C in 2070 to 2099 the food crop grown will be declined by 4 percent to 12 in South Asia and Sub-Saharan Africa. The impact of climatic and non-climatic on agriculture production have been assessed by many empirical studies in the world (Afrin et al., 2017; Chandio et al., 2020; Chao et al., 2014; Omoregie et al., 2018; Van et al., 2018 and Agbodi et al., 2019). Sarkal et al., (2014) conducted a study in Bangladesh and revealed that maximum and minimum temperature affects the productivity of agriculture crops. Chandio et al., (2021) also pointed out that along with temperature, rainfall, flood, solar radiation and drought have an adverse effect on the agricultural productivity. Variation in precipitation and temperature adversely affect resources of water and land, which heavily affect the agriculture productivity negatively (Mahmood et al., 20122). Ahmad et al., (2020), ahsan et al (2020). and Pickson et al., (2020) proposed in their study that rainfall and temperature are suitable proxies for climate change. Due to the availability of the data on rain fall and temperature the proposed model for estimation is provided as:

$$Lny = \beta 0 + \beta 1\, lnarea + \beta 2\, lnmaxtemp + \beta 3\, lnmaxtemp2 + \beta 4\, lnrainfall + \beta 5\, lnrainfall2 + Uit \quad (4)$$

Where lny is the dependent variable which show tomato yield in kgha-1, lnarea is the area under tomato production in ha, B's are the expected coefficients that need to be estimated, Maxtemp and Maxtemp2 represents the average maximum and average maximum temperature square, Rainfall and Rainfall2 shows the average rainfall and rainfall square, ln is the natural log, U is the error term while I and t represents the cross section and time period for the study.

Model Diagnostics

Several test are used to test which model fits the data well. In the case of the fixed effects model, there is a need for several model diagnostic tests as there are chances of several issues like; the problem of cross-sectional dependence, heteroscedasticity, and time effect autocorrelation (Bakirtas and Akpolat, 2018) in the fixed-effects model. To check these issues, different tests were employed. Pesaran test was employed to test the first issue. This test was conducted using different statistical software (De Hoyos and Sarafidis, 2006). If the p-value of the test is significant there exists a problem of cross-sectional dependence. The second problem in the fixed-effects model could be heteroskedasticity. This problem was identified by the Wald test of group-wise heteroskedasticity. The significant p-value in results shows that group-wise heteroskedasticity exists. The third possible issue in the fixed-effects model is of time

effect autocorrelation. This was checked by employing a test called Wooldridge test of serial autocorrelation. The significant p-value shows the presence of first-order serial correlation in panel data (Drukker, 2003).

With the development in panel data analysis has pointed out the need for cointegration and stationarity tests in panel data. The stationarity tests of panel data are more advanced than the tests of time series (Bouwer, 2011). The reason is the heterogeneity factor in panel data. Some of the simple panel unit-root tests are given. The Im, Pesaran, and Shin (IPS) and Breitung tests are two common methods for determining panel data stationarity. Due to the problems of cross-sectional dependence, heteroskedasticity, and serial correlation in the data set, the panel corrected standard errors (PCSEs) model was used to analyze final results. This is an advanced form of fixed effects model and estimates results considering the above-mentioned issues in the data.

Results and Discussion

In this chapter summary statistics of variables used in the model, results of the analysis derived through utilizing the panel corrected standard errors model (PCSE), and critical temperature and its impact on tomato yield are presented.

Impact of Climatic Variations on Tomato Productivity

Summary Statistics of Variables

The summary statistics of the variables used in the model is provided in table 1. The total observations are 168 i.e., N=6, T=28 and N*T=168. The mean log of yield was 9.00 kg/ha with a standard deviation of 0.55. The Second variable log of area was in the range of 3.40-8.53 ha with a mean of 5.68 and a standard deviation of 1.42.

Table 1. Summary statistics of variables

Variables	Obs	Mean	Std. Dev.	Min	Max
lny (Yit)	168	9.00 (9207.70)	0.55 (3645.74)	6.00 (3272.73)	9.59 (14620.69)
lnarea (Areait)	168	5.68 (863.56)	1.42 (1452.74)	3.40 (30.00)	8.53 (5051.00)
lnmaxtemp (Maxtemp)	168	3.55 (34.81)	0.07 (2.21)	3.35 (28.58)	3.66 (38.93)
$lnmaxtemp^2$ (Maxtemp2)	168	12.59 (1216.56)	0.46 (150.10)	11.24 (816.82)	13.41 (1515.16)
lnrainfall (Avrainfall)	168	3.90 (59.60)	0.63 (35.32)	2.26 (9.63)	5.29 (198.30)
lnrainfall2 (Avrainfall2)	168	15.64 (4792.17)	4.84 (5827.25)	5.13 (92.74)	27.98 (39322.89)

Source: Estimated from data, 1991-2018.

The mean of lnmaxtemp was observed to be 3.55 with a standard deviation of 0.07. Log of $maxtemp^2$ is the fourth variable of the model. Its mean was observed to be

12.59 i.e., in the range of 11.24-13.41 and its standard deviation was 0.46. lnrainfall is the model's fifth variable. Its mean is 3.90 with a standard deviation of 0.63. The range of mean is 2.26-5.29. The Log of rainfall square is the last variable of the model. It has a mean of 15.64 with a standard deviation of 4.84.

Panel Unit Root Tests

Panel unit root tests were performed to ensure data stationarity. Stationarity was checked for all the six variables used in the model. IPS and Breitung panel unit root tests were utilized for this purpose. Stationarity in yield was tested using IPS and Breitung test. The results showed that the yield was non-stationary when tested with trend. While it became stationary when intercept was added to the trend. It means that the significant p-values were obtained when tests included intercept of the yield along with its trend.

Table 2. Panel Unit Root Tests

Level					
		With Trend		**With Trend and Intercept**	
Variables		**Statistic**	**P-values**	**Statistic**	**P-values**
Yield (kg/ha)	IPS	-1.4405	0.0749	-3.2036	0.0007***
	Breitung	-0.5880	0.2783	-1.9513	0.0255**
Area (ha)	IPS	-0.8434	0.1995	-2.7580	0.0029***
	Breitung	0.5392	0.7051	-1.9025	0.0286**
Average Max. Temperature (ºC)	IPS	-6.0091	0.0000***	-6.4910	0.0000***
	Breitung	-5.1154	0.0000***	-6.3217	0.0000***
Average Max. Temperature Square (ºC)	IPS	-6.0059	0.0000***	-6.4878	0.0000***
	Breitung	-5.1156	0.0000***	-6.3115	0.0000***
Rainfall (mm)	IPS	-6.7616	0.0000***	-6.8424	0.0000***
	Breitung	-6.2615	0.0000***	-6.3718	0.0000***
Rainfall Square(mm)	IPS	-6.8782	0.0000***	-6.9517	0.0000***
	Breitung	-6.2545	0.0000***	-6.3597	0.0000***

Source: Estimated from data, 1991-2018.

Note: level of significance, ***p<0.01(1%), **p<0.05(5%)

For checking stationarity in the area i.e., the second variable of the model, both IPS and Breitung test were utilized. The result of both tests showed that the area is non-stationary when tested with trend only. However, adding intercept with trend made the variable stationary. The p-value of IPS for trend and intercept is highly significant and shows that the variable is stationary. Average maximum temperature is the third variable of the model. Both of the tests of panel unit root show that this variable is stationary with trend and with trend and intercept. P-values obtained are highly significant in the case of this variable. The same is the case with the fourth variable of the model, i.e., maximum temperature square. Both the IPS and Breitung tests show that rainfall is

stationary. The p-values obtained for trend and trend and intercept are highly significant i.e. 0.0000. The values obtained for rainfall square are also significant and show that the variable is stationary.

Test for Cross-Sectional Dependence and Serial Correlation

The cross-sectional dependence of data was checked using Pesaran's test of cross-sectional dependence having value of 4.000 with Pr value of 0.0001 indicating the existence of cross sectional dependence in the data. To check the heteroscedasticity problem Wald test was also employed and the results obtained show that [chi^2 (6) = 3174.45] with P value of 0.000 showing highly significance and the presence of heteroscedasticity problem in the data. Panel data autocorrelation was also tested using the Wooldridge test for autocorrelation. A highly significant p-value (Prob>F = 0.000) was obtained and it was observed that autocorrelation exists in data.

Estimates of PCSE Model for Panel Data (1991-2018)

In order to decide which model will be suitable for our data set, we used the Hausman test to decide between fixed effects model and random effects model. The result obtained from this test shows (Prob>chi2 = 0.0000) highly significant p-value and that the best fitted model is fixed effects model. For this study Panel corrected standard errors (PCSEs) model was used to analyze final results. This is an advanced form of fixed effects model and estimates results considering the issues in the data. Table 3 shows results for variables used in the model. Area is the first variable used in the study. Results reveal that a 1% increase in area will have a positive impact on productivity as it will rise by 0.12%. The second variable used in the model was average maximum temperature. The significant p value shows that the average maximum temperature has a significant impact on the productivity of tomato. The Positive coefficient shows that this impact is positive i.e., an increase in temperature will the result in increase in tomato productivity.

By looking at the position of temperature in the table, it can be interpreted that the average maximum temperature and average maximum temperature square are significantly affecting the tomato yield. The average maximum temperature has positive coefficient while the average maximum temperature square has a negative coefficient. This implies that the tomato yield initially increases as the temperature rises. It reaches the maximum at the critical temperature but shows a decline once the temperature rises from the critical level. Peña and Hughes (2007) Lipper *et al.* (2009), Shakoor *et al.* (2011), Loum and Fogarassy (2015), and Ghalib *et al.* (2017) and Hamdullah *et al.* (2020) find out similar finding in their studies. The average rainfall and average rainfall square have an insignificant impact on the productivity of tomatoes in districts studied for this research. Our results are in line with results estimated by Islam *et al*. (2009), GCISC (2009), and Khan *et al*. (2018). The reason behind the insignificant impact of rainfall on tomato productivity is the fluctuation observed in the rainfall pattern due to climate change.

Table 3. Estimates of PCSE model for panel data (1991-2018)

Group variable		Districts	Number of obs	168
Time variable:		Years	Number of groups	6
Panels		correlated (balanced)	Obs per group: min	28
Autocorrelation		panel-specific AR(1)	Avg	28
			Max	28
Estimated covariances		21	R-squared	0.9754
Estimated autocorrelations		6	Wald chi2(5)	64.67
Estimated coefficients		6	Prob > chi2	0
Panel-corrected				
lny	**Coef.**	**Std. Err.**	**Z**	**P>|z|**
lnarea	0.1195406	0.0297735	4.02	0.000***
lnmaxtemp	129.4095	55.68353	2.32	0.020**
lnmaxtemp2	-18.20628	7.785943	-2.34	0.019**
lnrainfall	-0.1110128	0.3007725	-0.37	0.712$^{n.s}$
lnrainfall2	0.0229631	0.0436393	0.53	0.599$^{n.s}$
_cons	-221.5111	99.47644	-2.23	0.026
rhos=	0.5237469	0.4038742	0.9387789	0.8580381

Source: Estimated from panel data, 1991-2018.

Note: level of significance, ***p<0.01(1%), **p<0.05(5%), ns shows non-significant

Variation in Yield in Response to Change in Temperature

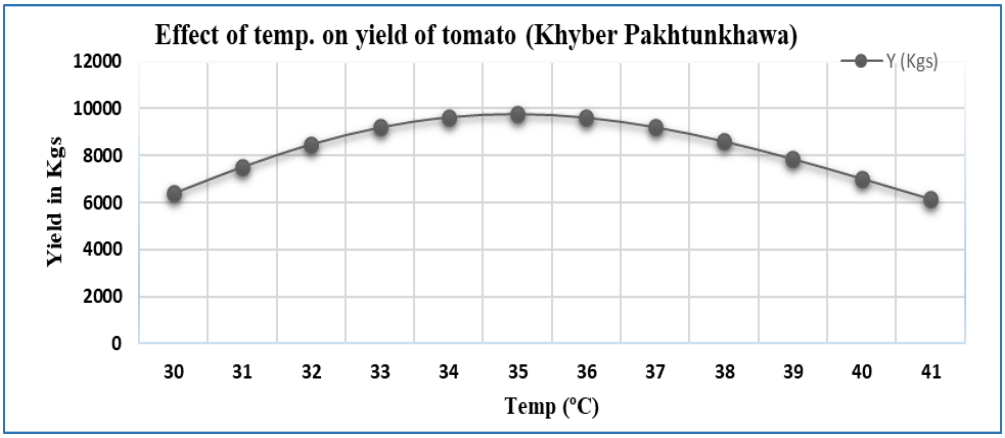
The critical temperature for tomato productivity was also calculated from the values given in table 3 by using the following formula.

$$\text{Critical temperature} = \exp(\beta_1/2^* \beta_2) \quad (5)$$

$$= \exp((-129.4095)/(2*(-18.20628))) = 34.95\ ^{o}C$$

The critical temperature for the province indicates that tomato yield will be highest in districts where the temperature reaches 34.95^{o}C during the vegetable's kharif cropping season. The maximum yield at critical temperature for the province is estimated to be 9763.050kh/ha. However, the yield will start declining when the temperature increases this critical value. A graph provided below was constructed to illustrate this relationship. Based on this graph and estimated critical temperature for the province, the critical temperature for every district used in the study was also estimated.

Figure 1. Variation in yield in response to change in Temperature.



Source: Authors' estimated from PCSE model for panel data, 1991-2018.

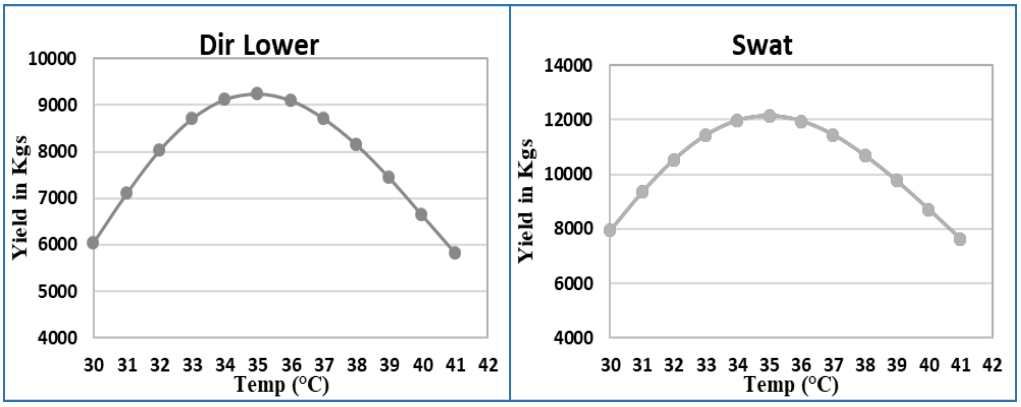
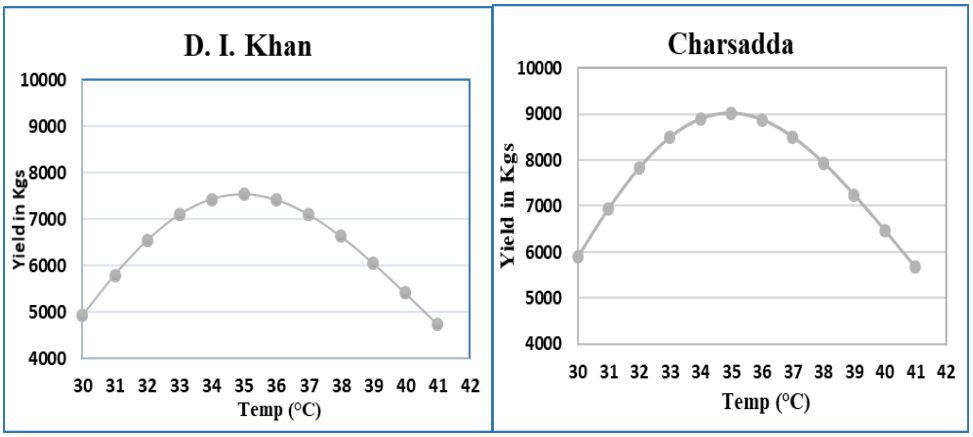
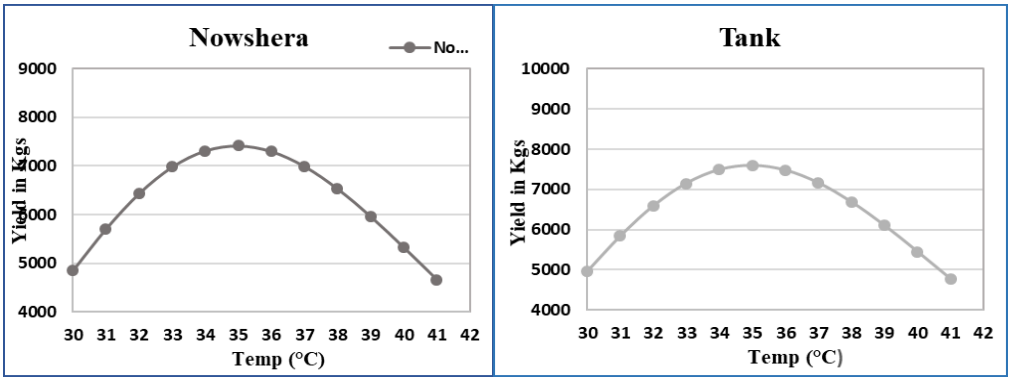


Figure 2. Variation in yield in response to change in temperature for districts



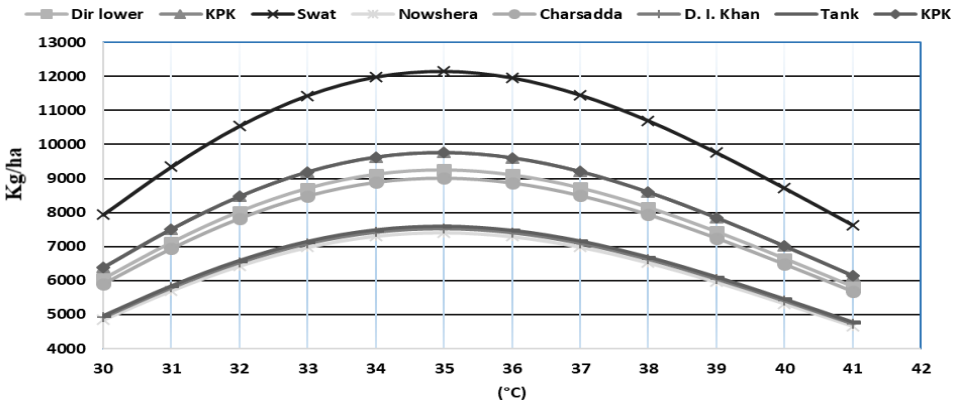


Source: Authors' estimated from PCSE model for panel data, 1991-2018.

Variation in Yield in Response to Change in Temperature for Districts

Figure 2 represents maximum yield points for their respective districts. The maximum yield at critical temperature (34.95 º C) in Dir Lower will be 9245.93 kg/ha. The yield is estimated to decline to 9100.52 kg/ha with a rise in temperature to 36 ºC. For Swat, the maximum yield at critical temperature is estimated to be 12143.47 kg/ha. The graph shows that this yield will decline to 11952.49 kg/ha with rise in temperature to 36 ºC. The maximum yield for Nowshera at 34.95 ºC is estimated to be 7416.12 kg/ha. This yield will decline to 7299.49 kg/ha with a 1ºC rise in temperature. In Charsadda, the maximum yield is estimated to be 8871.42 kg/ha. A decline to 8871.42 kg/ha is estimated with 1ºC rise in temperature. In D.I. Khan this yield is estimated to be 7530.69 kg/ha at critical temperature. It is expected to decline by 118.43 kg/ha with a 1ºC rise in temperature. While in the Tank the maximum yield is expected to be 7590.62 kg/ha. With a 1ºC rise in temperature this yield will decline by 119.37 kg/ha. All the graphs show that the yield for respective districts is highest at critical temperature and starts to decline with rise in the temperature.

Figure 3. Zone-wise variation in yield in response to Temperature



Source: Authors' estimate from PCSE model for panel data, 1991-2018.

Forecasting the Impact of Rising Temperature on Yield of Tomato According to Different Climate Change Scenarios

To study the climate trend in the country, the meteorological department of Pakistan and the Global Change Impact Studies Centre (GCISC) have carried out several studies (Islam *et al.* 2009). Tables 4 and 5 present a future scenario for temperature rise in relation to tomato impact based on their research. Table 5 shows the response of yield to rise in temperature more than 34.95 ºC i.e., critical temperature. The table shows that one degree rise in temperature will lower the yield of selected districts by 1.57%. This means that tomato growers across zones will suffer losses in terms of yield. The table also explains the impact of a 2 ºC rise in temperature on yield. It is estimated that this rise in temperature will lower tomato yield in selected districts by 5.73%. This reveals that climate change in the long-run is significantly harmful to tomato yield across agro-ecological zones of Khyber Pakhtunkhwa.

Table 4. Forecasting the impacts of temperature rise on tomato yield in Khyber Pakhtunkhwa according to different climate change scenarios

Climate change scenarios	Yield (Kg/ha)	Yield (%age)
Temperature increase by 1 °C	-153.54	-1.6%
Temperature increase by 2 °C	-559.26	-5.7%

Source: Authors' estimate from PCSE model for panel data, 1991-2018.

Table 5. Zone wise forecasting the impact of rising temperature on yield of tomato according to different climate change scenarios

Districts	Temperature	Yield (Kg/ha)	Yield (%age)
Dir Lower	1 °C	-145.41	-1.57%
	2 °C	-529.64	-5.73%
Swat	1 °C	-190.98	-1.57%
	2 °C	-695.62	-5.73%
Nowshera	1 °C	-224.49	-1.57%
	2 °C	-817.35	-5.73%
Charsadda	1 °C	-141.75	-1.57%
	2 °C	-516.31	-5.73%
D I khan	1 °C	-118.44	-1.57%
	2 °C	-431.39	-5.73%
Tank	1 °C	-119.38	-1.57%
	2 °C	-434.82	-5.73%

Source: Authors' estimate from PCSE model for panel data, 1991-2018.

Lowest and highest maximum temperature for districts

Table 6 shows the lowest maximum and highest maximum temperature for districts used in the study. The highest maximum temperature in Dir Lower shows that tomato yield in the district will increase with the rise in temperature as the district's temperature

hasn't crossed the critical temperature value i.e. 34.95ºC. However, temperature rise in the second district of this zone i.e. Swat will cause a decline in tomato yield as the district's highest maximum temperature has already crossed the critical value of 34.95 ºC. Nowshera and Charsadda, are already experiencing losses in the yield due to the highest maximum temperature of 38 .93 ºC. Also, districts taken from zone D have the highest maximum temperature more than the critical value calculated in the study. This means that in these four districts the tomato yield is declining.

Table 6. Lowest and highest maximum temperature for districts

Districts	Lowest maximum temperature	Highest maximum temperature
Dir Lower	28.58 °C	32.08 °C
Swat	31.86 °C	35.42 °C
Nowshera	34.6 °C	38.93 °C
Charsadda	34.6 °C	38.93 °C
D I Khan	34.08 °C	38 °C
Tank	34.08 °C	38 °C

Source: Authors' estimate for panel data, 1991-2018.

Conclusions and Recommendations

This study is aimed at estimating the impact of climate change on tomato productivity across agro ecological zones of Khyber Pakhtunkhwa (KP), Pakistan. Three agro ecological zones of KP i.e. A, C, and D were selected for this study. Districts from each zone are taken based on tomato productivity and data availability. The total districts are six i.e. Dir Lower and Swat from zone A, Nowshera and Charsadda from zone C, and D.I. Khan and Tank from zone D. Panel data was used for studying the impact and following variables. Secondary data for both climatic and non-climatic variables were used. Data on climatic variables was collected from the Regional Meteorological Department (RMD) Peshawar. While data on non-climatic variables was gathered from Crop Reporting Services (CRS). Fixed effects model was selected based on the results of the Hausman test. The Data set was also tested for contemporaneous correlation, heteroskedasticity, serial correlation, and stationarity. Results revealed that cross-sectional dependence, Heteroskedasticity, and serial correlation exist in data. Final results were estimated using panel corrected standard errors (PCSEs). The average maximum temperature and average maximum temperature square have a significant impact on tomato yield. The average maximum temperature has a positive coefficient while the average maximum temperature square has a negative coefficient. This implies that the tomato yield initially increases as the temperature rises. It reaches the maximum at the critical temperature but shows a decline once the temperature rises from the critical level. The average rainfall and average rainfall square have insignificant impact on the productivity of tomato in districts studied for this research. These results are

in line with results estimated by Islam *et al*. (2009), GCISC (2009), and Khan *et al*. (2018). The reason behind the insignificant impact of rainfall on tomatoes productivity is the fluctuation observed in the rainfall pattern due to climate change.

The Critical temperature for the maximum yield of tomato was calculated to be 34.95ºC. It was estimated that the yield in all districts of the study showed a decline with a rise in temperature above critical temperature. Based on the results of this study, it is recommended that policymakers should encourage tomato growers in Dir Lower and Swat so that yields in these districts can be increased. To reduce temperature rises, the government must concentrate and accelerate tree planting in districts such as Charsadda, Nowshera, D.I. Khan, and Tank. Also, heat resistant varieties of tomato should be developed for farmers of Nowshera, Charsadda, D.I. Khan and Tank to cope with the increase in temperature. Extension officers have to provide required guidance to farmers producing tomatoes in selected districts regarding climate change and its impacts.

Limitations of the Study

The study has several limitations. District Mansehra is top produced tomatoes from zone B, but this district was omitted due to statistical discrepancies in data on area under tomato and tomato production. Therefore, it can be said that the study doesn't cover all four agro-ecological zones of the province. Individual dummies for districts were not created because of the high variation in the data. The model used for the study used four basic climatic variables i.e., maximum temperature, maximum temperature square, rainfall, and rainfall square. Other important climatic variables could also be used for study. These include; minimum temperature, humidity, and sunshine.

Conflict of interests

The authors declare no conflict of interest.

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COMPARATIVE FINANCIAL ANALYSIS OF AGRICULTURE AND INDUSTRY IN MONTENEGRO

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ABSTRACT

Along with tourism, agriculture and industry are the most important sectors of the Montenegrin economy. The paper gives a financial analysis of these two sectors compared against the average for the Montenegrin economy. The analysis is based on the submitted final accounts for the period 2005 - 2019. The financial analysis in the paper showed that the growth of assets in agriculture was faster than the national average in the observed period, while in the case of industry it was slower. It also showed that agriculture has satisfactory solvency, while that in industry is a matter of concern, and although the debt level of the former is lower than that of the latter, the trend of debt growth is concerning. As for liquidity, it remains unsatisfactory in both sectors, but it is somewhat more favourable in industry.

Introductory remarks and methods

Montenegro is a small and highly open economy that is predominantly service-oriented. Its economic development over the past three decades has been very turbulent, facing numerous negative shocks such as transition, UN economic sanctions, hyperinflation, the global financial crisis, and the latest coronavirus pandemic.

These shocks have shown that too much focus on the service sector, especially tourism, is wrong, with this being even more so obvious during the global financial crisis and the coronavirus pandemic. The service sector was one of the most affected sectors during both crises and Montenegro faced a significant decline in economic activity, much higher than that experienced by countries with similar levels of development. One of the reasons for such a severe decline is the significant neglect of agriculture and industry as two sectors that played a much bigger role in the past than the one they have today.

Montenegro has exceptional natural conditions for the development of agriculture because 22.5 percent of its territory is farmland and 60 percent of the territory is

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covered in forests (Monstat, 2020). Also, Montenegro has a long history of industrial development as the leading branch in the period between World War II and the beginning of the transition process.

The neglect of these two sectors resulted in the obsolescence of their production capacities as well as unfavourable financial indicators that limit their further development. Therefore, this paper aims to provide a comparative financial analysis of these two sectors in order to give a realistic assessment of the state of affairs and the actions that need to be taken for their revival.

The aim of this study is to carry out a comparative financial analysis of industry and agriculture.[2] The aim is to determine the profitability, liquidity, indebtedness, and solvency of agriculture and industry and, based on these indicators, formulate recommendations for improving the current situation. The analysis of financial and other business indicators is based on the final accounts (income statements and balance sheets), which all legal entities are obliged to submit at the end of the year. The Central Bank of Montenegro has entered all balances into the electronic database and the author has calculated the required indicators for the two observed sectors on the basis of the created software. The balance sheets of all legal entities with agriculture and industry listed as their primary activity are aggregated from the database. The time series covers the period from 2005, when the final accounts became available, until 2019 as the last available year. The number of submitted final accounts varied from year to year, which was expected given the establishment of new and closure of existing companies, with 27,482 final accounts being submitted and processed for the last analysed year.

According to the best knowledge of the author, research of this type is unique in the world because due to the huge volume of work in other countries, income statements and balance sheetsare not aggregated, which unfortunately leaves economic policymakers without a large number of very useful indicators. This is precisely the first contribution of this study. The second contribution is reflected in the fact that so far no research study has dealt with the comparative analysis of financial indicators of agriculture and industry in Montenegro, and the third contribution is that recommendations for macroeconomic policymakers have been formulated on the basis of the obtained financial indicators.

The paper consists of five parts. After introductory remarks, a brief overview is given of the development of Montenegro`s agriculture and industry as of the end of the Second World War to date. The third part gives a comparative financial analysis of agriculture and industry. In the fourth part, recommendations are given to the creators of macroeconomic policy to improve the situation and the paper ends with concluding remarks.

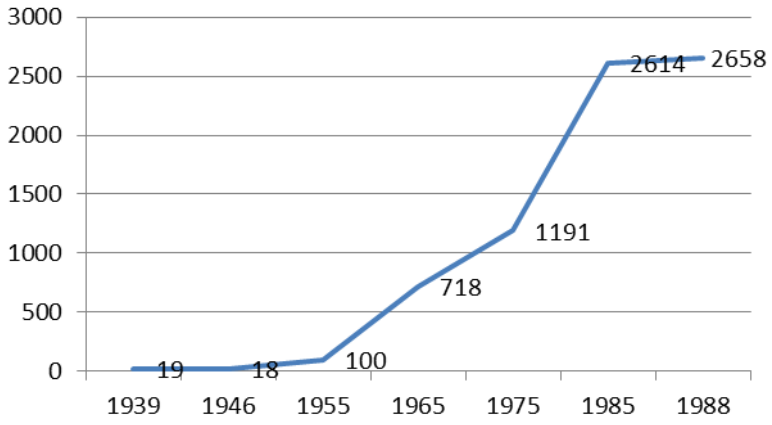
2 Therefore, the paper does not start from the approach often used in the literature to formulate research hypotheses that are subject to testing.

Social and economic development of industry and agriculture

Montenegro has natural conditions for agricultural development and a long tradition in agricultural production. In addition to its basic function, the importance of agriculture is manifold. It is the backbone of the development of food industry and tourism. It is an important factor in a balanced regional development, i.e. preventing migration from the north of the country. It provides a basic or additional source of income for a significant part of the population and thus contributes to alleviating social tensions (Central Bank of Montenegro, 2020).

After World War II, Montenegro was a backward agrarian area, with a traditional organisation of economic life and over 80 percent of the population living from agriculture, while only fifteen percent engaged in crafts, trade and other activities. In the post-war period, Montenegro has undergone several major structural changes. It started the process of accelerated industrialisation immediately after the war as this was a general trend in countries of the Western Europe and because it was considered at the time that industrialisation leads to a faster exit from poverty (Temin, 2002). The industry was constantly increasing its share in GDP creation, from 25.6 percent in 1952 to 38.5 percent in 1986, only to welcome the beginning of the transition in 1989 with a share of 45.3 percent (Žugić, 2012). Also, the development of the industry was uneven as it was in line with the socialist concept that was looking to bring to the forefront heavy large industry as the key driver of economic development so most investments and the fastest development was achieved in the metal industry and energy. During the pre-transition period, energy increased its share in GDP by more than four times, while that of the metal industry rose by more than 17 times. The following graph shows the pace of development of industry in Montenegro in the post-war period. Compared to the level shortly after the Second World War, the level of industrial production increased as much as 147 times.

Figure 1. Industrial production index in Montenegro (1955=100)



Source: Federal Bureau for Statistics (1989)

During this period, agriculture was continuously discouraged for ideological reasons and a policy of low prices of agricultural products was pursued in order to provide cheap food for industrial workers, with this resulting in the transfer of accumulation from agriculture to industry. Thus, after World War II, agriculture created 40 percent of Montenegro`s GDP, yet the country welcomed the transition process with this share standing at a mere 6.1 percent of GDP. This model of development also initiated the migration the population from the rural to urban areas, which led to both absolute and relative reduction in agricultural population that has shrunk from over 80 percent after the war to just 2.5 percent, as per the latest census (Monstat, 2012).

The main changes in the structure of population in Montenegro in the period after the Second World War went in the direction of reduction of agricultural population in favour of industrial population until the mid-1990s, and then on from industry to the service sector (Fabris, 2021). Certainly, the main reasons for migration should be sought in the pushing of industrialisation, forced relocation of a part of the rural population to other parts of Yugoslavia (Vojvodina), inadequate infrastructure, lack of investment, and poorer quality of life in the countryside.[3]

According to the World Bank study (2021) important challenges for Montenegrin agriculture are: country's low adoption of modern technology, small and fragmented farms, underdeveloped processing, low application of food safety standards, and high dependence on food imports.

These trends, namely the growth rates of industry, agriculture, and the average GDP growth rate in the SFRY in the period after the Second World War until the beginning of the transition process are shown in table below. It is obvious that the industry in Montenegro developed faster than average, while the discouraged branch of agriculture lagged significantly behind. The country's industrial production, amounting to around 5% in 1947, grew to over one third of overall economic output by the 1970s and the number of industrial workers exceeded agricultural employment significantly (ERIH, 2023). The table also indicates that structural changes in Montenegro were much more intense than those experienced throughout Yugoslavia.

Table 1. Average rates of growth of domestic product, industry, and agriculture in the period 1948 - 1989

	Total	**Industry**	**Agriculture**
SFRY	5.5	7.9	2.7
Montenegro	5.3	11.1	1.4

Source: Author's calculations

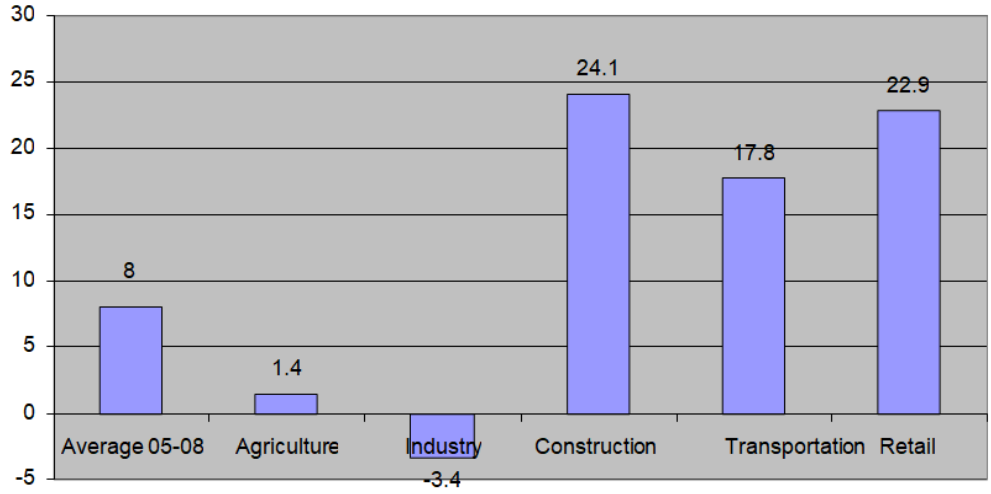
The 1990s were an extremely difficult period for industry, so the share of industry fell to 12 percent of GDP in 2000. This was a big drop from 45.3 percent in 1989 and probably

3 For more details on the reasons for migration see the "National Strategy for Sustainable Development until 2030", the paper "KolonizacijaCrnogoraca u Vojvodinu 1945-1946" and the book "Makroekonomski model razvoja Crne Gore".

the biggest structural change in the creation of Montenegro`s GDP. The industry welcomed the 21st century with worn-out and obsolete equipment, redundancies, low-quality products, and inefficient production. This is also the reason why a large number of industrial companies went bankrupt and foreign investors showed interest only in the energy and metal industries.

During the last decade of the 20th century and the first decade of this century, structural changes continued but it seems that the most significant structural changes took place in the three-year period of economic boom (2005–2008) when the average growth rate of Montenegro`s GDP was 8 percent (Fabris & Jandrić, 2011). In this period, the service sector experienced a rapid growth, while industry and agriculture were completely neglected. Industry recorded negative growth and agriculture saw only a modest growth that lagged significantly behind the average rate of the country`s economic growth.

Figure 2. Rates of growth of selected sectors of Montenegro`s economy over the period 2005



Source: Fabris, N. & Mitrović, M. (2011) Critical Overview of Montenegro's Growth Model. *East West Journal of Economics and Business,* 15(1-2), 129-150.

Therefore, it is not surprising that industry continued to reduce its share in GDP creation, with smaller annual oscillations, dropping to as low as 5.6 percent in 2009. During the second decade of this century, it slightly recovered and reached 8 percent in 2019.

As a result of decline of a large number of industrial enterprises during the 1990s and the realisation of how important the food security is (both for domestic consumption and as an input for tourism), the share of agricultural production rose to 11.3 percent of GDP in 2000.[4] However, with the further lagging of the north of the country and large population migrations to more developed parts of Montenegro, the share of agriculture

4 Agriculture, forestry and fishing observed together.

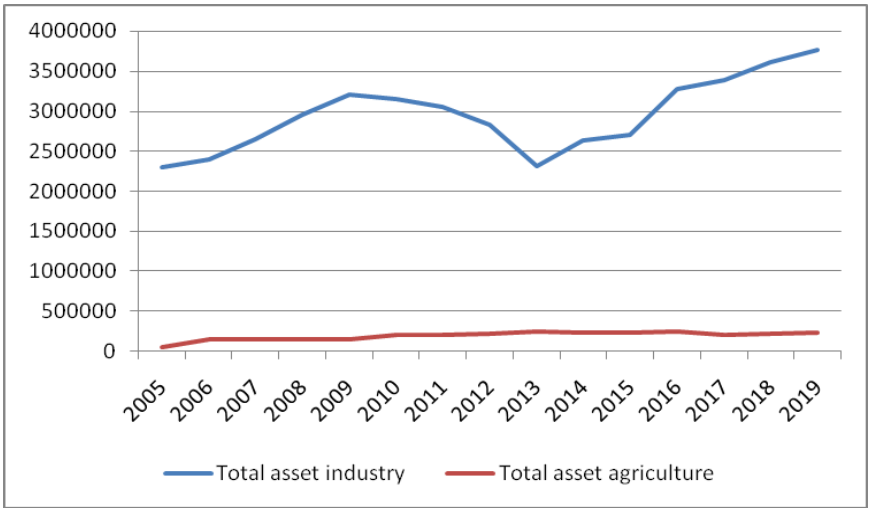
had been declining gradually and fell to 6.4 percent in 2019, which was just above the 1989 level. Over the past decade, the share of agriculture has continued to decline as it has failed to attract any significant level of foreign direct investments, production has not been modernized, there have been no land consolidations, and modern agrotechnical measure have not been sufficiently applied.

One of the structural characteristics of Montenegro is higher share of agriculture in gross domestic product than of the food-processing industry, that indicates a low level of finalization of agricultural products (Martinovic, et. al, 2020). This also indicates the existence of significant room for further connecting of industry and agriculture and increasing the volume of production. The Russian-Ukrainian conflict has additionally highlighted the importance of food security, and as pointed in World Bank study (2023), there are growing risks in food supply and risks posed by trade policies of big countries.

Results of Finacial analysis of agriculture and industry

The first indicator that we analyse is the movement of agricultural and industrial assets. Assets of both industry and agriculture rose during the observed period, as indicated in the graph below. However, agricultural assets were drastically lower than those of industry.

Figure 3. Agriculture and industry assets (000 EUR)



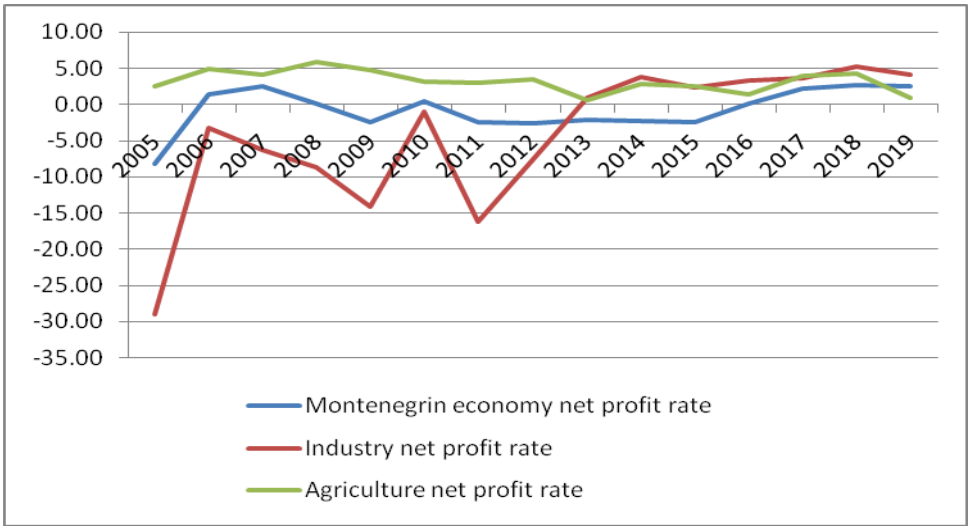
Source: Author's calculations

Assets of Montenegrin agriculture was on an uptrend and declines were seen in 2014, 2015, and 2017. They rose from 46 to 226 million euros, which is a very dynamic growth and an indicator of promising prospects of this sector. Industry assets increased by over 60 percent, being on the rise in the period from 2005 to 2011, then declining for the next three years, with the growth cycle picking up pace afterwards. However, unlike agriculture, which in the observed period increased its share in total assets of the

Montenegrin economy from 0.8 to 1.1 percent, industry reduced its share from 41.2 to 17.6 percent. Although industry is a capital-intensive activity, it is particularly interesting that with a share of 1.1 percent in total Montenegrin assets, agriculture generated 6.4 percent of GDP in 2019, while industry with its share of 17.6 percent generated only 8 percent of GDP, which points to the inefficient deployment of assets in industry.

When it comes to profitability analysis, we can conclude that agriculture kept recording positive net profit rates over the entire observed period. However, considering the committed funds, it is safe to say that they were still low. The cumulative profit of agriculture amounted to 39.2 million euros or an average of 2.6 million euros per year. Compared to the economy`s average, the net profit rate was lower only in the last observed year. Industry was achieving positive net profit rate since 2013 and its average exceeded that of the Montenegrin economy, being similar to the rate of profit of agriculture. If we look at the entire period, then we can see that industry ran a cumulative loss of 588 million euros.

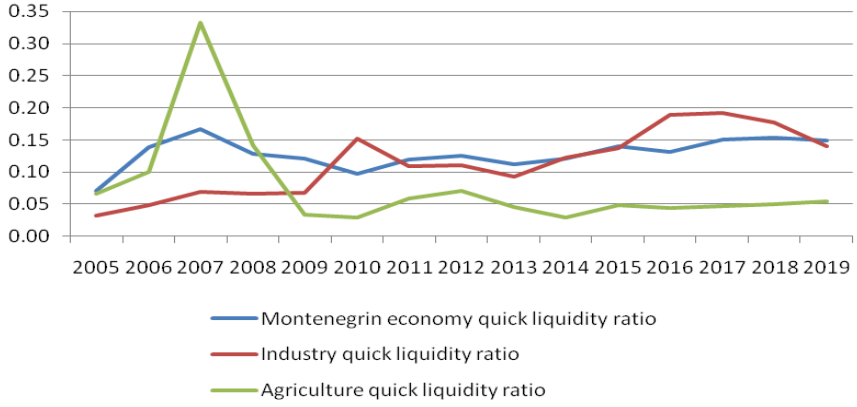
Figure 4. Net profit of Montenegro`s economy, agriculture and industry over the period 2005 –2019 (in EUR)



Source: Author's calculations

Liquidity movement over this period is also of great importance. The quick ratio is determined by offsetting current liabilities with cash and cash equivalents and current receivables. This indicator of current liquidity shows the ability to repay it short-term labilities (Matz, 2005).

Figure 5. Movement of the quick ratio in Montenegro`s economy, agriculture and industry

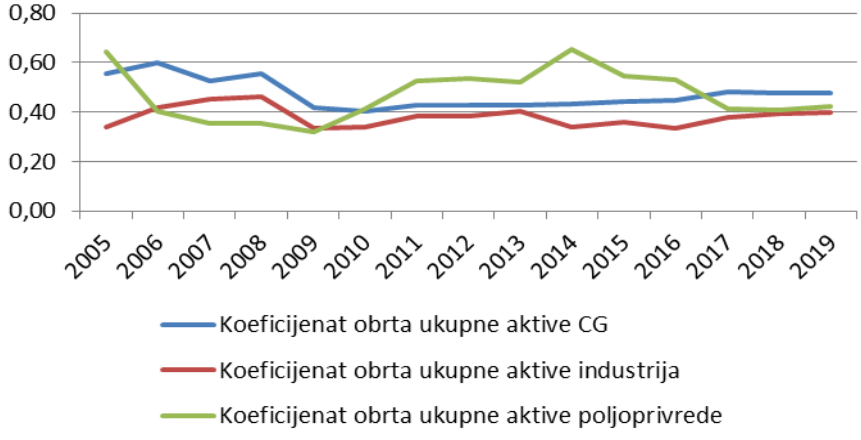


Source: Author's calculations

The graph above clearly shows that liquidity of agriculture was unsatisfactory and it was only better than the average for the Montenegrin economy in the period 2007-2008, being continuously worse than industry as of 2009. When it comes to industry, we can conclude that liquidity was also unsatisfactory albeit some improvement in the last five years but still it was worse that the economy`s average in most of the observed years.

The asset turnover ratio shows the relation between income and asset, i.e. the amount of income per euro of deployed assets. There is no general recommendation in the literature on the desirable value of this coefficient so this value should be sought by comparing the sector value and that of the closest competitor (Spasić, 2012). Theoretically, the higher the value of this indicator, the better the performance.

Figure 6. Asset turnover ratio of Montenegro`s economy, agriculture and industry

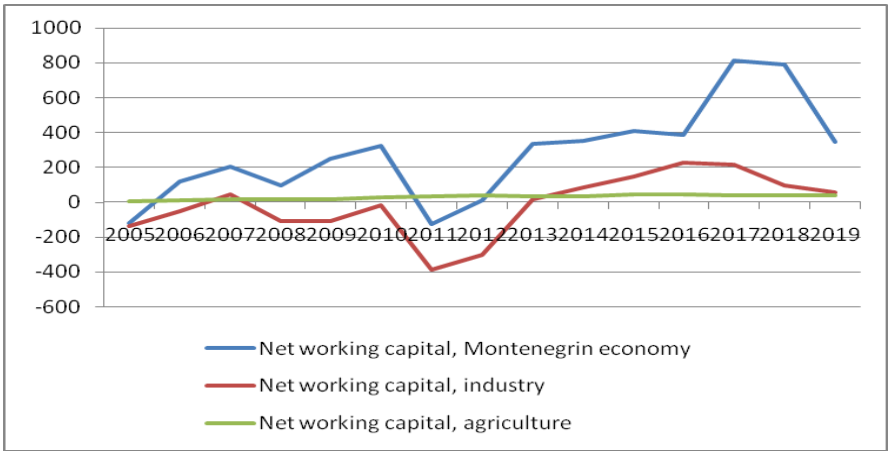


Source: Author's calculations

The values of the observed ratio, both for the entire economy and for agriculture, cannot be considered satisfactory because they indicate a low income capacity compared to total deployed assets. The situation in agriculture can be estimated as rather unfavourable given that we witnessed a continued downtrend of this ratio as of 2014. As for industry, the situation is even more unfavourable because the ratio was worse than the average of the Montenegrin economy throughout the observed period, being more favourable in relation to agriculture only during the period 2006-2009. However, this is partly the expected given that the value of this ratio is lower in capital-intensive activities such as industry that have a high level of fixed assets. Apart from some minor fluctuations, the value of this ratio was relatively stable for industry in the entire observed period.

Net working capital shows the coverage of current assets by long-term sources. There is no universal value of this indicator in the literature that would be considered acceptable, but it is emphasized that it depends on the activity, procurement policy, production and sales, growth and development of the company, etc. (Jakšić, 2006). Some authors recommend that this amount should be kept to a minimum, but to the extent that it does not jeopardize profitability and operating activities (Pupos, Peter & Demeter, 2009). Nevertheless, there is a consensus in the literature that a positive value of this indicator is desirable in order to be able to finance operating activities and cover short-term liabilities (Swarup, 2011).

Figure 7. Net working capital of Montenegro`s economy, agriculture and industry

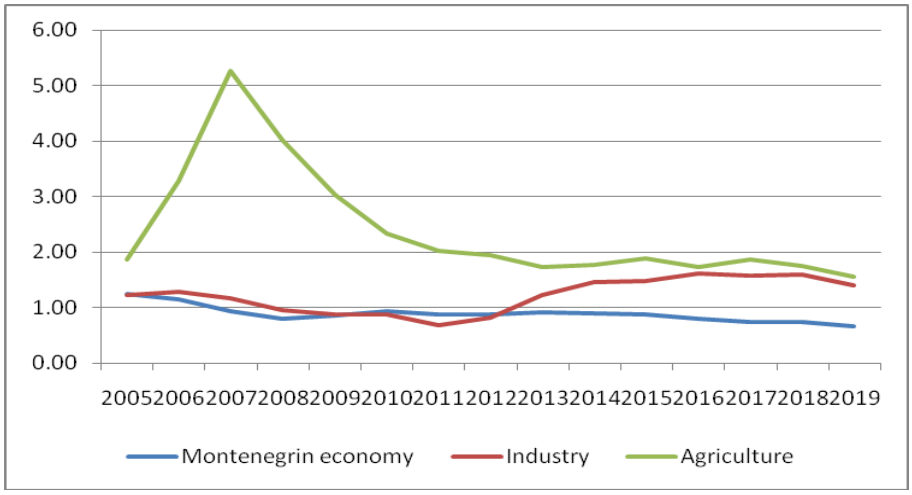


Source: Author's calculations

Net working capital of Montenegro`s agriculture were positive over the entire observed period, albeit at a relatively low level. A good indicator is that they have a tendency to grow slightly. When it comes to industry, the value of this ratio had been negative until 2013 (with the exception of 2007), being continuously higher compared to that of agriculture thereafter.

Considering the inadequate profitability of both agriculture and industry, we debate the issue of indebtedness of these two sectors. As an indicator of indebtedness, we use the debt ratio, which is the ratio of capital to total liabilities (capital and reserves / (short + long-term liabilities)). As indicated in Investopedia (2012), this ratio is used for assessing a company`s risk profile. A debt ratio less than 1.0 indicates that a company`s liabilities exceed its capital.

Figure 8. Debt ratio for Montenegro`s economy, agriculture and industry

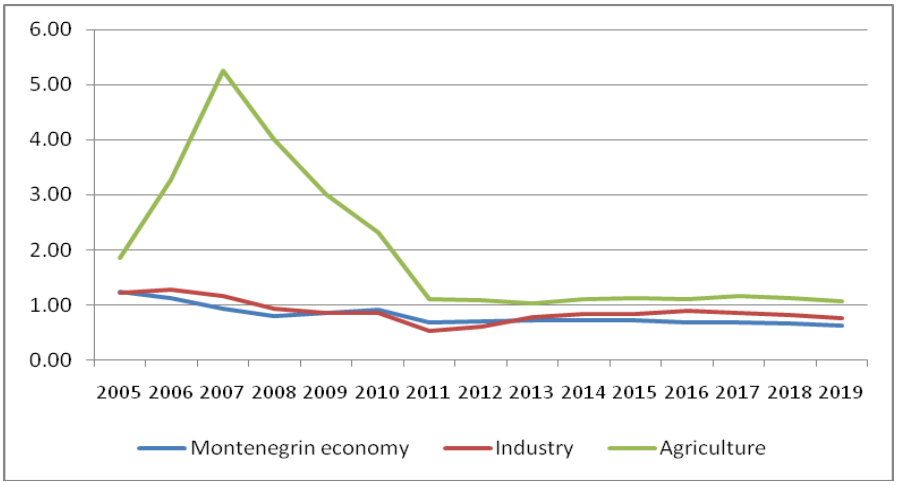


Source: Author's calculations

The graph above shows that Montenegro`s agriculture is not highly indebted unlike the country`s economy (which debt level exceeded capital and reserves in the observed period, with the exception of 2005 and 2006). However, the fact that this indicator tended to deteriorate in the last ten years is the reason for some concern. When it comes to industry, the level of indebtedness maintained acceptable levels since 2013 but industry remained more indebted than agriculture over the entire period.

The indicator showing the ratio of capital (reserves included) to fixed assets can be used to approximate solvency. Solvency indicators are important as they show financial security of a company, i.e. they reflect long-term risks of investing in the company (Jakšić, 2006). However, unlike banking where the value of the solvency ratio (capital adequacy ratio) is strictly regulated and is subject to the strictest controls (Kozarić & Fabris, 2012), there is no strict control for the non-financial sectors and solvency management is left to the companies. The value of this indicator of 1 suggests that fixed assets are fully covered by capital and this is usually considered as the minimum acceptable value. If it is below 1, a part of fixed assets is covered from funds of lower quality and shorter maturity. The following graph shows the movement of the solvency ratio for the Montenegrin economy, industry and agriculture.

Figure 9. Solvency ratios of Montenegro`s economy, agriculture and industry



Source: Author's calculations

In the case of agriculture we can see that the solvency ratio was greater than 1 in all the observed years and fixed assets were covered by capital increased by reserves. On the other hand, the value of this coefficient was less than 1 for the economy of Montenegro the entire time. When it comes to industry, apart from the first three years, this indicator was lower than 1 over the remainder of the period, which indicates inadequate solvency and high risks that exist in this sector.

Recommendation to economic policy makers

It is obvious that Montenegro must not leave agriculture to the operation of the free market alone, but a comprehensive program of support and development is necessary that should be based on improving the competitiveness of producers, sustainable management of resources, and raising the quality of life in the rural areas.

The financial analysis showed that agriculture has a low level of profitability, but that it is in the "positive result" zone. The ratio analysis showed that the key problem of Montenegrin agriculture is liquidity, while agriculture is not highly indebted and has no problem with solvency. Therefore, the priority task for improving the situation in the field of agricultural production should be the provision of liquidity loans. In the situation of insufficient interest of the banking sector in supporting agriculture, the alternative is for the state to encourage agriculture to a greater extent through the Development and Investment Fund or to directly subsidize banking loans for agriculture.

In order to raise the quality of life in the countryside and stop migration, certain measures need to be taken that will involve the provision of direct financial support to elderly households that base their existence on agriculture, the improvement of quality of infrastructure (roads, water supply, electricity) as well as the quality of life in villages (construction of sports and cultural facilities, health centers, and the like).

The state must continue to support agricultural production in the coming period, following the example of the most developed countries in the world, because otherwise, if a smaller amount of subsidies is approved than in competing countries, agricultural producers will be at disadvantage compared to the main competitors. Although support from the agricultural budget has been increasing, the allocated amounts are insufficient. Funds are used to fuel too many programs. As Dethier and Effenberger (2016) showed, increasing the size of farms is the key to increasing agricultural income, as it enables the use of mechanization, facilitates access to credit lines, and enables economies of scale and higher profitability per hectare. Budget support should concentrate on those programs in which Montenegro could achieve comparative advantages.

When it comes to industry, the financial analysis showed an unsatisfactory level of its liquidity and solvency as well as a high level of indebtedness. The industry was profitable only in the last six years of the observed period, and this was primarily under the influence of energy sector. It is obvious that Montenegro, as a small country, cannot develop all branches of industry, but must concentrate on those branches in which it can achieve comparative advantages and these are energy, food processing industry, and some types of mining.

Going forward, the priority actions must address the issue of financial situation, both with the aim to improve liquidity and to expand the scope of activities. Most industrial companies require debt restructuring and/or favourable loans. This will not be an easy task at all, bearing in mind that the banking system is not interested in over-indebted companies burdened with mortgages. The solution can be sought in international loans. However, these loans carry a potential risk given that they would require government guarantees, which could further burden the growing public debt. Therefore, the main course of action should be the search for strategic partners with new capital.

The help of the state in achieving international quality standards is also important, which would enable higher output and improve profitability. It would be very useful to form clusters, both horizontal and vertical, and the latter in particular as they would connect primary food producers and their processors. Similar potential exists in the wood industry and in some other industries, while a significant potential exists in the construction of new capacities in the field of renewable energy sources.

Conclusions

The sector that generates the largest share of GDP in Montenegro is the service sector, primarily tourism and related services, followed by agriculture and industry. Montenegro had a specific model of development after World War II. In accordance with the socialist concept of development, industry development was encouraged, while agriculture was discouraged and left without any investments only to be treated as a base for providing cheap food for the working class. The 1990s brought wars, economic sanctions, and dissolution of the former Yugoslavia. Against such backdrop, both agriculture and industry deteriorated, with industry deterioration being particularly

rapid as it lost the market and did not have funds to invest in modernisation and/or production maintenance. Development of these two sectors did not pick up pace with the transition. On the contrary, this led to a lack of investment in these two sectors and a large number of industrial companies that went bankrupt, leading to agriculture and industry accounting for 6.4 percent and 8 percent of Montenegro`s GDP in 2019, respectively. The neglect of these two sectors is probably one of the main culprits for the slower development of the country`s economy.

The paper presented the financial analysis of these two sectors based on the database of final accounts. The financial indicators of all industrial and agricultural enterprises, as well as the entire Montenegrin economy were aggregated for the period 2005-2019 (the period for which final accounts are available). The obtained financial indicators can be a useful indicator for economic policy makers regarding future directions for improvement of these two sectors.

The financial analysis showed that both observed sectors were characterized by the growth of assets in the observed period, yet the growth of agricultural assets was faster than that of the country`s economy, while industry reduced its share. The analysis further showed that agriculture was profitable throughout the observed period, albeit with a low net profit rate, while industry did not become profitable before 2013. Over the last examined six years, the rate of net profit of both these sectors was higher than the average of the Montenegro`s economy. The level of liquidity was unsatisfactory in both observed sectors, but the liquidity of industry has been better than the average of the country`s economy in recent years. The asset turnover ratio was not satisfactory for either agriculture or industry and it has been less favourable in both observed sectors than the average for the economy in recent years. Net working capital of Montenegro`s agriculture was positive over the entire observed period, while that of industry turned to positive value in 2013, recording higher levels than agriculture ever since. The level of indebtedness of agriculture is lower than that of industry, but its rapid growth is a matter of concern. Since 2012, both agriculture and industry had more favourable indebtedness indicators compared to the average for the country`s economy. The level of solvency in agriculture is at an acceptable level, while that in industry is at a worrying level and it indicates that a part of the fixed assets is not covered by capital but by funds of lower quality (shorter maturity).

Further research in this area should involve the inclusion of additional sectors in the comparative analysis, such as tourism, as well as the expanding of the time horizon of analysis once new indicators have become available.

Conflict of interests

The authors declare no conflict of interest.

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INVESTMENTS IN SERBIAN AGRICULTURE

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ABSTRACT

The paper shows the relation between gross domestic product (GDP) and investments in the Republic of Serbia. The observed relation was analyzed at the economy level, as well as in agricultural particular. The observation period is from 2005 to 2020. The function of investments is overviewed through the capital ratio. In this way, it was established to what extent part of the newly created value is returned to the production process, both at the level of the entire economy and at the level of agricultural activity separately. The low participation of investments in the gross domestic product is highlighted, which indicates an unfavorable relationship towards economic and agricultural activity for the observed time period.

Introduction

Agriculture production as a main economic activity of primary sector represents relevant part of the national economy of the Republic of Serbia. This activity has a

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significant share in the creation of the gross domestic product (GDP), although in recent years there is a tendency of relative decline. Milić et al., (2008) allege that the average participation of the GDP from agriculture in total GDP in the period 1996-2005 was 19.37%. Comparably, recent research indicates a gradual decrease in the share of the gross added value (GVA) of agricultural production in the total GVA of the Republic of Serbia, for the period from 2002 to 2015, at a rate of -5.4% annually (Novaković, 2019). Previously alleged facts confirm the presumption that as the economic activity of a country increases, the participation of agriculture in the formation of GDP decreases. According to data provided by World Bank (2021), the primary sector in the EU participates on average with 1.6% in the formation of GDP. In Republic of Serbia that share is significantly higher-6.34% (Statistical office of Serbia-SORS, 2022). In absolute terms, the GDP generated from agriculture in the Republic of Serbia has a tendency to grow, although there are certain fluctuations caused by: global inflation rate, weather conditions… The GDP is constantly increasing and economic activities from the secondary and tertiary sectors significantly contribute to the formation of GDP, while the relative participation of the primary sector is reduced to a single-digit rate. This phenomenon can be appraised as positive because the secondary and tertiary sectors achieve a higher added value than the primary.

According to the data provided by Statistical Office of the Republic of Serbia, engagement in agricultural employment in Serbia is declining. In 2012, 1.442.628 people worked (directly or indirectly) on these jobs, or 20.07% of the total population (SORS, 2012). In 2018, that share was 18.6%, or 1.336.940 people (SORS, 2018). The number of agricultural households is also decreasing. According to the 2012 agricultural census, there were about 631.000 registered households in Serbia, with an average of 2.3 people working on them. In 2018 about 560,000 households were recorded with an average of 2.4 people working on them (SORS, 2018).

In foreign trade balance only agricultural and food products show surpluses. The structure of the export of the Republic of Serbia is unfavorable, which further adversely affects competitiveness (Đukić et al., 2017). According to Marković (2010), "... in the last two decades, the dominant group in the structure of Serbian exports has been the primary product or products of lower stages of finalization (agricultural products, nonferrous metals and iron, timber, etc.)".

Sometimes it is difficult to achieve growth in agricultural production because both value factors (price and quantity) are often not under the influence of economically deprived countries, but under the control of global economic trends and climate factors that affect mainly primary production, which stands out in the Republic of Serbia. The aforementioned facts are only part of the reasons why agriculture must be encouraged and somehow protected by the state. In the Republic of Serbia, there are various types of support, but one of the most important for agriculture itself and the population in rural areas is defined by the Law on Incentives in Agriculture and Rural Development ("Official Gazette of RS", no. 10/2013, 142/2014, 103/ 2015 and 101/2016) which states that the budget of the ministry responsible for agriculture cannot be less than

5% of the budget of the Republic of Serbia for a given year. In such manner, a certain guarantee is created that funds will come to agriculture and contribute either directly or indirectly. In addition to economic development, creating GDP, employment, agriculture has another significant function - achieving food security. This aspect stems from organizing the production of agricultural products with one's own resources. In this way, agriculture presents on of the factors which are essential for stable functioning of the state. The best illustration of this allegations are the events of the last three years caused by the Covid-19 virus pandemic and the interstate conflict of countries that represent influential producers of (agricultural) raw materials in terms of energy and food markets.

Bearing in mind the importance of agricultural activity, the question arises to what extent it is necessary to invest and what is the willingness of society to give up the newly added value in order to return the funds to the sector that has proven to be significant. In accordance with alleged facts, the subject of this research are investments in fixed assets, their source of financing and GDP. Simultaneously, the main objective of this research is based on determination and analysis of the capital ratio, i.e., of the relation between GDP and investments in order to determine to what extent a part of the newly created value is returned to (agricultural) production, whether enough is invested in agriculture in order to achieve the goals defined by various strategic plans. In accordance with the defined subject and research objective, the following research hypothesis was defined:

H_0: Agriculture in the Republic of Serbia is not invested in the same share as it contributes to the economy, i.e., not enough for this sector to: achieve growth in production and productivity, adopt new technological solutions, modernize its fixed assets, successfully improve the vertical ally between crop and livestock production, ...

The research methodology and data source

Using the capital ratio, the relation between total investments and gross domestic product in the observed period is shown:

$$C = \frac{I}{GDP}$$

where are:

C- capital ratio; I - investments in fixed assets; GDP - gross domestic product (Milić et al., 2008).

Investments represent the use of a part of the domestic or available product to replace and expand the reproduction of basic funds in the economy and non-economic activities and to increase stocks, raw materials and unfinished production and finished products in the economy (Hirt and Block, 2005).

The majority of economic theorists, regardless of which economic school they represent,

agree that investments are the main accelerator of economic activities. Investments are of great importance for every national economy and they increase the GDP. Investment policy is considered one of the most important segments of economic policy. With better organization of work and management, better organization of the state, a higher level of general and professional education, greater use of production capacities, wider and faster application of technological progress, etc., a higher growth rate can be achieved at the same level of investment (Jurčić and Časni, 2018).

If investments increase and GDP remains the same, the capital ratio will increase, that is, a larger part of GDP would be returned through investments in (agricultural) production. Conversely, if investments decrease, the capital ratio will decrease.

Gross domestic product (GDP) represents the market value of all final products and services produced in a country for a period of one year. Real GDP per capita (corrected by the rate of inflation) is used as a key indicator in evaluating the economic strength of the country by year or for comparison with other countries (van den Bergh, 2007). It consists of funds intended for consumption and production.

If investments remain the same and GDP increases, the capital ratio decreases, that is, a smaller share of it is returned to (agricultural) production. In the case of a decrease in GDP at the same level of investment, the observed ratio increases.

Through the capital ratio, the results from the past and their part that is intended for further investment, i.e., investing in the future, are compared. The more society renounces consumption in the present, the higher this coefficient is, the assumption that better results will be achieved in the future.

The data were processed with standard statistical instruments of descriptive statistics such as: average value and average rate of change. The average rate of change is calculated according to the formula:

$$r = (G-1);\quad G = \left(\frac{Yn}{Y_1}\right)^{\frac{1}{n-1}}$$

where are: r - annual rate of change, G - constant relative change in value, Yn - absolute value of the last member of the series, Y_1 - absolute value of the first member of the series and n - total size of the series. (Tekić et al., 2019).

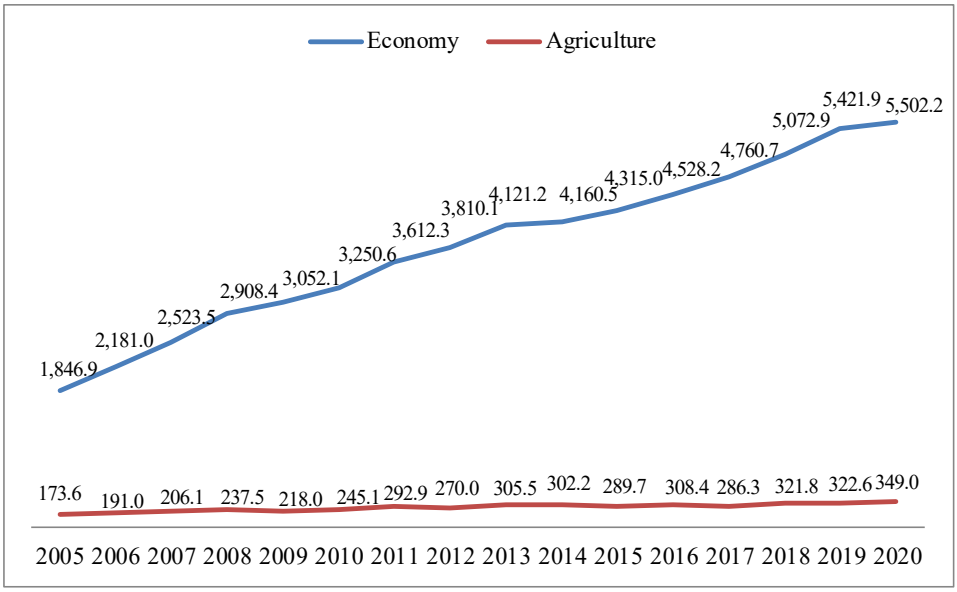
Data provided by Statistical Office of Republic Serbia related to the statistics of national accounts in current prices were used as the basic data sources (SORS, 2005-2020). Also, data from the World Bank were used, which refer to the participation of agriculture in the creation of GDP in the Republic of Serbia, the countries of the region and the European Union (WBO, 2020)

Results and discussions

The research results first showed the progress of agriculture's GDP and GDP during the observed period (Figure 1).

Figure 1 presented below shows the absolute growth of the total GDP as well as that one generated from agriculture. According to the data provided by SORS, the GDP of the Republic of Serbia has a pronounced tendency to grow during the observed period with an annual rate change of 7.55% per year. Agricultural activity has a slightly lower average growth rate, but it is still positive (4.76% per year).

Figure 1. The value of the GDP and the GDP from agriculture in the Republic of Serbia for the period 2005-2020, in current prices in billions of RSD



Source: author's calculation based on SORS data

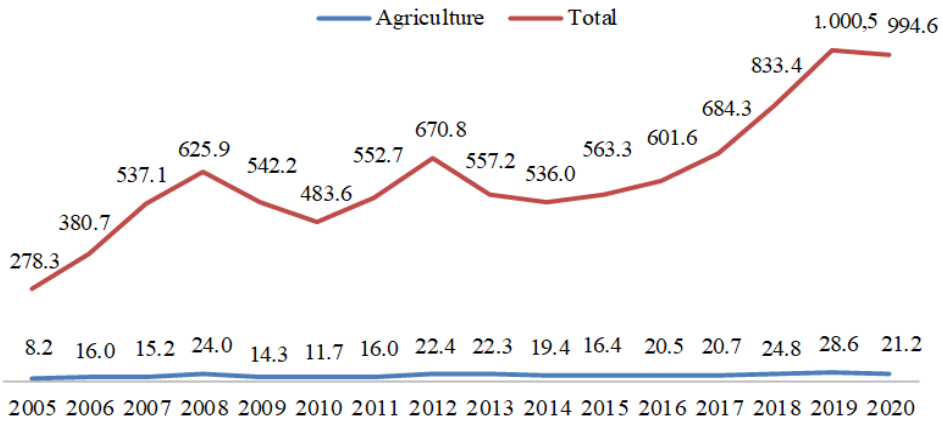
Looking at Figure 1 and the time series data from 1996-2005 (Milić et al., 2008), where agriculture accounted for almost a fifth of the total newly created value, it is concluded that agriculture continues to achieve GDP growth, but activities from the secondary and tertiary sectors simply do it more efficiently and progressively. For this reason, the relative participation of agriculture in the creation of GDP is decreasing, and the absolute values are increasing from year to year.

When looking at the GDP generated from agriculture in the Republic of Serbia in relation to other comparable countries, primarily from region that have a lot of comparable features (historical, cultural,... heritage and similar geographical features), the following groups of countries can be categorized: the first group consists of countries with a significant share of agriculture in the creation of GDP- Montenegro, North Macedonia and Albania, which has the most significant participation (19.12%). The Republic of Serbia and Bosnia and Herzegovina forms second group with approximately the same values (between 6% - 7%). The third group includes Bulgaria, Croatia, Hungary and Romania, which have averages almost twice as low as the Republic of Serbia (WBO,

2020). As comparative data, the EU average (1.65%) is used, whose agriculture is at a significantly greater level and which the observed countries tend to approach (some have already succeeded). Mizik (2012) states that the function of agriculture in the countries of the Western Balkans is greater than the average of European countries and that agriculture is characterized by: issues of imbalance, sectoral production, fragmented structure of agricultural holdings, relatively low yields, unfavorable structure of exports as well as poor hygiene and food quality control.

Comparison of total investments and investments in agriculture are shown in Figure 2. According to data provided by Statistical Office of the Republic of Serbia investments in the observed period tended to grow, which can be seen from Figure 2.

Figure 2. Value of total investments and investments in agricultural in the Republic of Serbia for the period from 2005 to 2020, in millions of RSD at current prices



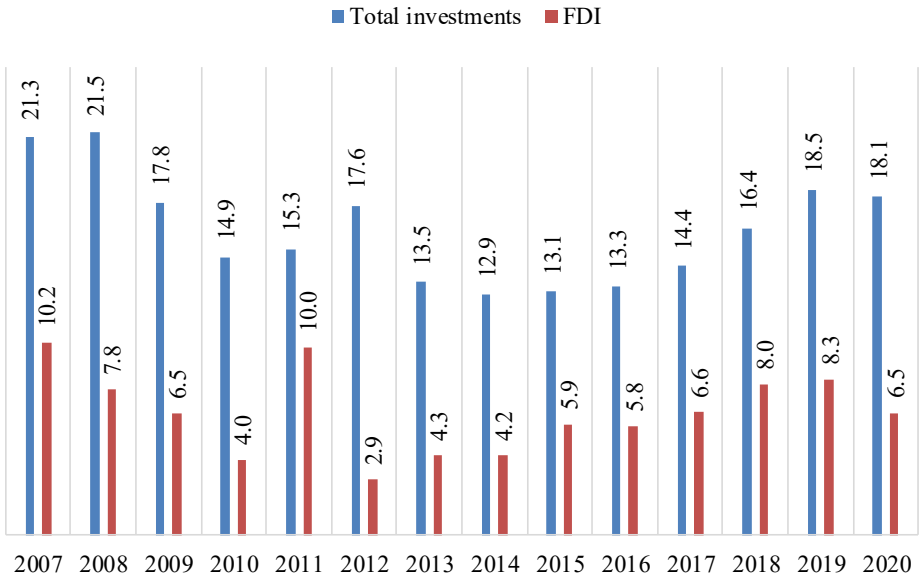
Source: author's calculation based on SORS data

From Figure 2, it can be seen that total investments in the observed period had a significant growth (8.86% per year on average). Investments in fixed assets were at the lowest level at the beginning of the analyzed period. Over time, investments increased gradually until the emergence of the world economic crisis in 2008 and 2009, when investments also decreased. However, when looking at the share of investments in agriculture compared to total investments, it comes to the conclusion that capital investments in this sector over the years were lower. This is supported by the rate of change, which for the entire observed period amounted to 6.6% on an annual basis. The average rate of investments in agriculture was 3.12% of total investments during the period from 2005 to 2020.

Investments in agriculture grew by an average of 6.6% during the observed period, while agriculture recorded an average absolute growth of 4.76%. Although the average investment rate was higher than the average growth rate, it was still insufficient to reach the growth achieved at the economy level (7.55%).

Investments represent a measure of investment in capital goods and also one of the main generators of economic development. In such manner, it is of particular importance to look at the ratio of foreign direct investments (FDI) and domestic investments generated from GDP (figure 3).

Figure 3. Ratio of total and foreign direct investments (FDI) in the Republic of Serbia in relation to GDP for the period 2007-2020. years, in % of GDP



Source: author's calculation based on SORS data

According to the data provided by Statistical Office of the Republic of Serbia in the period from 2007-2020 there were significant foreign direct investments (FDI). At the beginning of the observed period, investments accounted for 21.3% of total GDP, while FDI accounted for 10.2%. The lowest share of investments in relation to GDP was in 2014 (12.9%), and foreign investments in 2012 (2.9%). The highest values of the observed categories were those from the beginning of the period.

The calculation of the capital ratio at the economy and agriculture level is presented. In both cases, the period is divided into two sub-periods. The first one begins in 2005 because this paper can be seen as a sequel of a research conducted by Milić et al., (2008), in which the observed time series ends in 2005. What marks this period of time is the world economic crisis that began in 2008 and affected business activity in the following years, the consequences of which were observed until 2012. The second period marks the end of the world economic crisis and the gradual increase in economic activities (2013-2020). Tables 1 and 2 provide insight into the calculated capital ratios at the economy level of the Republic of Serbia, for the periods from 2005-2012 and 2013-2020 respectively.

Table 1. Capital ratio (economy level) for period 2005-2012, in millions of RSD.

	Year							
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
I	278295,7	380673,3	537142	625875,6	542204,3	483646,3	552733,5	670802,3
GDP	1846853,2	2181034,6	2523495,5	2908444,7	3052135,5	3250581,3	3612266,6	3810057,9
C	0,15	0,17	0,21	0,22	0,18	0,15	0,15	0,18

Source: author's calculation based on SORS data

The capital ratio in the observed sub period had the highest value in 2008 (0.22), while its lowest value was recorded in 2005, 2010 and 2011, when it was 0.15. The average value of this indicator in the analyzed eight-year period was 0.176, which means that 17.6% of GDP was invested back into the economy.

Table 2. Capital ratio (economy level) for the period 2013-2020, in millions of RSD

	Year							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
I	557239,9	535986,2	563283,1	601619,8	684290,7	833399	1000511,1	994602,4
GDP	4121200,2	4160548,5	4315020,4	4528191,9	4760686,4	5072932,2	5421851,3	5502216,3
C	0,14	0,13	0,13	0,13	0,14	0,16	0,18	0,18

Source: author's calculation based on SORS data

The capital ratio in the observed sub period had the highest value in 2019 and 2020 (0.18), while its lowest value was recorded in 2014, 2015 and 2016, when it was 0.13. The average value of this indicator in the analyzed eight-year period was 0.149, which means that 14.9% of GDP was returned through investments in the economy.

Tables 3 and 4 provide an insight into the calculated capital ratios related to agricultural activity for the periods from 2005-2012 and 2013-2020 respectively.

Table 3. Capital ratio (agriculture) for the period 2005-2012, in millions of RSD.

	Year							
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
I	8153,5	16021,2	15166,3	24049,7	14286,4	11709,6	15951,9	22394,6
GDP	173608,4	191007,7	206083,9	237474,6	218005,3	245127,5	292918,7	269999,8
C	0,047	0,0839	0,0736	0,1013	0,0655	0,0478	0,0545	0,0829

Source: author's calculation based on SORS data

The capital ratio in the observed sub period had the highest value in 2008 (0.1013), while its lowest value was recorded in 2005, when it was 0.047. The average value of this indicator in the analyzed eight-year period was 0.070, which means that on average 7% of the GDP generated from agriculture was returned through investments.

Similarly, the capital ratio for the period from 2013-2020 had the highest value in 2019 (0.0885), while the lowest value was recorded in 2015, when it was 0.0565. The average value was 0.07, which means that 7% of GDP was returned through investments in the agricultural production process.

Table 4. Capital ratio (agriculture) for the period 2013-2020, in millions of RSD

	Year							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
I	22258,5	19448,5	16377,9	20477,9	20702	24752,2	28551,2	21152,8
GDP	305519,7	302226,3	289704	308422	286315	321765	322560	349004
C	0,0729	0,0644	0,0565	0,0664	0,0723	0,0769	0,0885	0,0606

Source: author's calculation based on SORS data

Observing the values of the capital ratio at the level of the entire economy, i.e., agricultural activity for the total period 2005-2020, it was established that the average value of the capital ratio at the level of the entire economy is 0.16. In other words, it can be said that 16% of GDP was intended for investment in fixed assets. The rate of change, although it is positive and amounts to 1.2% for the observed period, is at a relatively little level, so no significant changes are to be expected in the following period.

On the contrary, the average value of the capital ratio of agricultural activity, for the period from 2005 to 2020, was 0.0690, which means that on average 6.9% of the GDP generated from agricultural activity was invested in fixed assets related to agriculture. The rate of change of the capital coefficient related to agricultural activity for the observed period is at a slightly higher level and amounts to 1.7%. However, the stated rate of change is also at a relatively low level, so taking into account the data from the previous period, significant increases in the future are not to be expected.

Conclusion

The conducted research indicates that the agricultural activity in the Republic of Serbia contributed on average to the creation of the total GDP with 7.33%, while the share of investments intended for agricultural activity is at the level of only 3.12% of the total investments. The average value of the capital ratio specific to agricultural activity was approximately 2 times lower than the capital ratio at the economy level.

To this extent, it was shown that agricultural activity creates a far greater production value than is returned to it through investments in fixed assets. In addition, agricultural activity shows positive results that are reflected in the creation of new value and the achievement of absolute growth. However, the calculated capital ratios indicate that GDP is growing in absolute terms, regardless of how much was invested in agricultural production in the previous period. The obtained results related to the low capital coefficients in agricultural production indicate that in the future there may be a lag and a decrease in the participation of agriculture in the creation of GDP, not only due to the increase in economic activities from other sectors, but also because off minor investing in agriculture.

The growth in the value of agricultural production, which is not supported by significant allocations in the form of investments, can be explained by the permanent development of production technology on a global level, on the basis of which higher values are realized per unit of capacity. The above indicates that there is capacity for additional improvement and the achievement of even better production results if the investments were directed towards improving efficiency and achieving greater productivity, which implies investments in more modern machinery, the adoption of new technological solutions, as well as the improvement of the vertical ally between crop and livestock production, which ultimately results in the development of primarily livestock production. However, we must point on capacity of agriculture in Republic of Serbia to receive additional investments, considering the very features and functions of this activity. Regarding the factors of production used in conventional production, there is no significant difference compared to countries with developed agriculture, which leads us to the conclusion that it is necessary also to invest in the education of personnel responsible for the production and organization process.

The growth of GDP, which was accompanied by a decrease in the share of the value of agricultural production in the total realized GDP, indicates that the agricultural activity is not directly responsible for the growth of the overall economic activity, but the merits belong to other activities that belong to the secondary and tertiary sectors and which are obviously increased their activity and thus contributed to the growth of the total GDP. From all of the above, it can be said that the research hypothesis is partially accepted, and that is in the part where it is proven that the agriculture of the Republic of Serbia is not invested as much as it participates in the creation of new value. Bearing in mind that GDP generated from agriculture is growing despite lower capital ratios, it can be said that in this part the research hypothesis is partially rejected. Investments are not the only factor that affects the development of agriculture and there is a presence of technological progress that consists of the adoption of new technologies, technological procedures, increased productivity... as a result of transferring from other sectors, which does not require direct investments in agriculture itself.

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Conflict of interests

The authors declare no conflict of interest

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AGRICULTURE AND ECONOMIC GROWTH: THE EU 27 RECORD FROM 2002 TO 2021

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ABSTRACT

The aim of this paper is to analyze the contribution of the agricultural sector to the European Union member states' economic growth in the period from 2002 to 2021. This paper makes an attempt to answer the question of whether the agricultural sector contributes to the economic growth of the European Union countries, in terms of incentives that their governments give to the agricultural sector. For this purpose, a multiple regression model is developed with one dependent and several independent variables, and the obtained research results show a positive influence of the agricultural sector, expressed through agricultural production, on economic growth rate of EU 27 countries in the analyzed period.

Introduction

The agricultural sector represents an important economic segment of many countries. Its contribution to economic growth and development is not the same in all countries. It largely depends on country's level of economic growth. In this regard, numerous theories of economic growth have been created, which look at economic growth, i.e. economic growth factors, from different standpoints. The past thirty years have seen radical changes in the agricultural sector, where the application of technological innovations and the concept of sustainable development occupy a significant place. What is more, the relationship between agriculture and economic growth has been the subject of a large number of studies. The focus of these studies are the countries of Asia and Africa, as well as some European countries. However, there are no comprehensive studies that would include the countries of the European Union. In order to fill this research niche, this paper tries to analyze the relationship between agriculture and the economic growth of

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the European Union countries in the period from 2002 to 2021. The paper is divided into two parts. The first part gives an overview of literature covering theoretical-empirical research on the relationship between agriculture and economic growth. It summarizes the results of the most significant studies dealing with this issue. Proceeding from the identified research gap, the second part develops research methodology, hypotheses and sample, which includes EU27 countries. A multiple regression model is developed, with one independent and several dependent variables. The model also includes the effect of the COVID 19 pandemic crisis. The obtained research results show the positive impact of the agricultural sector on the economic growth of the EU27 countries.

Literature review

The importance of agriculture in economic development varies from country to country. In other words, the role of agriculture in economic development depends on a country's level of economic growth. Thus, for underdeveloped countries in initial development stages, agriculture is of great importance. The population and labor force structure in underdeveloped countries prove this, given the high share of agricultural population and agricultural labor force. Agriculture is becoming the dominant form of production in these countries (Božić et al., 2011).

Therefore, the relationship between agriculture and economic growth has been the subject of a large number of studies, which differ from each other in terms of methodology, content, as well as standpoints and recommendations for further research. Bearing in mind the previously presented economic growth models, studying this relationship attracted and attracts economists wishing to identify the factors and perspectives of economic growth and development (Humphries & Knowles, 1998). All this points to the fact that the agricultural sector had and still has a key place in global economic development. From a historical point of view, pre-industrial economies had a large share of agriculture in total active population, and this population is characterized by low labor productivity. In this context, Lewis (1955) points to the presence of surplus labor as a prerequisite for the growth of other economic sectors. In this way, as he says, the agricultural sector is a source of labor (and capital) that can be redirected to other economic sectors in order to stimulate their production growth. Based on these research results, further research indicates that the transfer of labor force from the American agricultural sector to other more productive sectors, after World War II, was the main factor in the US economic growth until the 1970s (Denison, 1985). Similar results come from research related to Japan (Ōkawa & Rosovsky, 1973) and Europe (Johnson, 1997). Furthermore, a large number of authors come to the conclusion that high productivity growth in agriculture is a fundamental factor to achieve economic development in many countries (Johnston & Mellor, 1961; Rostow, 1959). Johnston (1991) estimates that the average rate of labor productivity growth in industrial countries in the post-war period up to 1980 was 4.3% per year, compared to 2.6% in other economic sectors.

Given that previous studies point to the importance of productivity boost in agriculture, all subsequent studies focus on the factors that generate technical changes

in agriculture, which ultimately lead to higher productivity. Thus, Hayami & Ruttan (1971) and Binswanger & Ruttan (1978) develop the concept of the so-called induced technical change, where the higher cost of labor in the rest of the economy encourages the development of labor-saving technology in agriculture. These authors specifically identify the importance of technology in agriculture, which, on the other hand, depends on resources some countries have. Thus, Dimitri et al. (2005) analyze these tendencies looking at the US agricultural sector. In 1900, 41% of the total labor force worked in the agricultural sector, and this share decreased to 16% in 1945 and 4% in 1970. Total factor productivity in US agriculture grew at an average annual rate of 1.5% from 1948 to 2008, which is four times higher than productivity growth in the rest of the economy.

As we can see, all these studies primarily analyze productivity in the agricultural sector, which should lead to economic growth. Furthermore, a large number of researchers, analyzing the relationship between agriculture and economic growth, focus on developing countries, i.e. the countries of Asia and Africa, where, by nature, agriculture is one of the most important economic sectors.

So, Phiri et al. (2020) conclude that despite the positive impact of agriculture on Zambia's economic growth, it faces enormous challenges. First of all, this refers to the migration of the labor force, especially the educated people, towards the increasingly important service sectors. On the other hand, this has led to a decrease in the share of agriculture in GDP, and, thus, to overall economic growth. An additional challenge facing the agricultural sector in Zambia, according to this group of authors, relates to the impact of droughts and adverse weather conditions on agriculture. This study has shown that, with the enormous potential of agriculture in Zambia, its economic and social benefits to the country and the region as a whole can be more significant. Steenkamp et al. (2020) conclude that agriculture plays an important role in solving the problem of unemployment and economic growth in the countries of South Africa. Through the analysis of international best practices, these authors provide insight into how the government can support the agricultural sector by implementing various measures, such as: financial assistance, adequate agricultural insurance, improving the advisory role for farmers, as well as investing in the implementation of various innovative solutions in agriculture.

Agriculture is the driver of India's economic development, as theoretical and empirical studies show (Khan et al., 2019). However, the share of agriculture has been declining since 2000. Despite the decline in the share of agriculture in GDP and expenditure on agriculture, cereal production has seen impressive growth in India. In particular, research has shown that agriculture has a long-term relationship with the industrial and service sectors, that is, that the growth of the agricultural sector leads to the growth of other sectors and the overall economy.

Similar research was conducted in Nigeria, and results show that certain sub-sectors of agriculture, such as fisheries, forestry, livestock and grain production, have a significant impact on economic growth (Agboola et al., 2022). The results highlight the importance

of agricultural development in order to achieve long-term sustainable economic growth. The relationship between agriculture and economic growth has also been studied in Pakistan (Nadia et al., 2020), where the focus was on value added in production, value added in agriculture and economic growth. To conclude, if economic policy measures are aimed at value added in production and value added in agriculture, it will have positive effects on long-term economic growth. Also, the relationship between agriculture and economic growth was studied in Tunisia (Abdelhafidh & Bakari, 2019), but in terms of investment in agriculture. Research results show that investments in agriculture are a fundamental and strong source of economic growth in Tunisia, which is why the state should implement various measures to further encourage investments in agricultural sector. Such conclusions also come from the study on the relationship between agriculture and economic growth of sub-Saharan African countries (Runganga & Mhaka, 2021). The results of this study show that agriculture is the driver of economic growth, in the short term, and that it should be supported by macroeconomic policy measures in order to bring long-term economic growth.

The previous overview of studies on the relationship between agriculture and economic growth confirms the previously stated thesis that this relationship was mainly analyzed in different African and Asian countries. A small number of researchers have dealt with the issue of this relationship in developed countries (Awokuse & Xie, 2015), especially the EU countries. In this way, the research question is whether the agricultural sector contributes to EU countries' economic growth, in terms of incentives that their governments give to the agricultural sector.

Research methodology, hypotheses and data

Taking into account the result of theoretic and empirical research, the research question relates to whether agriculture production in the EU27 has an adequate contribution to the dynamics of economic growth? In accordance with this research question, null and alternative hypotheses have been formed. The null hypothesis is – H0: Agriculture production in the EU27 has no positive impact on the dynamics of economic growth. Alternative hypothesis H1: Agriculture production in the EU27 has a positive impact on the dynamics of economic growth. To give an answer to this research question, it is necessary to define the timeframe of analysis, select the research methods and parameters to be observed. The aim is to observe the EU27 countries in the period from 2002 to 2021. This twenty-year period is sufficiently long to provide for valid observation results, and also represents a period in which there was an expansion and contraction of the level of economic activity, so that it takes into account the reality of the cyclical nature of economic activity.

As regards the research method, multiple regression is chosen. Multiple linear regression is the most common form of linear regression analysis. As a predictive analysis, the multiple linear regression is used to explain the relationship between one continuous dependent variable and two or more independent variables. Parameters to be observed in the defined time period have been adjusted to the research question. In this regard, the dynamics of economic activity is analyzed using the real GDP growth rate, as a significant aggregate macroeconomic indicator. This value will, in this study, stand for the dependent variable.

On the other hand, the independent variable will be the one that represents the agriculture production in the selected countries. This is undoubtedly agriculture production as a % GDP. Besides the dependent and independent variables, multiple regression also requires the control variables. This study focuses on the two such variables, which, without any doubt, have an impact on the dynamics of economic activity, namely the real economic growth rate.

The first control variable is final consumption expenditure of general government % GDP. The choice of this control variable is the result of the fact that, final consumption expenditure of general government are close correlated with economic activities in agriculture sector. At the same time final consumption expenditure of general government during observation period were topic of critics for unsustainable government budget deficits in EU countries and main constrain for further economic growth. The second control variable is the Gross fixed capital formation (investments) %GDP. The third control variable is COVID-19 crisis that occurred in the period analyzed, whose omission would reduce the validity of the findings in this study. The COVID-19 is constructed as an artificial binary variable (dummy). 2020 year is marked as the crisis years. In this year, in the countries studied, the dummy variable value is 1, while in other years, when there was no financial crisis, the value of this variable is 0. All data is taken from Eurostat and presented in the annex to this work. We emphasize that we are focus on COVID-19 crisis as variable.

As already mentioned, multiple regression model will be used to analyze the 27 EU countries, so the number of countries shall be presented as $i = 1, ...27$. These countries are observed over a period of 20 years, $t = 1, ...20$. The regression model is as follows:

$$y_{it} = \alpha + x_{it}'\beta + c_i + u_{it} \quad (1)$$

where y_{it} is the dependent variable, α is the constant, x_{it}' is K-dimensional row vector which is related to the independent and control variables, β is K-dimensional column vector of parameters with the independent and control variables, c_i is the effect of the specificity of the observed economy and u_{it} represents the residual. If the number of years analyzed is 20, then T = 20, so all observations for each country are summarized by the following matrix:

Dependent variable y_i is presented by using the following matrix:

$$y_i = \begin{bmatrix} y_{i1} \\ . \\ . \\ y_{i5} \\ . \\ . \\ y_{i20} \end{bmatrix}, \; y_i = [20 \times 1]$$

For independent and control variables X_i, the matrix is as follows:

$$X_i = \begin{bmatrix} \acute{x}_{i1} \\ . \\ . \\ \acute{x}_{i5} \\ . \\ . \\ \acute{x}_{i20} \end{bmatrix}, \; X_i = [20 \times 4]$$, as the focus of analysis is on 4 variables

(one independent and three control) in the regression model, so the number of K dimensions in this case is 4.

The matrix of residual in the analyzed model is:

$$u_i = \begin{bmatrix} u_{i1} \\ . \\ . \\ u_{i5} \\ . \\ . \\ u_{i20} \end{bmatrix}, \quad u_i = [20 \times 1]$$

If the last of the countries analyzed *i* is marked by $N, and \; (N = 27)$ and the last year analyzed *t* is marked by $T, and \; (T = 20)$, then NT will mark all observations in all countries over the entire observation period, namely: dependent variable *y* is presented in the form of the matrix

$$y = \begin{bmatrix} y_1 \\ . \\ . \\ y_i \\ : \\ y_{27} \end{bmatrix}, \text{of order } y = [NT \times 1]$$

Independent and control variables X are presented in the form of the matrix:

$$X = \begin{bmatrix} X_1 \\ . \\ . \\ X_i \\ : \\ X_{27} \end{bmatrix}, \text{ of order } X = [NT \times K].$$

Residual u_i is presented in the form of the matrix:

$$u = \begin{bmatrix} u_1 \\ . \\ . \\ u_3 \\ : \\ u_{20} \end{bmatrix}, \text{of order } u = [20 \times 1]$$

The question that arises in the model shown in equation (1) is whether there is correlation between the residual u_{it} (containing the specific effect of the observed country c_i), on one side, and independent and control variables, on the other side. Speaking in mathematical terms, the question is whether $E = (u_{it}|X_i, c_i) = 0$, when there is no correlation, or $E = (u_{it}|X_i, c_i) \neq 0$, when there is correlation.

In theoretical terms, this is a multiple regression model with random or fixed effects (Schmidheiny, 2015). Multiple random-effect model in this particular case would imply that the specificity of the observed country marked by c_i is not correlated with the independent and control variables, and that it changes over time independently of the country. This is an extremely rigorous assumption that is very rarely applied by economists in such research. Multiple fixed-effect model implies that the specificity of the observed country can be correlated with the independent and control variables, and that it does not change with the passage of time, i.e. that it reflects the specifics of business and system environment, characteristic of each country. This assumption is much more realistic and more prevalent in macroeconomic research. In the present study, multiple fixed-effect model has been chosen, with the implementation of adequate statistical tests to check its validity in relation to the random-effect model.

Results and discussion

The analysis starts by descriptive statistics, in order to assess the connection between the analyzed variables. Results of descriptive statistics are shown in Table 1.

Table 1. Descriptive statistics and names of variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
Real GDP growth rate	540	.0219333	.0390993	-.177	.252
Agriculture production as % GDP	540	.0411168	.0272961	0	.21467
Final consumption expenditure of general government % GDP	540	.1970587	.0338316	.1122844	.27935
Gross fixed capital formation (investments) %GDP	540	.2140759	.0423539	.106	.536
Dummy	540	.05	.218147	0	1

Source: Authors' calculations

The results show that, among the 27 countries surveyed in the eight-year period, there is a significant standard deviation of the real economic growth rate, several times the average value. On the other hand, the case with independent variable is opposite. This fact has been a further research challenge to prove the importance of agriculture production for economic growth in the countries studied. What follows is the presentation of the correlation matrix between dependent, independent, and control variables.

Table 2. Correlation matrix between independent variable and predictors

Variable	Real GDP growth rate	Agriculture production as % GDP	Final consumption expenditure of general government % GDP	Gross fixed capital formation (investments) %GDP	Dummy
Real GDP growth rate	1.0000				
Agriculture production as % GDP	0.1280	1.0000			
Final consumption expenditure of general government % GDP	-0.2759	-0.3598	1.0000		
Gross fixed capital formation (investments) %GDP	0.2983	0.0847	-0.1753	1.0000	
Dummy	-0.4042	-0.0449	0.0884	0.0496	1.0000

Source: Authors' calculations

Results in Table 2 show that among the variables there is no significant correlation, which is extremely important for the application of multiple regression model. It is interesting that between the dependent and independent variables there is a very weak correlation, which further complicates the research question, but also confirms the proper approach in choosing the research method. The results of the selected research method, multiple regression with fixed effect, are shown in the following table.

Table 3. Multiple regression using fixed effect model

Fixed-effects (within) regression	Number of obs 540
R-sq: within =0.2982	Number of groups= 27
between=0.3759	Obs per group: min=20
overall=0.2534	avg=20
	max=20
	F (3,509)=54,06
corr (u_i, Xb)= -0.5623	Prob > F= 0.0000

Real GDP growth rate	**Coef.**	**Std. Err.**	**t**	**P > | t |**	**[95% Conf. Interval**	
Agriculture production as % GDP	.2474049	.1230462	2.01	0.045	.005664	.4891458
Final consumption expenditure of general government % GDP	-.4793007	.1096693	-4.37	0.000	-.6947608	-.2638405
Gross fixed capital formation (investments) %GDP	.2564649	.0423044	6.06	0.000	.1733521	.3395776
Dummy	-.0669529	.0065413	-10.24	0.000	-.0798042	-.0541016
_cons	.0546559	.0268875	2.03	0.043	.0018317	.10748
sigma_u	.01646069					
sigma_e	.03192857					
rho	.209979	(fraction of variation due to u_i)				
F test that all u_i=0: F(26, 509) = 2.18 Prob > F = 0.0008						

Source: Authors' calculations

The results in Table 3 show that independent and control variables in the model are statistically significant. F test statistics has an adequate level of probability, which shows that all coefficients of variables are different from zero, and have an impact on the dependent variable (in this case, real economic growth rate). It should also be noted that the correlation between variables (independent and control) and residual is different from zero, in this case -0.5623. Its negative value shows that the variables were properly introduced into the constructed model. More specifically, if the independent and control variables effectively determine the value of the dependent variable, then the value of residual (statistical error) is less. Based on the above, it can be concluded that the econometric model is adequate, and reads:

$$(Real\ GDP growth\ rate)_{it} = 0{,}247(Agriculture\ production\ as\ \%\ GDP)_{it} - 0{,}479(Final\ consumption\ expenditure\ of\ general\ government\ \%\ GDP) 0{,}256\ (Gross\ fixed\ capital\ formation\ (investments)\ \%GDP)_{it} - 0{,}067(Dummy)_{it} + 0{,}546 + c_i + u_{it} \quad (2)$$

The results of the model shown in equation 2 point to the conclusion that, by applying *ceteris paribus* clause (with other circumstances unchanged), if a country in the EU27 in one year increases the agriculture production as a % of GDP for one percentage point, it causes increase in real economic growth rate in that year by 24,7 percentage points. The present model is in line with theoretical postulates and the starting hypothesis. The presented model has a coefficient of determination R = 0.3759, which means that it is valid in 37.59% of observations in the EU27 in the period from 2002 to 2021. This has unequivocally confirmed the alternative hypothesis H1.

Hausman test for Endogeneity of the Model

The constructed multiple regression model has started from the assumption that there is a correlation between the residual u_{it} (containing the specific effect of the observed country c_i), on one side, and the independent and control variables, on the other side. Speaking in mathematical terms, $E = (u_{it}|X_i, c_i) \neq 0$. More specifically, multiple regression model with fixed effect has been designed. This means that the specificities of the observed countries have an endogenous character, i.e. represent the internal determinant of real economic growth rate, and are correlated with the independent and control variables. To verify the validity of this assumption, and, therefore, the constructed econometric model, Hausman test is applied. The null hypothesis in this test states that there is no correlation between the residual u_{it} (containing the specific effect of the observed country c_i), on one side, and the independent and control variables, on the other side. In other words, random-effect model should be used. An alternative hypothesis is that the correlation does exist, and that it is a fixed-effect model that is adequate. For this purpose, the random-effect model has been constructed (Table 4), and the test results are presented in Table 5.

Table 4. Regression using random effect

Fixed-effects (within) regression			Number of obs=540			
R-sq: within=0.2982			Number of groups=27			
between=0.3759			Obs per group: min=20			
overall=0.2534			avg=20			
			max=20			
			F (3,509)=54,06			
corr (u_i, Xb)= -0.5623			Prob > F= 0.0000			
Real GDP growth rate	**Coef.**	**Std. Err.**	**z**	**P > | z |**	**[95% Conf. Interval**	
Agriculture production as % GDP	.0504913	.0693423	0.73	0.467	-.0854172	.1863997
Final consumption expenditure of general government % GDP	-.2400944	.0575645	-4.17	0.000	-.3529187	-.1272701

Gross fixed capital formation (investments) %GDP	.2663691	.0366096	7.28	0.000	.1946157	.3381225
Dummy	-.0714343	.0064126	-11.14	0.000	-.0840028	-.0588658
_cons	.0137185	.016016	0.86	0.392	-.0176722	.0451092
sigma_u	.00692184					
sigma_e	.03192857					
rho	.04488886	(fraction of variation due to u_i)				

Source: Authors' calculations

Table 5. Hausman test result

	- Coeficients -			
	(b) fixed	(B) random	(b-B) Difference	Sqrt (diag (V_b-V_B)) S.E.
Agriculture production as % GDP	.2474049	.0504913	.1969136	.1016465
Final consumption expenditure of general government % GDP	-.4793007	-.2400944	-.2392063	.0933471
Gross fixed capital formation (investments) %GDP	.2564649	.2663691	-.0099042	.0211992
Dummy	-.0669529	-.0714343	.0044814	.0012912
b = consistend under Ho and Ha; obrained from xtreg **B = incosistent under Ha, efficient under Ho; obrained from xtreb** **Test: Ho: difference in coefficients not systematic** **chi2 (4) = (b-B) ` [(V_b-V_B) ^ (-1)] (b-B) = 10.72** **Prob>chi2 = 0.0298** **(V_b-V_B is positive definite)**				

Source: Authors' calculations

The result of Hausman test with a probability of 97,2% rejects the null hypothesis, based on which the random-effect model is more appropriate. This clearly suggests that the alternative hypothesis is confirmed. More specifically, there is a correlation between the residual u_{it} (containing the specific effect of the observed country c_i), on one side, and the independent and control variables, on the other side. Speaking in mathematical terms, $E = (u_{it}|X_i, c_i) \neq 0$. This means that the constructed multiple regression fixed-effect model is entirely acceptable.

The research carried out clearly suggests that the increase economic activities in agriculture sector has a significant positive impact on the real rate of economic growth in the EU27 countries from 2002 to 2021.

Conclusion

Research on the relationship between agriculture and economic growth attracted and still attracts a large number of researchers. Agriculture itself occupies a significant

place in the economies of a number of countries, and its contribution to the economy is conditioned by the achieved level of economic growth. In this regard, a large number of economic growth theories have been developed. The fact of particular interest is that in recent years agriculture itself has experienced significant changes as a direct consequence of technological innovations and the concept of sustainable development. Thus, more and more people are talking about multi-functional agriculture. As research on the relationship between agriculture and economic growth mainly focuses on the countries of Asia and Africa, as well as some European countries, note that no comprehensive research has been conducted that would include the EU countries. In order to fill this research niche, the aim of this paper was to analyze the relationship between agriculture and economic growth in EU27 countries, for the time period from 2002 to 2021. This reflects the scientific contribution of this paper. The paper gave a theoretical analysis of the most significant studies on the relationship between agriculture and economic growth. The second part of the paper developed an exploratory multiple regression model with dependent and independent variables, with a focus on EU27 data. The results showed a positive influence of agriculture on the economic growth of the EU27 countries in the analyzed time period. However, this research also has certain limitations that primarily relate to the time period, which could be broader, as well as the inclusion of dependent variables.

Conflict of interests

The authors of this study have no conflict of interest.

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MODERN DECISION-MAKING MECHANISM IN THE PROCESS OF DEVELOPMENT OF SMALL FARMS

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ABSTRACT

The use of multi-criteria decision-making methods can contribute to finding the most rational solution more easily and efficiently. The purpose of the research is to investigate the applicability of the PROMETHEE and TOPSIS methods at the level of family farms and their comparative analysis in the case of the purchase of agricultural mechanization. Both methods start from a set of criteria established based on the subjective expectations of 48 farmers (decision makers) who were asked to choose the decision criteria. Then, mathematical models are used to determine the most suitable choice for the farm. Based on the research findings, it can be concluded that applying both methods in parallel leads to similar outcomes. Although decision support systems can be instrumental in making the right decisions, their usage is still not widely adopted in family farms due to the challenges of introducing new solutions in a production setting.

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Introduction

Agriculture is characterized by multi-criteria decision-making in planning, strategic management and production, and decision-making mainly consists in evaluating a set of possible alternatives and solutions in relation to a defined set of criteria. In the agricultural sector, decision-making problems are usually poorly structured, and the possible decisions are insufficiently defined. It can be concluded that agriculture is a very risky activity in which the risk must be studied every day, and the right decisions must be made. For this reason, the use of multi-criteria decision-making methods can be a powerful tool when making decisions. The optimization problem of plans has to be in the system of modernization agriculture (Bešić, et al., 2022). The goals of the research are what the way of modernity is and, on the other, what the relationship is between modernization and the decision-making process.

Modern production methods require the use of agricultural mechanization, without which efficient and economical agricultural production would not be conceivable today. Agricultural mechanization is a significant symbol of the transformation from traditional agriculture to modern agriculture. The choice of agricultural machinery plays an important role in the management of agricultural mechanization production and directly affects economic benefits (Lu et al., 2022). Mechanization is one of the most important conditions for good and high-quality cultivation of agricultural land. The absence of mechanization, inadequate application, or its poor quality can cause huge negative consequences. Frequent consequences are increased soil compaction, poor execution of processing, sowing and care, mechanical damage to plants and fruits of plants, increased losses during harvesting, performing agrotechnical operations outside of optimal terms, and "pollution" of soil, water, and air with harmful substances from exhaust gases or chemical protection. Excessive soil compaction caused by the mechanical action of the wheel and the working units of agricultural machines disrupts the ratio of air and water in the soil. At the same time, it increases the resistance to the development of the root system of plants and creates very unfavourable conditions for the development of microbiological activity, which has a negative effect on the provision of soil fertility elements: food, water, oxygen, heat, and others. Research has shown that this phenomenon can be alleviated by the application of technical and agrobiological measures, followed by the controlled movement of machinery and reduction of the number of passes. Low-quality and inadequate tillage can reduce yields by 15-25%, while poorly executed sowing can cause a decrease of 10-15%. On the other hand, low-quality mechanization can lead to yields that are half as much. When picking fruits, losses can also be high as a result of machine imperfections or poor operating modes. Losses in wheat can reach 5%, seed corn 7%, sugar beet 8%, and in some vegetable crops, even 20% (Radivojević, 2012).

The market for modern agricultural machinery is extensive and varied, with countless manufacturers, machine types, and varieties. At the same time, the supply of agricultural mechanization, accessories, irrigation systems, and other machinery is continuously expanding. In these circumstances, the following question arises: what

is the most appropriate choice to meet one's needs? Selecting a rational choice can contribute to the best, above-average result. Conversely, choosing a less appropriate option can cause serious negative financial consequences for the agricultural holding. The development of agricultural mechanization not only has an important impact on improving agricultural productivity but also plays a vital role in enhancing crop yield and farmers' quality of life (Fu, Dan, 2014).

Decision support systems can play a crucial role in making the right decision. These procedures allow the decision-maker to find a satisfactory, rational solution. The need for modern management and decision-making mechanisms, however, requires much more than possessing the appropriate data. Of course, we need to know what the situation is, but even more, we need to know what to do. Once modern computers are available - hopefully in the near future - we can solve not only generating, handling, and processing data but also multivariable planning and optimization of planning in a contemporary manner (Cvijanović, Sedlak & Vojinović, 2018; Pantić et al., 2022). We can surely state that exact and comprehensive analysis is inconceivable without such information provided by a model that solves a number of decision types: optimal production structure, gains, technologies, use of resources, shadow prices, sensitivity analysis, assumptions, simulating, and analyzing "what if…" situations, etc. The relationship between optimization and economical regulation in the decision-making mechanism also deserves our attention (Janković et al., 2022; Prdić & Kostić, 2022). Sedlak et al., 2016).

Companies worldwide are focused on two topics: how to modernize their production process and how to modernize the company's decision-making mechanism. These two issues are tightly linked. To have modern management in place, not only must the means of production and the technical level of manufacture be developed, but the decision-making system as well. It should be considered an axiom that modern development can be achieved only through modern decision-making, and this includes modern analysis, flow and processing of information, multivariate planning, and deciding on the optimal version (Ciric et al., 2019).

Multi-Criteria Decision Making is a well-known branch of operations research models that deals with decision problems when several decision criteria exist (Tzeng *et al*., 2007). Nowadays, there are many methods in the field of *MCDM* methods, among which the *PROMETHEE, TOPSIS, ELECTRE* and *AHP* methods can be highlighted (Nedeljković, Puška & Krstić, 2022). All that applies to agricultural production.

Materials and methods

MCDM has a relatively short history; the basics of modern *MCDM* were laid in the 1950s and 1960s (Zavadskas, Turskis & Kildiene, 2014). The rapid growth of this field has been recorded since 1980 (Dyer et al., 1992). *MCDM* involves situations in which the decision-maker needs to choose one alternative from a set of alternatives, which are evaluated based on several criteria. *MCDM* is a decision-making process when

there is a large number of criteria that are usually opposed to each other. This fact is an extremely important step towards the types of problems that should be solved by different methods of multi-criteria decision making. *MCDM* is one of the most important areas of decision-making theory, which is widely applied in solving real-life problems (Bobar, 2014). Furthermore, two methods of multi-criteria decision-making will be presented, as well as their application in solving real problems in terms of buying agricultural machinery.

The basis of the *TOPSIS* (Technique for Order Preference by Similarity to Ideal Solution) method is the definition of ideal and anti-ideal solutions. The method is based on the concept that the chosen alternative should have the shortest distance from the ideal solution and the longest from the anti-ideal one. The ideal solution minimizes the price criteria and maximizes the profit criteria; the reverse situation applies to the minimum ideal solution. The ideal solution is defined by the best rating values of the alternatives for each criterion, and the negative ideal solution implies the worst rating values of the alternatives. The terms 'best' and 'worst' are considered for each criterion separately, depending on whether the criterion is a maximization or minimization one. The optimal alternative is defined as the alternative that is geographically closest to the ideal solution, that is, the one that is farthest from the anti-ideal solution. The ranking of alternatives is done on the basis of the 'relative similarity to the ideal solution,' which avoids the situation of simultaneous similarity of the alternative to the ideal and anti-ideal solution (Chang, Lin, Linz & Chiang, 2010).

PROMETHEE methods (Preference Ranking Organization METHODS for Evaluation) are multi-criteria decision-making methods used to rank a finite number of alternatives. *PROMETHEE* methods were introduced by Professor Jean-Pierre Brans in 1982. The methods are intended for processing quantitative and qualitative data, as well as for treating different scales (Szántó, 2012).

Today there are four types of these methods:

1. *PROMETHEE I,* which results in a partial ranking of alternatives;
2. *PROMETHEE II,* which provides a complete ranking of alternatives;
3. *PROMETHEE III,* which gives an interval order of the alternatives;
4. *PROMETHEE IV,* which is an extension for continuous sets of alternatives (Stanimirović, Stojković & Petković, 2007).

The basis of the *PROMETHEE* method is the use of the criterion function P for all alternatives that have been evaluated using criterion functions. One alternative, for example alternative a_1, is considered better than alternative a_2 based on the function f if the following is true: $f(a_1) > f(a_2)$.

The preference function refers to a single-criterium comparison of alternatives. Based on this function, a multi-criteria index of preference of alternative a_1 over alternative $a_2$is defined.

It is essential to determine the positive and negative flow of some alternative, from which net-flow defines and on the basis of which multi-criteria ranking of alternatives is performed. If an alternative a_1 has a higher net flow, this alternative is considered "better" than alternative a_2. (Brans & Mareschal, 2005)

The multicriteria problem represents as follows: max $\{g_1(a), g_2(a), ..., g_j(a), ..., g_k(a), a \in A\}$, where A is the set of possible alternatives $\{a_1, a_2, \ldots, a_i, \ldots, a_n\}$ and $\{g_1(\cdot), g_2(\cdot), ..., g_j(\cdot), ..., g_k(\cdot)\}$ is the set of criteria.

As with the previous method, every criterion in decision matrix needs to be assigned the appropriate weight w_j. Theset of criterion weights defines the relative importance of the criterion during decision-making.

PROMETHEE methods are based on comparing each pair of alternatives for each of the selected criteria. In this way, the decision-maker has the opportunity to assign a preference to one of the alternatives. Preferences can have a value in the interval of 0 to 1. The greater the value, the higher the preference. This specifically implies that the decision-maker analyzes a certain function of preference for each criterion.

The application of the *PROMETHEE* method consists of two basic steps:

1. construction of the relation of preference in the set of alternatives *A;*
2. incorporating that relation to respond to the problem.

In the first step, a complex relation of preference is determined (to emphasize the fact that this relationship is based on applying more criteria, this routing is called outranking relation. The preference index is defined and the complex relation of preference is formed, which is displayed using the preference chart. The aim of the first step is for the decision-maker to show their preferences between two alternatives, according to each of the criteria, based on the difference in the value of the alternatives they want to compare. The formed relation of preference is used in that way to calculate the input and output flow in the chart for each alternative. In order for the method to function, it is necessary to determine the general type of criteria for each individual criterion.

Results and Discussion

In this paper, it is assumed that the agricultural farm wants to expand its production, therefore the primary goal is to choose the appropriate and the best mechanization based on criteria (Table 2.).

In addition to defining alternatives, it is necessary to determine criteria on the basis of which the best alternative will be selected. After researching the market and collecting the necessary data, 48 farmers, decision makers, were asked to choose the decision criteria (10 out of 32). Regarding the importance of certain characteristics of mechanization, decision makers assigned scores on a Likert scale from 1 (least importance) to 10 (highest degree of importance) for each criterion. The general average rating of all decision makers according to all criteria was 7.54. When looking

at the surveyed experts individually, the lowest overall score was 3.41, and the highest was 9.80. The distribution of general average scores of 48 decision makers does not deviate significantly from normal flatness (flatness measure K=3.11) but is significantly negatively asymmetric (asymmetry measure S= -0.95), so it does not follow a normal distribution (Jarque-Bera statistic is JB=12.66, p=0.002). Due to the deviation from the normal schedule, finding the extreme value in the general average ratings of individual decision-makers was performed with a non-parametric test, i.e. IQR (Interquartile Range). The lower limit for the extreme value was 3.26, and the upper limit was 12.01. Since the minimum and maximum value shown above belong to this interval, it follows that no extreme value was detected, the average rating of any decision-maker does not deviate significantly downwards or upwards from the others, so it was not necessary to exclude the answers of individual respondents from further data processing. The internal consistency of the survey was checked using Cronbach's α coefficient. It was concluded that the ratings assigned in the survey meet the condition of consistency and are a suitable basis for analysis and application in further research. A higher α value indicates a higher degree of internal consistency, an acceptable level is greater than or equal to 0.6, values greater than or equal to 0.8 are considered good, while values greater than or equal to 0.9 reflect excellent internal consistency of the survey. α-coefficients on the criteria are shown in *Table 1*.

Table 1. Values of α

Criteria	α	Degree of internal consistency
Market price (EUR)	0.94	excellent
Engine power (kW)	0.86	good
Manufacturer's reliability	0.88	good
Euro standard	0.88	good
Delivery time (days)	0.82	good
Max speed (km/h)	0.90	excellent
Pump capacity (l/min)	0.87	good
Lifting power (kg)	0.87	good
Front weights (kg)	0.86	good
Soil-protecting and environmentally friendly	0.90	excellent

Source: Authors' calculations based on data obtained from the decision makers

Table 2. Initial data for application of TOPSIS i PROMETHEE method

	Market price (EUR) MIN	Engine power (kW) MAX	Manufacturer's reliability MAX	Euro standard MAX	Delivery time (days) MIN	Max speed (km/h) MAX	Pump capacity (l/min) MAX	Lifting power (kg) MAX	Front weights (kg) MAX	Soil-protecting and environmentally friendly MAX
Mechanization 1	21588	42.3	5	3	14	29	48.5	2.200	80	very low
Mechanization 2	29988	54	5	3	14	30.41	48.5	2600	300	high
Mechanization 3	23990	57.8	4	4	0	33.4	45	3500	900	average
Mechanization 4	25190	60	4	4	0	33.4	45	3200	360	high
Mechanization 5	24590	60	4	4	0	33.4	45	3200	200	low
Mechanization 6	45600	65	3	3	14	40	48	2500	160	very high
Mechanization 7	29940	58.8	2	3	0	40	35.2	2610	300	high
Mechanization 8	32340	66.5	2	3	60	40	35.2	3200	300	high

Source: Authors' calculations based on data obtained from the decision makers

One of the criteria that is very important for the author is soil-protecting and environmentally friendly tillage systems, as it contains elements of the circular economy. They are as follows:

- Central loosening system: It can be used to improve the condition of deeper soil layers, mitigate cultivation errors and environmental damage. Its economic benefit is the improvement of the safety of crop cultivation, and the reduction of quantitative and qualitative losses related to the effect of drought due to the elimination of the compact state. The first element of the system is shallow, mulch-free stubble stripping that reduces moisture loss. Thus, the soil does not dry out even in the dry season, and loosening can be carried out to the planned depth;
- Cultivator system: The agronomic and indirect economic benefit of the system is the preservation of the soil structure, which can be fully utilized if the condition of the root zone is not compacted. An essential element is mulching, which helps prevent the soil from drying out and improves its workability. It is suitable for maintaining the favorable condition in the year following relaxation. Dusting and mixing elements are built-in front of, behind, or between the rows of harrows of modern cultivators. The advantage of the cultivator system is that the number of passes can be made independent of the moisture content of the soil. Cultivation that leaves mulch and reduces moisture loss is more important on dry and moist soil. Damage to the structure can be safely prevented even on wet – even arable – soil;
- Disc system: Its application risk can be reduced by adapting to the condition of the soil. In the gentle cultivation system, the function of the disc is stubble stripping and basic cultivation, in both cases combined with cultivation. The sparing of

the soil structure of the flat disc dusters is similar to that of the cultivators. Due to the dusting, the traditional discs with spherical glass plates do not meet the requirements for structural protection. It is definitely recommended to use a roller in the same pass as dialing to seal the dialed area;

- Streamlined plowing systems: The purpose of these systems is to maintain plowing, the method favored by farmers, to prevent typical errors, and to reduce cultivation and environmental risks. Plowing must not increase erosion, deflation, soil compaction, lumpiness, and dustiness. The emission of carbon dioxide, the reduction of organic matter, and the disturbance of the habitat of earthworms can also be controlled in plowing systems. A plowing system can be rationalized by reducing the frequency, rotation damage, risk associated with its time, the number of processes between plowing and sowing without loss of quality, and the total number of passes.

In addition to the soil- and environment-friendly cultivation methods, the least expensive yet effective agrotechnical element, the reasonable, professionally thought-out crop rotation, should definitely be mentioned. Even before we start cultivating our soils with one of the above-mentioned technologies, we should think about the range of plant species we want to grow and their succession in the same area (Fazekaš, Bobera, & Ćirić, 2017).

In application of ***TOPSIS*** method the first step in solving a given problem is to define the criteria for the selection of agricultural mechanization (as shown in *Table 1*.).

The next step is to transform qualitative indicators into quantitative ones using a measurement scale from 1 to 5 (*Table 3*.).

Table 3. Data evaluation in the application of TOPSIS method- mechanization

Criteria	Initial data	Weight	Value	Detailed data
(C1) Market price (EUR)	Very high	Very low	1	≥ 45.000
	High	Low	2	30.000 ≤ x < 45.000
	Average	Average	3	25.000 ≤ x <30.000
	Low	High	4	22.000 ≤ x < 25.000
	Very low	Very high	5	<22.000
(C2) Engine power (kW)	Very low	Very low	1	<50
	Low	Low	2	50 ≤ x < 55
	Average	Average	3	55 ≤ x < 60
	High	High	4	60 ≤ x < 65
	Very high	Very high	5	≥ 65
(C3) Manufacturer's reliability	Not reliable	Very low	1	1
	Under-average reliable	Low	2	2
	Average reliable	Average	3	3
	Reliable	High	4	4
	Very reliable	Very high	5	5

Criteria	Initial data	Weight	Value	Detailed data
(C4) Euro standard	Very low	Very low	1	1
	Low	Low	2	2
	Average	Average	3	3
	High	High	4	4
	Very high	Very high	5	5
(C5) Delivery time (days)	More than one year	Very low	1	182 <
	Several months	Low	2	30 < x ≤ 182
	Several weeks	Average	3	14 < x ≤ 30
	Several days	High	4	0 < x ≤ 14
	No waiting	Very high	5	0
(C6) Max speed (km/h)	Very small	Very low	1	<25
	Small	Low	2	25 ≤ x < 30
	Average	Average	3	30 ≤ x < 35
	Big	High	4	35 ≤ x < 40
	Very big	Very high	5	≥ 40
(C7) Pump capacity (l/min)	Very small	Very low	1	<35
	Small	Low	2	35 ≤ x < 42
	Average	Average	3	42 ≤ x < 45
	Big	High	4	45 ≤ x < 48
	Very big	Very high	5	≥ 48
(C8) Lifting power (kg)	Very small	Very low	1	<2300
	Small	Low	2	2300 ≤ x < 2600
	Average	Average	3	2600 ≤ x < 3200
	Big	High	4	3200 ≤ x < 3500
	Very big	Very high	5	≥ 3500
(C9) Front weights (kg)	Very small	Very low	1	<100
	Small	Low	2	100 ≤ x < 200
Criteria	**Initial data**	**Weight**	**Value**	**Detailed data**
(C9) Front weights (kg)	Average	Average	3	200 ≤ x < 300
	Big	High	4	300 ≤ x < 400
	Very big	Very high	5	≥ 400
(C10) Soil-protecting and environmentally friendly	Very low	Very low	1	1
	Low	Low	2	2
	Average	Average	3	3
	High	High	4	4
	Very high	Very high	5	5

Source: Authors' calculations

The third step is to determine the weight of each criterion (*Table 4.*).

Table 4. Presentation of weights of criterion in the TOPSIS method - mechanization

Criteria	Weights of criterion
C1	0.18
C2	0.1
C3	0.13
C4	0.14
C5	0.05
C6	0.08
C7	0.05
C8	0.07
C9	0.05
C10	0.15

Source: Authors' calculations

The next step is to normalize the decision matrix to obtain a normalized matrix *a* as $R=[r_{ij}]_{mxn.}$ After that have to multiply the normalized matrix by weight coefficients. This step is realized through the formula: $v=w_j \times r_{ij}$; $i = 1, ..., m, j = 1, ..., n.$ The sixth step is to determine the ideal A^+ and ideal negative A^- solutions. The next step is to calculate the distance of all alternatives from the ideal and anti-ideal solution. The eighth step is to determine the relative closeness of the alternatives to the ideal solution (*Table 5.*).

Table 5. Display of the relative closeness of individual alternatives to the ideal solution – mechanization

Alternatives	RC
Mechanization 1	0.631
Mechanization 2	0.559
Mechanization 3	0.715
Mechanization 4	0.537
Mechanization 5	0.638
Mechanization 6	0.388
Mechanization 7	0.492
Mechanization 8	0.447

Source: Authors' calculations

The last step is to rank the alternatives using the *TOPSIS* method. Based on the calculated values of the relative closeness of alternatives to the ideal solution, the best alternative can be determined. According to the presented table and the performed analysis, the tractor with the highest value, i.e., **Mechanization 3**, achieved the best result, followed by **Mechanization 5** in second place and **Mechanization 1** in third place. **Mechanization 6** occupied the last place.

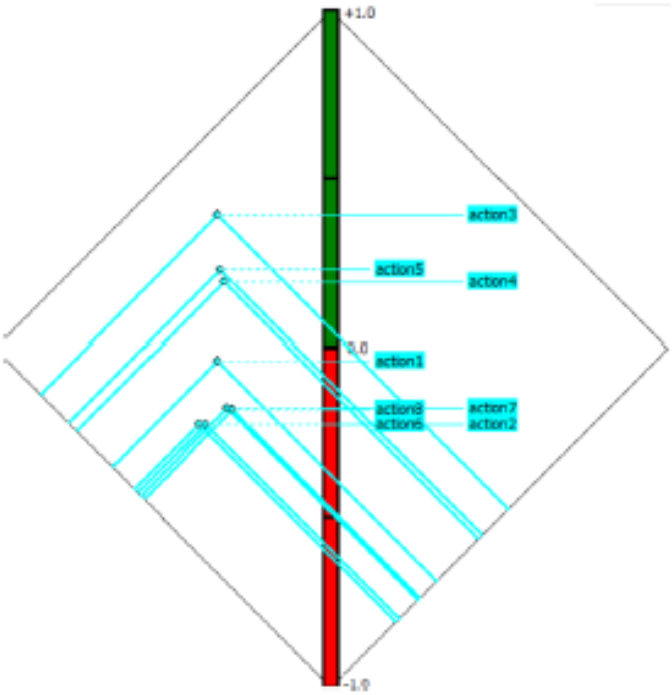
PROMETHEE method is applied using softwer Visual Promethee (Promethee & Gaia Software, 2020). In the application of *PROMETHEE* method four types of criteria are used: normal, level, linear, and criterion of shape V.

The *normal* criterion was applied to the criteria "Market price", "Engine power", "Euro Standard" and "Delivery time" because the agricultural economy strictly prefers the lowest possible price and delivery time, as well as the highest engine power and the highest level of the Euro standard. The criterion *level* was applied to the criteria "Manufacturer's reliability" and "Soil-protecting and environmentally friendly", because the data were ranked from 1-5. The *linear* criterion was applied in the case of the criteria "Pump capacity", "Lifting power" and "Front weights" because there are both preference and indifference thresholds in this case. The *criterion of shape V* was applied to the „Max speed" criterion. In this case, there is a preference threshold of 5 units of measure, which implies that if the difference between the alternatives becomes greater than that value, the farm will strictly prefer that alternative.

After selecting the preference and indifference threshold for individual criteria, the weights of the criteria are determined. In this case the same weights were taken as when applying the *TOPSIS* method, i.e., 0.20; 0.10; 0.15; 0.15; 0.05; 0.08; 0.05; 0.07; 0.05 and 0.1. As the last step, it should be determined whether it is a *MAX* or *MIN* criterion. Of course, agriculture prefers the minimum possible price and delivery time, while for other criteria it wants to get the highest possible value.

Then the program calculates and obtains the most rational possible alternative. The results obtained can be presented in the Figure 1.

Figure 1. Solution of the problem in Visual Promethee, diamond – mechanization



Source: Author in software Visual Promethee

The closer the action is to unity, the more desirable it is. Based on the solution, it can be concluded that the best alternative is alternative number 3, followed by alternative number 5, then alternative number 4, i.e. **Mechanization 3**, **Mechanization 5** and **Mechanization 4**. The last place is occupied by **Mechanization 6** when applying this method.

After detailed analyzes and explanations of the *TOPSIS* and *PROMETHEE* methods in the previous two chapters, it is necessary to summarize their results and the decisions that should be made based on them.

The *TOPSIS* and *PROMETHEE* methods are applicable for analysis sets of elements and ranking alternatives. They assume the existence of multiple attributes that are used as criteria. Both methods enable the aggregation of qualitative and quantitative criteria of different importance. However, an important difference is that for the *PROMETHEE* method to work, it is necessary to select the types of general criteria, whereas with *TOPSIS*, there is only one type of criterion, and there is no choice of criterion type.

This is the main reason why these two methods do not necessarily give the same solutions. It is possible to obtain one alternative as preferable with one method and another alternative with another. With the *PROMETHE*E method, the result largely depends on the type of general criterion that is chosen, while the *TOPSIS* result depends on the weighting coefficients and the farmer's preference of one criterion over another.

The first method selects the best possible solution from all methods. It can be concluded there is only a small deviation between individual methods due to the large number of clearly defined alternatives. Differences in ranking occur due to the existence of criteria types, preference, and indifference threshold in the *PROMETHEE* method, which were not used at all in the case of *TOPSIS.*

Conclusions

Multi-criteria decision-making is a complex process with diverse applications in all segments of human activity. One of the more significant areas of application is actually the agricultural sector, for the reason that all participants involved in the agricultural production system make different, complex decisions on a daily basis. This paper presents the application of two multi-criteria decision-making methods that represent a realistic picture of the inclusion of decision-making methods in the agricultural sector. Using the *TOPSIS* and *PROMETHEE* methods is a very important tool in solving complex decision-making problems. With the help of these methods, the most efficient and profitable solution can be found in a simple way, that is, the most adequate alternative when purchasing different agricultural machinery.

Mechanization is certainly one of the most important conditions for good and high-quality soil cultivation and for more profitable products. If there is an absence of mechanization, if it is not applied adequately, or if its quality is poor, the consequences can be significant. Versatile and high-quality mechanization is a condition for successful production on large areas. For this reason, multi-criteria analysis has become indispensable in planning their purchase.

The mechanism of spreading something "modern" is worth studying to understand how modern solutions are being implemented in agriculture. In this context, questions arise such as: How long does it take for a new and modern procedure, technique, machine, work, or production plant organization system to be implemented in our fields? If we lack resources to modernize everything at the same time, how do we choose among the possible solutions? The flow of information and orientation is vital in the mechanism of spreading modern and contemporary achievements.

Farms choose among new solutions based on their own resources. However, introducing a new solution in a production plant can be challenging. The problem lies in the fact that a novelty does not always increase profits, and it may even lead to losses. Yet, production plants still choose to introduce something new, even if it will not increase profits. This is a new mixture of necessary and free course decisions. Farms assume the introduction of a new thing against some other advantage: the farm will be granted a loan for the novelty, but also for some other things. New solutions should be tested and experimented with, and support is needed for that. This is also one possible way of support, although a bit complex. Farms assume it because of their good reputation, because they want to be proud of finding avant-garde solutions in the economy. Farms assume it because they believe that later it will be profitable.

The research work showed that by applying one of the two methods, we can significantly influence the decision maker. Often the alternative that would be chosen at first glance is not the right one. Every participant in the agricultural sector should have knowledge about some methods of multi-criteria analysis. This gives farmers, managers, agronomists and all other employees in the agricultural sector the opportunity to save time, money and energy.

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Conflict of interests

The authors declare no conflict of interest.

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THE ROLE OF INDOOR SMART GARDENS IN THE DEVELOPMENT OF SMART AGRICULTURE IN URBAN AREAS

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ABSTRACT

The increasing global population and urbanization have led to a growing interest in urban farming to provide sustainable food production. Indoor smart gardens, a new form of urban farming, have emerged as an innovative and technology-based solution to urban agriculture. This paper explores the role of indoor smart gardens in modern urban farming and their potential impact on food production, environmental sustainability, and human health. Consequently, comparison was used of traditional outdoor farming vs. indoor smart gardening. Also, a comparative study was conducted using the case study of two leading brands of indoor smart gardens: Aerogarden and Click & Grow. The research's results show that smart gardens have significant potential to revolutionize urban farming practices and address the growing demand for food production in urban areas. Our review of the literature and case study showed that smart gardens can significantly increase food production, improve environmental sustainability, and enhance human health in urban areas.

Introduction

In the modern world, people have come to prioritize technology over nature. That's because advances in technology allow for more convenience and connectivity in our daily living. And while innovation in technology is vital for global progression, nature plays a crucial role in our overall health and happiness as humans. When you need a break from work, and some space to clear your mind, the first place you turn to is the outdoors. That's because being surrounded by nature allows for us to disconnect from

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the hustle and bustle of our busy lives, and reconnect with something calmer, more beautiful, and more peaceful than all that goes on in our urban jungles.

In general, the urban population is increasing, which implies several factors besides the preoccupation with the production of food, which can be enlivened by the participation of society's individuals and public agencies (Dal Moro et al., 2020). On the other hand, the world population is growing rapidly, and by 2050, it is estimated that 68% of the global population will be living in urban areas (UN, 2018). This trend has led to a significant increase in demand for food production in urban areas. Urban farming has emerged as a promising solution to address this demand and ensure food security in urban areas. However, traditional urban farming practices face several challenges, such as limited space, poor soil quality, and inadequate water supply.

Smart gardens have emerged as a new form of urban farming that leverages technology to address these challenges. Smart gardens use sensors, artificial intelligence, and automation to optimize plant growth and improve food production in urban areas. In this paper, we explore the role of smart gardens in modern urban farming and their potential impact on food production, environmental sustainability, and human health. Also, smart gardens have gained popularity in recent years due to their potential to revolutionize urban farming practices. Studies have shown that smart gardens can significantly increase food production in urban areas (Barbosa et al., 2020; Grewal et al., 2021). For example, a study conducted by Barbosa et al. (2020) showed that smart gardens can increase crop yield by up to 80% compared to traditional farming methods.

Smart gardens can also improve environmental sustainability in urban areas. Traditional farming practices often require large amounts of water and pesticides, which can have negative impacts on the environment. Smart gardens use sensors and automation to optimize water usage and reduce the need for pesticides (Koirala et al., 2021). This can significantly reduce the environmental impact of urban farming practices. Smart gardens can also have positive impacts on human health. Studies have shown that exposure to nature can have significant health benefits, such as reducing stress and improving mental health (Bowler et al., 2010). Smart gardens can provide urban residents with access to nature and green spaces, which can enhance their well-being.

Literature review

Modern society is becoming more informed and intelligent with the development of digital technology, in which humans, objects, and networks relate with each other (Woo, Suh, 2021). Indoor smart gardens have gained significant attention in recent years as a potential solution for sustainable food production in urban areas. This literature review aims to examine the role of indoor smart gardens in the development of smart agriculture in urban areas. Our agricultural system has a gigantic task ahead, by 2050 it will need to increase food production by about 70% in order to meet the needs of a global population of 9.7 billion people, 68% of whom are projected to live in urban areas (Cerro, 2022). Presently, 38% of the planet's unfrozen land is used for growing food,

using 70% of our water consumption (Cerro, 2022). Numerous studies have shown that indoor smart gardens have the potential to increase food production in urban areas. For instance, (Despommier, 2010) notes that indoor farming can produce up to 20 times more crops per square foot than traditional outdoor farming. Additionally, (Graamans et al., 2018) conducted a study on vertical farming, which is a type of indoor smart garden, and found that it could reduce the land use and water consumption associated with traditional agriculture.

Indoor smart gardens can also improve environmental sustainability in urban areas. (Huang et al., 2020) argue that indoor farming can reduce the environmental impact of agriculture by reducing pesticide and herbicide use, minimizing water use, and reducing carbon emissions associated with transportation. Moreover, (Ohyama et al., 2019) found that indoor farming can recycle nutrients and water, leading to a closed-loop system that is highly sustainable. Also, indoor smart gardens have the potential to enhance human health in urban areas. (Lee et al., 2019) argue that indoor farming can improve food security and access to fresh, healthy produce in urban areas. Furthermore, (Soga et al., 2016) found that urban green spaces, including indoor gardens, can improve mental health by providing a sense of calm and relaxation.

Several technological advancements have played a significant role in the development of indoor smart gardens. For example, (Lu et al., 2021) note that the integration of artificial intelligence and machine learning in smart agriculture has improved the precision and efficiency of indoor farming. Furthermore, (Wu et al., 2019) suggest that the use of light-emitting diodes (LEDs) in indoor smart gardens can improve crop growth and yield while reducing energy consumption.

In addition to the environmental and health benefits of indoor smart gardens, they can also provide economic benefits for urban areas. (Koga et al., 2020) argue that indoor farming can create jobs and generate revenue in urban areas, while also reducing the need for importing food from rural areas. Moreover, (Tong et al., 2021) suggest that smart agriculture can lead to the development of new technologies and industries, providing further economic opportunities for urban areas. However, indoor smart gardens also face several challenges. (Jiang et al., 2019) note that high initial investment costs and technological complexity can make it difficult for small-scale farmers to adopt smart agriculture practices. Additionally, (Sanyé-Mengual et al., 2020) suggest that indoor smart gardens may face regulatory barriers related to zoning and land use, which can limit their widespread adoption in urban areas.

The technology development is paving way for the automation to be made to the existing machines leading to the new technology called Internet of Things (Kuppusamy, 2016). But, smart agriculture is not only a technology to ease the human life, but it has rather become a necessity or even a compulsion to cope with rapidly increasing food demand of the world population, which is multiplying itself every second (Bhuvaneswari et al., 2021). Indoor smart gardens have significant potential to contribute to the development of smart agriculture in urban areas, with benefits including increased food production,

improved environmental sustainability, enhanced human health, and economic opportunities. While challenges such as high initial investment costs and regulatory barriers remain, ongoing technological developments and collaborations among stakeholders can help to overcome these challenges and realize the full potential of indoor smart gardens in urban agriculture.

This literature review demonstrates that indoor smart gardens have significant potential to contribute to the development of smart agriculture in urban areas. By increasing food production, improving environmental sustainability, and enhancing human health, indoor smart gardens can play a crucial role in creating more sustainable and livable urban environments.

Materials and methods

To investigate the role of indoor smart garden in modern urban farming, a mixed-methods research design was employed. The research methodology comprised of two main components: a comparative study of two leading brands of indoor smart gardens and a literature review. Also, comparison was used of traditional outdoor farming vs. indoor smart gardening. To conduct the comparative study, two leading brands of indoor smart gardens, namely Aerogarden and Click & Grow, were selected. The study compared the effectiveness of these indoor smart gardens in terms of their ability to grow plants, ease of use, and sustainability. The data collected was analyzed using descriptive statistics to compare the two brands of indoor smart gardens.

To complement the comparative study, a comprehensive literature review was conducted to explore the role of indoor smart gardens in modern urban farming. The review focused on identifying the benefits of indoor smart gardens in urban agriculture, their impact on the environment, and their potential as a sustainable solution to food security. The literature review followed a systematic approach, which involved searching for relevant peer-reviewed articles, books, and reports. The sources used for the literature review were selected based on their relevance and quality. The information obtained from the literature review was synthesized and analyzed to provide a comprehensive understanding of the role of indoor smart gardens in modern urban farming.

Overall, the mixed-methods research design was employed to provide a comprehensive understanding of the role of indoor smart gardens in modern urban farming. The comparative study and literature review were used to complement each other and provide a holistic view of the research problem. The findings of the study and literature review were used to draw conclusions and make recommendations for the future development and use of indoor smart gardens in urban agriculture.

How Does a Smart Garden Work?

The whole world is jumping on the green train, and it's not hard to see why. Countless business all across the planet are revitalizing dull corporate spaces through living green walls, vertical gardens, green accessories, and planted rooftops. Not only does

being in a garden-like environment increase productivity and focus, but it's also been shown to remove air pollutants, normalize temperatures, improve biodiversity, reduce noise, and enhance the overall sense of wellbeing at the office. Climate-proof construction is the future, and by getting your own indoor garden, you're taking the first step towards leaving a better world behind for the unborn generations of tomorrow. Precision home gardening management system may optimize resources utilizations, smart sensors deployment and improves society awareness towards pollution free environment (Sharma et al., 2020). In technical terms, a smart garden is a technological gardening device that is (mostly) run by a computer. These devices often come with an app that can be controlled via your Android or iOS phone. By applying technology in the agricultural sector, it can reduce energy and time wasted due to the application of conventional methods (Hadi, 2020). With the growing pace of time the technology had brought in a great revolution in the world and made our daily life works a lot easier (Singh et al., 2020). Smart gardens are typically designed for indoor use, seeing as they manage their own lighting sources and plant nutrient supply. They also water themselves as needed. Smart gardens give you the ability to effortlessly grow your own fresh produce, or even grow plants and flowers at home.

Depending on what you wish to grow, you can purchase smart garden pods that contain seeds encased in a biodegradable unit. This saves you the hassle of managing messy soil while removing external environmental factors as uncontrollable aspects to consider. While there are different smart garden companies out there, offering different indoor garden designs with varying effort required, the answer to "how does a smart garden work" is standard across the board.

The Setup. When you purchase a smart garden, you'll need to choose which produce or plants you want to grow at home. From edible fruits, vegetables, and herbs, to decorative plants and flowers, your options are bigger than your backyard. Once you have your smart garden, all you really need to do is place the pods in the device, plug it into the wall, and switch it on. For some, you may have to refill the water levels from time to time, whereas others come with an attachable water supply unit.

Starting to Sprout. Depending on which smart garden device you've chosen, your plants will either grow with their roots in water, or both in water and air. While the latter won't make much of a difference to your plant health, some reports suggest that plants that grow with roots in both air and water live longer.

LEDs. All smart gardens are powered by overhead LED lights. These emit specific colors within the light spectrum at different periods of growth. While all of these colors offer exactly the light source these plants would receive from the sun, targeting your plants with specific intensities helps speed up the growing process. For example, the red spectrum of light helps make the photosynthesis process far more efficient and problem-proof.

Timing is Everything. The lamps contained in your smart garden are set to a timer. The standard setting for your smart garden lamp is 16 hours on and 8 hours off. These

specific times mimic the natural day cycle, and provide the perfect amount of light for optimal growing condition.

The science behind smart gardens is as simple as it comes. Plants need perfect lighting, ample water, and a loving environment to thrive. And that's exactly what these indoor gardens provide.

Results and Discussion

Traditional outdoor farming involves planting crops in open fields or plots of land where they are exposed to natural weather conditions, sunlight, and soil. Farmers rely on rainwater and irrigation systems to water their crops, and they use pesticides and herbicides to control pests and weeds. This method of farming requires a significant amount of land and can be impacted by weather conditions, pests, and diseases. In contrast, indoor smart gardening involves growing plants in a controlled environment, often using hydroponic or aeroponic systems. This method of farming allows for year-round growing, uses significantly less water, and allows for precise control of environmental factors such as temperature, light, and nutrients. Additionally, indoor smart gardening can be done in smaller spaces and is less susceptible to weather, pests, and diseases.

Table 1 provides a comparison of traditional outdoor farming and indoor smart gardening across several different factors, including water usage, land usage, pest control, and yield potential. The data in this table shows that indoor smart gardening can be a more sustainable and efficient method of food production in certain circumstances, particularly in areas with limited land or water resources.

The data in this table suggests that indoor smart gardening can be a more sustainable and efficient method of food production in certain circumstances, particularly in areas with limited land or water resources. Indoor smart gardening requires less land and water than traditional outdoor farming, as the closed-loop system recycles water and nutrients, resulting in less waste and runoff. Indoor smart gardens are also less susceptible to pests, reducing the need for pesticides.

Table 1. Comparison of traditional outdoor farming vs. indoor smart gardening

Factor	Outdoor Farming	Indoor Smart Gardening
Water usage	Higher due to natural evaporation	Lower due to closed-loop systems
Land usage	Requires large amounts of land	Minimal land usage
Pest control	May require pesticides	Minimal need for pesticides
Yield potential	Dependent on climate and weather	Consistent and high yield potential

Source: Author's research

However, traditional outdoor farming may have advantages in terms of yield potential and lower energy usage. Outdoor farming can yield larger quantities of crops and is powered by natural sunlight, whereas indoor smart gardens rely on LED lighting, which

can be energy-intensive. Outdoor farming is also more accessible for individuals or communities who have access to arable land and can be a more cost-effective method of food production. Overall, the choice between traditional outdoor farming and indoor smart gardening depends on a variety of factors, including location, available resources, and personal preferences.

Water usage: This factor compares the amount of water needed for traditional outdoor farming versus indoor smart gardening. Outdoor farming typically requires more water due to natural evaporation and the need for irrigation. Indoor smart gardens, on the other hand, use closed-loop systems that recycle water, resulting in lower water usage.

Land usage: This factor compares the amount of land needed for traditional outdoor farming versus indoor smart gardening. Traditional farming often requires large amounts of land, which may not be available in urban areas. Indoor smart gardens can be set up in smaller spaces, such as apartments, and require minimal land usage.

Pest control: This factor compares the need for pest control measures in traditional outdoor farming versus indoor smart gardening. Outdoor farming may require the use of pesticides to protect crops from pests. Indoor smart gardens are generally less susceptible to pests due to their enclosed environment, resulting in minimal need for pesticides.

Yield potential: This factor compares the potential yield of crops in traditional outdoor farming versus indoor smart gardening. Traditional farming is highly dependent on weather conditions and climate, which can impact yield. Indoor smart gardens can provide consistent and high yield potential year-round due to their controlled environment.

Table 2 provides a comparison of plant growth rates for three different crops in traditional outdoor farming versus indoor smart gardening. The data in this table suggests that indoor smart gardening can lead to faster plant growth rates for some crops, which could be an advantage for urban farmers who need to maximize their yield in a limited space.

Table 2. Comparison of plant growth rates between traditional outdoor farming and indoor smart gardening

Crop	Outdoor Farming Growth Rate	Indoor Smart Gardening Growth Rate
Tomatoes	2-3 months	1-2 months
Lettuce	1-2 months	3-4 weeks
Herbs	2-3 months	1-2 months

Source: Author's research

Crop: This column lists three different crops (tomatoes, lettuce, and herbs) that are commonly grown in both traditional outdoor farming and indoor smart gardening.

Outdoor farming growth rate: This column provides an estimate of how long it typically takes for each crop to mature in traditional outdoor farming. The data shows that the growth rates for these crops can vary widely, with tomatoes taking 2-3 months, lettuce taking 1-2 months, and herbs taking 2-3 months.

Indoor smart gardening growth rate: This column provides an estimate of how long it typically takes for each crop to mature in indoor smart gardening. The data shows that indoor smart gardening can lead to faster plant growth rates for some crops, with tomatoes taking 1-2 months, lettuce taking 3-4 weeks, and herbs taking 1-2 months.

Table 3 provides a comparison of energy usage between indoor smart gardens and traditional farming. The data in this table suggests that indoor smart gardens may use more energy than traditional farming due to the need for LED lighting, but may also have lower energy usage in other areas, such as water pumps.

This information could be useful for readers who are interested in understanding the environmental impact of different types of food production.

Table 3. Comparison of energy usa0ge between indoor smart gardens and traditional farming

Factor	Indoor Smart Gardens	Traditional Farming
Lighting	High energy use due to LED lighting	Minimal energy use
Heating/cooling	May require additional energy for climate control	Minimal energy use
Water pumps	Low energy use	N/A

Source: Author's research

Lighting: This factor compares the energy usage of LED lighting in indoor smart gardens versus the minimal energy usage needed for lighting in traditional farming. Indoor smart gardens typically require LED lighting to provide the optimal light spectrum for plant growth. While LED lighting is energy-efficient compared to other lighting sources, it still requires more energy than natural sunlight.

Heating/cooling: This factor compares the energy usage needed for climate control in indoor smart gardens versus the minimal energy usage needed for climate control in traditional farming. Indoor smart gardens may require additional energy for heating or cooling to maintain a consistent temperature, while traditional farming does not require additional heating or cooling beyond natural weather patterns.

Water pumps: This factor compares the energy usage of water pumps in indoor smart gardens versus the lack of water pump usage in traditional farming. Indoor smart gardens typically use water pumps to circulate water in their closed-loop system. While these pumps are energy-efficient, they still require some energy to operate. Traditional farming does not require water pumps, as water is typically delivered to crops through natural rainfall or irrigation.

These tables 3 provide valuable information on the differences between traditional outdoor farming and indoor smart gardening, and can help readers understand the advantages and disadvantages of each approach.

From system and pod costs, to their selection of plant pods, LED lighting systems, noise output, yield, and ease of use, we've compared two of the best smart gardens on the

market, with the aim of investigating their impact on food production, environmental sustainability and human health.

The basic differences between Click & Grow and AeroGarden are reflected in the following characteristics.

- *System Costs.* Keep in mind that prices will vary depending on the size you want your smart indoor garden to be. For a full comparison of models, we suggest checking out each site. But as a base, here are the ranges of the lowest costing model to the highest for each system. Click & Grow offers indoor smart gardens that start at $139.95 for a 3-Pod Model, going up to $2,499.95 for a Wall Farm Indoor Vertical Model. AeroGarden's lowest price model is also a 3-Pod design, but it's valued at $79.95. For their largest, 24-Pod FarmXL, this model is priced at $845.95 (AeroGarden vs Click & Grow: Real Life Review, 2022).
- *Pod Costs*. When it comes to pod prices, these are subject to change based on pod selection. It's important to note that the pod prices between Click & Grow and AeroGarden are incredibly similar, and how much you spend depends on what you'll be growing. As with the system costs, here are price comparisons from the lowest to the highest option. Click & Grow pods range from between $1.85 to $3.32 per pod. AeroGarden's price per pod is between $1.91 and $4.65. (AeroGarden vs Click & Grow: Real Life Review, 2022).
- *Pod Selection.* Here's where the real comparison comes into play. While the system and pod prices for both Click & Grow and AeroGarden aren't all that dissimilar, the system isn't what most buyers are after. If a system works, and can grow plants, then that's all it needs to do. The real determining factor of which smart garden you should buy has to do with what you can grow. Crowning a winner in this category is like comparing apples and oranges. In this case, both companies have a wide selection of fruits, vegetables, plants, herbs, and even flowers to choose from. Depending on personal taste (both visually and in your mouth…) different people will prefer one company over the other. But the main difference between the two is with how they package their selections. Click & Grow is great for buyers who want to order specific types of plants for their systems, while AeroGarden packages their pods in variety packs. So, depending on whether you want to grow one type of plant or many at once, choosing your winner should be easy.
- *LED Lighting System*. Both of these low maintenance gardens are exceptionally bright. And while this may be a big benefit to your plants, you may want to keep these smart indoor gardens in a room that you aren't relaxing or sleeping in after the sun sets. Thankfully, both LED lighting systems are designed to be on for 16 hours a day and off for 8, just like the average person's sleeping patterns. For wattage output, AeroGarden's model has upwards of 10 watts, whereas Click & Grow's LEDs only give off 8 watts.

- *Noise.* Due to the AeroGarden's hydroponic nature, it uses a water pump that works using a motor. Although not deafening, there are significant noise differences for this reason – which makes the Click & Grow system seem completely silent in comparison (because it is).
- *Yield.* Because both systems function off similar principles, the growth speed and results are often incredibly similar. It is worth mentioning that if you're hoping to feed yourself from either of these systems, the smaller models will work just fine. But if you're hoping for your yield to feed your family and friends too, opting for more pots in your unit is a smart idea.
- *Ease of Use.* Click & Grow makes growing plants at home easy enough for the whole family. And while the AeroGarden isn't by any means complicated, it does offer more customization for users. So, if you still want to feel in control of growing plants at home, AeroGarden gives you more of that feeling. However, rest assured that both systems will do the job with very little need to interfere.

A more detailed analysis of the characteristics of these smart gardens requires the use of the latest data obtained directly from the manufacturer. Table 4 presents a summary of the main criteria used to compare the two brands, including plant growth, ease of use, sustainability, and price.

Table 4. Comparison of Aerogarden and Click & Grow Indoor Smart Gardens

Criteria	Aerogarden	Click & Grow
Plant Growth	5-10 times faster than soil	2-3 times faster than soil
Ease of Use	Easy to set up and maintain	Easy to set up and maintain
Sustainability	Uses less water and fertilizer than traditional farming	Uses less water and fertilizer than traditional farming
Price	Starting at $99.95	Starting at $99.95

Source: Aerogarden. (n.d.). Retrieved March 30, 2023, from https://www.aerogarden.com/
Click & Grow. (n.d.). Retrieved March 30, 2023, from https://www.clickandgrow.com/

This table shows that Aerogarden allows for faster plant growth, with plants growing 5-10 times faster than they would in soil. In comparison, Click & Grow allows for plants to grow 2-3 times faster than in soil. Also, both Aerogarden and Click & Grow are easy to set up and maintain.

The sustainability criterion assesses how environmentally sustainable the two brands of indoor smart gardens are. The table shows that both Aerogarden and Click & Grow use less water and fertilizer than traditional farming methods, making them more environmentally sustainable. The price criterion compares the starting price of the two brands of indoor smart gardens. The table shows that both Aerogarden and Click & Grow have a starting price of $99.95.

Overall, the table provides a quick and easy way to compare the main features of Aerogarden and Click & Grow indoor smart gardens, allowing consumers to make an informed decision when choosing between the two brands. Both of these low

maintenance garden systems are incredibly effective, efficient, and easy to use. So, if you want to grow plants at home, both Click & Grow and AeroGarden are smart choices.

Table 5. provides information on some of the key environmental factors that can be monitored in an indoor smart garden, along with their ideal ranges and example values. The first column lists the environmental factor being monitored, such as temperature, humidity, light intensity, CO2 levels, pH level, and nutrient levels. The second column lists the ideal range for each factor, which can vary depending on the specific plants being grown in the smart garden. For example, most plants grow best in a temperature range of 18-26°C (64-79°F), and humidity levels of 50-70%.

Table 5. Environmental Data and Ideal Ranges for Indoor Smart Gardens

Environmental Data	Ideal Range	Example Value
Temperature	18-26°C (64-79°F)	22°C (72°F)
Humidity	50-70%	60%
Light Intensity	Varies depending on plant species, generally 200-400 µmol/m²/s	300 µmol/m²/s
CO2 Levels	800-1200 ppm	1000 ppm
pH Level	Varies depending on plant species, generally 5.5-6.5	6.0
Nutrient Levels	Varies depending on plant species and growth stage	400 ppm Nitrogen, 200 ppm Phosphorus, 600 ppm Potassium

Source: Sarkar, D. J., Sharma, A., & Prasad, R. (2021). Indoor farming technology: Prospects and challenges. In *Sustainable agriculture reviews 47,* Springer, 317-339. https://doi.org/10.1007/978-3-030-61981-1_10

The third column provides example values for each environmental factor. These values are not necessarily ideal, but are intended to illustrate what typical measurements might look like in a functioning smart garden. For instance, a light intensity of 300 µmol/m²/s might be appropriate for growing some types of plants indoors. It's worth noting that the optimal values for each environmental factor will depend on the specific plants being grown, as well as the growth stage of those plants. For instance, different types of plants may require different levels of nutrients at different stages of growth. Therefore, it's important to carefully research the ideal environmental conditions for each plant species being grown in the smart garden, and to use high-quality sensors to accurately monitor these conditions.

Table 6 provides a useful summary of the main benefits of indoor smart gardens in urban agriculture, highlighting their potential to increase sustainability, reduce resource usage, and increase access to fresh produce in urban areas. This table presents the benefits of indoor smart gardens in urban agriculture. The table summarizes the main advantages of indoor smart gardens:

- Year-round Production: This benefit indicates that indoor smart gardens allow for year-round production of fruits and vegetables, regardless of weather conditions or season. This is particularly advantageous in urban settings, where outdoor farming may not be feasible due to space constraints or unfavorable weather conditions.

- Reduced Water and Fertilizer Usage: This benefit highlights that indoor smart gardens use significantly less water and fertilizer than traditional farming methods. This is due to the fact that indoor smart gardens are typically designed to be more efficient in their use of resources, such as by incorporating hydroponic or aeroponic growing systems that use water more efficiently than soil-based systems.
- Space Saving: This benefit emphasizes that indoor smart gardens require less space than traditional farming methods, making them particularly useful in urban settings where space is limited. This is because indoor smart gardens can be designed to maximize vertical space and make use of otherwise unused or underutilized areas, such as walls or corners of rooms.
- Increased Food Security: This benefit suggests that indoor smart gardens can help to increase food security by providing a reliable source of fresh produce that is not dependent on external factors such as transportation or availability. This is particularly important in urban settings where access to fresh produce may be limited, or where food deserts are prevalent.

Table 6. Benefits of Indoor Smart Gardens in Urban Agriculture

Benefits	Description
Year-round Production	Indoor smart gardens allow for year-round production of fruits and vegetables, regardless of weather conditions or season.
Reduced Water Usage	Indoor smart gardens use up to 90% less water than traditional farming methods.
Reduced Fertilizer Usage	Indoor smart gardens require up to 70% less fertilizer than traditional farming methods.
Space Saving	Indoor smart gardens require less space than traditional farming methods and can be used in small apartments or urban settings.
Increased Food Security	Indoor smart gardens provide a source of fresh produce that is not dependent on external factors such as transportation or availability.

Source: Hodges, L., & Grover, R. (2018); Montero, J.I., Pérez-Mesa, J.C., & Aenlle, A. (2017).

What Are the Limitations of an Indoor Smart Garden? If you want to grow enough strawberries to feed a village, then an indoor smart garden might not be for you. Hydroponic gardens offer a relatively small output of plants, making them ideal for small homes and apartments – but the benefits of indoor gardening far outweigh any limitations you might experience. Another reason why people avoid buying indoor smart gardens is that they believe refill seed pods are unaffordable. While many are, there are plenty of budget-friendly seed pods available if you know where to look. The benefits of indoor gardening are truly infinite, giving you the chance to nurture your green thumb and take control of your anxiety for good! Ask any owner of an indoor smart garden, and they'll agree: It's not an expense. It's an investment into physical, mental, spiritual, and emotional wellbeing.

Smart gardens have the potential for future development and growth in urban farming. Advancements in technology and automation can further optimize plant growth

conditions and reduce costs. Additionally, collaborations between urban planners, technology developers, and farmers can create more efficient and sustainable urban farming systems. Furthermore, the integration of smart gardens with other urban systems, such as waste management and energy production, can create a more holistic and sustainable urban environment.

Conclusions

Smart gardens are a promising solution to the challenges faced by urban farming. Urban agriculture faces numerous challenges such as limited land availability, water scarcity, and pollution. In contrast, smart gardens offer a more sustainable approach to growing food in urban environments by utilizing hydroponic or aeroponic systems, which use significantly less water and space than traditional outdoor farming. Moreover, smart gardens allow for year-round growing, which can increase the yield and quality of produce. However, there are challenges associated with smart gardens. One of the main challenges is the high initial investment cost. Setting up a smart garden requires a significant amount of capital investment, including the cost of infrastructure, equipment, and technology. Moreover, the technological complexity of smart gardens may be a barrier for many potential users.

Despite these challenges, smart gardens have the potential to play a significant role in the development of sustainable urban environments. Future development and collaboration can further optimize smart gardens and make them more accessible and affordable. Additionally, research and development can address the technological complexities and make smart gardens more user-friendly. Overall, smart gardens are a promising solution for sustainable urban agriculture and have the potential to transform the way we grow and consume food in urban environments.

The research results indicate that smart gardens have significant potential to revolutionize urban farming practices and address the growing demand for food production in urban areas. The review of the literature and case studies demonstrate that smart gardens can significantly increase food production, improve environmental sustainability, and enhance human health in urban areas. One of the major advantages of smart gardens is their ability to increase food production in urban areas. Smart gardens can produce higher yields per square foot compared to traditional outdoor farming due to their efficient use of resources such as water, energy, and nutrients. Moreover, smart gardens can grow a wider variety of crops year-round, providing fresh and healthy produce for urban communities. Another significant advantage of smart gardens is their potential to improve environmental sustainability. Smart gardens use significantly less water than traditional outdoor farming and can operate with fewer pesticides and herbicides. Additionally, smart gardens can reduce the carbon footprint associated with transporting food from rural areas to urban centers.

Finally, smart gardens have the potential to enhance human health in urban areas. The availability of fresh and healthy produce can improve the nutritional intake of urban

residents, which can help reduce the incidence of diet-related diseases such as obesity and diabetes. Furthermore, the act of gardening has been shown to have mental health benefits, such as reducing stress and anxiety.

In conclusion, the research results demonstrate that smart gardens have significant potential to revolutionize urban farming practices and address the growing demand for food production in urban areas. By increasing food production, improving environmental sustainability, and enhancing human health, smart gardens can help create more sustainable and livable urban environments.

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Conflict of interests

The authors declare no conflict of interest.

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ANALYSIS OF THE USE OF THE CODE OF ETHICS OF AGRICULTURAL ACCOUNTANTS USING QUANTITATIVE METHODS

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ABSTRACT

This paper investigates the possibility of applying the meta theory of strategic games in the domain of the ethical code of conduct of agribusiness accountants. The focus is on the case when an accountant detected incorrect financial reporting by the client's management of material nature. As a generally quantitative method, the model of strategic games in such a case allows to quantify and find a balanced relationship between the interests of management and accountants in the world where, there is constantly sustainable problem of ethics and unethics of accountants, which is an extremely important issue in the agricultural sector, which is a developing branch.

Introduction

International accounting standards and positive national legislative regulations provide frameworks for the methodological corpus of processes of accounting inclusion in business changes. The ultimate goal is for agribusinesses to obtain financial reports that objectively reflect the state of such enterprises without material errors, through the proper inclusion of business changes. If we formalize the process of accounting reporting (Vasić, 2022) to our problem, then we position the following case in the form

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of developing strategies that are the basis for applying the theory of strategic games, namely on the following problem of our research: financial reports are not fairly and objectively presented by accountants and as such are accepted by the management (this is a case where both parties acted intentionally and violated ethical standards). Positioning our subject of the contribution, we will try to apply the Theory of Strategic Games more precisely to the Prisoner's Dilemma model. What are the relations between management and accountants in this case following the fact that only 5% of the total audit reports in Serbia are negative, and that reports with a reserve or a distraction are not of material importance.

Research methodology

The paper uses game theory as a basic method to relate the relationship between management and accountants.

Numerous literature has covered the topic of applying the game theory. We tried to present this theory in a simple way, that can be applied in this research segment as well, as an example when both the manager and the accountant did not comply with ethical codes, using the Prisoner's Dilemma model because corporate social responsibility is present in real business environments (Hohenfels, Quick, 2022; Casey, Grenier, 2015). This game belongs to non-zero sum games for two participants. For such a game, each input must contain a_{ij} and b_{ij} payoffs-benefits for both First (I) and Second (II) player, respectively, corresponding to strategies A_i and B_j.

When using game theory, a game is most often defined as a set of rules and agreements that players must follow (Tošić, 2022). The subject of game theory are conflict situations in which the interests of two or more parties are opposed, so game theory analyzes mathematical models of real conflict situations.

According to the nature and scope of information about the game, there are games with complete and incomplete information. In a game with complete information, each player knows all previous moves and the state of the game with each new move. Games in real conflict situations, especially war games, take place with incomplete information.

According to the rules of the game theory model, the results of the game should be expressed numerically. The simplest game is the one between opponents in which the gain of one side corresponds to the loss of the other side.

In general, players prepare for a game by having good moves available for many expected game situations, which are called strategies. When players have a finite number of strategies, then the game will be finite.

Finite games are presented in matrix forms as in the example.

Table 1. Game model

i / j	1	2	⋯	n
1	a_{11}	a_{12}	⋯	a_{1n}
2	a_{21}	a_{22}	⋯	a_{11}
⋯	⋯		⋯	⋯
m	a_{m1}	a_{m2}	⋯	a_{mn}

Source: Authors' form

Note: Choice of games with P_i

The matrix shows that the player P_1 has m, and that player P_2 has n strategies. When player P_1 chooses *strategy i, then* player P_2 will answer with strategy j. In the intersection of those strategies, there is a coefficient a_{ij} that represents the gain of the player with strategy i, as a result of the conflict with strategy j.

Johann van Neumann has proved the basic theorem – minmax in 1928 while studying game strategies in his paper "Towards a theory of social games" (Mukić, 2014). In his paper he starts from the realistic assumption that players P_1 and P_2 are both intelligent (they adopt a rational game system) and prudent (Hemed, 2022). They show prudence by choosing a strategy for which both of them will obtain the greatest gain. For player P_1 this means choosing a strategy in row i of the matrix with the lowest coefficient. *Min* $a_{ij}=a_{ij0}$ guarantees him a minimum profit. Any strategy that player P_2 plays other than 0 can only increase that gain.

Since player P_1 does not want to take a risk in order to ensure the maximum safe gain, he will choose strategy $i=i_0$ for which:

$$\underset{i}{Max}\min_{j} a_{ij} = a_{i_0 j_0}$$

Since, according to the rules of the game, player P_1's gain is equal to player P_2's loss, as a prudent player he tries to reduce the loss as much as possible. That's why he chooses column j of the payoff matrix, with the expectation that player P_1 will choose strategy i^0 that would mean the biggest loss for P_2, i.e.

$$a_{i^0 j} = \max a_{ij}$$

As a prudent player, P_2 chooses strategy j^0 for which his loss will be the smallest, regardless of player P_1's moves, i.e.

$$a_{i^0 j^0} = \min_{j} a_{i^0 j} = \min_{j}\max_{i} a_{ij}$$

It has been proven for games that the maximum is most often equal to the minimax

$$\max_{i}\min_{j} a_{ij} \le \min_{j}\max_{i} a_{ij}$$

When a case happens that all elements of one column are greater than the elements of another column of a matrix, it can be reduced for that dominant column of the matrix. This is because the dominant strategy is always less favorable for player P_2 and he will never choose it. Dominance reduction certainly simplifies the game.

In order to improve the quality of strategy games and bring them closer to practical problems, it is necessary to analyze the used models and adjust them with real parameters.

Non-zero sum strategy games

The normal form of The Prisoner's Dilemma is:

Table 2. Prisoner's Dilemma

Management	An accountant		
		N	P
	N	3.3	1.4
	P	4.1	2.2

Source: Authors' form

Where N is a plea of not guilty, and P is a plea of guilty. Hypothetically speaking, suppose that an independent audit found beyond dispute that the financial statements were unfairly and falsely presented and the manager and the accountant were reasonably suspected of having committed an ethical violation together. They are guilty and the management and the accountant know it, but it is difficult to prove in the proceedings (Đorđević, 2020) whether the accountant did it knowingly or not, which is analogously true for management, whether he knew about it or not. If management and the accountant admit guilt and do not cooperate with each other, the respective "results-gains" i.e. their punishment will be greater than if they both did not confess (N). This would mean that if they cooperate and if one confesses and the other does not, the "gain-result-punishment" of the one who confesses is greater (he confessed) and for the one who did not confess, the "gain-result-punishment" is also figuratively greater (he did not confess). The dilemma is that no matter what his colleague (manager, accountant) testifies, the suspect (management, accountant) prefers the outcome in case they do not cooperate. When both admit that the reports are false - the result is worse than if both did not admit to unfairly and falsely presenting their financial statement, which is the case where the authorities are involved. A manager can influence employees, including accountants, if he possesses certain abilities (power, knowledge of the nature of people and ability to motivate) (Adžić et al., 2022).

Our case investigates how will management and accountants behave if they are not constrained by any rules, which is the subject of our further consideration. Under the influence of American theory, there is a slogan „leadership cycle", which is orientation, decision-making, realization (Beasley et al., 2021). In this sense, let's assume that the dilemma of the strategic game is actually a conflict between management and the accountant. Each of them has two possibilities before reaching judicial authorities,

which is to escalate or non-escalate the conflict, it must be noted that leadership is considered to be the most studied and least understood phenomenon. (Jestrović, 2021) In this sense, let's take into consideration the conflict situation between management and the accountant, which assumes that both parties are aware of the fact that the financial statements are unfairly and untruthfully presented in the material sense. Both parties have the option to go to court or opt out. If one conditionally speaking escalates (comes into conflict) and the other does not, the one who escalates has won, because he can refer to the fact that he unwittingly generated false reports. If both sides escalate, that means one side says that it unwittingly generated untrue reports, and the other management says that it is impossible to determine the validity of the reports with the given samples, then in the event of a dispute, both sides are worse off. It is a much better strategy for both sides not to escalate the conflict. This can be shown with the Prisoner's Dilemma on the next matrix, where escalation is marked with E and non-escalation with N.

Table 2. Management's and accountant's alternative

		II alternative An accountant	
		N	E
I alternative Management	N	(3.3) non-escalation	(1.4) accountant's win
	E	(4.1) management's win	(2.2) escalation

Source: Authors' form

The basic characteristic of strategy results - escalation or non-escalation - their quantitative indicator (Galjak, 2022) is the relativity of sizes. These sizes are chosen according to the preferences of management and accountants (Vukša, 2019). For example, management prefers winning through non-escalation versus losing through escalation. In further elaboration of the Prisoner's Dilemma, it is necessary to introduce the concepts of individual rationality.

Individual rationality

In a strategic game of two players, result - profit - outcome is determined as rational for player I (player according to the rows of the matrix - management), if the highest value for him is in the column (where each column corresponds to the profit of the strategy from the strategic choice of player II - Accountants for each of the strategies of player I - management). I strategy game corresponds to the gain for each choice of player II – the accountant. A similar definition applies to player II (column player - Accountant). For each player we define a similar rational choice - payoff for each strategy of player I (management) where that strategic game corresponds to that benefit for each choice of player II.

Here an essential question arises when the equilibrium state is reached, i.e. when are the benefits of management and accountants stable? (Garcia-Sanchez et al., 2022)

This balance marks a departure from ethical principles and the acceptance of profit maximization. According to the theory, the Nash equilibrium point (1) occurs when both parties escalate (E-E). It was experimentally established that through multiple iterations a stable equilibrium is more likely to be obtained at the point of non-escalation (N-N). What does the Metastrategic theory say (Mihajlović, 2018), does it confirm that 5% of negative opinions in Serbia, does it confirm meta strategic games with unregulated financial reporting?

Metastrategic games

Metastrategic games show that both escalation and non-escalation are equilibrium points and will produce stable results-gains (achieved by spoken - agreed or unagreed agreement of both sides, management vs accountants) for any of the mentioned strategies. Let us note, which is not the subject of our consideration, that the equilibrium result (N-N) satisfies the concept of group rationality and the growth rate (Ashraf et al., 2020).

When we generalize the original game for the purpose of determining the equilibrium points, we determine all possible ways of reaction of player II (the accountant) to the moves of player I (management). More precisely, the possible reactions of player II to player I's moves are UN ("always non-escalating"), UE ("always escalating in relation to player I's moves"), T ("reciprocated with the same measure", same move of player II as player I), O ("always opposite of I player"). Such a sequence would form the following matrix:

Table 3. Management's and accountant's alternative – Metastrategic games

	II An accountant's meta alternative			
	UN	UE	T	O
I alternative Management	N 3,3 non-escalation	E 1,4 II-win	N 3,3 non-escalation	E 1,4 II - win
	N 4,1 I- win	E 2,2 escalation	E 2,2 escalation	N 4,1 I - win

Source: Authors' form

Player II's alternatives are called meta alternatives, or policies. They constitute a set of all functions from first alternatives relative to second alternatives, i.e. elections. If we look at the Nash equilibrium profits in the matrix, we find that only E-UE (referring analogous to E-E of the first example of the prisoner's dilemma) contains the maximum numerical score in its column (for the first number) and its row (for the second number). Thus, we do not have a new Nash equilibrium.

Let's form a matrix of all combinations between I (management) and II (accountant) strategies for the accountant's meta alternatives.

Table 4. Matrix of combinations

		II-meta alternative			
		AN	NE	T	O
II-meta alternative	NNNN	3,3	1,4	3,3	1,4
	EEEE	4,1	(2,2)	2,2	4,1
	EEEN	4,1	2,2	2,2	1,4
	EENE	4,1	2,2	(3,3)	4,1
	EENN	4,1	22	3,3	1,4
	ENEE	4,1	1,4	2,2	4,1
	ENEN	4,1	1,4	2,2	1,4
	ENNE	4,1	1,4	3,3	4,1
	ENNN	4,1	1,4	3,3	1,4
	NEEE	3,3	2,2	2,2	4,1
	NEEN	3,3	2,2	2,2	1,4
	NENE	3,3	2,2	(3,3)	4,1
	NENN	3,3	2,2	3,3	1,4
	NNEE	3,3	1,4	2,2	4,1
	NNEN	3,3	1,4	2,2	1,4
	NNNE	3,3	1,4	3,3	4,1

Source: http://www.math.rs/p/files/16-TI2020.pdf

In this matrix there are three equilibria - one refers to the relation E-E as in the previous one, and the other to two cases for the relation N-N (underlined row). This case represents a key policy for I - player escalating against any other player's policy, except strategies (T - retaliation). This policy EENE and policy T (retaliation in kind) for player II is an equilibrium and leads to unique non-escalation. The remaining second pair is NENE for I - player and T (reciprocity) for the II - player. By choosing these policies, players can reach an equilibrium in relations. It is essential to identify that the current strategy is available to the opponent and to recognize that policy can and should be formulated by each player, and both players will strive to achieve an equilibrium outcome (Bogavac et al., 2021). The target strategy of EENE, as well as NENE, manifests the profit orientation and the devastation of the ethical behavior of accountants and management, indicating that "turning a blind eye to untrue and non-objective financial reports" signifies the poor position of the accounting profession (Nadoveza, 2022) in the agro-industrial complex.

Conclusions

Our research and application of the Prisoner's Dilemma model shows us that the accountant is a rational economic agent, i.e. profit maximizer, as we treated him in our case as an ethical subject of an oriented rational individual. The results of the model analysis indicate that the accountant, apart from negligible recklessness and incompetence, has a stronger impulse to maximize profit. Often, the variables that express change management, as well as activities aimed at research and innovation, show a connection with the variable expressing conflict resolution. A reasonable

assurance procedure, which provides reasonable but not absolute assurance that material misstatements will be detected. An accountant can avoid material errors, but in some cases he is not able to. We have analyzed precisely the case where the account can avoid material errors, but that due to striving to maximize profit and his fear of losing a client, he is blocked. Then there is the case when both management and the accountant know that financial reports are unfair and untrue. It is the case that indicates the Prisoner's Dilemma in the case of Metastrategic games, where opportunities are created for both parties to defend their positions by creating one of the possible equilibria on a given hypothetical example, which leads to de-escalation of cases (3,3) for EENE, and the case of NENE with values (3,3), which correspond to both participants of the games.

Conflict of interests

The authors declare no conflict of interest.

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PROMOTION ON THE INTERNET AS A FUNCTION OF AGRIBUSINESS DEVELOPMENT IN CENTRAL SERBIA

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ABSTRACT

The advancement of information technologies during the past several decades has excelled, especially those that are applicable to all aspects of human activity. The aim of this paper is to determine the views of agricultural product producers in Central Serbia on e-business, with a focus on determining the perception of the promotional potential of the Internet itself. As social media networks, play an increasing role in e-business globally, the intention is to emphasize the importance of their use in order to promote various agricultural and food products. The survey included a final sample of 92 respondents. The basic hypothesis in this paper is that the Internet as an e-business technology has great potential for improving the position of farmers and producers, but also that it is not used in its full potential. The results confirm the aforementioned hypothesis, while the conclusions are directed towards the necessity of education in order of getting to know the benefits of e-business, as well as the advantages of promotion via social networks.

Introduction

This research was conducted in order to examine the connection between some of the leading topics in agribusiness, namely how many farmers in Central Serbia use the Internet in their everyday business, what attitude they take towards promotional

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activities on social networks, and which (if any) of the social networks they use for advertising and selling their goods. E-business is an area that includes all of the aforementioned segments, but also many other aspects of business in today's market, however, the focus of this research is on general attitudes within e-business, as well as on determining the perception of social networks for promotional purposes, i.e. discovering preferences in relation to their choices. Therefore, the purpose of this research is to determine the views of farmers on promotion via social networks, as well as opinions on the advantages of e-business. The research is based on the perceived advantages of e-business is limited to the general opinion about this way of organizing business activities, without entering into questions related to the perception of specific techniques of business improvement using Internet technologies and excluding farmers' attitudes on promotion on social networks. This is also a limitation of the research, that shall be explained in the second part of the conclusion.

The Internet has proven its capabilities to many individuals and organizations in the promotion of their products, but also in other business segments (Grubić, et al., 2013). 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 (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; Prdić & Kostić, 2022) is directly related to this. The field that deals with this topic, Internet marketing and promotion, is the segment of e-business, that has social networks as a key tool. Internet marketing, as well as promotion on the Internet, which is a part of it, is a relatively new concept in the agribusiness sector and to farmers, when it comes to the use of modern digital technologies in order to create marketing strategies for promotin and selling of their goods. The goal of using the Internet in this market is to make the process of promotion, sale, distribution and purchase of agricultural products easier and more efficient. Using modern technologies, agricultural producers can quickly expand their customer base, reach a wider audience and strengthen their competitive advantage in a short period of time. Promotion via Internet plays a major role in this, as it includes the potential of social networks, and in a broader sense, relevant Internet and mobile technologies as well as other technological approaches in customer relationship management processes (Ratković et al., 2013). This paper will discuss "Internet marketing" through its key segment, which is promotion via social networks, in the context of the market of food and agricultural products in Central Serbia.

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). 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). In other words, although the

characteristics of agricultural products largely determine the choice and application of key marketing instruments, promotion is a segment that can always be realized via Internet, if the target audience is on this channel. The key goal of Internet promotion is to represent brands, create preferences and increase sales (Bojkić, et al., 2016).

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). Social networks provide effective ways of quickly and cheaply reaching a large number of potential customers, which makes them an attractive choice for the promotion and sale of agricultural goods. While the Covid-19 pandemic was ongoing, the possibility of ordering products via the Internet and social networks became even more attractive, which directly implies the importance of their integration into marketing strategies, and as part of the overall e-business.

Literature review

By adequate strategic planning, agriculture in Serbia can give a significant contribution to the economic development of the country. Agriculture encourages employment, takes a significant part in foreign trade, provides a food security of citizens, contributes to rural development (Leković et al., 2020) and ecological balance.

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 stress that application of prevention measures is of a particular importance in order to protect the crops from negative effects of climate changes. In addition to the above-mentioned, it is required to provide small and medium agricultural households a greater availability of knowledge, technique and technology and funding.

In a context of contemporary social changes some authors (Ćirić et al., 2018) state that there is a connection between innovativeness of a farmer and their acceptance of the Internet and social media. The authors mentioned state that if the farmers are more open for new ideas and they try out new products, services and technologies, then they shall have less resistance to changes of habits and thus their usage of Internet and social media is higher. The results of the study mentioned (Ćirić et al., 2018; Pantić et al., 2022) show that farmers are mainly interested in Facebook and YouTube, and their intensified usage is expected. Instagram and Twitter are the networks that still aren't widely accepted among farmers and they are used by those farmers with the highest innovativeness level and desire to try out new things.

In a similar survey in conducted Croatia (Cerjak, Tomić, 2014; Sofronijević & Kocić, 2022) the results have shown that only 18.3% of surveyed businesses sell their own products over the Internet. According to respondents, the main reason for not using Internet sales is the lack of interest of customers for this way of shopping. The share of web sales in total sales, among 65.4% of business entities that offer the possibility

of selling products via the Internet, is only 15%. Among business entities that offer the possibility of selling products via the Internet, 69.2% of them offer the possibility of Internet banking. The research results show that the surveyed business entities are aware of the advantages and necessity of Internet business, as well as the use of e-marketing, and therefore should use this way of business more, in practice. The main limitation, according to the respondents, is the ignorance of business partners, which creates a need for education of subjects within the agricultural sector and related activities, as well as consumers, on the topic of the possibilities and advantages of e-business. One third of India's population is directly or indirectly dependent on agriculture, making it an agricultural country. Having more than 30.02% contribution in the GDP, agriculture plays a significant role in the Indian economy. In the last two decades, all industries have gone digital. Following the same way in marketing, organizations have started selling their goods on e-commerce platforms. Promotional activities have began developing on social networks, such as e-mail, website, messages etc. Realizing the convenience, effectiveness and efficiency of digitization, the Indian government has promoted the use of technology in the organizational function, although it seems somewhat inconvenient to use these types of technologies in unorganized sectors like agriculture (Shrikant, et al., 2017).

The potential of using the Internet in agribusiness is very great (Tsekouropoulos, et al, 2011), however there are still many problems regarding it. Numerous studies (White, et al., 2014; Alavion et al., 2017; Bhalchandra Balkrishna & Deshmukh, 2017) have confirmed that the adoption of e-marketing and Internet technologies in agriculture is a necessity for local farmers, because in this way information regarding agricultural products can be available to a very large number of potential buyers and without a direct role in buying and selling. In all mentioned studies, it is recommended to accelerate the adoption of Internet marketing, and that its advantage and potential for the users should be demonstrated. Finally, in order to speed up the adoption of Internet promotion, users should be educated on the subject of familiarization with ways of integrating different platforms such as video presentations and workshops.

In Serbia, it is planned to introduce the "eAgrar" system by the end of 2023. The website of the Ministry of Agriculture, Forestry and Water Management, states that the introduction of this information system will enable agricultural farms to function more simply in terms of registration, submission of requests for approval of current incentives, faster payment, etc. It is expected that farmers will get significantly closer to e-business in the part of business they have with the state system, as well as funds through which they can secure significant financial resources that they can use and apply for through this information-administrative system. It maz be assumed that, by becoming familiar with the mentioned benefits, farmers will be more ready to accept other segments of e-business. According to data from 2019, the share of agricultural production in Serbia's GDP is 4 times higher than in other European Union countries, which is 6-7%. However, it is assumed that this is due to insufficient development of other production activities. In Table 1, we see data on agricultural holdings in the Pomoravlje and Šumadija districts.

Table 1. Data on agricultural farms in the Šumadija and Pomoravlje regions

Region1	Number of farms	Used agricultural land (ha)	Arable land and gardens (ha)	Orchards (ha)	Vineyards (ha)	Meadows and pastures (ha)
Šumadija region	26.941	111.974	75.165	9.971	772	23.682
Pomoravlje region	24.990	92.223	70.883	3.914	1.217	14.970
Total	51.931	204.197	146.048	13.885	1.989	38.652

Source: RZS, 2019

In one study (Ristić, Obradović, 2017), in the total number of agricultural farms in the Pomoravlje region (24,990), the share of family farms is dominant (24,887), as well as in the Šumadija region, where out of a total of 26,941 agricultural farms, 26,838 are family farms, and 26,838, whereas legal persons and entrepreneurs are only 103 each in both areas, with 300 employees each in 2012. When it comes to the level of training of farmers, agricultural experience gained through practice dominates, with most often completed secondary school that is not in the field of agriculture. Other profitable activities, apart from agriculture, are engaged in by about 12% of agricultural farms in the Šumadija region and 7% of farms in the Pomoravlje region, mostly processing agricultural products.

Method

The framework of this research is determined by the terms e-business, Internet promotion and social networks. An important segment of Internet promotion today is social networks, while the Internet promotion itself is an important part of e-business. These key terms are placed in the above-mentioned relationship solely to illustrate their importance, while the ultimate focus of the research is on determining the perception of promotion through social networks and the general attitude of agricultural producers from Central Serbia on the topic of e-business.

The purpose of this paper is to determine the attitudes of agricultural producers from Central Serbia towards e-business, as well as to determine their perception towards the use of social networks in the promotion of agricultural products, and the space for business improvement through this segment of Internet marketing. The main goal of this paper is in accordance with the aforementioned, and refers to presenting the potential of using social networks in the promotion of agricultural products. An additional goal is to present the importance of e-business as a complementary way in relation to the traditional ways of doing business for agricultural producers in Central Serbia.

Based on a sample group of 92 respondents, owners and holders of agricultural farms, we wanted to find out how familiar they are with and how much they use the benefits of Internet promotion via social networks, as well as how much and which social networks they use to promote and sell their agricultural products. Additionally, the focus of the research is on discovering the attitudes of the same respondents about e-business in

general. The research was conducted in the period from October to November of 2022, on the territory of Central Serbia. The sources of data are primary and secondary, while the level of presentation of research conclusions is based on a descriptive analysis. The survey was used to collect primary data, which was sent to 126 email addresses that were obtained with the help of the "Young Farmers of Serbia" association. The positivity of the attitude was measured through five-point Likert rating scales in which the respondents assessed how interested they were in e-promotions through social networks, as well as what attitude they had about e-business.

Bearing in mind the trends in the area of Internet promotion, then the initiative of implementing certain segments of e-business through the „eAgrar" system on the territory of the Republic of Serbia, but also the advantages of social networks in the context of supporting the promotion and sale of agricultural products during the pandemic, along with the set goals of this research, the following hypotheses have been established:

H1: Agricultural producers in central Serbia do not sufficiently use the capacities of social networks for the purpose of promotion.

H2: Agricultural producers from central Serbia have a positive attitude towards e-business as a way of organizing their business activities.

The Sample

The survey was sent to 126 addresses and the correct form of answers was submitted by 92 respondents, of which 54 respondents were male and 38 were female, i.e. more males 58.7% compared to females 41.3%. All of the respondents are also owners of the land they work on, and when we look at the length of time the farm has been in operation, it is noticeable that a large number answered up to 10 years since its establishment, or 82.6 percent, and only 16 respondents answered that their farm has existed for more than 10 years. years, or 17.4 percent. When it comes to whether work on the farm is done independently or with the help of the family, it is approximately the same, i.e. 41 respondents or 44.6 percent answered independently, and 51 or 55.4 percent answered with the help of the family (Table 2).

Table 2. Presentation of the structure of the sample according to the sociodemographic characteristics of the respondents

Sociodemographic characteristics		**Number**	**Percentage**
Gender	Male	54	58.7
	Famale	38	41.3
Years of farmwork	up to 10 years	76	82.6
	over 10 years	16	17.4
Independently or with family	independently	41	44.6
	with family	51	55.4

Source: Author's research

Results and discussion

Agriculture has been the base of economic development for centuries and is still an integral part of a well-functioning economy. The role of agriculture in GDP is particularly important in developing countries, where it plays a key role in providing food and employment.

Modern agribusiness integrates the application of modern management tools and techniques, advanced technologies, sustainable solutions, and support from the government in the form of incentives and strategic support (Bešić, et al., 2022). In some researches (Lio, Liu, 2006; Maurseth, 2018, Dukić-Mijatović, 2022) the conclusion was reached, that the use of up- dated industrial inputs in agricultural output is dependent on an information and com- munication infrastructure. There is a statistic regarding the inline of higher economic growth with higher Internet access (Suroso, et al., 2022).

The results from Table 3 show that a large number of respondents, 73 or 77.17 percent, would accept e-business as the only way of doing business, which is confirmed by the answers to the question "does e-business contribute to better business?". As many as 72 respondents or 78.26 percent answered "agree" or "completely agree" that e-business can contribute to better business. The respondents see the only barrier to the adoption of e-business in the safety and reliability of this way of doing business, as many as 49, while 6 respondents have no opinion on this issue. This would mean that the respondents are not familiar with the elements of e-business integration in terms of security, which implies the need for education on this topic.

Table 3. Presentation of the distribution of respondents' answers to questions in the questionnaire

Questions		Number	Percentage
Would you accept e-business as the only way to do business?	Yes	73	79.3
	No	19	20.07
e-business contributes to better business	I don't agree at all	7	7.61
	I do not agree	3	3.26
	I neither agree nor disagree	10	10.87
	I agree	40	43.48
	I completely agree	32	34.78
e-business is safe and reliable	I don't agree at all	24	26.09
	I do not agree	25	27.17
	I neither agree nor disagree	6	6.52
	I agree	18	19.57
	I completely agree	19	20.65

Source: Author's research

We applied the X^2 test to identify the association between the gender of the respondents and the answer to the question: "Would you accept e-business as the only way of doing business?" X^2 (1, N=92)=11.025, p=0.001. The data show that men, to a greater extent than women, believe that it is possible to do business only via e-business (Table 4).

Table 4. Would you accept e-business as the only way of doing business

Gender	N	Yes	No	X^2	p
Female	38	37	1		
Male	54	36	18	11.025	.001
Total	92	73	19		

Source: Author's research
Note: N- number of respondents, x2 statistic, p-statistical significance

For the purpose of the research, five different social networks Facebook, Twitter, Instagram, Pinterest, LinkedIn, own website and the answer option "other" were singled out. The intention is to find out which social networks the respondents use and to what extent.

Table 5. Social network you use to promote your products

	Very rarely	Quite rarely	Neither rarely nor often	Quite often	Very often
Facebook	8.8%	9.2%	2.1%	39.13%	52.17%
Twitter	88.04%	10.87%	1.09%	/	/
Instagram	91.30%	5.43%	3.26	/	/
LinkedIn	75%	11.96%	5.95%	/	/
web portals	17%	97.78%	3.26%	6.52%	3.26%
Other	36.96%	51.09%	4.35%	5.42%	2.17%

Source: Author's research

As can be seen in the Table 5, the vast majority of respondents advertise their products on Facebook. Of these, 36 (39.13%) respondents answered "quite often", and even 52.17% answered "very often". Other social networks are used little, and it is noticeable that the use of own web pages is very small. And research in other countries (López-Becerra, et al., 2016; Fernández-Uclés, et al., 2020) confirms the above-mentioned, that the use of web portals should be greater, and in some cases it is insufficiently used.

Internet marketing in agriculture is a great way for farmers to increase their visibility. By using modern technology, farmers can create social media-based Internet promotion strategies to reach a wider audience and strengthen their competitive advantage in a short period of time. For example, in one research (Ilić-Kosanović, et al., 2019), the vast majority of respondents agree that the use of ICTs can be a useful resource for acquiring knowledge about organic production methods. The insufficient use of information technologies and tools is explained by the inadequate network infrastructure of the elderly population, or the lack of education. The conclusion is that internet technology is suitable for small farmers and helps in all activities, interaction, accessibility and fast exchange of data.

Based on the obtained results, it is particularly emphasized that Internet security is an important factor in the adoption of e-commerce. The above data are confirmed by other

researches, e.g. the Government of India attempted to connect farmers across the country through an electronic platform in 2016. It has been observed that lack of participation and awareness among farmers, information literacy, sense of security, as well as lack of advisory services still represent a bottleneck for the implementation of marketing institutions and the adoption of e-marketing in agriculture (Damodar, et al., 2022).

Conclusion

There are various techniques that the agricultural industry can use to promote their products and services through social media. One approach is through sponsored content, where ads are placed next to users' daily activities where they can be easily seen. Platforms such as Facebook, Instagram and Twitter are commonly used for sponsored content advertising, as they have large user bases and are designed for shorter content, making them ideal for this purpose.

Similarly, social media can be used to interact directly with customers and potential customers. Through posts and comments, the industry can get instant feedback from those interested in their products and services and quickly answer any questions they may have.

Numerous studies, presented in this paper, confirm that using the website, agricultural producers can inform their customers about their current offer and introduce them to new products. In addition, they can use these websites to create loyalty programs such as discounts for regular customers or special offers for referrals. By running promotions and giveaways, they can get in touch with their customers and generate interest in their products.

Thus, respondents positively evaluate e-business in general, but perceive a certain degree of uncertainty and reliability towards this way of doing business. Also, the data show that men, to a greater extent than women, believe that it is possible to do business only via e-business. Based on other answers, but also the fact that the state imposes certain e-administration systems, as well as overall trends in the acceptance of certain actions via the Internet by the population, it can be assumed that, with the condition that farmers are better informed and educated, e-business will to be much more prevalent than before in Serbia as well. In addition, and with the aim of more successful positioning on the networks and in general in the Internet environment, it is necessary to adapt the methods of promotion to the characteristics of different target groups. Great attention should be paid to the older generations, who are less computer literate than the younger ones.

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. In addition, the results show that a small number of agricultural producers from central Serbia have their own website, which can be one of the places to improve future promotion and sales.

Based on the data obtained, the respondents mostly use Facebook in their business, while a very small number of them have and use their own web sites for business, it can be concluded that the hypothesis H1: *Agricultural producers in central Serbia do not sufficiently use the capacities of social networks*, has been confirmed. Also, it can be concluded that hypothesis H2: *Agricultural producers from central Serbia have a positive attitude towards e-business as a way of organizing their business activities*, has been confirmed. The data show that men, to a greater extent than women, believe that it is possible to do business only via e-business.

Limitations and recommendations

In addition to the fact that this research does not cover the segments of e-business, but only the general opinion about it, it is not possible to give guidelines on the direction of education of agricultural producers. In accordance with the mentioned limitations, it is recommended that further research deepen the mentioned topics, and that in accordance with the received answers, the researchers arrive at a more precise situation about the perception of social networks, as well as about e-business.

Conflict of interests

Authors declare no conflict of interest.

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DYNAMICS AND INTENSITY OF STRUCTURAL CHANGES IN AGRICULTURAL OUTPUT: THE CASE STUDY OF THE REPUBLIC OF SERBIA

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ABSTRACT

Agriculture as a primary sector is constantly subject to structural changes – adjustments in product features, production and consumption, technology, size of farms and agricultural holdings, manufacturing models, etc. Given the most dramatic changes occurring in the production sector, structural changes in agricultural output are precondition for understanding country's food production and food security. Accordingly, the paper analyses the agricultural output in the Republic of Serbia in the period from 2007 to 2019. The aim of the research is to examine an intensity and dynamics of structural changes, in order to determine the most dynamic agricultural branches and period when these changes are the most intensive. The research has been conducted using Michaely Index and Lilien Index as the indicators of structural changes. Research results can be beneficiary for policy makers in developing a strategy, aiming to ensure food security and further development of key agricultural branches.

Introduction

Economic development of a country, reflected in a change of sectors' relative importance in the economy, implies reallocation of resources from agricultural to other activities. While majority of authors agree that productivity growth leads to these transformations, there is still not consensus is technological progress more important in agriculture or in industry

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(Boehlje, 2013). Considering the absolute importance of agriculture in the economy of a country, understanding key driving forces of structural changes is crucial (Johnston, 1990). Those determinants are diverse and complex, including: demand changes, invention of new products and processes, technology, financial and value chain forces, human capital performances, farm life cycle, etc. (Kenneth et al., 1992).

Agriculture in Serbia traditionally plays a vital role in the national economy. In addition to its main role in providing food and raw materials for industry, agriculture in Serbia still employs a significant part of rural population and thus alleviates higher unemployment in rural area. Agricultural products with their significant share in the balance of payment, mainly in export of Serbia, notably contribute to the economic development of the country. Beside its economic importance, agriculture has a key social role reflected in ensuring the living standards of population and in reducing poverty (Ćurčić at al., 2021).

The paper evaluates agricultural output of the Republic of Serbia in terms of dynamic and intensity of structural changes in agricultural goods output (crop and animal production) and agricultural services. The aim is to determine the most dynamic and intensive changes of agricultural output, as well as years when these changes occur. The research results can serve as guidelines for economic and agriculture policy makers to focus on the most dynamic and intensive agricultural branches and encourage a development of others.

The paper is structured in four parts. The first part deals with the theoretical background and literature review on structural changes and their driving forces. Research methodology and research questions are defined in the second part. The empirical analysis and discussion of the research results are elaborated in the third part. The last part is dedicated to concluding remarks and recommendations for improving the efficiency of agricultural production in Serbia.

Literature review

Changes in the structure of production and employment, during the development process of certain sectors at the expense of others, were recognized as a feature of modern economic growth by economists Forasti and Simon Kuznets (Raiser et al., 2003). Both authors observed, based on historical data of industrialized countries, a decline in the relative importance of agriculture, a rapid growth of industry and a gradual increase in the significance of the service sector in the economy as a pattern of development.

Clark, Kuznets and Sirkin (Alvarez-Cuadrado, Poschke, 2011) have documented a process of structural changes: a decline in the share of agriculture in total income and employment, followed by a long-term increase in per capita income. As an example, among other analyzed countries, they stated that in the US economy in 1800, three quarters of workers were employed in the agricultural sector when agriculture recorded almost more than half of the total income. Two hundred years later, only 2.5% of the total workforce is engaged in agriculture, and the share of agricultural production in GDP has fallen to just 1%. Over the course of these two centuries, per capita income in the US has increased by almost more than 25 times (Alvarez-Cuadrado, Poschke, 2011).

Structural changes between the primary and secondary sector can be explained by two models. Lewis (1954) develops a *"laborpull"* model indicating that capital accumulation in the modern industrial sector reflects wage growth in urban areas and attracts extra labor from agriculture (Alvarez-Cuadrado, Poschke, 2011). Reinvestment of profits maintains the continuity of the process. Harris and Todaro (1970) confirmed through a two-sector model that rural-urban migration results from a positive difference between the expected urban income and agricultural output per worker. These theories indicate that productivity in industry affects income growth and leads to structural changes. In this case, higher earnings in industry attract lower paid workers or unemployed population from agriculture to industry (Alvarez-Cuadrado, Poschke, 2011). On the other hand, some of theorists find the agricultural productivity as one of the driving force of structural changes. Nurks emphasizes that the spectacular industrial revolution would not have been possible without prior agricultural revolution (Alvarez-Cuadrado, Poschke, 2011). Progress in agriculture enabled solving the food problem so resources could be reallocated from primary to secondary sector, and this model is known as "*laborpush"*. Additionally, movement of labor force from agriculture to non-agricultural activities can be also affected by reduction of reallocation costs (Ashraf, Öztürk, 2012). It is assumed that the equilibrium in the labor market is established by equalizing the marginal labor product in agriculture and marginal labor product in non-agricultural activities increased by reallocation costs. Those costs include costs of gaining additional working skills in non-agricultural activities, costs of migration from rural to urban environment, etc. (Lu, Lin, 2013).

Huge differences in the productivity level between sectors in the economy are mostly recognized in developing countries as indicators of allocative inefficiency that reduces general labor productivity. However, this inefficiency can also be considered as an important driving force (Comin at al., 2021). When labor and other resources are moved from less to more productive activities, the economy grows even when there is no productivity growth within the sectors. This type of development structural changes can significantly contribute to the economic growth (European Commission, 2014). Highly developed economies have experienced this kind of structural changes. Big polarity in development between Asian countries on one hand and African and Latin American countries on the other, stems from a variant contribution of these structural changes to the overall economic development. Structural changes in African and Latin American countries rather led to a slowdown in economic growth at the end of the 20th century (McMillan, Rodrik, 2011). It is also considered by Diao, McMillan and Rodrik (2019) that growth acceleration is reflected in rapid growht in productivity within sector (Latin Amirica) or in structural changes that contribute to the growth (Africa), but very rear in both at the same time.

The dual economic model, developed by Arthur Lewis, emphasis the distinction in productivity between rural (traditional) and urban (modern) sectors (McMillan, Rodrik, 2011). Though, the distinction in productivity can also exist within the sector. The gap can occur as well among firms and their facilities within the same sector.

Another theory that deals with structural changes in agriculture is the "*polarization theory*", with its roots in the time of Lenin. Back in the 1960s, Lenin pointed to rapid

development of rural capitalism, disappearance of small scale farmers and polarization of agrarian structure. However, there are contrary opinions to what this theory advocated that the so-called small farmers are more resistant to changes (Djiirfeldt, Gooch, 2002). The polarization theory starts from the hypothesis that those who can accumulate capital (big scale farmers, capitalists) are able to turn their wealth into land and property alienated from less successful farmers. Nevertheless, relevant research and practice of numerous countries have not confirmed that the agrarian structure was polarized in the way predicted by theorists. Namely, the survival of small and medium-size farmers can be explained in a different way from large-size farmers. They ensured a certain degree of independence from the market, both in terms of production and consumption, by hiring workers from their families on farms. In that way, they were spared from frequent market fluctuations, especially during the crisis period (Djiirfeldt, Gooch, 2002).

Structural changes in agriculture were constant when it comes to the number of agricultural holdings and their size. Parallel to the decrease in number, although less proportionally, the size of agricultural holdings grew. Agricultural ventures have also changed over time (Comin at al., 2021). Agriculture uses inputs, finance, processing, packaging and transport services that come from outside the agricultural enterprises. Although the number of both agricultural and industrial enterprises is decreasing, the timing of their reduction does not coincide. Decrease in the number of agricultural enterprises preceded the decrease in the number of industrial enterprises associated with them (Johnston, 1990). Structural changes in agriculture, followed by advanced agricultural technologies, financial challenges, etc. resulted in adjustment in advisory services as well (Radić at al. 2022). More often, especially with new information and communication technologies, a crucial role in technology diffusion have farmer communities and virtual networks (Norton, Alwang, 2020, Calicioglu at al., 2021). Despite all changes, agriculture, as the sector related to the people essential needs, still present a stabilizer in the economy, contributing to the economic growth and supporting employment in rural areas (Loizou et al. 2019).

Methodology and research questions

Changes in the sectoral structure of the economy, along with changes within its sectors, can be examined by several statistical methods available in the relevant literature from this field (Monda, Standaert, 2019; Pardez, Alston, 2019; Dietrich, 2012). The subject of the analysis, given the three-sector model of the economy, is to measure the sectoral transformation between two points in time, aiming to calculate a structural change index for agricultural sector.

With this aim, two indicators have been applied and elaborated in the research. The fist indicator has often been used in the research due to the smooth implementation. *Norm of Absolute Values (NAV)* is also known in theory as Michaely-Index or Stoikov-Index (Dietrich, 2012).

$$NAV_{s,t} = 0.5 \cdot \sum_{i=1}^{n} \left| x_{[it]} - x_{[is]} \right|$$

where:

NAV_{st} – Norm of Absolute Values or Michaely-Index for the given time frame, respectively between period s and period t,

x_{it} – share of the agricultural branch in the overall agricultural output at the end of period (t)

x_{is} – share of the agricultural branch in the overall agricultural output at the beginning of period (s).

In order to calculate the *Norm of Absolute Values*, the differences between the share of branches in agricultural output for the given time frame need to be calculated, and then add up the absolute value of those differences. Given the double calculations of all changes, standardization in this method takes place by dividing with two, resulting with NAV. As for the Norm of Absolute Values, the size of structural changes equals to the share of branches' movements as a percentage of the agricultural output.

The value for this index ranges between 0 and 1. The unchanged structure will result with the value 0. On the other hand, in the completely transformed structure of the agricultural output the value of NAV equals 1 (Dietrich, 2012).

The second most often applied indicator of structural changes is *Lilien-Index.* Aiming to measure the structural change where "x_{it}" indicates the share of the sector "i" in the period "t", this indicator requires certain conditions to be fulfilled (Dietrich, 2012):

(1) The index has to be equal zero due to the unchanged sectoral composition:

$$SCI_{[s,t]} = 0 \Leftrightarrow x_{i_s} = x_{i_t} \forall i \in \{1,...,n\}$$

(2) Structural changes between two periods (two points in time) need to be independent regarding the change direction, given the relevance of the only scope of changes. Accordingly, the structural change index depends only on the scope of changes and remain the same regardless of whether the changes between period s toward period t have been analyzed, or vice versa (from period t towards period s):

$$SCI_{[s,t]} = SCI_{[t,s]}$$

(3) Structural changes of one period in time cannot be greater than sum of calculated structural changes of at least two sub-periods:

$$S_{[s,t]} \leq S_{[s,q]} + S_{[q,t]} \text{ for } s < q < t.$$

(4) The index should be a measure of dispersion;

(5) Index should take into consideration the sector size.

When it comes to the evaluation of structural changes in agricultural output, Lilien index

measures standard deviation of the growth rate of agricultural output, from period s to period t.

$$LI_{s,t} = \sqrt{\sum_{i=1}^{n} x_{[it]} \cdot \left(\ln \frac{x_{[it]}}{x_{[is]}} \right)^2}, x_{[is]} > 0, x_{[it]} > 0$$

where:

$LI_{s,t}$ – Lilien-Index for the certain time frame, i.e. between period s and period t,

x_{it} – share of the agricultural branch in the overall agricultural output at the end of the period (t)

x_{is} – share of the agricultural branch in the overall agricultural output at the begging of the period (s).

Given that Lilien-Index does not fulfill the conditions (2) и (3), a slight modification of the index was carried out in order to meet all the aforementioned conditions for the index of structural changes. Thus, the index was increased by the weighted participation of the sector in both periods. The influence of the sector i has grown proportionally to its size, but also proportionally to its relative growth. Modified Lilien-Index (MLI) is as follows:

$$MLI_{s,t} = \sqrt{\sum_{i=1}^{n} x_{[is]} \cdot x_{[it]} \cdot \left(\ln \frac{x_{[it]}}{x_{[is]}} \right)^2}, x_{[is]} > 0, x_{[it]} > 0$$

Considering the previously elaborated methodology, the research goal in the paper is to comprehensively evaluate structural changes in agricultural output of RS in the thirteen years' period, focusing on intensity and dynamics of those changes. The information base of the research are data available in the publications of the Statistical Office of the Republic of Serbia (Statistical Yearbook and Economic Accounts for Agriculture). Following the main goal, the research questions are:

1) Have the structural changes in agriculture of Serbia been reflected in the same degree of intensity among crop, animal production and agricultural services?

2) Have the structural changes in agriculture of Serbia intensified over the analyzed period, contributing to its smoother adjustment to the changed market environment?

3) To which extent the intensity match direction and speed of structural changes in agricultural output, as well as in crop and animal production?

Research results and discussion

The research results have been divided into two parts in accordance with the main research goal: direction and intensity of structural changes. The information base for the both parts, respectively Michaely-Index and Lilien-Index is the value of agricultural goods and

services, reflected in the value of crop and animal production and value of agricultural services. Therefore, when calculating these indexes, x_i indicates the participation of a certain agricultural branch in the total production value of agricultural goods and services.

The agricultural output at producers' prices for the period from 2007 to 2019, that represent the bases for evaluation of structural changes in agriculture of RS, are presented in table 1. According to these data, agricultural services are 2-3% of total agricultural output in Serbia in the whole analyzed period, while crop production accounts for two third and animal production for one third of agricultural goods output.

Table 1. Agricultural output at producers' prices of the current year, 2007–2019

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Agricultural output	330,174	417,832	407,851	466,811	519,960	502,684	565,521
Agricultural goods output	320,756	407,406	396,221	455,753	509,125	491,597	552,079
Crop production	217,274	278,825	265,101	328,981	359,103	324,451	378,833
Cereals	90,749	134,575	110,384	146,733	175,221	138,325	174,602
Industrial crops	26,549	32,309	30,737	44,619	46,655	52,806	51,487
Forage plants	12,761	14,147	14,586	17,601	17,184	18,693	16,626
Vegetables and horticultural products	22,585	24,879	28,753	42,903	27,246	28,986	27,375
Tomato	8,318	8,314	9,747	17,695	17,870	12,342	19,102
Fruits	33,929	39,324	37,040	41,159	50,860	53,932	61,567
Wine	21,796	24,758	33,316	17,873	23,713	18,925	27,535
Other crop product	587	521	538	399	355	443	540
Animal productions	103,482	128,581	131,119	126,772	150,022	167,146	173,246
Animals	69,001	87,759	95,853	89,606	102,774	113,463	118,893
Cattles	21,439	24,736	26,670	24,797	29,059	31,377	32,407
Pigs	32,955	46,734	51,192	45,392	48,768	58,642	60,983
Equines	129	118	105	61	61	377	203
Sheep and goats	6,524	6,771	7,363	8,516	9,315	7,801	8,121
Poultry	7,954	9,401	10,523	10,839	15,572	15,266	17,179
Other animals	34,482	40,822	35,266	37,166	47,248	53,684	54,353
Milk	25,352	30,397	25,480	26,943	34,212	36,777	38,018
Eggs	8,288	9,704	8,649	8,608	10,810	14,678	13,395
Other animal products	842	721	1,137	1,615	2,226	2,229	2,940
Agricultural services	9,418	10,426	11,630	11,058	10,834	11,087	13,443

Source: Statistical Yearbook 2003-2020 & Economic Accounts of Agriculture, Statistical Office of the Republic of Serbia

Note: The last years have not been included considering the changed methodology of agricultural production in the Statistical Yearbook since 2020

Table 1. Agricultural output at producers' prices of the current year, 2007–2019 (continued)

	2014	2015	2016	2017	2018	2019
Agricultural output	584,300	534,780	589,818	543,747	589,704	605,291
Agricultural goods output	569,276	520,966	574,818	529,890	574,704	589,978
Crop production	390,748	351,927	419,400	357,056	398,514	414,529
Cereals	178,776	139,584	164,832	113,760	157,004	158,829
Industrial crops	54,393	48,501	58,940	59,443	62,531	63,157
Forage plants	23,688	17,553	27,063	20,985	28,649	33,557
Vegetables and horticultural products	28,813	35,588	40,579	32,538	26,097	31,554
Tomato	13,025	13,642	13,892	11,687	13,218	11,805
Fruits	56,880	73,670	74,991	76,995	68,816	67,045
Wine	34,621	22,795	38,569	42,112	41,579	48,249
Other crop product	552	595	535	538	620	533
Animal productions	178,528	169,038	155,418	172,834	176,190	175,450
Animals	123,133	111,012	104,281	120,478	114,530	121,969
Cattles	32,114	31,703	30,353	31,040	33,687	32,412
Pigs	65,765	57,098	54,272	66,199	57,503	63,583
Equines	151	77	367	383	36	320
Sheep and goats	10,108	8,971	5,998	8,416	8,299	10,612
Poultry	14,995	13,163	13,291	14,441	15,006	15,043
Other animals	55,396	58,026	51,137	52,356	61,660	53,481
Milk	38,459	37,310	35,048	35,388	44,261	37,192
Eggs	14,971	15,507	13,741	14,504	13,357	13,559
Other animal products	1,966	5,209	2,349	2,465	4,042	2,730
Agricultural services	15,024	13,814	15,000	13,856	15,001	15,313

Source: Statistical Yearbook 2003-2020 & Economic Accounts of Agriculture, Statistical Office of the Republic of Serbia

Note: The last years have not been included considering the changed methodology of agricultural production in the Statistical Yearbook since 2020

Based on the agricultural output data, for the purpose of analyzing the intensity of structural changes in agriculture, Michaely-Index has been calculated for the whole thirteen years' period (2007-2019), for two sub-periods (2007-2012, 2013-2019) and for each year individually (table 2).

Table 2. The intensity of structural changes in agricultural output of Serbia, based on the Michaely-Index (Norm of Absolute Values - NAV)

	2008-2007	2009-2008	2010-2009	2011-2010	2012-2011	2013-2012	2014-2013
Agricultural output							
Agricultural goods output	0.00357	0.00356	0.00483	0.00285	0.00122	0.00171	0.00194
Crop production	0.00925	0.01732	0.05474	0.01410	0.04520	0.02445	0.00114
Cereals	0.04723	0.05143	0.04368	0.02266	0.06182	0.03357	0.00278
Industrial crops	0.00308	0.00196	0.02022	0.00585	0.01532	0.01400	0.00205
Forage plants	0.00479	0.00190	0.00194	0.00466	0.00414	0.00779	0.01114

	2008-2007	2009-2008	2010-2009	2011-2010	2012-2011	2013-2012	2014-2013
Vegetables and horticultural products	0.00886	0.01096	0.02141	0.03951	0.00526	0.00926	0.00091
Tomato	0.00529	0.00400	0.01401	0.00354	0.00982	0.00923	0.01149
Fruits	0.00865	0.00330	0.00265	0.00964	0.00947	0.00158	0.01152
Wine	0.00676	0.02243	0.04340	0.00732	0.00796	0.01104	0.01056
Other crop product	0.00053	0.00007	0.00047	0.00017	0.00020	0.00007	0.00001
Animal productions	0.00568	0.01376	0.04992	0.01696	0.04398	0.02616	0.00080
Animals	0.00105	0.02499	0.04307	0.00570	0.02806	0.01548	0.00050
Cattles	0.00573	0.00619	0.01227	0.00277	0.00653	0.00512	0.00234
Pigs	0.01204	0.01367	0.02828	0.00345	0.02287	0.00882	0.00472
Equines	0.00011	0.00002	0.00013	0.00001	0.00063	0.00039	0.00010
Sheep and goats	0.00355	0.00185	0.00019	0.00033	0.00240	0.00116	0.00294
Poultry	0.00159	0.00330	0.00258	0.00673	0.00042	0.00001	0.00471
Other animals	0.00674	0.01123	0.00685	0.01125	0.01592	0.01068	0.00130
Milk	0.00403	0.01028	0.00476	0.00808	0.00736	0.00593	0.00141
Eggs	0.00188	0.00202	0.00277	0.00235	0.00841	0.00551	0.00194
Other animal products	0.00082	0.00106	0.00067	0.00082	0.00015	0.00076	0.00183
Agricultural services	0.00357	0.00356	0.00483	0.00285	0.00122	0.00171	0.00194
NAV (Agricultural output)	**0.00357**	**0.00356**	**0.00483**	**0.00285**	**0.00122**	**0.00171**	**0.00194**
NAV (Crop production)	**0.00463**	**0.00866**	**0.02737**	**0.00705**	**0.02260**	**0.01222**	**0.00057**
NAV (Animal production)	**0.00284**	**0.00688**	**0.02496**	**0.00848**	**0.02199**	**0.01308**	**0.00040**
NAV (Agricultural services)	**0.00179**	**0.00178**	**0.00241**	**0.00143**	**0.00061**	**0.00086**	**0.00097**

Source: Authors' calculations

Table 2. The intensity of structural changes in agricultural output of Serbia, based on the Michaely-Index (Norm of Absolute Values - NAV) (continued)

	2015-2014	2016-2015	2017-2016	2018-2017	2019-2018	2012-2007	2019-2013	2019-2007
Agricultural goods output	0.00012	0.00040	0.00005	0.00005	0.00014	0.00647	0.00153	0.00323
Crop production	0.01067	0.05299	0.05441	0.01913	0.00906	0.01262	0.01496	0.02678
Cereals	0.04495	0.01845	0.07025	0.05703	0.00384	0.00032	0.04634	0.01245
Industrial crops	0.00240	0.00924	0.00939	0.00328	0.00169	0.02464	0.01330	0.02393
Forage plants	0.00772	0.01306	0.00729	0.00999	0.00686	0.00146	0.02604	0.01679
Vegetables and horticultural prod.s	0.01724	0.00225	0.00896	0.01559	0.00788	0.01074	0.00372	0.01627
Tomato	0.00322	0.00196	0.00206	0.00092	0.00291	0.00064	0.01427	0.00569
Fruits	0.04041	0.01061	0.01446	0.02491	0.00593	0.00453	0.00190	0.00800
Wine	0.01663	0.02277	0.01206	0.00694	0.00920	0.02837	0.03102	0.01370
Other crop product	0.00017	0.00021	0.00008	0.00006	0.00017	0.00090	0.00007	0.00090
Animal productions	0.01055	0.05259	0.05436	0.01908	0.00892	0.01909	0.01649	0.02356
Animals	0.00315	0.03078	0.04477	0.02735	0.00729	0.01673	0.00873	0.00748
Cattles	0.00432	0.00782	0.00562	0.00004	0.00358	0.00251	0.00376	0.01138
Pigs	0.00578	0.01475	0.02973	0.02423	0.00753	0.01685	0.00279	0.00523
Equines	0.00011	0.00048	0.00008	0.00064	0.00047	0.00036	0.00017	0.00014
Sheep and goats	0.00052	0.00661	0.00531	0.00140	0.00346	0.00424	0.00317	0.00223
Poultry	0.00105	0.00208	0.00402	0.00111	0.00059	0.00628	0.00552	0.00076

	2015-2014	2016-2015	2017-2016	2018-2017	2019-2018	2012-2007	2019-2013	2019-2007
Other animals	0.01370	0.02181	0.00959	0.00827	0.01621	0.00236	0.00776	0.01608
Milk	0.00395	0.01035	0.00566	0.00998	0.01361	0.00362	0.00578	0.01534
Eggs	0.00338	0.00570	0.00338	0.00402	0.00025	0.00410	0.00129	0.00270
Other animal products	0.00638	0.00576	0.00055	0.00232	0.00234	0.00188	0.00069	0.00196
Agricultural services	0.00012	0.00040	0.00005	0.00005	0.00014	0.00647	0.00153	0.00323
NAV (Agricultural output)	**0.00012**	**0.00040**	**0.00005**	**0.00005**	**0.00014**	**0.00647**	**0.00153**	**0.00323**
NAV (Crop production)	**0.00533**	**0.02649**	**0.02720**	**0.00956**	**0.00453**	**0.00631**	**0.00748**	**0.01339**
NAV (Animal production)	**0.00527**	**0.02629**	**0.02718**	**0.00954**	**0.00446**	**0.00955**	**0.00824**	**0.01178**
NAV (Agricultural services)	**0.00006**	**0.00020**	**0.00003**	**0.00002**	**0.00007**	**0.00323**	**0.00076**	**0.00161**

Source: Authors' calculations

Michaely-Index, with its values from 0 (unchanged structure) to 1 (completely changed), has confirmed in the research that structural changes in the agricultural output of Serbia occur over time. However, the intensity of these changes is stronger at the beginning of the analyzed period and getting weaker in recent years. Among the observed annual structural changes in agricultural output, the most intense are those in 2010, while the mildest changes are in 2017 and 2018. Accordingly, the first sub-period (2007-2012) shows more intense changes than the second (2013-2019). In addition to overall agricultural output, more intense structural changes in the first sub-period are recognized also for animal production and agricultural services, while only crop production strengthens the intensity of changes in the second sub-period. For both crop and animal production, the most intensive years are 2010, 2012, 2013, 2016 and 2017. On the other hand, with the lowest value of Michaely-Index, agricultural services in the entire analyzed period show only minor changes which almost disappear in recent years. In both sub-periods animal production has Michaely-Index higher than crop production. When it comes to the structural changes of the entire period (2007-2019), crop and animal production have almost the same degree of intensity, higher than intensity of overall agricultural output and agricultural services, as well as higher than intensity of sub-periods.

Applying the same information base as for the Michaely-Index, Lilien-Index measures the direction and speed of structural changes in agricultural output of Serbia in thirteen years' period (2007-2019), two sub-periods (2007-2012, 2013-2019) and for each year individually (table 3).

Table 3. Direction and speed of structural changes in agricultural output of Serbia, based on the Lilien-Index

	2008-2007	2009-2008	2010-2009	2011-2010	2012-2011	2013-2012	2014-2013
Agricultural goods output	0.001551	0.001547	0.002096	0.001239	0.000530	0.000745	0.000843
Crop production	0.004019	0.007521	0.023769	0.006125	0.019626	0.010616	0.000494
Cereals	0.020489	0.022308	0.018953	0.009839	0.026801	0.014573	0.001207
Industrial crops	0.001339	0.000852	0.008760	0.002542	0.006646	0.006077	0.000889
Forage plants	0.002079	0.000827	0.000843	0.002021	0.001797	0.003374	0.004818

Vegetables and horticultural prod.	0.003845	0.004753	0.009269	0.016933	0.002284	0.004014	0.000394
Tomato	0.002294	0.001735	0.006030	0.001536	0.004243	0.003990	0.004953
Fruits	0.003754	0.001431	0.001150	0.004186	0.004113	0.000686	0.005001
Wine	0.002934	0.009701	0.018405	0.003174	0.003450	0.004782	0.004581
Other crop product	0.000229	0.000031	0.000200	0.000075	0.000086	0.000032	0.000004
Animal productions	0.002468	0.005973	0.021654	0.007363	0.019084	0.011358	0.000349
Animals	0.000456	0.010846	0.018672	0.002477	0.012175	0.006720	0.000217
Cattles	0.002488	0.002687	0.005320	0.001201	0.002836	0.002221	0.001017
Pigs	0.005225	0.005933	0.012248	0.001497	0.009910	0.003830	0.002049
Equines	0.000047	0.000011	0.000054	0.000006	0.000239	0.000166	0.000043
Sheep and goats	0.001541	0.000802	0.000083	0.000143	0.001040	0.000502	0.001274
Poultry	0.000691	0.001433	0.001121	0.002914	0.000183	0.000003	0.002045
Other animals	0.002925	0.004875	0.002975	0.004883	0.006909	0.004637	0.000567
Milk	0.001752	0.004458	0.002066	0.003507	0.003196	0.002576	0.000610
Eggs	0.000815	0.000876	0.001200	0.001020	0.003635	0.002390	0.000840
Other animal products	0.000356	0.000457	0.000291	0.000356	0.000066	0.000332	0.000791
Agricultural services	0.001550	0.001546	0.002093	0.001238	0.000529	0.000744	0.000843

Source: Authors' calculations

Table 3. Direction and speed of structural changes in agricultural output of Serbia, based on the Lilien-Index (continued)

	2015-2014	**2016-2015**	**2017-2016**	**2018-2017**	**2019-2018**	**2012-2007**	**2019-2013**	**2019-2007**
Agricultural goods output	0.000052	0.000174	0.000022	0.000020	0.000060	0.002809	0.000664	0.001401
Crop production	0.004632	0.023007	0.023623	0.008306	0.003933	0.005482	0.006496	0.011631
Cereals	0.019503	0.008011	0.030402	0.024707	0.001668	0.000139	0.020105	0.005407
Industrial crops	0.001041	0.004010	0.004078	0.001426	0.000736	0.010668	0.005771	0.010365
Forage plants	0.003346	0.005645	0.003162	0.004329	0.002976	0.000635	0.011121	0.007252
Vegetables and horticultural prod.	0.007457	0.000978	0.003888	0.006743	0.003417	0.004659	0.001617	0.007046
Tomato	0.001396	0.000849	0.000895	0.000401	0.001264	0.000278	0.006122	0.002464
Fruits	0.017462	0.004609	0.006276	0.010799	0.002575	0.001966	0.000824	0.003475
Wine	0.007189	0.009812	0.005230	0.003013	0.003995	0.012159	0.013338	0.005940
Other crop product	0.000073	0.000089	0.000036	0.000027	0.000074	0.000382	0.000032	0.000382
Animal productions	0.004580	0.022807	0.023572	0.008285	0.003873	0.008290	0.007159	0.010228
Animals	0.001368	0.013355	0.019401	0.011871	0.003165	0.007264	0.003791	0.003248
Cattles	0.001876	0.003394	0.002441	0.000017	0.001553	0.001091	0.001631	0.004937
Pigs	0.002512	0.006401	0.012869	0.010503	0.003271	0.007309	0.001212	0.002273
Equines	0.000049	0.000190	0.000036	0.000220	0.000169	0.000153	0.000073	0.000060
Sheep and goats	0.000227	0.002839	0.002288	0.000610	0.001499	0.001838	0.001375	0.000967
Poultry	0.000456	0.000903	0.001745	0.000483	0.000258	0.002721	0.002395	0.000331
Other animals	0.005944	0.009450	0.004162	0.003592	0.007030	0.001024	0.003368	0.006976
Milk	0.001714	0.004488	0.002457	0.004329	0.005901	0.001574	0.002510	0.006648
Eggs	0.001465	0.002471	0.001466	0.001745	0.000109	0.001778	0.000559	0.001173
Other animal products	0.002643	0.002419	0.000239	0.001001	0.001011	0.000808	0.000299	0.000840
Agricultural services	0.000052	0.000174	0.000022	0.000020	0.000060	0.002802	0.000664	0.001400

Source: Authors' calculations

Lilien-Index, measuring the growth rate of agricultural branches from period s to period t, ranges as well from 0 to 1. With regards to the annual structural changes in agricultural goods output, the highest value of this index is also recorded in 2010 and the lowest in 2018. Lilian-Index, the same as the Michaely-Index, achieves its highest values for crop and animal production in 2010, 2012, 2013, 2016 and 2017. Agricultural services record in all years the lowest value of this index. Also, based on the Lilian-Index, in both sub-periods animal production has higher values than crop production, while their index for the entire period is almost the same. The most dynamic changes within crop production have industrial crops, while for animal production are milk and cattles.

Conclusion

Agriculture has been facing many changes over years, due to the more challenging market environment, globalization, rapid technological development, climate changes, etc. Raising living standard of the population causes increased demand for more quality products with affordable prices, improved services, substantial information, expected flexibility, and timely response. Innovation, followed by constant use of the new technology, has been crucial for success of agricultural holdings. However, their size also was the subject of changes, as well as the average farmers' age. Accordingly, agricultural output has been affected and adjusted to these changes.

Aiming to assess the intensity and dynamic of structural changes in agricultural output of Serbia, the study employs the Michaely and Lilien indexes on data from Statistical Yearbook and Economic Accounts of Agriculture as publications of the Statistical Office of the Republic of Serbia, within the period 2007-2019. The conducted thirteen years' analyses of agricultural output in Serbia met the main research goal and responded to the established research questions. Structural changes in agriculture of Serbia, measured by Michaely and Lilien index, lead to the same conclusion regarding their intensity and direction. While agricultural services in the analyzed period from 2007 to 2019 show very mild changes, crop and animal production have slightly greater changes based on these indexes. On the annual basis, crop and animal production alternately have more intense changes, while in both sub-periods animal production has more intense structural changes. Even though the Michaely-Index achieves positive values over years, structural changes in the overall agricultural output are less intensive in the recent years than at the beginning of observed period. This is confirmed by annual values of Michaely-Index, as well as its higher values for the first sub-period compared to the second. This is result of fluctuations in changes of crop and animal production, but also impact of almost no changes in agricultural services.

Given the above research results, one could conclude that structural changes in the agricultural output has occurred over time, but in slight intensity. Moreover, these changes reduced the intensity in recent year indicating insufficient adjustment to the technological development, globalization, climate changes, etc. While industrial crops within crop production and milk and cattles within animal production have the most dynamic changes, other agricultural branches still have a room for a better and needed

response to a changed market environment. Also, agricultural services, not only with their very low share in the total agricultural output, they also are quite unchanged over years. The exploitation of potential improvements within agricultural production, and particularly some branches, would bring overall benefit for agriculture and the economy considering as a result a contemporary, efficient and flexible agricultural production.

The limitations of the research are related to the fact that the data of agricultural output cover only several years, which may affect the generalization. Additionally, the very last years (2020-2022) have been excluded in the research considering the changed methodology of the Statistical Office of RS when it comes to agriculture. Also, structural changes have been examined only based on two indicators, focusing on intensity and dynamics of structural changes in the analyzed period. Accordingly, the study could be further extended to respond to these challenges with the aim of enhanced quality of the research.

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Conflict of interests

The authors declare no conflict of interest.

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WHAT FACTORS INFLUENCE HOUSEHOLDS' EXPENDITURE ON FISH? EVIDENCE FROM URBAN MALAWI

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ABSTRACT

The purpose of this study was to find the drivers of fish expenditure in urban Malawi using Blantyre as a case study. Previous demand studies on the fisheries sector in Malawi have concentrated on the determinants of consumer choices and demand for tilapia fish thereby making information regarding households' general consumption pattern of fish scanty. Results show that statistically significant negative determinants of per capita fish expenditure include the price of vegetables, the price of rice, the number of adults in the household, and the household's per capita food expenditure away from home, while, the price index of food, price of maize, the predicted value of food, and household's income level are the statistically significant positive drivers of per capita fish expenditure. General policy implications arising from this study are that policymakers need to ensure that households have higher incomes and that food prices are kept low.

Introduction

Food has always been one of the most widely used indicators of poverty such that every single effort to investigate any country's poverty level has always included measurements of food expenditures and food consumption. It is due to the recognition

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of the importance of food that the United Nations lists the eradication of hunger by 2030 among its 17 Sustainable Development Goals (SDGs). Similarly, the government of Malawi regards food security as being crucial in its poverty eradication efforts. This is evidenced by the fact that, in the year 2006, it came up with the national food security policy whose overall goal is to dramatically improve the access to food by all Malawians by, among others, ensuring that Malawians have the ability to purchase enough nutritious food in a dignified manner so as to live an active and healthy life.

In Malawi, the fisheries sector is divided into three sub-sectors namely; capture fishery, aquaculture, and ornamental or aquarium trade, as explained in the subsequent paragraphs.

Further divided into artisanal and commercial production, capture fishery is practiced on Malawi's lakes and rivers such as Lake Malawi, Lake Chilwa, Lake Malombe, Lake Chiuta, and Shire River. In terms of their contributions to total catch, these water bodies contributed 93.88 percent, 1.82 percent, 2.28 percent, 0.93 percent, and 1.09per cent, respectively, to the total fish production in 2020 (GoM, 2021). Lake Malawi is, particularly, significant for fish production in that it has over 800 endemic fish species, which are of both local and international scholarly importance and also act as a source of tourism. Specifically, it is the South Eastern arm of the lake which is highly productive due to the occurrence of seasonal hydrological events that result in a plentiful supply of food for the fish.

Aquaculture, on the other hand, is mainly practiced in ponds in upland locations of the country and it is, largely, practiced by smallholder farmers. Despite there being signs of growth, Malawi's aquaculture sector is still in its nascent stage. Production rose from about 800 tons in 2005 to about 7,672 tons in 2016 and 9, 399 tons in 2020. The sector employs about 15,465 smallholder farmers, 61.51 percent of them being males and 38.49 percent females (GoM, 2021). The farmers are loosely organized in farmer clubs such that as of 2020, the total number of recorded ponds in Malawi was 10, 000 which translated to a total pond area of 251.59 hectares (GoM, 2021). Ornamental or aquarium trade concentrates on Mbuna fish which is exported live to countries such as Germany, Hong Kong, Denmark, and France (GoM, 2021).

With respect to marketing, most of the high-valued fish from both aquaculture and capture fishery are sold to customers in the urban areas such as Blantyre, Lilongwe, and Mzuzu while the low-valued fish species are sold locally around the fish ponds and the other water bodies. Traders transport these fish species using buses, pick-ups, bicycles, and motorbikes. The fish is sold either fresh or processed so as to prevent loss of quantity and quality. The main fish processing methods used include sun-drying, smoking, and salting. Fresh fish, either frozen or chilled, is particularly commonly sold in areas close to aquaculture farms and Malawi's lakes and rivers. In terms of market outlets, fish is either sold in public markets or supermarkets or retail outlets which are, mainly, owned by aquaculture companies. In the public markets, fish is usually sold on the basis of size by piece, buckets, heaps, or units while in supermarkets and retail outlets, it is sold based on weight. According to Brummett (2000), the determinants of average retail prices of fish in Malawi include the fish market factors and the fish attributes.

In terms of participation in fish marketing, fish trading is dominated by males as only a small proportion of women is engaged in fish processing and trading. Factors contributing to the lack of women's participation in fish marketing include lack of capital and the traditional division of labour. The major species of fish that are caught and sold in Malawi, on which this study focuses, include *Engraulicypris sardella* (usipa), *Copadichromis spp* (utaka), *Lethrinops spp* (kambuzi); *Clarias gariepinus* (mlamba), *Rhamphochromis spp* (mcheni), *Barbus paludinosus* (matemba) and Tilapia species of Lake Malawi tilapia *(chambo),* hereafter referred to as usipa, utaka, kambuzi, mlamba, mcheni, chambo and matemba, respectively.

In recognition of the significant nutritional and economic value of fish, the government of Malawi developed the National Fisheries and Aquaculture Policy (NFAP) whose main goal is to promote sustainable fisheries resource utilization and aquaculture development in order to contribute to food and nutrition security and economic growth of the country (GoM, 2016). Specifically, the NFAP aimed at increasing fish supply in the country so as to increase Malawi's per capita fish consumption from 8.12 kilogrammes in 2014 to 10 kilogrammes by 2020 (GoM, 2016) something which it has, regrettably, failed to achieve since only 9.51 kilogrammes were consumed per capita in 2020(GoM, 2021). This development turned out to be very discouraging considering the numerous interventions the government of Malawi has put in the fisheries sector.

However, information about factors that influence households' expenditure on fish is very scanty because previous demand studies on the fisheries sector in Malawi have concentrated on the determinants of consumer choices and demand for tilapia fish (Chikowi et al., 2020), or analysing factors affecting the demand for fish products, namely; smoked fish, dried fish, tinned fish, and fresh fish (Nankwenya et al., (2014). This study, therefore, bridges this knowledge gap by determining factors that influence Malawian households' expenditure on food, in general, and expenditure on fish, in particular. Furthermore, the study estimates the marginal effects of each determinant of food expenditure so as to get a clear picture of key factors that influence the likelihood of food purchases in Malawi. Research questions include: (1) what factors affect a household's expenditure on both food and fish in Malawi? (2) Are there any interdependencies between fish consumption and the consumption of other food commodities in Malawi? Providing answers to these questions will help unearth immensely useful insights for policymakers on how they can improve Malawian households' food consumption, in general, and fish consumption in particular. This, ultimately, can help improve the welfare of people in the country. Thus, this study contributes to the literature on fisheries by finding the drivers of fish consumption in Malawi, an area that has scarcely been given adequate attention by most studies in the fisheries sector in Malawi.

Materials and methods

The target population for the study was households in the city of Blantyre. The households were selected using a multistage stratified sampling procedure. Firstly, on the basis of income levels, the city was stratified into high- and low-density strata.

Secondly, using simple random sampling, clusters were selected from each stratum. Thirdly, from each cluster, households were randomly selected to form the final sample. The study targeted either household heads or other members of the household who were primarily responsible for the purchase of food in the household as respondents. To determine the sample size, the study used the formula (Zikmund et al., 2009):

$$n = \frac{z^2 pq}{e^2} \quad (1)$$

Where: n is number of respondents (households),

p is proportion of the population of the households in the city that were interviewed which, following Chikowi et al. (2020), was equal to 46 percent in this study.

$q = 1 - p$ is the estimated proportion of failures. It was equal to 54 percent in this study.

z is the statistical confidence level. This study used a 95 percent confidence level which gave a z statistic of 1.96

$e =$ the maximum allowance for error between the true proportion and the sampling proportion. For this study, the allowance of sampling error was not greater than 4 percentage points.

Using the above information, the representative sample size for the study was calculated as follows:

$$n = \frac{1.96^2(0.46)\,(0.54)}{0.04^2} = 596 \quad (2)$$

However, upon factoring in the design effect, 514 households were added to the sample thereby adjusting the sample size for the study to 1,110 households. The data was collected through face-to-face interviews using semi-structured questionnaires. Specifically, the data collected included the socio-economic and demographic factors of the respondents and households' food purchase decisions. On consumption, information collected included the types and quantities of food consumed and the food expenditures in the past seven days. Consumers were also presented with *Engraulicypris sardella*, *Copadichromis virginalis*, *Lethrinops spp.; Oreochromis karongae (*Lake Malawi Chambo); *Clarias gariepinus* (Catfish); *Rhamphochromis spp*; *Diplotaxodon*; and *Oreochromis shiranus* (Shire Tilapia). Thereafter, quantities purchased of each fish species alongside their prices were elicited.

The study has used different variables and estimation methods on the basis of the research question being addressed. Specifically, the ordinary least squares (OLS) regression model has been used to find the drivers of households' per capita food expenditure while the determinants of households' per capita fish expenditure have been

investigated using the censored Tobit regression model. Table 1 provides a description of the variables that were used in the OLS per capita food expenditure regression model alongside their expected signs.

Table 1. A Description of the Variables that Were Used in the OLS Per Capita Food Expenditure Regression Equation

Variable	Description	Expected Sign
Dependent Variable		
LnPCFE	Natural log of per capita fish expenditure	+
Independent Variables		
PI	Price index of fish	+/-
Age	Age of the household head	+/-
Agesq	Square of age of household head	+/-
Years	Years of formal schooling	+/-
Primary	Dummy (1-primary education, 0-otherwise)	+/ -
Secondary	Dummy (1-secondary education, 0-otherwise)	+/ -
Hhsize	Household size	+/-
Children	Number of children less than 7 years old in a household	+/-
Adults	Number of adults more than 13 years in a household	+/-
Employed	Number of people employed in a household	+/-
Lnincome	Natural log income level of a household	-
Lnincomesq	Natural log of the square of the income level of a household	+
Female	Dummy (1-if a household head is female, 0-otherwise)	+/-
Unmarried	Dummy (1-if a household head is married, 0-otherwise)	+/-
Low	Dummy (1-if a household is located in a low-density area, 0-otherwise)	+/-

Source: Own compilations

As Table 1 shows that the dependent variable in the OLS per capita food regression equation was the natural log of the per capita food expenditure while the independent variables included socio-economic variables in addition to the price index of food. Table 2 presents variables that were used in the Tobit per capita fish expenditure regression model.

Table 2. A Description of the Variables that Were Used in the Tobit Per Capita Food Expenditure Regression Model.

Variable	Description	Expected Sign
Dependent Variable		
LnFE	Natural log of per capita fish expenditure	+
Independent Variables		
LnPO	Natural lo of price index of food	+/-
LnPV	Natural log of price of vegetables	+/-
LnPR	Natural log of price of rice	+/-

Variable	Description	Expected Sign
LnPMA	Natural log of price of maize	+/-
LnPCH	Natural log of price of chicken	+/ -
LnPE	Natural log of price of eggs	+/ -
FD*	Predicted value of the per capita food expenditure	+/-
FD*sqd	Square of the predicted value of per capita food expenditure	
Age	Age of household head	
Agesq	Square of age of household head	
Children	Number of children less than 7 years old in a household	+/-
Adults	Number of adults more than 13 years in a household	+/-
Employed	Number of people employed in a household	+/-
Lnincome	Natural log income level of a household	-
Lnincomesq	Natural log of the square of income level of a household	+
Female	Dummy (1-if a household head is female, 0-otherwise)	+/-
Married	Dummy (1-if a household head is married, 0-otherwise)	+/-
Lnpcfew	Natural log of a household's per capita food expenditure away from home	+/-

Source: Own compilations

Table 2 indicates that the dependent variable in Tobit per capita fish expenditure regression model was the natural log of the per capita fish expenditure. Additionally, it shows that variables such as prices of various food commodities and the household's per capita food expenditure away from home are added to the list of the independent variables used in the OLS regression model.

Results and Discussions

This section presents and discusses the results of various regression models that have been used to address the study objectives. In particular, it focuses on the results from the food expenditure regression equation and the Tobit fish expenditure regression model.

Results from Food Expenditure Regression Equation

Using variables presented in Table 1, the following OLS regression equation was estimated:

$$lnPCFE = f(PI, Y, Z, \varepsilon_i) \quad (1)$$

Where:

$lnPCFE$ is the natural log of per capita food expenditure;

PI is the household specific food price index;

Y is a vector of per capita household income which was expressed in both linear and quadratic forms;

Z is a vector of household characteristics, and

ε_i is the error term.

Following Gujarati (2004), the study endeavoured to test and correct for the presence of the problems of non-normality, multicollinearity, and heteroskedasticity during the estimation of the OLS regression. The results of the foregoing tests are presented in the subsequent paragraphs.

Results of Normality Test

The normality assumption is one of the key assumptions underlying OLS regression model whose violation results in inflated standard errors leading to wider confidence intervals and wrong hypothesis testing. Ultimately, the violation of the normality assumption leads to biased estimates. A Kolmogorov-Smirnov test was, therefore, used to test for the presence of non-normality in the data used in the study. The Kolmogorov-Smirnov test gave a Chi-squared statistic with a p-value of 0.0000<0.01 thereby suggesting the rejection of the null hypothesis no-normality. This implies that the data was normally distributed.

Results of Multicollinearity Test

The presence of multicollinearity problem results in inefficient or inconsistent parameter estimates and inaccurate p-values thereby making it difficult to separate the independent effect of each parameter estimate on the dependent variable (Gujarati, 2004). Hence, in order to detect and measure the presence and the severity of the multicollinearity problem, the study employed the variance inflating factors (VIF) results of which are shown in Table 3.

Table 3. Results of the Multicollinearity Test

Variable	VIF	tolerance
Lnincomesq	271.13	0.003688
Lnincome	270.74	0.003694
Age	45.41	0.022022
Agesq	44.62	0.022413
Years	5.68	0.176206
Secondary	3.91	0.255430
Primary	3.78	0.264871
Hhsize	2.58	0.388150
Adults	2.50	0.400565
Children	1.38	0.725149
Employed	1.37	0.729368
Low	1.17	0.855924
Female	1.09	0.918474

Variable	VIF	tolerance
PI	1.07	0.932967
Unmarried	1.01	0.988765
Mean VIF	43.83	

Source: Own compilations

As indicated by Table 3, the mean VIF value for all the explanatory variables used in the OLS regression model was 43.83 thereby suggesting that there was a multicollinearity problem in the variables used in the OLS regression model since many of the regressors had VIF values far more than 10. Therefore, to control for the multicollinearity problem, the OLS regression equation was estimated without a constant.

Results of Heteroscedasticity Test

The presence of heteroscedasticity in the data set has very damaging consequences in that it results in high standard errors, which in turn, leads to wider confidence interval problems and biased parameter estimates. The study used the Breusch–Pagan test for heteroskedasticity which yielded a chi-squared statistic value of 28.23 with an associated p-value of 0.0000. This led to the rejection of the null hypothesis of constant variance thereby suggesting the presence of heteroscedasticity in the data set. To surmount the heteroscedasticity problem in the study, robust standard errors were used during the estimation of the OLS regression equation, the results of which are presented in Table 4.

Table 4. Parameter Estimates of the Food Expenditure Regression Equation

Variable	coefficient	robust standard error	t-statistic	p-value
PI	0.1587***	0.0511	3.11	0.002
Age	0.0121	0.0130	0.93	0.352
Agesq	-0.0001	0.0002	-0.74	0.463
Years	0.0061	0.0192	0.32	0.751
Primary	-0.3060	0.1968	-1.55	0.121
Secondary	-0.0282	0.0748	-0.38	0.706
Hhsize	-0.1816***	0.0255	-7.13	0.000
Children	0.0166	0.0529	0.31	0.754
Adults	0.0022	0.0256	0.08	0.932
Employed	0.0513	0.0338	1.52	0.129
Lnincome	1.0969***	0.0605	18.12	0.000
Lnincomesq	-0.0187***	0.0032	-5.88	0.000
Female	0.0337	0.0308	1.09	0.275
Unmarried	0.1617**	0.0769	2.10	0.036
Low	-0.0122	0.0566	-0.22	0.829
F (15, 589) = 42678.03 Prob > F = 0.0000				

Source: Own compilations

Note: Asterisks represent level of statistical significance: *(10% significance), **(5% significance), ***(1% significance).

As shown in Table 4, statistically significant positive determinants of the per capita food expenditure are the price index of food (p-value<0.01), the household's income level (p-value<0.01), and the household head's status of being unmarried (p-value<0.05). This suggests that an increase in the price index of food, an increase in the household's level of income, and the household head's state of being married will lead to an increase in per capita food expenditure. However, it is noteworthy that the coefficient of the squared income term is negative and statistically significant at a 1 per cent level of significance (p-value<0.01). This finding conforms to the finding by Dey et al., (2000) who found that the fish expenditure's response to changes in income is significant but non-linear. It, particularly, implies that as households' income levels progressively increase, per capita food expenditure also increases up until it reaches a maximum, beyond which, any further increase in the income levels results in a decrease in per capita food expenditure. This finding conforms to Engel's law which states that as a household's income level increases, the percentage of the income allocated for food purchases decreases.

Furthermore, Table 4 shows that household size is the statistically significant negative determinant of per capita food expenditure (p-value <0.01). This suggests that as the number of people in a household increases, there are more people who have to share in the household's food budget thereby lowering the household's per capita food expenditure. This finding is consistent with the finding by Dey et al., (2000) who found that bigger households negatively influence the per capita food expenditure in Bangladesh.

In addition to the results presented in Table 4, the study computed conditional marginal effects for each variable. By definition, conditional marginal effects are the elasticities of each variable computed at a specific value. The specific value used in this study is the mean. Table 5 presents the marginal effects of the variables.

Table 5. Marginal Effects of the Parameter Estimates of the Food Expenditure Regression Equation

Dependent variable: Per capita food expenditure					
variable	**coefficient**	**standard error**	**t-statistic**	**p-value**	**X**
PI	0.1587***	0.0511	3.11	0.002	-0.2066
Age	0.0121	0.0130	0.93	0.351	35.548
Agesq	-0.0001	0.0002	-0.74	0.462	1328.92
Years	0.0061	0.0192	0.32	0.751	13.6722
Primary	-0.3060	0.1968	-1.55	0.120	0.0497
Secondary	-0.0282	0.0748	-0.38	0.706	0.3891
Hhsize	-0.1816***	0.0255	-7.13	0.000	4.3676

Dependent variable: Per capita food expenditure					
variable	**coefficient**	**standard error**	**t-statistic**	**p-value**	**X**
Children	0.0166	0.0529	0.31	0.754	1.1242
Adults	0.0022	0.0256	0.08	0.932	2.7368
Employed	0.0513	0.0338	1.52	0.129	1.3874
Lnincome	1.0969***	0.0605	18.12	0.000	12.9607
Lnincomesq	-0.0187***	0.0032	-5.88	0.000	168.745
Female	0.0337	0.0308	1.09	0.274	0.6722
Unmarried	0.1617**	0.0769	2.10	0.035	0.0132
Low	-0.0122	0.0566	-0.22	0.829	0.0912
F (15, 589) = 42678.03 Prob > F = 0.000					

Source: own calculations

Note: Asterisks represent the level of statistical significance: **(5% significance), ***(1% significance).

As shown in Table 5, for a unit change in the food price index, there will be a 15.87 percent increase in the per capita food expenditure. Similarly, for a unit change in the household size, there will be an 18.16 percent decrease in the per capita food expenditure. Also, Table 5, shows that for a unit change in a household's income level, there will be a 110-percentage increase in per capita food expenditure. Lastly, the change of marital status of the household head from being married to being unmarried leads to a 10-percentage increase in the per capita food expenditure.

Results from Fish Expenditure Tobit Regression Equation

In this study, the model for the determinants of per capita fish expenditure the dependent variable attains values equal to or greater than 0. In other words, the dependent variable is censored from below at 0. Consequently, applying OLS to a regression equation whose dependent variable, as in this case, is censored from below yields biased results. Hence, this study used the Tobit model to estimate the determinants of per capita fish expenditure. The Tobit model where the distribution of the dependent variable is censored from below at point α can be expressed as follows:

$$Y_i = \begin{cases} Y^* \; if \; Y > \alpha \\ 0 \; \; if \; Y \leq \alpha \end{cases}$$

Such that $Y_i = Y_i^* = X_i\beta + \varepsilon_i$ (2)

Where: Y_i^* is the latent variable and, in this study, it represents per capita fish expenditure,

X_i represents a vector of regressors as shown in Table 2,

β represents a vector of slope coefficients, and

$\varepsilon_i \sim N(0, \sigma^2)$ is the error term which is normally distributed with mean equal to zero, and has a homoscedastic variance equal to σ^2.

The Tobit regression model was estimated using robust standard errors and without a constant so as to control the problems of heteroscedasticity and multicollinearity, respectively. The results of the Tobit fish expenditure regression equation are presented in Table 6.

Table 6. Parameter Estimates of the Fish Expenditure Tobit Regression Equation

Dependent variable: Per capita fish expenditure				
variable	**coefficient**	**robust standard error**	**t-statistic**	**p-value**
LnPO	0.6698***	0.0514	13.04	0.000
LnPV	-0.1087*	0.6020	-1.81	0.072
LnPR	-0.1779**	0.0858	-2.07	0.039
LnPMA	0.1915*	0.1118	1.71	0.083
LnPCH	0.1620	0.1134	1.45	0.148
LnPE	0.0185	0.0318	0.58	0.562
FD*	0.5545***	0.1830	3.03	0.003
FD*sqd	-0.0560***	0.0185	-3.03	0.003
Age	0.0098	0.0243	0.40	0.688
Agesq	-0.0001	0.0003	-0.40	0.687
Children	0.0330	0.0999	0.33	0.742
Adults	-0.1108**	0.0477	-2.32	0.021
Employed	0.0478	0.0591	0.81	0.419
Lnincome	1.1668***	0.1288	9.06	0.000
Lnincomesq	-0.0198**	0.0083	-2.38	0.018
Lnpcfew	-0.1151***	0.0377	-3.06	0.002
Female	0.0113	0.0550	0.21	0.838
Married	-0.1125	0.1240	-0.91	0.365
F (18, 387) = 8619.00 Prob > F = 0.000 Pseudo R^2 = 0.7976				

Source: own calculations

Note: Asterisks represent level of statistical significance: *(10% significance), **(5% significance), ***(1% significance).

As indicated in Table 6, the estimated parameter of the price index for fish is positive and statistically significant at 1 percent level of significance (p-value<0.01), thereby, suggesting that an increase in the price index of fish will result in an increase in the per capita fish expenditure. This implies that fish is a necessity so much so that even if its price rises people will still continue buying it, thereby making the total expenditure on fish increase.

This finding is consistent with the finding by Dey *et al.* (2000) who found that fish is a necessity in Bangladesh. Additionally, the coefficient for price of maize is positive and statistically significant (p-value <0.1) implying that an increase in the price of maize leads to an increase in per capita fish expenditure. The coefficients of the linear and squared forms of the predicted food expenditure variable exhibited statistically significant positive and negative signs, respectively. This suggests that there exists a nonlinear relationship between food expenditure and fish expenditure. Particularly, it shows that as the budget for food increases, progressively, the per capita expenditure on fish also increases up until it reaches a maximum beyond which it eventually declines. This shows the general behaviour of respect to food consumption whereby consumers have a certain threshold for food consumption such that upon reaching that threshold, consumers can never be induced to purchase more food even if their income levels have increased. This finding is consistent with the finding by Dey *et al* (2000) who found that there exists a non-linear relationship between food expenditure and fish expenditure in Bangladesh.

Furthermore, Table 6 shows that the coefficients of income and the squared term of income are statistically significant at a 1 per cent level of significance (p-value<0.01), even though they are positive and negative, respectively. This, again, suggests that there is a presence of a non-linear relationship between per capita food expenditure and households' income level. It, particularly, implies that as households' income levels progressively increase, per capita food expenditure also increases up until it reaches a maximum, beyond which, any further increase in the income levels results in a decrease in per capita food expenditure. This finding conforms to Engel's law which states that as a household's income level increases, the percentage of the income allocated for food purchases.

Table 6 further indicates that the price of vegetables, the number of adults in the household, and the household's per capita food expenditure away from home are statistically significant negative determinants of per capita fish expenditure. Particularly, it shows that an increase in the price of vegetables, an increase in the number of adults in the household, and an increase in the household's per capita food expenditure away from home lead to a reduction in the per capita expenditure on fish.

The finding that the number of adults in the households has a negative influence on the households' expenditure on fish is consistent with the findings by Murray *et al.* (2017) who found that, in British Colombia of Canada, households spend more on fish as the number of young people in the household increases. These findings are, however, inconsistent with the findings by Thong & Solgaard (2017) who found that households with more elderly people spend more on fish compared to those with a small number of elderly people.

Conclusions

This study set out to investigate the drivers of both food expenditure and fish expenditure in Malawi. It has found that the positive determinants of a household's per capita food expenditure include the price index of food, the household's income

level, and the household head's state of being unmarried while the household size is the only statistically significant negative determinant of per capita food expenditure. Again, with respect to fish expenditure, the study has found that statistically significant negative determinants of per capita fish expenditure include the price of vegetables, the price of rice, the number of adults in the household, and the household's per capita food expenditure away from home. On the other hand, the study has found that the price index of food, the price of maize, the predicted value of food, and household income level are the statistically significant positive drivers of per capita fish expenditure.

Policy implications arising from this study are that in order to increase the consumption of food in Malawi, it is imperative that policymakers should ensure that households have a small number of people with a lot of income-generating activities. Having a lot of income-generating activities will enable households to spend more on food. Additionally, with respect to fish consumption, policymakers should do the following: make sure that the prices of vegetables do not just rise anyhow, make that households do have a small number of adults, through among others, the creation of a lot of employment opportunities, and make expenditure on food away from home unattractive. One of the possible ways of making food expenditure away from home is by charging higher taxes on restaurants and other food-eating joints. Other important policy options that can help increase households' per capita expenditure on fish include making sure households have a lot of income-generating activities and maintaining the price of food low. If these policies are successfully implemented, then the households' expenditure on both food and fish will improve thereby leading to an improvement in the welfare of Malawian households.

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Conflict of interests

The authors declare no conflict of interest.

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ENTREPRENEURIAL ELEMENTS IN RURAL TOURISM - FINDINGS FROM PLS-SEM

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ABSTRACT

The aim of this paper is to determine the interrelationship between innovation, proactivity and risk-taking, as a dimension of entrepreneurial orientation and their connection with relational capital, in order to indicate the entrepreneurial behavior that gives the best results for the development of sustainable rural tourism. The research was conducted on the basis of questionnaires collected on the territory of the Republic of Serbia during the year 2022. The data were analyzed using the PLS-SEM method. The results show a positive relationship between proactivity and innovation, between relational capital and innovation, and proactivity and relational capital, while a positive relationship between risk-taking and innovation and risk-taking and relational capital was not confirmed. Results provide important elements for making decisions about innovation and competitiveness of rural tourism destinations.

Introduction

Considering the cultural and natural attractiveness in rural areas, rural tourism can play an important role in revitalizing rural areas. Also, development of rural tourism can create new employment and more income opportunities for local populations (Gao, Wu, 2017). Rural tourism is one of the types of tourism whose sustainable form in various economic, social and ecological dimensions paves the way for achieving sustainable development of local communities (Farahani et al., 2021; Melović, 2022; Dimitrijević et al., 2022).

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The tourism potential of rural areas is underdeveloped, and it can be a potential for entrepreneurship that can improve regional development (Dašić et al, 2020, Lordkipanidze et al., 2005). Especially important is a sustainable agricultural practice that combines three types of balance: economic, social and ecological (Sobczyk, 2014). Rural tourism is considered a potentially good product in promoting the country, as well as involving the community in the tourism industry (Amir et al., 2015; Milošević et al., 2021). Sustainable development in Republic of Serbia has great perspectives and challenges for the development of entrepreneurship based on cultural and natural attractiveness in rural tourism (Kallmuenzer, Peters, 2017, Aslanova, 2019). The motivations of entrepreneurs in this industry are related to lifestyle, are social or sustainable, family-driven and influenced by the regional environment (Dias, Silva, 2021).

Family companies are dominated in the rural tourism industry. This is very important because the family interests guide entrepreneurial behavior (Kallmuenzer, Peters, 2018). In the case of family firms in rural tourism, in particular, it remains unclear what type of entrepreneurial behavior is desirable for the firm to perform well and what factors explain this behavior (Andersson et al., 2002). Family firms generally need to be willing to be innovative, proactive, and thoughtfully take risks in response to market opportunities in order to maintain competitive advantages and perform well (Lumpkin, Dess, 2008). The subject of this study is the connection between the dimensions of entrepreneurial orientation, innovation, proactivity, risk taking, as well as relational capital as a dimension of entrepreneurial behavior on the example of rural tourism. The aim of the paper is to investigate which type of entrepreneurial behavior is important and acts synergistically in order for family firms of rural tourism to do well. For the purpose of researching the subject, the following hypotheses were tested:

H1: There is a positive correlation between risk-taking and innovation

H2: There is a positive correlation between risk-taking and Relational Capital

H3: There is a positive correlation between Proactivity and Innovation

H4: There is a positive correlation between Proactivity and Relational Capital

H5: There is a positive correlation between Relational Capital and Innovation

Literature review

Tourists as drivers of innovation

Tourists are characterized by their willingness to acquire and/or buy a certain amount of tourist goods (Edensor, 2001). Willingness depends not only on the "quantity" of their tourist needs, but also on a whole series of other factors, such as income, prices, exchange rate, quality, method of promotion and a number of other factors (Stefanović, 2017). Tourism today brings innovations in various fields, from destination to attractions and creators of tourist services. The main task of innovation in tourism services is tourist satisfaction (Liat et al., 2020). The tourist is the main driver of the development

of tourism, and the expressed satisfaction is the end point, forming a complete circle of the tourist service (Opute et al., 2020).

In the early works of tourism theory, tourists were depicted as homogeneous portraits in the sense of a general type and the conceptualization did not deal with different meanings and motivations (Čavlek et al., 2010). States of feeling or motivational forces among tourists recognized to be changed in postmodern times: preferences, interests, values and experiences of tourists (Dujmović, 2015). At the macro level, tourist expectations are at least partly created by marketing strategies and advertising brochures (Song et al., 2010). People expect more from vacation and travel has become part of lifestyle and human culture. Experience has become the core of tourist travel (de Freitas Coelho and others, 2018). How to spend an unforgettable vacation has become more important to tourists than where to spend it (Čavlek et al., 2010). Tourists are looking for a more substantial and high-quality product, regardless of the location of the tourist destination (Huete-Alcocer, 2019).

Rural tourism and entrepreneurial behavior

A wide range of literature on corporate entrepreneurship suggests that entrepreneurial attitudes and behavior are key antecedents for the short- and long-term success of an enterprise (Omerzel, Čivre, 2015). Despite the fact, that the COVID-19 pandemic has negatively affected entrepreneurship, it is one of the recognized development opportunities for rural tourism (Ivanović-Đukić et. al., 2022). The most common topic among those interested in entrepreneurial orientation concerns the positive implications that entrepreneurial processes have on the development of rural tourism (Milojević, Pavlović, 2017). Differentiated services and a good image of tourist companies in the environment can only be achieved by having and managing human, structural and relational capital (Ognjanović, 2016). Relational capital is a very important component of entrepreneurial behavior aimed at market success (Paoloni et al., 2021).

Empirically, the positive impact of the dimensions of entrepreneurial orientation and entrepreneurial behavior on the development of rural tourism is supported by several studies (Lee, Chu, 2017). In order to investigate the entrepreneurial behavior of rural tourism firms, this paper relies on the corporate entrepreneurship literature that views entrepreneurial orientation and behavior as the basis for business success (Rauch et al., 2009).

Tourism literature shows that research on the relationship and impact of innovation, proactivity and risk-taking is very limited, but many scholars agree that innovative and proactive behavior is necessary for long-term survival in ever-changing environments such as tourism (Hjalager, 2015). Lumpkin & Dess (2008) suggest that the implications of entrepreneurial orientations on the development of rural tourism enterprises are specific and may vary independently of each other in a given organizational context. Dias & Silva (2021) analyzed the relationship between tourist destination and innovation. The results showed that place knowledge and relational capital have a positive effect on innovation.

Innovation and development of rural tourism

Despite the general opinion that services are non-innovative or that innovations in services occur less often, innovations in tourism are numerous and more complex than in some other sectors or industries (Čavlek et al., 2010). The tourism industry is in a process of continuous changes, so innovation is not only a factor of competitiveness (Vujko et al., 2016), but also a factor of survival, growth and development in an extremely turbulent tourism market (Jiang, 2019). Innovation means doing things differently, and applying this concept in tourism will help create a new experience for tourists every time (Weiermair, 2003). Good management and committed entrepreneurship are integral pillars of innovation in rural tourism and the key to success (Polukhina et al., 2021). Innovations in tourism lead to easier navigation and research of the destination and the possibility for the tourist to create the perfect service himself (Zellweger & Sieger, 2012). Innovation refers to the introduction of any new concept, whether it is new to customers, a sector or an organization (Hjalager, 2015). As one of the main drivers of competitiveness, innovation should be subject to review and strengthening of stakeholders in tourist destinations (Pikeemaat et al. 2018). Increasing competitiveness through innovation ensures differentiation in the dynamic tourism market (Ribarić, 2015).

Tourism requires continuous innovation of the tourist offer, because tourists today increasingly strive for new and better quality products, new destinations, new experiences, activities and experiences (Song et al., 2010). New experiences become the main motive for the decision on a tourist trip. Many tourist companies have begun to complement their service more and more using innovative technology to meet the demands of modern tourists (Pencarelli, 2020). The purpose of innovation is to make the tourism product unique and authentic, and therefore different, that is, different from competing products (Weiermair, 2003).

Proactivity and development of rural tourism

By exploiting asymmetry in the market, the first mover can realize unusually high profits and gain an advantage in establishing brand recognition (Lumpkin & Dess, 2008). Thus, taking initiative by anticipating and following new opportunities and participating in emerging markets are associated with entrepreneurship (Corrêa et al., 2021). This characteristic of entrepreneurship is often called proactivity. Proactivity is a forward-looking perspective characterized by monitoring and anticipating future market wants and needs (Kallmuenzer, Peters, 2018). Proactivity also actively shapes the external environment and anticipates future market demands. This is an important characteristic of the entrepreneurial behavior of family firms and a key source of sustainable growth and performance for many family firms (DeMassis et al., 2014). Since proactivity suggests an emphasis on initiating activities, it is closely related to innovation, as in the case of new product introductions (Hjalager, 2010). When proactive, companies capitalize on new opportunities and shape the evolving competitive environment (Zellweger & Sieger, 2012).

Risk taking and development of rural tourism

Risk taking refers to the degree to which managers are ready to undertake large and risky commitments (Zellweger & Sieger, 2012). Thus, risk taking generally refers to bold actions taken under conditions of uncertainty (Short et al., 2009). Risk-taking is related to the trade-off between risk and return that is common in financial analysis. Baird and Thomas (1985) argued that risk taking consists of venturing into the unknown, engagement of a relatively large part of assets and large borrowing. Risk-taking firms show a tendency to "take bold actions such as entering unknown new markets" without certain knowledge of likely outcomes (Habbershon et al., 2010). In today's rapidly changing and highly uncertain markets, rural tourism businesses must be prepared to take risks, because without taking risks, the prospects for business development are slim (Cirill et al., 2021).

Entrepreneurial activities in family businesses involve taking risks, and to a lesser extent than in non-family businesses (Braga, 2017). On the other hand, risk-taking in family businesses probably means that these companies make decisions that are less based on carefully calculated risks; less based on a systematic, unbiased way; and with less inclusion of outsider perspectives and expert opinions (Nordqvist et al., 2007).

Relational capital and the development of rural tourism

Relational capital also plays an important role in innovation. It is defined as close interaction on a personal level between partners (Kale et. al., 2000). Relational capital as part of the lifestyle of entrepreneurs engaged in rural tourism can increase the small volume of business, because it allows greater proximity to different stakeholders (Cunha, 2020). They may offer more individualized experiences created through co-creation processes and have a greater understanding of the needs of travellers. Additionally, they exhibit more participation in neighborhood affairs.

Doing business in today's market conditions requires the ability to articulate with a network of partners that contribute to the overall tourist experience, where innovation is increasingly linked to the inseparability between demand and supply (Dias & Silva, 2021). The ability to innovate is strongly related to personal competencies and life and market experience, especially the development of one's network through relational capital (Bredvold & Skalen, 2016). The existence of a common environment is essential for the exchange of knowledge and innovations of entrepreneurs. However, having good relational capital may not be sufficient to generate innovation in small businesses (Cooper, 2015). It will depend on the entrepreneur's ability to absorb the knowledge and opportunities that arise from these connections with local partners.

Materials and methods

The target group for this research is entrepreneurs who operate in tourism activities in rural areas of the Republic of Serbia. The target group was selected on the basis of 2 new research criteria (Dias & Silva, 2021): 1) they perform work related to tourism

activity (hotels, restaurants or visitor attractions); and 2) the primary activity is situated in a rural area.

The PLS-SEM method (Partial Least Squares Structural Equation Modeling) will be used in the work to test the defined research hypotheses. The PLS-SEM approach is a methodology of structural equation modeling that extensively features in research endeavors pertaining to the examination of the attitudes and performances of service consumers. The main advantage of this approach is a significant benefit as it effectively elucidates the variance, thereby predicting the underlying associations between the latent variables and maximizes the explained variance. A lot of research has been done using this way of studying in this area (Gim, 2018; Lakićević et al, 2021). That's why we chose to use it for our research. In addition to the mentioned method, qualitative methodology will be used to draw conclusions, as well as the following methods: content analysis, induction, deduction, descriptive method and system analysis.

To examine the identified variables within this particular field of inquiry, a suitable questionnaire was created for the investigated geographical area. The questions distributed through the questionnaire were adapted based on the outcomes of previous study by the authors Kallmuenzer & Peters (2018) and Dias & Silva (2021). This study analyzed the relationship between four factors, the action of which is still significant for the development of rural tourism, and which are measured by the appropriate number of questions from the questionnaire: innovation (5 questions), proactivity (6 questions), risk taking (4 questions) and relational capital (3 questions). All attitudes were measured using a five-point Likert scale, where 1 means "strongly disagree" and 5 means "strongly agree". In addition to these questions, the questionnaire contains seven questions related to the general and demographic characteristics of the respondents in terms of company name, headquarters, gender, age, company generation, size and completed education of the owner/manager.

The questionnaire was distributed through the e-mail addresses of tourism companies in the Republic of Serbia, through tourism organizations that forwarded the questionnaires to tourism service providers in their territory, or through a face-to-face survey. In order to gather as many respondents as possible, the Questionnaire was also distributed through social networks - Instagram and Facebook. A total of 112 valid and correctly completed questionnaires were collected in period April – August 2022.

Results and Discussions

The first table shows the results of the demographic characteristics of the respondents' profiles.

Table 1. Demografic characteristic of respondents

Indicator		Contribution
Gender structure of respondents	male	46%
	female	54%

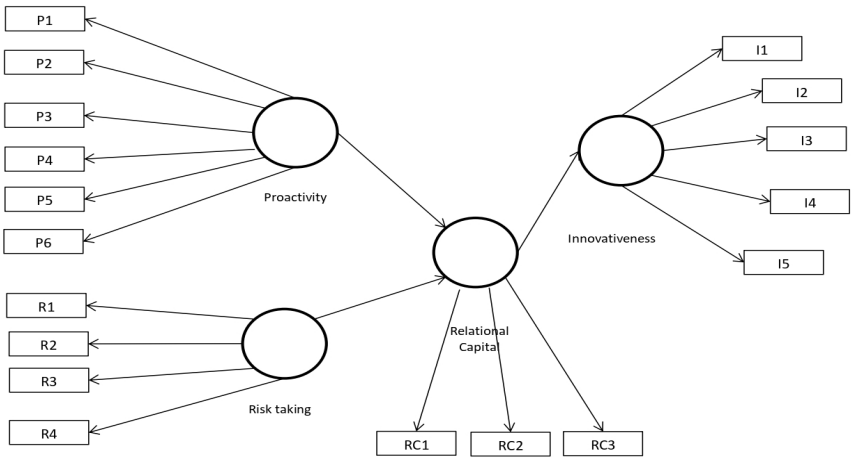
Indicator		Contribution
Ownership structure of respondents	founder of the company	86%
	successor	14%
Age structure of respondents	21-30	8%
	31-40	22%
	41-50	42%
	51-60	20%
	Over 60	8%
Educational structure of respondents	high education	36%
	secondary education	64%

Source: Authors' Calculation

Table 1 shows an overview of the respondents' gender and ownership structure. Only two companies belong to the small category (between 10 and 49 employees), all others are in the micro category. The age and educational structure are also given in Table 1.

In order to examine hypotheses and research the relationship between variables, a theoretical model was created. Based on the review of the literature, the relationships between the observed variables can be concluded, for research purposes they are shown in the model in Figure 1.

Figure 1. Initial theoretical model



Source: Authors

In order to evaluate the validity of the model, the value of Cronbach's Alphas was calculated, and the results are shown in Table 2.

Table 2. Validation of the model

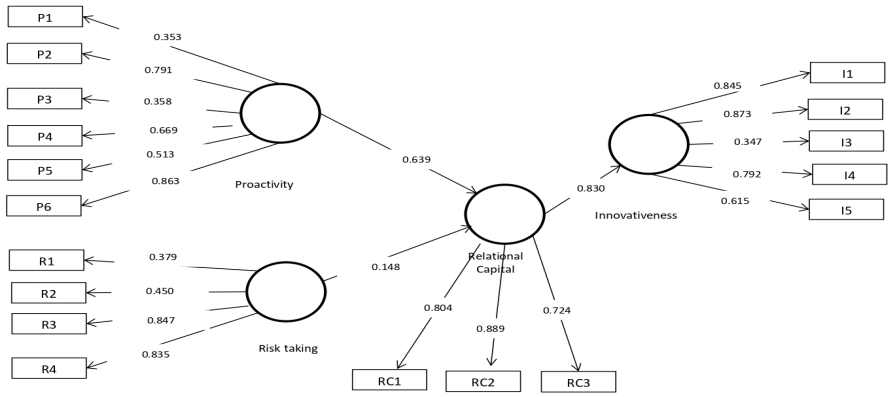
	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Innovativeness	0,65	0,87	0,76	0,52
Risk taking	0,61	0,57	0,74	0,50
Proactivity	0,71	0,80	0,77	0,50
Relational Capital	0,73	0,74	0,85	0,65

Source: Authors' Calculation

Based on the data in Table 2, it can be seen that the model is valid, for proactiveness and relational capital, the results can be interpreted with greater reliability, because are Cronbach's Alpha values greater than 0.7, while for innovation and risk-taking Cronbach's Alpha values are "poor", which is why the results should be interpreted with caution. As an additional measure of validity, the value of Average variance extracted (AVE) was calculated and according to this indicator the model is also valid, given that in all AVE values greater than 0.5 (Bagozzi & Yi, 1988).

The values of the regression coefficients were determined after the model's validity was verified, and the preliminary PLS-SEM model results are displayed in Figure 2. In Figure 2, it can be clearly seen that all the obtained regression coefficients are positive.

Figure 2. Result of PLS-SEM model



Source: Author's Calculation

Calculating the associated p-values for each regression coefficient is important in order to test the set of hypotheses since they show the statistical significance of the calculated coefficients (Table 3).

Table 3. Regression coefficients and statistical significance test

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Risk taking Innovativeness	0.12	0.15	0.13	0.95	0.34
Risk taking Relational Capital	0.15	0.17	0.15	0.97	0.33
Proactivity Innovativeness	0.53	0.53	0.11	4.89	0.00
ProactivityRelational Capital	0.64	0.64	0.13	4.99	0.00
Relational Capital Innovativeness	0.83	0.84	0.03	28.19	0.00

Source: Authors' Calculation

After checking the statistical significance of the regression coefficients at the level of $p<0.05$, it is observed that regardless of the positivity of the coefficient, the results obtained for determining the relationship between risk-taking and Innovativeness and risk taking and relational capital are not statistically significant and should not be considered. This means that hypotheses 1 and 2 are not supported. Despite the high positive ratios of the regression coefficients in this case, we cannot confirm the hypothesis with certainty.

The examination of the relationship between proactiveness and innovativeness is defined by hypothesis H3. A positive regression coefficient (0.53) was obtained for this relationship, and this hypothesis is confirmed. This result is consistent with the findings obtained in the study by Kallmuenzer & Peters (2018). This means that owners and managers should focus on the synergistic effect of innovation and proactivity as decisive behaviors of small tourism businesses. The results for innovativeness confirm assumptions from previous literature, that in family businesses in rural tourism, innovations in the form of problem-solving ideas are key to improving financial performance (Hjalager, 2015).

Based on the analysis of the regression coefficient of the relationship between proactivity and relational capital (0.64), hypothesis 4 was also confirmed. The strongest positive relationship (regression coefficient 0.83) was established between relational capital and innovation, and hypothesis 5 was also confirmed. This result is similar with the research conducted by Dias & Silva (2021). This connection means that the degree of integration into the community and the degree of local knowledge provide the basis for both the creation of new products and for tourist experiences based on the peculiarities of the area in which they develop their activity. It is necessary to use the knowledge of this capital and turn it into innovative solutions that strengthen rural tourism. This ability is linked to the ability of these entrepreneurs to be close to customers and to develop personalized experiences to increase the volume of business.

The potential for the development of rural tourism for regional communities in the Republic of Serbia reflects the significance of this study. Specifically, the growth of rural tourism entails the creation of a short- and medium-term product that is socially, economically, and environmentally sustainable and benefits local communities in rural areas. By facilitating the flow of resources and liquidity into communities through visitor consumption and the creation of new small businesses and employment, rural tourism development can operate as an agent for the change of rural areas. Without an entrepreneurial orientation, there is no success in rural tourism. Cultivating the entrepreneurial and cooperative abilities of local family firms and creating regional cooperative initiatives would lead to the creation of profits for the local community.

One of the more significant limitations of this work is reflected in the low response of tourist companies to fill out the questionnaire. Turning to tourist organizations for help also did not give the expected results in terms of the number of completed questionnaires. An additional paradox is the fact that a certain number of tourist organizations submitted an answer that they do not have the data, because the scope of work related to tourist companies that deal with rural tourism has been transferred to local government.

Conclusion

Rural tourism benefits the local economy, particularly through raising economic revenue and raising people's quality of living. In rural tourism, entrepreneurship is essential to the survival and growth of travel businesses. The goal of this paper was to find out how family businesses in rural tourism can improve their future business, and through observing the relationship between the dimensions of entrepreneurial orientation and relational capital in order to find sustainable development solutions. The paper highlighted the connection between innovation, proactivity, risk-taking and relational capital. This is indicated by the results of the conducted analysis. A positive relationship was established between proactivity and innovation, proactivity and relational capital and between relational capital and innovation, and hypotheses 3, 4 and 5 were confirmed, while hypotheses 1 and 2 were not after testing, i.e. the positive impact of risk-taking on innovation and risk-taking on relational capital was not confirmed.

This paper did not cover all dimensions of entrepreneurial orientation (for example, competitive aggressiveness and autonomy), so future research can be directed to an extended analysis. Also, it is possible to include other types of intellectual capital and see the connection with certain dimensions of entrepreneurship. It would be interesting to investigate the relationship between certain dimensions and the trend of financial performance of tourist companies.

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Conflict of interest

The authors declare no conflict of interest.

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EDUCATION AND INOVATION AS A DRIVER FOR RURAL DESTINATION DEVELOPMENT

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ABSTRACT

In this paper, authors started from the hypothesis that innovations contribute to creativity and that children become more aware of in what way they can contribute to the development of rural areas. With children, play is important, and games that strengthen the imagination and encourage children to think for themselves are one of the best ways to encourage making future, strategic decisions. The challenge was to test the game "Tesla" on older school age children from 12 to 14 years old from rural areas. 138 children from five rural schools on Fruška Gora were examined. The results showed that children from rural areas, with the help of smart devices, played the game at the same level as children from any world metropolis. What's more, through the game, the children showed awareness of the importance of the village, staying in the village and what is needed for the village to "live".

Introduction

When it is said education, what most people think of is learning. It takes place in schools from primary education to education in high schools and colleges. However, such education represents the basis and belongs to formal education. It is not the only form of education.

In addition to this form, there is also informal education. This is education that includes different courses for different professions, training within the company adapted to the

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requirements of the same, permanent education or continuous learning during work, education of "new" personnel (animators, consultants, moderators, "guest relation" informants, etc.) , or "new" education of existing occupations (education with new techniques), education of the population, and others (Flynn and Whiten, 2010). This form of education most often takes place in a new way with many elements of psychology, communication skills, tacit knowledge, planning specific jobs, writing projects and the like (Broesch et al., 2011; Gonul et al., 2018). In doing so, the acquired knowledge represents a starting point and a basis for further independent upgrading. The interactive game "Tesla" is just such a "tool" that can be used to activate children's imagination, influence their creativity and willingness to come to the most adequate solution in a constructive way. This is an educational board game that challenges children to think on the spot and make strategic decisions. By introducing them to a world where everything depends on their decisions, children behave more maturely and show a certain amount of seriousness and businesslike (Sheridan et al., 2016).

The paper started from the initial hypothesis that innovations contribute to creativity and that children become more aware of that in what way they can contribute to the development of rural areas. Children in villages have the same predispositions for playing games and learning with the help of the game "Tesla", which in this case served as an "innovative tool" to encourage creativity. On the other hand, we wanted to see if children at that age are aware of the importance of staying in villages, the development of rural destinations and what are the strong and weak sides of rural life. It wanted to see if innovations in education could contribute to the development of rural destinations and how to improve the strengths and overcome all the shortcomings? Innovative learning represents the "backbone" of progress (Lillard, 1993; McGuigan et al., 2017), because only by keeping up with innovations, it is possible to improve oneself and society (Schmidt et al., 2011). Children are more ready than adults for innovation. They were born in a world where technology and progress are part of everyday life. It is necessary to influence the fact that children, using educational programs and games, improve their knowledge and their environment. The problem of Serbian villages is that young people mostly leave them (Vujko et al., 2021). However, innovations should contribute to staying in villages, returning to villages and developing rural destinations as desirable places for young people to live.

For the purposes of this research, a research survey method was used, where 138 questionnaires were taken into analysis, and the research was conducted in five villages on Fruška Gora, in the period from March to May 2023. Detailed analysis and processing of research data confirmed the initial hypothesis. The Chi - square test (Pearson Chi - Square Test) was used. In addition to research data, the authors used available statistical and other secondary documentation.

Literature review

Education is the key to success, there is no doubt about that, but if during that process one does not work on stimulating the creative part of the brain, i.e. the right brain

hemisphere, then there is not much benefit from that process. The right hemisphere of the brain is called the analog brain and controls three-dimensional sense, creativity, imagination, intuition and artistic senses. Scientists (Cutting et al., 2011; Carr et al., 2016) agree that it is necessary to stimulate both sides of the brain to achieve results. They also agree that through various innovative processes during the educational process is stimulated the right side of the brain - so, the side that is in charge of creativity. Innovations are not only the basis of changes in the traditional sense of the word, but are responsible for human incredible success, starting with the invention of fire, and ending with a diverse range of products, services, value systems, and technology.

According to Carr et al., (2016) Childhood innovations appear in a number of domains: games, pretend play, drawing, storytelling, and more general language. Innovation does not have to be something very big. On the contrary, even a small change in the course of an established routine constitutes an innovation capable of making a visible change.

Children are especially "sensitive" to innovations and are able to react to them in an incredible way. It is enough to give them space and observe the change. Games as a tool of innovation make a particularly interesting tactic to stimulate creativity in children. In that case, numerous ideas are observed that are the product of using the right side of the brain. Scientists agree that games have the ability to help children make decisions more easily and creatively and come up with projects to improve the space they live in (Care et al., 2016).

Scientists agree (Defeyter & German, 2003; Ilić et al., 2022; Hruschka et al., 2018; Kline et al., 2018) that children will react equally if they have the same conditions. If the work requires the Internet, the children will have the same conditions for work whether they are from rural or urban areas. However, as creativity and strategic thinking are influenced by the experience gained in the environment in which the child is located, scientists claim that children from villages will have more constructive solutions for improving life in villages.

According to Lancy (2010), children have a more developed imagination and ability to create creative solutions than adults. You just have to "listen" to them. In his next work, Lancy (2016) believes that children are able to innovate even the most banal thing because they see everything through "rose-colored glasses". If they are given the opportunity to help, they will certainly do so. The development of rural destinations is possible based on the application of some constructive solutions designed by children, especially at an older age (Legare & Nielsen, 2015).

Every job requires creativity for being done the best way, so people who have the ability to think like this are the ones who lead the world into the future. Every child has creativity in him and the task of non-formal education is to help the child to develop imagination into a creative mind. Some authors (Neldner et al., 2017) believe that creativity is the freest form of self-expression and that children do not need a lot of stimulations to show their creative side. Children are satisfied and fulfilled when they can express themselves openly, and especially when they know that what they have to

say is being heard. The creative ability, creating of something from personal feelings and experiences, can reflect and nurture a child's emotional health.

When it comes to non-formal education, it is important to introduce games that encourage creativity. They help children express themselves and show in the best way how useful members of society they can be. Children perceive things with their heart and therefore it is important to consult them (Neldner et al., 2019; Manić et al., 2022). According to Nielsen (2013), children are considered children whose main role is to play, but if they are given the opportunity to solve some task, children can be very constructive and creative.

Games like "Tesla" help children see the world through the eyes of their experience and express themselves in a creative way (Rawlings & Legare, 2021). In this way, it is possible to solve certain problems in a timely manner, such as life in the countryside. In most cases, young people leave the villages, and if their words are not taken seriously, if the problems imposed by modern trends are not addressed and innovations are not introduced in time in education and life, the villages will remain deserted. The fate of such villages is almost certainly sealed (Rogoff, 2018).

The research methodology

The research was conducted in five villages on Fruška Gora in Vojvodina (Ledinci, Rakovac, Čerević, Susek and Sviloš) . These are total of 127 children in higher grades of primary schools, from 12 to 14 years old. The children were presented with the interactive game "Tesla", adapted to their age and interests, and then they were asked 12 open questions, to which they had to answer as honestly as possible. The paper started from the initial hypothesis that innovations contribute to creativity and that children become more aware in what way they can contribute to the development of rural areas. The children were first introduced to the game "Tesla" and how it works. The children were very interested in the game, and particularly mattered was that the game is multidimensional and encourages creativity. In the game, everything depended on themselves. After "playing", the children were asked a group of 9 open questions, to which they gave honest, creative and very interesting answers. The questions were grouped into three groups. The first three questions were related to their perception of villages and rural areas.

Those questions were: 1a. What is the difference between life in the country and life in the city? 2a. Is there a difference between children in villages and children in cities? 3a. What are the main advantages of living in the countryside? The second three questions were related to the real state of life in the countryside. Here the children were asked the following questions: 1b. What are the cultural and entertainment facilities in the villages? 2b. How do people in villages preserve traditions? 3b.What makes you happy? The third group of questions was their vision of the village in the future, that is, what they would do to improve life in the village to make them stay in the village or return after graduating from the Faculty. 1c. How would you improve the living conditions in

the countryside? 2c. How would you reduce the differences between the countryside and the city? 3c. How can villages contribute to the living of people in cities? 4c. In what ways can innovation contribute to a better life for people in villages? 5c. How important is innovation-based education in education? 6c. How did a game you played help you realize that you can do anything you wish?

Respondents' answers are grouped by similarity and are presented as such in the research results.

Two groups of statistical analyzes were used: descriptive statistics (description of the group of respondents, with obtained parameters - frequencies, mean values), inference statistics (making conclusions and testing hypotheses). One of the procedures for analyzing the obtained data was the Chi-square test (Pearson Chi-Square Test). This test is a very practical test which served to determine whether some obtained (perceived) frequencies (answers of male respondents compared to answers of female respondents) deviate from the frequencies that were expected. In this test was asked if there is a connection between these two variables and the probability of connection. In the paper, it was assumed that there would be no difference in the answers of respondents of both sexes, but in order to verify that assumption (hypothesis), this test was applied. Statistically significant differences are taken for those having $p < 0.05$.

Results and discussion

The analysis showed that almost twice as many girls (90) than boys (48) participated in the research. This was expected, because girls at this age are much more open and mature for conversation (Knight, 2013). Before conducting the survey, the children were familiar with the game "Tesla", when they are enabled a creative approach to giving an answer. What the authors noticed was that the children were relaxed after the game and that they energetically approached giving answers. These were exactly the required prerequisites for good research.

Table 1. Gender of respodents

		Frequency	Percent
Valid	Male	48	34.8
	Female	90	65.2
	Total	138	100

Source: Authors' calculations

Similar answers are grouped, so in this paper, a certain grouping of answers, based on similarity, was presented. Looking at table 2, it can be concluded that children from all villages gave very uniform answers, percentage wise. The group with the most answers was the commitment to the society members in the villages. The second was the fact that there is much more greenery in the villages than in the cities. At the start, the children singled out two basic indicators of the quality of life in rural areas: household behavior and living in greenery (Zečević et. al., 2022).

Table 2. The difference between life in the countryside and in the cities

		Gender		Total
		Male	Female	
What is the difference between life in the country and life in the city?	No difference	7	12	19
	Life in the countryside is healthier	7	8	18
	The air is cleaner in the villages	9	5	14
	Food is healthier in villages	7	8	18
	In the villages, everyone knows each other and greets	9	20	29
	The villages have much more greenery and people live in houses	3	22	25
	People in villages as well as people in cities use the Internet	6	15	15
Total		48	90	138

Source: Authors' calculations

By looking at table 3, it can be seen that there is a statistically significant difference in the responses of respondents in relation to gender because p=0.000. This is attributed to the fact that there are many more female respondents at the start, so the answers given by girls are also more diverse.

Table 3. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26,156[a]	6	,000

Source: Authors' calculations

The answers in table 4 show the children's opinion about the differences between their peers in cities and whether, in their opinion, there are any. Here, quite uniform answers were given, so table 5 does not show a statistically significant difference in the answers, in relation to gender. Among the most interesting answers, the "closeness" of children in villages stood out, because in villages everyone knows each other and most children live in multi-member families, which in itself is a characteristic of villages (Vujko et al., 2021).

Table 4. Difference between children in villages and cities

		Gender		Total
		Male	Male	
Is there a difference between children in villages and children in cities?	Children in villages are more dexterous	4	12	16
	Children in villages all know each other	13	27	40
	Children in villages live with many people (grandparents, sisters, brothers) in households	19	14	33
	Children in the villages help their parents in the fields	1	15	16
	Children in villages learn to drive earlier because they drive a tractor early	4	11	15
	Children in the villages know how to light a fire by themselves	7	11	18
Total		48	90	138

Source: Authors' calculations

Table 5. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14,636[a]	5	,012

The main advantage of living in the villages, according to the children, is healthy food, a healthy life and respect for tradition (Table 6). Scientists agree just on this point, that "health", "homemade food", tradition and the like are the main reasons for visiting and staying in villages (Zečević et al., 2021).

Table 6. Advantages of living in the countryside?

		Gender		Total
		Male	Male	
What are the main advantages of living in the countryside?	The village has healthier air	1	15	16
	The village has healthier food	13	21	34
	In the countryside, everything is homemade	19	10	29
	The tradition is nurtured in the villages	1	28	29
	People in the villages are never hungry because they produce everything themselves	7	8	15
	There are many animals in the villages and everyone can have many pets	7	8	15
Total		48	90	138

Source: Authors' calculations

Statistical significance was also observed in this question, p=0.000 (Table 7).

Table 7. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32,417[a]	5	,000

Source: Authors' calculations

Statistical significance was also observed in this question, as it is important for children to play and have fun, so the next group of questions related to cultural and entertainment facilities in the villages (Table 8). Obviously, the children also showed the inside of their families with their answers, so it was recorded that many older women (mothers, grandmothers, aunts, etc.) go to women's associations and thus empower themselves (Maksimović et al., 2019). It is a very important component of life in the villages, because a "strong" and satisfied woman is the pillar.

Table 8. Facilities in the villages

		Gender		Total
		Male	Male	
What are the cultural and entertainment facilities in the villages?	In the villages we have manifestations	3	9	12
	In the villages, women socialize in women's associations	14	27	41
	In the villages we have KUDs and we travel and art societies come to us	19	16	35
	In the villages we have "moba" and we help each other. That's fun.	1	13	14
	We have knitting, weaving and other crafts classes	6	14	20
	The boys play football and have matches every week	5	11	16
Total		48	90	138

The non-existence of statistical significance in the answers shows the degree of maturity in children, in relation to gender, given that p=0.44 (Table 9).

Table 9. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11,387[a]	5	,044

Source: Authors' calculations

Another advantage of living in villages is tradition. It is really very important that children recognize this as a comparative advantage of living in villages, but also as a way to develop rural areas. Customs, folklore, national costumes, but also ecologically grown food and products made from such raw materials, represent the real treasure of life in the countryside and the development of rural areas (Vuković et al., 2019).

Table 10. Preserving traditions in the villages

		Gender		Total
		Male	Female	
How do people in villages preserve traditions?	They make traditional food	2	13	15
	They play folklore and wear national costumes	13	23	36
	They stick to customs	22	17	39
	They cultivate the land in a traditional way	2	14	16
	They nurture old crafts	3	14	17
	They pass the tradition from generation to generation	6	9	15
Total		48	90	138

Source: Authors' calculations

Statistical significance was observed in the answers to this question, in relation to the respondents' answers (Table 11).

Table 11. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16,995[a]	5	,005

Source: Authors' calculations

If we consider happiness as something that represents the essence of life (Busseri and Quoidbach, 2021), then it is really interesting what the children from the village answered when they were asked about happiness. Helping parents and "playing games" were the two most common answers. This shows that children in villages are absolutely the same as children in cities, that is, with adequate conditions (internet) they have the same opportunity to do the same things. This is in favor of the development of rural areas, because knowing this information, the Internet is and must be the right of everyone, wherever lives.

Table 12. Happiness

		Gender		Total
		Male	Male	
What makes you happy?	Hanging out with friends	6	12	18
	Helping parents in the fields and playing with animals	11	22	33
	Playing games in free time	14	14	28
	Playing sports	5	20	25
	Learning new things	8	12	20
	Cycling	4	10	14
Total		48	90	138

Source: Authors' calculations

No statistically significant difference was shown in relation to the answers, but that was expected, because of course, boys and girls have different interests regarding some things (Table 13).

Table 13. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5,792[a]	5	,327

Source: Authors' calculations

And as far as this question is concerned, the children gave different answers in relation to gender, so no statistically significant difference was observed here either (Table 15). However, the children agree that "events" are the key to the development of villages and rural areas, as well as that tourism is a way to develop the village and for people in the villages to get a job, which automatically means staying of young people in the villages as well as the return of people to the villages (Vujko et al., 2018).

Table 14. . Improvement of living conditions in the countryside

		Gender		Total
		Male	Male	
How would you improve the quality of life in the countryside?	It should be enable more work for people in the countryside	8	13	21
	People need to engage in tourism and let other people into their households	17	26	43
	There should be more manifestations such as cobasiciades, slaniniades and the like	16	29	45
	Some male and female singers should be brought to hold concerts in villages	7	22	29
Total		48	90	138

Source: Authors' calculations

The results that can be seen in table 14 show the opinion of children about the possibilities of improving life in the villages, that is, the rural development of destinations. The children agree that events are the key to life in villages, and that rural tourism is the backbone of that development.

Table 15. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1,990[a]	3	,574

Source: Authors' calculations

Table 15. shows that there is no statistically significant difference p=0.574.

Table 16. Reducing differences between villages and cities

		Gender		Total
		Male	Male	
How would you reduce the differences between the countryside and the city	Children from cities should spend more time in villages	45	90	135
	I don't know	3	0	3
Total		48	90	138

Source: Authors' calculations

To find a solution to the answers we saw in tables 2 and 4, almost all children agreed that children from cities (people, in general) should spend more time in villages. Building on the previous question and the answer given regarding the development of rural tourism (Table 14), the way how children could spend more time in villages is clear, but also the direction of development of rural areas. Rural tourism and the development of rural tourism are a constructive solution. Here too, the answers are uniform, so it is very commendable that the children are thinking in a constructive way. he data in the following table show that statistically significant difference is not exist in relation to gender (Table 17).

Table 17. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5,750[a]	1	,016

Source: Authors' calculations

Innovations affect life in every sense, so on children and people in villages. Networking, cooperation, association and connection represent the essence of an innovative worldview (Žarnauskaitė, 2023). The Internet represents a "window to the world" and today, knowing how to work with computers and using the Internet is the "new literacy" (Beck et al., 2012). Therefore, it is normal that the children in the villages highlighted the Internet as one of the greatest innovations of humanity, which is additionally innovated and developed every day. The Internet, properly used, represents a base for innovative learning (Carpenter and Nielsen, 2008). The Internet provides opportunities for people to see how people live and work anywhere on the planet (Beck et al., 2016). Looking at table 19, it can be seen that there is no statistically significant difference, given that p=0.246.

Table 18. Contribution of innovations to a better life

		Gender		Total
		Male	Male	
In what ways can innovation contribute to a better life for people in villages?	The Internet enables people to learn something new	6	19	25
	People in the villages can see how other people in the villages live and work	19	23	42
	New recipes can be seen	13	32	45
	The Internet provides the opportunity for connect and meet	10	16	26
Total		48	90	138

Source: Authors' calculations

Table 19. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4,150[a]	3	,246

Source: Authors' calculations

The results that can be seen in tables 20 and 22 show the children's attitude towards the game "Tesla", which the children played before the start of the test. It was something completely new, which helped the children to relax and to approach answering the questions in a creative way (Boyette, 2016). Bearing in mind the children's enthusiasm for the game "Tesla", their answers are clear, in which most children answer that education based on innovations in education is very important and desirable.

Table 20. Importance of education based on innovations in education

		Gender		Total
		Male	Male	
How important is innovation-based education in education?	It is very important	45	90	135
	I don't know	3	0	3
Total		48	90	138

Source: Authors' calculations

The data seen in Table 21 show that there is no statistically significant difference, p=0.016

Table 21. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5,750a	1	,016

Source: Authors' calculations

Children's opinion about the game "Tesla" is in accordance with everything that has been said so far. There were many answers here, but all of them were grouped together under the answer: "It helped a lot" (referring to the game), (Table 22). The children gave very creative answers, such as: "it stimulated my imagination", "it freed me

and encouraged me to think", "I was excited to decide what and how to do and that everything depends on me", "this game made me invincible", "the game is interesting, creative, fun", "I didn't even know that I knew all this. Thank you for allowing us to try the game", "the game is great", "the game opens up a new view of the world", "while I was playing the game I thought I was a superhero", "I know I can do anything because it all depends of me ", "I want and can do whatever I want", and many more similar answers. The children were aware that their opinion was respected and that they had the posibility to create solutions and make decisions. As in real life, everything depends on the decisions they made. Even the future itself.

Table 22. Children's opinion about the game "Tesla"

		Gender		Total
		Male	Male	
How did a game you played help you realize that you can do anything you wish?	It helped a lot	45	90	135
	I don't know	3	0	3
Total		48	90	138

Source: Authors' calculations

Table 23. Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5,750a	1	,016

Source: Authors' calculations

Looking at table 23, it can be seen that in the answer to this question, there is no statistically significant difference p=0.016.

Conclusion

Play is important, just like education. Scientists agree that it is necessary to find ways to permanently increase the efficiency of learning and the rate of knowledge acquisition (Carruthers, 2002; Nielsen and Tomaselli, 2010). Traditional methods are considered outdated and not follow the step with the time in which we live. Therefore, teaching needs to be enriched with active interactive content that enables active participation in solving tasks (Gonul et al., 2019). That interaction should allow children to give their best. Children are creative and able to make mature decisions. The right part of the brain hemisphere, responsible for creativity and ideas, functions on the principle of "stimulation" which, if it comes from a familiar environment, can manifest its full potential (Gopnik, 2020).

Therefore, children go from observers to active participants. In this research, it showed that children from villages can provide good constructive solutions for the development of rural areas. This is especially important, because it is the children who will be adults tomorrow who should stay in the villages and for whom the villages should "live". The children we examined are aware of the advantages of staying in the villages and very

maturely, encouraged by the interactive game, gave guidelines for the development of the village in the future. If we were to go a little deeper into the analysis of those answers, we would see that they are actually the choices of some of their future occupations. Both girls and boys gave uniform answers which, first of all, also show the maturity of the changes in life in the villages, from the typically patriarchal to the modern one, in which the woman in the village is also strong and independent.

There are numerous ways for education to develop, improve, be enriched with innovative content and as such adapt to modern life and the needs of new generations (McGuigan et al., 2011). This is also the obligation of education as we know it today. Education must "listen" to needs and respond to them. One of the ways to innovate education is the introduction of interactive games into teaching. A game like "Tesla" allows children to express their potential and to feel that everything depends on them. In fact, while playing the game, children apply certain elements of the game in real life as well, which enables an easier and unhindered reaction to different situations. With this, we officially confirmed the starting hypothesis of the work: that innovations contribute to creativity and that children become more aware in what way they can contribute to the development of rural areas.

Conflict of interests

The authors declare no conflict of interest.

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IMPROVEMENT OF RURAL TOURISM IN THE AREA OF BOSNIA AND HERZEGOVINA USING MULTI-CRITERIA ANALYSIS

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ABSTRACT

The aim of the study was to evaluate rural households from five different regions of Bosnia and Herzegovina based on predetermined economic, ecological, and sociological criteria, using assessments from five expert professionals in the field. The study employed the fuzzy multi-criteria decision-making method called TOPSIS to ensure research accuracy. The results indicated that the rural household "Radoja" received the highest rating, which could serve as a solid foundation for future rural tourism development in Bosnia and Herzegovina. Based on the obtained results, it is possible to conduct future research in other regions of the country, providing appropriate guidelines for the development of rural tourism in Bosnia and Herzegovina.

Introduction

In the era of global digitalization of work processes and lifestyles, there is an increasing need for an active way of relaxation in natural surroundings. Rural destinations have become a refuge for many people seeking a break, and their development and offered amenities serve as a draw for an increasing number of visitors from nearby and distant areas or regions. According to Cvijanović et al. (2021), rural tourism is a broader concept than rural tourism alone, as it encompasses areas outside settlements. On the other

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hand, Blešić et al. (2021) highlight that rural areas significantly differ in their specific characteristics from other natural areas, especially urban and suburban environments. Rural tourism has become a driver of economic development in these areas, as tourists visiting rural regions stay there and purchase local products, thereby influencing the economic growth of the region (Nedeljković, et al., 2022). Ezung (2011) provides perhaps the most precise definition of rural tourism, defining it as a form of tourism that allows visitors to have personal contact with the warmth of home, physical and human environments, and, as much as possible, participate in activities, traditions, and the way of life of the local population.

When considering tourism offerings, it is necessary to take into account the social, economic, and environmental background of the local community (Puška et al., 2020). According to Prevolšek et al. (2020), in the implementation of this type of tourism, it is important to utilize not only accommodation facilities but also other forms of content in rural areas, such as sports and recreational facilities, themed attractions, ethno-parks, adventure parks, eco-villages, ethno-villages, and more. This way, tourists receive a complete service, leading to higher satisfaction and loyalty (Pantić et al., 2022; Dileep Kumar, et al., 2020; Pantović et al., 2023).

Bosnia and Herzegovina is a rural country with a rich cultural tradition of its local population, which gives it the right to strive for further development of rural and agritourism. More and more people of different profiles and income statuses are showing interest in the rich traditions and customs of local areas across the country. In line with this, Puška et al. (2020a) conclude that there is progressive investment in improving the tourism offerings in rural regions of Bosnia and Herzegovina. On the other hand, the supply is still relatively scarce and should undergo more intensive development (Puška et al., 2022). A good example can be found in Italy, where over 23,000 farms offer some form of agritourism/rural tourism, contributing to an annual revenue of over one billion euros (Stevanović et al., 2022; Stankov & Roganović, 2022; Palmi and Lezzi, 2020). Similarly, in Poland, services of this kind of tourism were provided on over 8,200 rural households in 2016. (Roman, et al., 2020).

For the development of rural tourism, it is crucial to evaluate the development level of rural settlements based on specific criteria and their assessment (Nedeljković et al., 2022a). Nedeljković et al. (2022) argue that due to the importance of these criteria for tourism development, a holistic approach should be applied when evaluating tourism capacities. Therefore, the main objective of this study is to assess the offering of rural tourism in Bosnia and Herzegovina based on predetermined criteria and employing expert assessments and a multi-criteria research method, as well as selecting the most attractive rural tourist destination. The research subject consists of five selected rural households located in different regions of Bosnia and Herzegovina. They were chosen by five experts from local tourism organizations with extensive work experience in this field.

Literature review

In previous research, many authors have focused on the development of rural tourism. Puška et al. (2021) observe in their study that rural tourism becomes a promoter of rural development, with tourism emerging as one of the main industries in the development of rural populations (Puška et al., 2019). Some authors view it as a representation of rural way of life and the values that this form of tourism provides in its natural environment, offering tourists an alternative to urban lifestyles (Zolfani et al., 2015; Sagić et al., 2019). Podovac et al. (2019) examined the improvement of rural tourism in the Goč region, where they found a need to enhance the quality of accommodation facilities and additional amenities. Puška et al. (2019), on the other hand, evaluated the tourism potentials of four rural settlements in the Brčko District and provided guidelines for their future development.

Kostić and Stanišić (2022) explore rural tourism in Serbia in their study. They find that the studied areas have preserved natural environments and emphasize the need for appropriate valorization of available potentials. Maksimović et al. (2018) investigate rural tourism in the Stara Planina region, while Šarković (2018) examines the impact of media on the development of rural tourism in Serbia. Ristić (2013) studies the importance of state development policies in certain rural areas, as well as the revitalization of rural areas in Serbia. Wang (2021) explores the impact of the internet on improving conditions in rural areas through a case study of rural tourism in China, while Zhang et al. (2022) identify rural settlements as the main carriers of quality rural tourism in China, emphasizing the need to utilize the spatial arrangement of rural settlements to enhance this form of tourism. Additionally, it is worth noting that some authors have recently conducted research on the development of agrotourism as one form of rural tourism in specific countries (Giaccio et al., 2018; Roman et al., 2020; Tseng et al., 2019; Adamov et al., 2020, etc.).

When it comes to the application of multi-criteria decision-making and analysis in this field, there are several examples of research by foreign and domestic authors (Park, et al., 2017; Muhacir and Tazebay, 2017; Anabestani, 2016; Jeong, et al., 2016; Mahboban and Talebi, 2015; etc.). Nikolić, et al. (2015) utilize SWOT analysis and the Analytic Hierarchy Process (AHP) method for research and providing guidelines for further development of tourist destinations in the Stara Planina region. Prelovšek, et al. (2020) use the DEX method to assess the state of tourist offerings in ethno villages in Bosnia and Herzegovina. Nedeljković, et al. (2022), using the DEX multi-criteria decision-making method, provide guidelines and recommendations for further development of rural tourism in the Republic of Srpska. Through the application of multi-criteria analysis of rural tourist capacities, based on a random sample of four tourist facilities, they obtain results from which they conclude that they have adequately utilized the natural resources available in the Republic of Srpska. This method is also employed by Puška, et al. (2020) in their research, justifying its role in managing rural tourist offerings. Nedeljković, et al. (2022a), using the fuzzy SWARA multi-criteria analysis method, recommend measures to strengthen certain criteria in order to further enhance rural tourism in the Brčko District, using it as an example.

Materials and methods

The TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution) was used as the working method. The method used is based on the fact that the chosen alternative has the shortest distance from the positive ideal solution as well as the longest distance from the negative ideal solution. It is considered one of the best techniques for selecting alternatives based on their similarity to the ideal solution. Additionally, it has been found to be satisfactory in various areas of analysis (Yavuz, 2016). To obtain a larger rating interval for decision-makers, which enhances accuracy in the selection process, we expand this method by using triangular fuzzy numbers to replace the numerical linguistic scale for evaluation and weighting.

The following stages in the application of the method used are presented below:

Stages 1: Create a decision matrix

Stages 2: Create the normalized decision matrix

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right); \quad c_j^* = max_i\, c_{ij}; \textit{ Positive ideal solution}$$

$$\tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right); \quad a_j^- = min_i\, a_{ij}; \textit{ Negative ideal solution}$$

Stages 3: Create the weighted normalized decision matrix

Taking into account the weights of each criterion, the weighted normalized decision matrix can be calculated according to the following formula.

$$\tilde{v}_{ij} = \tilde{r}_{ij}.\tilde{w}_{ij}$$

Where $\tilde{w}_{ij}$ represents weight of criterion c_j.

Stages 4: Determine the fuzzy positive ideal solution (FPIS, A^*) and the fuzzy negative ideal solution (FNIS, A^-).

$$A^* = \{\tilde{v}_1^*, \tilde{v}_2^*, \dots, \tilde{v}_n^*\} = \left\{\left(\max_j v_{ij} \,|i \in B\right), \quad \left(\min_j v_{ij} \,|i \in C\right)\right\}$$

$$A^- = \{\tilde{v}_1^-, \tilde{v}_2^-, \dots, \tilde{v}_n^-\} = \left\{\left(\min_j v_{ij} \,|i \in B\right), \quad \left(\max_j v_{ij} \,|i \in C\right)\right\}$$

Where $\tilde{v}_i^*$ is the max value of *i* for all the alternatives and $\tilde{v}_1^-$ is the min value of *i* for all the alternatives. *B* and *C* represent the positive and negative ideal solutions, respectively.

Stages 5: Calculating the distance and the distance between each alternative and the fuzzy positive and negative solutions A^* and A^-.

The distance between each alternative and FPIS and FNIS are according to the following expression:

$$S_i^* = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^*) \quad i=1,2,\ldots,m$$

$$S_i^- = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^-) \quad i=1,2,\ldots,m$$

d is the distance between two fuzzy numbers, when given two triangular *fuzzy* numbers (a_1, b_1, c_1) and (a_2, b_2, c_2), e distance between the two can be calculated as follows:

$$d_v(\tilde{M}_1, \tilde{M}_2) = \sqrt{\frac{1}{3}[(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2]}$$

In this case $d(\tilde{v}_{ij}, \tilde{v}_j^*)$ and $d(\tilde{v}_{ij}, \tilde{v}_j^-)$ are crisp numbers.

Stages 6: Closeness coefficient and ranking of alternatives

The closeness coefficient can be obtained based on the following formula:

$$CC_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

We can find sources for constructing appropriate criteria in previous studies by various authors (Romao et al., 2018; He et al., 2019; Muresan et al., 2019; Spenceley, 2019; Zhang et al., 2019; Prevolšek et al., 2020; Hopkins, 2020; Puška et al., 2020). Due to the significance of sustainability in this industry, ecological criteria are also included in the study. The criteria are divided in the following manner:

- Economic criteria: Price of tourism services/products, quality of offered services and organization, accommodation facilities, transportation connectivity, attractiveness of services for tourists.
- Ecological criteria: Availability of natural resources, quality of natural resources, landscape/environment, diversity of agricultural resources, geoFigureic characteristics.
- Sociological criteria: Offer of local products, possibility of organizing new tourism activities and events, accessibility of tourist facilities, transfer of knowledge from tradition to consumers, importance of local community development.

The research sample consisted of rural households from five different regions of Bosnia and Herzegovina engaged in rural tourism. The selection of these households was based on the expert opinions of five decision-makers with extensive experience in the field. The following selected households were used as alternatives for the research purposes:

- Household „*Ostrovica*“, (Kulen Vakuf Municipality),
- Household „*Šadrvan*“, (Vareš Municipality),

- Household „*Grabovica*“, (Tomislavgrad),
- Household „*Dedić*“, (Srebrenica Municipality),
- Household „*Radoja*“, (Šipovo Municipality).

Additionally, available and accessible professional and scientific literature in the analyzed field was used as a data source in the study, and the results were presented in tabular and Figureical form.

Results and discussion

As previously mentioned, in the study, we utilized the expert assessment of five experts in the field based on 15 predefined criteria. The following Table 1 shows the types of criteria and their weights, which were assessed as equal by the experts for the purposes of this research, assuming that each criterion has equal importance.

Continuing with the study, the results of the remaining steps of the applied research method are presented.

Table 1. Criteria used

	The name of the criteria	Category	Criteria weight
1	Price of tourism services/products	-	(0.067, 0.067, 0.067)
2	Quality of offered services and organization	+	(0.067, 0.067, 0.067)
3	Accommodation facilities	+	(0.067, 0.067, 0.067)
4	Transportation connectivity	+	(0.067, 0.067, 0.067)
5	Attractiveness of services for tourists	+	(0.067, 0.067, 0.067)
6	Availability of natural resources	+	(0.067, 0.067, 0.067)
7	Quality of natural resources	+	(0.067, 0.067, 0.067)
8	Landscape/environment	+	(0.067, 0.067, 0.067)
9	Diversity of agricultural resources	+	(0.067, 0.067, 0.067)
10	GeoFigureic characteristics	+	(0.067, 0.067, 0.067
11	Offer of local products	+	0.067, 0.067, 0.067)
12	Possibility of organizing new tourism activities and events	+	(0.067, 0.067, 0.067)
13	Accessibility of tourist facilities	+	(0.067, 0.067, 0.067)
14	Transfer of knowledge from tradition to consumers	+	(0.067, 0.067, 0.067)
15	Importance of local community development	+	(0.067, 0.067, 0.067)

Source: Authors

In the following Table 2, the fuzzy scale used in the study is presented.

Table 2. Fuzzy Scale

Code	Linguistic terms	L	M	U
1	Very low	0	0	1
2	Low	0	1	3
3	Moderately low	1	3	5
4	Moderate	3	5	7

Code	Linguistic terms	L	M	U
5	Moderately high	5	7	9
6	High	7	9	10
7	Very high	9	10	10

Source: According to Mijajlović et al., 2020

The following table 3 shows the results of the decision matrix.

Table 3. Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
A1	3.400, 5.400, 7.400	3.400, 5.400, 7.400	3.200, 5.000, 7.000	3.000, 5.000, 7.000	4.600, 6.600, 8.400	3.800, 5.800, 7.800	3.200, 5.000, 7.000	3.400, 5.400, 7.400	3.400, 5.400, 7.400	1.800, 3.400, 5.400	4.600, 6.600, 8.600	4.200, 6.200, 8.200	3.800, 5.800, 7.800	2.200, 4.200, 6.200	2.600, 4.600, 6.600
A2	5.000, 7.000, 8.800	3.800, 5.800, 7.800	3.200, 5.000, 7.000	3.000, 5.000, 7.000	5.000, 7.000, 9.000	4.200, 6.200, 8.000	3.000, 5.000, 7.000	3.400, 5.400, 7.400	4.200, 6.200, 8.000	2.000, 3.800, 5.800	3.400, 5.400, 7.400	4.200, 6.200, 8.000	4.600, 6.600, 8.600	1.600, 3.400, 5.400	1.800, 3.400, 5.400
A3	5.400, 7.400, 9.200	5.000, 7.000, 8.800	4.600, 6.600, 8.200	4.600, 6.600, 8.600	5.000, 7.000, 8.400	4.600, 6.600, 8.200	4.200, 6.200, 8.000	3.400, 5.400, 7.400	3.200, 5.000, 6.800	3.400, 5.400, 7.400	3.800, 5.800, 7.800	4.600, 6.600, 8.200	5.000, 7.000, 8.400	3.400, 5.400, 7.200	3.600, 5.400, 7.200
A4	4.600, 6.600, 8.400	5.400, 7.400, 8.800	4.600, 6.600, 8.400	4.200, 6.200, 7.800	5.800, 7.800, 9.200	3.800, 5.800, 7.600	5.400, 7.400, 9.200	4.600, 6.600, 8.400	4.200, 6.200, 8.000	5.400, 7.400, 9.000	5.000, 7.000, 8.800	4.600, 6.600, 8.600	4.600, 6.600, 8.400	5.000, 7.000, 8.600	3.400, 5.400, 7.400
A5	5.000, 7.000, 8.600	5.200, 7.000, 8.400	3.800, 5.800, 7.800	2.800, 4.600, 6.600	6.200, 8.000, 9.400	5.000, 7.000, 8.600	5.400, 7.400, 9.000	5.800, 7.800, 9.200	4.600, 6.600, 8.400	5.000, 7.000, 8.800	6.200, 8.200, 9.600	5.000, 7.000, 8.600	5.400, 7.400, 9.200	5.400, 7.400, 9.200	4.600, 6.600, 8.400

Source: Authors

The normalized decision matrix is shown in the table below.

Table 4. Normalized decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
A1	0.459, 0.630, 1.000	0.386, 0.614, 0.841	0.381, 0.595, 0.833	0.349, 0.581, 0.814	0.489, 0.702, 0.894	0.442, 0.674, 0.907	0.348, 0.543, 0.761	0.370, 0.587, 0.804	0.405, 0.643, 0.881	0.200, 0.378, 0.600	0.479, 0.688, 0.896	0.488, 0.721, 0.953	0.413, 0.630, 0.848	0.239, 0.457, 0.674	0.310, 0.548, 0.786
A2	0.386, 0.486, 0.680	0.432, 0.659, 0.886	0.381, 0.595, 0.833	0.349, 0.581, 0.814	0.532, 0.745, 0.957	0.488, 0.721, 0.930	0.326, 0.543, 0.761	0.370, 0.587, 0.804	0.500, 0.738, 0.952	0.222, 0.422, 0.644	0.354, 0.563, 0.771	0.488, 0.721, 0.930	0.500, 0.717, 0.935	0.174, 0.370, 0.587	0.214, 0.405, 0.643
A3	0.370, 0.459, 0.630	0.568, 0.795, 1.000	0.548, 0.786, 0.976	0.535, 0.767, 1.000	0.532, 0.745, 0.894	0.535, 0.767, 0.953	0.457, 0.674, 0.870	0.370, 0.587, 0.804	0.381, 0.595, 0.810	0.378, 0.600, 0.822	0.396, 0.604, 0.813	0.535, 0.767, 0.953	0.543, 0.761, 0.913	0.370, 0.587, 0.783	0.429, 0.643, 0.857
A4	0.405, 0.515, 0.739	0.614, 0.841, 1.000	0.548, 0.786, 1.000	0.488, 0.721, 0.907	0.617, 0.830, 0.979	0.442, 0.674, 0.884	0.587, 0.804, 1.000	0.500, 0.717, 0.913	0.500, 0.738, 0.952	0.600, 0.822, 1.000	0.521, 0.729, 0.917	0.535, 0.767, 1.000	0.500, 0.717, 0.913	0.543, 0.761, 0.935	0.405, 0.643, 0.881
A5	0.395, 0.486, 0.680	0.591, 0.795, 0.955	0.452, 0.690, 0.929	0.326, 0.535, 0.767	0.660, 0.851, 1.000	0.581, 0.814, 1.000	0.587, 0.804, 0.978	0.630, 0.848, 1.000	0.548, 0.786, 1.000	0.556, 0.778, 0.978	0.646, 0.854, 1.000	0.581, 0.814, 1.000	0.587, 0.804, 1.000	0.587, 0.804, 1.000	0.548, 0.786, 1.000

Source: Authors

The following table 5 shows the weighted normalized decision matrix

Table 5. The weighted normalized decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
A1	0.031, 0.042, 0.067	0.026, 0.041, 0.056	0.026, 0.040, 0.056	0.023, 0.039, 0.055	0.033, 0.047, 0.060	0.030, 0.045, 0.061	0.023, 0.036, 0.051	0.025, 0.039, 0.054	0.027, 0.043, 0.059	0.013, 0.025, 0.040	0.032, 0.046, 0.060	0.033, 0.048, 0.064	0.028, 0.042, 0.057	0.016, 0.031, 0.045	0.021, 0.037, 0.053
A2	0.026, 0.033, 0.046	0.029, 0.044, 0.059	0.026, 0.040, 0.056	0.023, 0.039, 0.055	0.036, 0.050, 0.064	0.033, 0.048, 0.062	0.022, 0.036, 0.051	0.025, 0.039, 0.054	0.034, 0.049, 0.064	0.015, 0.028, 0.043	0.024, 0.038, 0.052	0.033, 0.048, 0.062	0.034, 0.048, 0.063	0.012, 0.025, 0.039	0.014, 0.027, 0.043
A3	0.025, 0.031, 0.042	0.038, 0.053, 0.067	0.037, 0.053, 0.065	0.036, 0.051, 0.067	0.036, 0.050, 0.060	0.036, 0.051, 0.064	0.031, 0.045, 0.058	0.025, 0.039, 0.054	0.026, 0.040, 0.054	0.025, 0.040, 0.055	0.027, 0.040, 0.054	0.036, 0.051, 0.064	0.036, 0.051, 0.061	0.025, 0.039, 0.052	0.029, 0.043, 0.057
A4	0.027, 0.035, 0.050	0.041, 0.056, 0.067	0.037, 0.053, 0.067	0.033, 0.048, 0.061	0.041, 0.056, 0.066	0.030, 0.045, 0.059	0.039, 0.054, 0.067	0.034, 0.048, 0.061	0.034, 0.049, 0.064	0.040, 0.055, 0.067	0.035, 0.049, 0.061	0.036, 0.051, 0.067	0.034, 0.048, 0.061	0.036, 0.051, 0.063	0.027, 0.043, 0.059
A5	0.026, 0.033, 0.046	0.040, 0.053, 0.064	0.030, 0.046, 0.062	0.022, 0.036, 0.051	0.044, 0.057, 0.067	0.039, 0.055, 0.067	0.039, 0.054, 0.066	0.042, 0.057, 0.067	0.037, 0.053, 0.067	0.037, 0.052, 0.066	0.043, 0.057, 0.067	0.039, 0.055, 0.067	0.039, 0.054, 0.067	0.039, 0.054, 0.067	0.037, 0.053, 0.067

Source: Authors

The positive and negative ideal solutions are presented in the following Table 6. From it, we can observe that within the group of economic criteria, the price of tourism services/products has an advantage over other criteria in that group. Similarly, the criteria of diversity of agricultural resources and importance of local community development have advantages within the group of ecological criteria and sociological criteria, respectively.

Table 6. The positive and negative ideal solutions

	Positive ideal	Negative ideal
Price of tourism services/products	(0.025, 0.031, 0.042)	(0.031, 0.042, 0.067)
Quality of offered services and organization	(0.041, 0.056, 0.067)	(0.026, 0.041, 0.056)
Accommodation facilities	(0.037, 0.053 ,0.067)	(0.026, 0.040, 0.056)
Transportation connectivity	(0.036, 0.051, 0.067)	(0.022, 0.036, 0.051)
Attractiveness of services for tourists	(0.044, 0.057, 0.067)	(0.033, 0.047, 0.060)
Availability of natural resources	(0.039, 0.055, 0.067)	(0.030, 0.045, 0.059)
Quality of natural resources	(0.039, 0.054, 0.067)	(0.022, 0.036, 0.051)
Landscape/environment	(0.042, 0.057, 0.067)	(0.025, 0.039, 0.054)
Diversity of agricultural resources	(0.037, 0.053, 0.067)	(0.026, 0.040, 0.054)
GeoFigureic characteristics	(0.040, 0.055, 0.067)	(0.013, 0.025, 0.040)
Offer of local products	(0.043, 0.057, 0.067)	(0.024, 0.038, 0.052)
Possibility of organizing new tourism activities and events	(0.039, 0.055, 0.067)	(0.033, 0.048, 0.062)
Accessibility of tourist facilities	(0.039, 0.054, 0.067)	(0.028, 0.042, 0.057)
Transfer of knowledge from tradition to consumers	(0.039, 0.054, 0.067)	(0.012, 0.025, 0.039)
Importance of local community development	(0.037, 0.053,0.067)	(0.014, 0.027, 0.043)

Source: Authors

In comparison to the results of previous similar studies in neighboring regions and countries, we can observe both similarities and differences. For example, in the research conducted by Nedeljković et al., (2022a) on the development of rural tourism in Brčko

District, they identified rural facilities and services as the highest-rated criterion among the analyzed households. However, Nedeljković et al., (2022) in a study focusing on the territory of Republic of Srpska identified criteria from the ecological group as the highest-rated among the selected households, with price being the dominant economic criterion. Another recent study (Puška et al., 2022) in this field, covering the territory of Bosnia and Herzegovina, also emphasized the dominance of economic criteria in the selection of rural households, particularly price and quality, which aligns somewhat with the findings of this research. Any differences among these studies are likely influenced by the fact that different regions were examined, each with its own specificities and variations.

Table 7 shows the distance from the positive and negative ideal solutions.

Table 7. Distance from positive and negative ideal solutions

	Distance from positive ideal	Distance from negative ideal
Alternative 1	0.207	0.031
Alternative 2	0.193	0.044
Alternative 3	0.112	0.126
Alternative 4	0.06	0.177
Alternative 5	0.029	0.207

Source: Authors

The best obtained alternative is the closest to the Positive Ideal Solution (FPIS) and the furthest from the Negative Ideal Solution (FNIS). The coefficients of closeness for each alternative and their ranking are shown in the following Table 8.

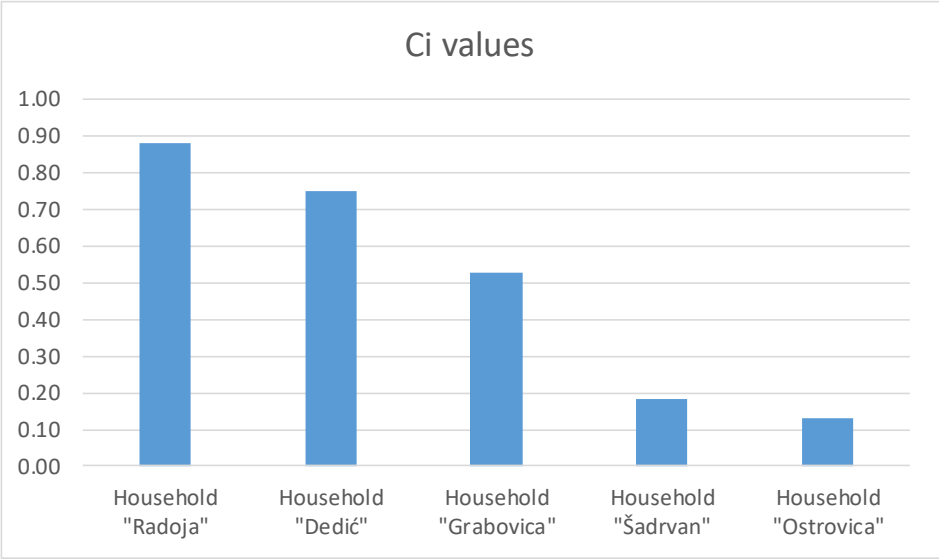
Table 8. Ranking of alternatives

	Ci	Rank
Alternative 1	0.131	5
Alternative 2	0.184	4
Alternative 3	0.53	3
Alternative 4	0.748	2
Alternative 5	0.876	1

Source: Authors

The visual representation of the closeness coefficients for each of the provided alternatives is shown in Figure 1, which follows in the paper. From the Figure, we observe that alternative 5, or the household "*Radoja*" is rated the highest. This particular household is located in an extremely rural area in the village of Pljeva, at an altitude of 450 meters and seven kilometers away from the city of Šipovo. The household is situated near the Pliva River, and the surrounding area is mountainous, characterized by untouched and attractive nature that fully enables the organization of all essential tourist activities.

Figure 1. Closeness coefficient



Source: Authors

Conclusions

The study considered and applied a multi-criteria decision-making model in selecting a household engaged in rural tourism. Based on the evaluation of five rural tourist destinations chosen by five experts in the field, the household "Radoja" from the municipality of Šipovo was selected as the best-rated alternative. The criteria considered were of economic, ecological, and sociological nature. Due to the significance of rural tourism for the entire territory of Bosnia and Herzegovina, rural households from five different regions were included in the study. The mentioned household effectively utilized all the unique features offered by the natural surroundings in this part of Bosnia and Herzegovina, making it a valuable example for the overall development of this form of tourism in the country. This, of course, has significant implications for the local development of this area.

The chosen decision-making method used in the study has proven to be highly flexible for research purposes, but it does not exclude the use of other multi-criteria analysis methods in this field. The focus of future research in rural tourism should be on the application of these methods in other rural regions of the country, with the aim of establishing rational guidelines for further development of rural tourism in those areas.

Conflict of interests

The authors declare no conflict of interest.

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MANAGEMENT OF PLANT PRODUCTION (NARCISSUS L.) THROUGH THE APPLICATION OF NON-STANDARD GROWING METHODS IN ORDER TO INCREASE THE FINANCIAL VALUE OF PRODUCTION

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ABSTRACT

Geophytes are plants of high biological diversity that depends to a great extent on the growing process. Based on what is stated, any new method of production of Narcissus L. has a decisive effect on its production. The aim of the study is to determine if it is possible to achieve better economic-agricultural results with a new method/form of plant growing (Narcissus L., Amaryllidaceae). Under the conditions of the Pannonian environment the production of two methods/forms of growing is compared. By measuring physical plant parameters (p=.00) the results show that the production is better using the standard method of growing. The realized value on the market is higher for the plants grown using the standard method of production (p<.05). The contribution of the author of the study is to indicate a new way of growing, which leads to a higher total value of production.

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Introduction

Narcissus L. is perennial geophytes those are narrowly distributed along the Mediterranean basin. Narcissus L. is a member of Amaryllidaceous a family comprising several horticulturally important plant genera. Decorative and sensory values (Hobson & Davies, 1977; Ehret, et all, 1990; Arroyo & Dafni, 1995; Arroyo & Barrett, 2000; Briggs & Christie, 2002; Folta & Maruhnich, 2007) Narcissus shows high horticultural potential. It is used as an ornamental bulb for growing in the ground, in containers or cut flowers (Kinoshita & Wada, 2000; Kinoshita, et al., 2001; Horton & Ruban, 2005; Loreto, et all, 2009; Lubbe, et all, 2009; Katalin, at all, 2020) then it is used to maintain biodiversity, as well as for plant breeding programs, Narcissus (Rudnicki & Nowak, 1976; Mathew, 2002; Sun, et all., 2005; Okazawa & Nishijima, 2007; Bjelica et all., 2017; Gul, et all., 2018; Safratová, et all., 2018; Zelenović et all., 2018; Bakmaz et all., 2020) it is also widely used in the pharmaceutical industry (alkaloids), to alleviate the symptoms of Alzheimer's disease.

Narcissus poetic's bulbs are also a source of narpoethane-a substance that stimulates the growth of cereals and cotton. The scent of Narcissus flower extract is used in the perfume industry, aromatherapy and hortitherapy. Due to the large application of narcissus and its reaction to growing conditions (Popović, et all., 2018).

Due to the large application of narcissus and its reaction to growing conditions agro-economic observation of plant growing is gaining in importance, particularly in case of plant growing where there is a requirement of making a visual impression on the observer.

The purpose of the research is to present possible agro-economic benefits of plants grown in previous years in public areas under a natural shade. The purpose of the study is to point to the specialists in the relevant field, as well as top management, particularly in public enterprises, to choose an optimum method of (*Narcissus* L.) plant growing.

This plant is one of the first spring types that enrich public parks. In addition to that, this is one of the rare studies showing that the economic value of the plant grown by applying two methods could be measured, and the methods employed are the standard one and the method of growing based on planting (*Narcissus* L.) bulbs grown in the previous three years under a pronounced natural shade in public park areas in the cities.

Numerous authors emphasize that there is a great number of heterogeneous factors that might have an impact on plant growing. Such production conditions often imply a shade, i.e. insufficient quantities of natural light, which has a significant impact on physical properties of the plants grown (Devlin, et all., 2007; Boanca, et all., 2014; Nowak, et all., 2016; Baráth, & Fertő, 2017).

For a comprehensive valuation of (*Narcissus* L.) plant growing, it is necessary to consider a great number of heterogeneous agronomic impacts on the plants. The authors of the study point out that it is necessary to take into account a very great number of heterogeneous economic factors when deciding on the production, as well as to employ a greater number of internal control factors in the respective enterprises.

Besides, in the operations of public utility companies which are essentially providing services to citizens it is of particular importance to take care of the value of production as such operations is funded by taxpayers.

Materials and methods

Conducting an Experiment

The realization of the experiment took place on a park area in the City of Novi Sad (latitude 45° 20; longitude 19° 51'). It is a continuation of the previous three-year experiment, the results of which were published in and which included standard planting of plants (Narcissus L.) with the application of a new method of planting the same plant species.

In the standard cultivation of the mentioned plant species on the park areas of cities in the conditions of cultivation where there was a pronounced shade (1000 lx during the day) after three years the plants were destroyed. This was done because the plants had significantly lower growth, i.e. their visual effect on visitors to city parks was much weaker.

The paper gives an innovative or new approach to production, which meant that plants were not destroyed but replanted in park areas in cities where there is a normal amount of daylight. A three-year experiment was done that included both ways-forms of production.

The obtained results of 8 physical parameters of cultivated plants in both forms-forms of production are economically observed path of economic value that this plant has on the retail market in the year of production, but also during the duration of the experiment.

The purpose of the experiment was to find a new way to improve the economy in the production of these plants. Therefore, measurements of the economic effects of both modes of production were made in order to obtain valid answers that would be useful for some future production. The aim of the author was to discover the possible economic justification of the new way-form of plant cultivation, especially since their production is done with the money of local government taxpayers.

Interval and Course of the Experiment

The interval of the experiment was in the period 11/01/2017, until 03/30/2019. The experimental area is characterized by an average annual temperature of 10.9 ° C, average precipitation of about 578 mm and an altitude of 86 m.

The authors measured 8 selected plant parameters that were observed in total in both production methods in order to determine the achieved results by comparison. The experiment began with the planting of bulbs on the city park area, i.e. on land mechanically cleared of weeds, which had standard conditions of natural light during the day. Planting was done on two plots close to each other (about 40 m).

The first plot was planted with bulbs from plants that were grown as standard and the second plot was planted with bulbs from plants that had been grown in the previous three years in conditions of extreme natural shade (1000 lx during the day).

Objectives of Experimental Research

First goal of the study was to discover the existence of differences in both methods of cultivation through morphological changes, i.e. by monitoring 8 physical values of selected parameters of cultivated plants.

The second goal was to determine the existence of differences in the amount of direct economic investments in both methods of production.

The third goal was to determine whether the realized value of plant production is the same in both methods of production by years of observation.

The fourth goal was to determine whether the total realized value of plant production was the same for both methods of production in the entire observation period.

The fifth goal was to determine whether the same total difference in value for the entire observation period is achieved with both methods-forms of production.

Hypotheses

Taking into account the previously stated views, the authors of the study developed the following hypotheses.

H: 1 Plants (Narcissus L.) produced from plants grown in natural light conditions in Parks of Cities (hereinafter the first method of production) in the first year of production after planting achieve the same production results measured over 8 physical parameters as plants that originate from plants that have been grown in the shade for the previous three years (1000 lx; hereinafter another method of production).

H: 2 Plants (Narcissus L.) grown in the first method of production in the second year of production after planting achieve the same production results measured over 8 physical parameters as plants grown in the second method of production.

H: 3 Plants (Narcissus L.) grown in the first method of production in the third year of production after planting achieve the same production results measured over 8 physical parameters as plants grown in the second - an innovative method of production.

H: 4 Plants (Narcissus L.) produced in the first year of cultivation require the same direct economic investment in production in both production methods.

H: 5 Plants (Narcissus L.) produced in the second year of cultivation require the same direct economic investment in production in both production methods.

H: 6 Plants (Narcissus L.) produced in the third year of cultivation require the same direct economic investment in production in both production methods.

H: 7 Plants (Narcissus L.) produced in the first year of cultivation achieve the same market value in both production methods.

H: 8 Plants (Narcissus L.) produced in the second year of cultivation achieve the same market value in both production methods.

H: 9 Plants (Narcissus L.) produced in the third year of cultivation achieve the same market value in both production methods.

H: 10 Plants (Narcissus L.) produced in a three-year observation period achieve the same total market value in both production methods.

H: 11 Plants (Narcissus L.) produced in the three-year observation period achieve the same difference in value, taking into account direct investments in production and the realized value on the retail market in both production methods. centered.

Concluding remarks after the presentation in the study

In the study conducted by the authors, 5 main conclusions are given.

The first conclusion is that after measuring 8 physical parameters of the plants grown, the results obtained are better than in case of the first method/form of production in all three years of observation.

The second conclusion is that direct investments in production are significantly greater for the first method/form of production in the first year of production, whereas in the second and third year they are approximately the same.

The third conclusion is that the realized value of plant production in each of the three years under observation is greater in case of the first method/form of production than in the second.

The fourth conclusion is that the total realized value of plant production in all three years is greater in case of plants grown by the standard way of production than in case of plants grown by the new method/form of production ($p<.05$).

The fifth conclusion is that in the three-year period of observation the total difference in value in case of plants grown by the new method/form of production is greater, whereby the value of total direct investments in production and values on the retail market ($p<.05$) are taken into account.

Data processing

Statistical package SPSS IBM 22.0 was used for data processing. This was done in order to test the hypotheses. The authors used descriptive statistics with cross-tabulation, and from the statistical tests the t-test for independent samples and the t-test for independent samples with Bonferroni correction were used.

Results

The main objective of the paper is to present the results obtained in the production based on an experimental research of both methods of production, which would enable making an optimum decision on a possible production in the future.

The results are presented through 5 interconnected units that essentially complement each other and create a general picture of the importance of an innovative approach in the production of a plant species (*Narcissus* L., Amaryllidaceae) in urban production conditions.

Morphological characteristics of cultivated plants measured over 8 physical parameters in the cultivation of two forms of production

The authors measured 8 physical parameters, namely: flower diameter, stem length, stem diameter, leaf length, leaf width, mass of aboveground part, bulb diameter and bulb mass in both methods of plant production.

The results are presented by descriptive statistical processing for the period 2017-2019 for both forms of production, and they are strengthened by T-test of independent samples, Tables 1 and 2.

Table 1. Display of total measurement results of 8 physical parameters per year

Year of observation	Method of production	N	Mean	Std. Deviation	Std. Error Mean
2017	standard mode of production	100	**78.40**	3.216	.322
	new mode of production	100	**46.40**	3.216	.322
2018	standard mode of production	100	**69.80**	2.871	.287
	new mode of production	100	**52.80**	3.939	.394
2019	standard mode of production	100	**72.00**	.000	.000
	new mode of production	100	**64.40**	1.752	.175

Source: Author's research

Table 2. Results of t-test of physical parameters of plant production and production methods

Year of observation	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
2017	**70.356**	198	.000	32.000	.455	31.103	32.897
2018	34.878	198	.000	17.000	.487	16.039	17.961
2019	43.370	198	.000	7.600	.175	7.254	7.946

Source: Author's research

Direct economic investments and the form of organization of production

The authors made a gradation of direct economic investments taking into account three levels of gradation, namely: small level, medium and high level of investment. The presentation of the obtained results is given in Table 3 in the three observed years (2017-2019) in which the research was conducted, Table 3.

Table 3. Representation of the gradation of direct economic investments in relation to the form of production

Year of observation	Direct economic investment in production	Form of production	
		Standard mode of production	New mode of production
		Column N (%)	Column N (%)
2017	Little level	0.0%	80.0%
	Middle level	0.0%	20.0%
	High level	100.0%	0.0%
2018	Little level	80.0%	80.0%
	Middle level	20.0%	20.0%
	High level	0.0%	0.0%
2019	Little level	100.0%	100.0%
	Middle level	0.0%	0.0%
	High level	0.0%	0.0%

Source: Author's research

Realized value on the retail market in relation to the form of production by years of observation

The authors performed measurements of the realized value in the retail market in relation to the form of production by years in which the experiment was performed, which is reinforced by the presentation given in Table 4, after the Bonferroni coefficient t-test.

Table 4. Values obtained after Bonferroni t-test by correction by years of observation

Year of observation	Form of production	
	Standard mode of production	New mode of production
	Mean	Mean
2017	10_a	6_b
2018	9_a	7_b
2019	9_a	8_b

Source: Author's research

Realized total value of production in relation to the form of production

After the research and the Bonferroni correction t-test, the authors presented the results of the total realized value of plant production in relation to the form of production for the observation period 2017-2020, Table 5.

Table 5. Values obtained after Bonferroni t-test by correction by years of observation

Period of research by years of observation	Form of production	
	Standard mode of production	New mode of production
	Mean	Mean
2017-2019	9_a	7_b

Source: Author's research

The realized total difference in the value of production arose on the basis of the ratio of direct investments and the realized value on the retail market

Table 6. Overview of the total realized value difference taking the ratio of direct economic investments and the realized value on the retail market after Bonferroni t-test by correction

Period of research by years of observation	Form of production	
	Standard mode of production	New mode of production
	Mean	Mean
2017-2019	6_a	7_b

Source: Author's research

The authors present (Table 5) the realized total difference in the value of production obtained by the ratio of direct investments and the realized value in the retail market in both methods of production for the observation period 2017-2020.

The first conclusion would be that plants that were previously grown in conditions of normal natural light in all three years achieve better results measured over 8 physical parameters than plants derived from previously grown plants in conditions of extremely low natural light (1000 lx), (Table 1). This was confirmed by conducting statistical significance by t-test for independent samples, at the level of significance p = .00 (Table 2).

The second conclusion is that direct economic investments in production in the first year of cultivation are significantly higher with the standard method of production than with the new form of production, while in the next two years direct economic investments are equal (Table 3).

The third conclusion is that plants derived from standard-grown plants achieved higher value in the retail market compared to plants planted from previously grown plants with pronounced shade during the entire observation period (p <.05), (Table 4).

The fourth conclusion is that in the entire observation period standard grown plants have a total significantly higher value compared to plants grown with a new form of production in the entire observation period (p <.05), (Table 5).

The fifth conclusion is that the plants grown in the new way-form of production achieved a greater total difference in value, taking into account direct economic investments in production and the realized value in the retail market (p <.05), (Table 6).

Discussion

As compromises between the appearance of a product and its value are increasingly sought it is necessary to innovate the production process, particularly taking into account the total economic cost relating to the resulting production (Barlev & Haddad, 2003; Brown & Szimayer, 2008; Aczel, 2015; Novaković, et all., 2018; Popović, D, et all., 2018; Wang, 2019; Murphy, 2019). This research is conducted having in mind that the plant in question is among the first early spring plants, particularly in city parks, improving the visual impression of the area. In addition to this visual impression

of visitors, plants grown in public areas are subject to other evaluations and they predominantly refer to economic costs of maintenance of public areas in cities as such maintenance is funded with the money of taxpayers (Sun, et all., 2005; Rodriguez, et all., 2019; Rajičić, et all., 2020; Radović, et all., 2021; Ugrenović, et all., 2021; Vitomir, et all., 2021; Popović, 2021). Due to that, public enterprises set up internal control aimed at reduction of production costs (Cantino, 2009; Popović, 2014; Popović, et all., 2014; Wynen & Verhoest, 2016).

With due regard to all published views, the authors, by making working assumptions, wanted to discover actual possibilities of innovating the method/form of production of (*Narcissus* L.) plant. To accomplish that, they used the results of a previous three-year research (*Narcissus* L.). They made a comparison of a standard plant growing method and the new method of growing. The innovated method the authors employed meant they used bulbs grown in the previous three years under conditions of a reduced natural light (1000 lx) during daytime instead destroying them and planted them. The authors measured the results obtained in the plant growing that way in the following three-year period.

Upon presentation of the obtained results (Table 1) hypotheses 1-3 can be rejected as morphological properties of the plants grown show that the standard method/form of growing yields better results in all three years of observation, which is also confirmed after the t-test is made for independent samples with the significance level p=.00 (Table 2).

The results presented show that direct economic investments in production (Table 3) in year one of growing are significantly higher in case of standard plant growing and therefore H:4 is rejected, whereas H:5 and H:6 are accepted as direct investments in year two and three are approximately the same.

The total value of production, when growing method is concerned, is significantly higher in case of the standard method grown plants in all three years, and H:7, H:8. H:9 are rejected, which is supported by the T-test with the Bonferroni correction (Table 4).

The obtained total value of production over the entire period of observation is higher in case of the standard growing than in case of the new method of production and therefore H:10 can be rejected with confidence as the obtained results are (Table 5), ($p<.05$).

The total difference in the production value presented in the ratio of direct investments to the value realized on the retail market is higher in case of the new method/form of production and H:11 can be rejected with confidence (Table 6), ($p<.05$).

During the preparation of this work, the authors used already published works in which there are notes that during the new organization of economic activities it is desirable to use all the economic benefits that arose on the basis of a different (innovative) economic activity (Soltani, 2009; Williams, 2010; Anwar & Sun, 2015; Chen, et al., 2017). In addition to what has been stated, the authors have also taken into account the views that include the factors of production organization and the existence of specific conditions that can affect the entire organization of production, such as the factors of the existence of the needs of residents within the existence of local self-government units, on which they are

pointed out by the authors (Alibegović, et al., 2018). Respecting all the previously stated views of the authors, the authors of this paper essentially continued with the previously started and published works (Popović, et all., 2015) as a basis for that research to innovate with new research which essentially had a multidisciplinary approach.

The results presented in the paper indicate that this research could be upgraded in some future efforts by introducing other types of plants in the research and conducting new experiments. In addition to a new research, it is possible to conduct subsequent ones by introducing new parameters in observation relating to economic investments in production, use of machines, labour etc. The primary goal of a possible future research would be imposed by taxpayers themselves as they would ask detailed explanations as to the investments made relative to their requirements. The authors believe that in the years to come there will be a greater number of papers on multidisciplinary monitoring of plant production, as well as agricultural production in general.

Conclusions

The importance of this work is reflected in pointing out the importance of applying a multidisciplinary approach in which the authors combined agronomic, ecological, psychological and economic observations. In addition, this work clearly indicates the importance of making the most optimal decision about the way/form of growing plants (Narcissus L.). It is of great importance in the organization of agricultural production. Such a way of organizing production should enable the satisfaction of the needs of taxpayers in local self-governments. The authors pointed to the realization of possible benefits if a new way of organizing production is implemented. The main authors pointed out the importance of managing the processes of agronomic production by means of a non-standard organization of agricultural production of the mentioned plant species.

Based on the review of this paper, the existence of three basic conclusions can be observed (the existence of possible benefits) if a new (innovative) approach is applied in the organization of a plant species (Narcissus L.) in urban conditions.

The first conclusion would be that the real existence of optimal plant production can be based on the improvement of the required morphological properties of cultivated plants (significance level p=.00; table 2), with the simultaneous existence of economic benefits in the production (table 3) of the mentioned plant species, especially in in the first year of production if the new and shown production method is applied.

Another conclusion would be that optimal plant production should also include an analysis of the total realized value of production by methods (ways) of growing plants.

The third conclusion would be that optimal plant production should include the results of the analysis of the total economic difference in the value of production in both methods/forms of production (table 5).

The above three conclusions derived from the obtained results of this work, in the author's opinion, represent a realistically applicable model in the production of a plant

species (Narcissus L.) in urban conditions. At the same time, such an approach in the application of plant production is also possible with other plant species, which can be a realistic upgrade of this approach to production in the next multidisciplinary researches in the field of organization of plant production.

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Conflict of Interests

The authors declare no conflicts of interest.

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DIGITAL TECHNOLOGY IN AGRICULTURE: EVIDENCE FROM FARMS ON THE TERRITORY OF AP VOJVODINA

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ABSTRACT

Agricultural and rural development is a very current issue in the world. Today, agriculture is expected to meet the growing demands for the production of a sufficient amount of food. So, it is necessary to increase productivity in agriculture, while taking into account the long-term agricultural sustainability. The implementation of digitalization in agriculture leads to increased productivity, enables the growth of agricultural producers' profits and maintenance of food security. The aim of the paper is to analyze the application of digitalization in agriculture on farms in AP Vojvodina. In the paper 46 farms from the territory of AP Vojvodina were surveyed as part of the research. The results of the research showed that digital technology is still not used enough on farms in AP Vojvodina, and the main limiting factors are financial resources, education and lack of different types of training.

Introduction

Today, agriculture is facing numerous challenges and global changes. In the future, according to the UN's scenario, the growing population will reach 9.5 billion people in 2050 (FAO, 2018a) which must be fed while adapting to a context of increasing

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devastation: climate change, collapse of biodiversity, reduction of resources (soil, fresh water, phosphorus). Agriculture nowadays must accelerate changes to implement production systems that are more respectful of animal welfare and reduce its impact on the environment (reduction of the use of inputs such as fertilisers, pesticides, sustainable use of natural resources such as soil, water, reduction of greenhouse gas emissions) and contribute to the preservation of biodiversity (Bellon Maurel, Brossard, Garcia, Mitton, Termier, 2022).

Although agricultural production is currently sufficient to feed the world, 821 million people still suffer from hunger, and processes such as rapid urbanization have important implications for food production and consumption patterns (FAO, 2018b). The agri-food sector is still critical for livelihoods and employment, as there are more than 570 million small farms worldwide, and agriculture and food production make up 28% of the total global workforce (Lovder, Skoet, Ranei, 2016). Therefore, achieving the UN Sustainable Development Goal of 'a world without hunger' by 2030 will require more productive, efficient, sustainable, inclusive and resilient food systems, and this will require transformation of the current agricultural and food system (Trendov, Varas, Zeng, 2019).

In order to feed everyone without compromising the entire ecosystem and achieve food security, it is urgent to intervene by redesigning an efficient and sustainable food production system (Stankov & Roganović, 2022). Rolandi, Brunori, Bacco, Scotti, 2021). Nowadays many rural communities are faced with numerous problems. They have difficulty in reaching markets, there is a lack of public and health services, and depopulation is present which negatively affects sustainable food production. Bearing in mind these challenges implementation of digitalization in agriculture can contribute to both agriculture (through efficient use of resources) and rural communities (through the establishment of new services) (OECD, 2019; WEF, 2018). Also, implementation of digitalization in agriculture can contribute to achieving the UN Sustainable Development Goals (SDGs) in rural areas, such as "no poverty", "zero hunger", and "climate action" (FAO, 2018a; Campbell, Hansen, Rioux, Stirling, Twomlow, Wollenberg, 2018; Pantić et al., 2022). Sustainable food production system is crucial for achieving food security, especially nowadays in crisis situations.

The Republic of Serbia has very favorable conditions for the development of various types of agricultural production, and in terms of the volume and structure of available agricultural land, 0.7 hectares of agricultural land, i.e. 0.46 hectares of arable land per person (Ministry of Agriculture, Forestry and Water Management of Serbia, 2014). There are a large number of small family farms which are of great importance. However, small family farms don't have adequate support from the state. The size of farm is crucial for the efficiency of operations in agriculture, so with unfavorable size of farms it is hard to be competitive in the market and in terms of increased competition (Munćan, Todorović, Munćan, 2014). In the Republic of Serbia, small farms with fragmented land have high production costs and inefficient use of resources. Also, farms in Serbia have a low level of technical and technological equipment, small number of livestock per unit of agricultural

land and insufficient financial resources which makes it difficult to increase productivity in production. Therefore, such low productivity in production negatively affects the price competitiveness of production and puts the average agricultural producer in a difficult position on the market (Milovanović et al., 2022: Nestorov-Bizonj, Kovljenić, Erdelji, 2015; Ilić et al., 2022; Popović, Kovljenić, 2017).

In order for farms in the Republic of Serbia to survive in market competition, it is necessary for them to adopt new digital technologies that would enable them to increase their productivity, manage resources sustainably and achieve food security. Therefore, the aim of the paper is to analyze the application of digitalization in agriculture on farms in AP Vojvodina.

Literature Review

Part of the solution to achieving greater production and food security in the future may be the use of digital innovation and technology. Several sectors are rapidly transforming under the influence of the so-called "Fourth Industrial Revolution" (Industry 4.0) such as blockchain, Internet of Things and artificial intelligence (Trendov, Varas, Zeng, 2019).

As a consequence of the spread of mobile technologies, remote sensing and computing services in the agriculture and food sector there is an increase access to information, inputs, markets, finance by small farmers. Digital technologies are creating new opportunities to integrate small farmers into a digitally driven agri-food system (USAID, 2018) and the next period of growth in mobile connections is expected to come mainly from rural communities. Already, 70% of the poorest 20% in developing countries have access to mobile phones, and more than 40% of the world's population has access to the Internet (World Bank, 2016). So, nowadays there are major initiatives to increase the use of digital technologies by small farmers of developing countries.

Large number of authors dealt with issues of digitalization in agriculture and the benefits and limitations of its application. However there are not enough research that deal with the application of digital technology on farms in AP Vojvodina. Franklyn & Tukur (2012) have concluded that numerous factors could influence adoption of digitalization in agriculture and use in agricultural organizations, such as access to IT, demographic, IT training/education, trust, and time. Jurjević, Bogićević, Đokić, & Matkovski (2019) analyzed a set of indicators of economic, ecological and social sustainability and their connection with the implementation of information technologies in agriculture of Serbia. Their results of the research have shown that the application of information technologies in Serbia's agriculture is modest, compared to EU countries. This is due to the unfavorable educational structure of agricultural producers, and limited financial resources, which significantly affect the implementation of IT. Lakota, Stajnko, Vindiš, Berk, Kelc & Rakun (2019) analyzed the use of digital technology in Slovenian agriculture and they concluded that user-friendly and accessible technology is necessary for achieving food security. Salemink, Strijker, & Bosworth (2017) observed that initiatives to promote digitalization in rural contexts are mainly based on a free-market rationale without

considering contextual specificities (e.g., digital skill levels, private investments, and trust in technology). Rotz et al. (2019) state that automatized agriculture significantly improves the lives of farmers and workers who can utilize digital technologies, creating new job opportunities, but also a radically bifurcated labor market increasing social asymmetries. Rolandi, Brunori, Bacco & Scotti (2021) state that digitalization may reduce costs for farms, environmental impact of agricultural production, improve crop yields, and farmers' income. They also state that there is a risk that these improvements will only occur for farmers in high-income countries.

Farms in the Republic of Serbia are characterized by the fragmentation of farms, large number of small family farms, unfavorable age structure of farmers, outdated machinery with traditional production technology, low purchase prices, problems with the marketing of agricultural products, underdeveloped cooperatives, insufficient subsidies, outdated plantations, as well as small number of conditional livestock fund (Ristić, Knežević, Bošković, 2020). Also, these farms constitute the majority of the total structure (Census of Agriculture, 2012). In the agricultural sector of Serbia, the application of digital technology is at a low level, compared to highly developed countries. There are numerous factors that limit the use of digital technology, but one of the important limiting factors is the inadequate educational structure of farmers. Mostly large farms, which are market-oriented, invest significantly in new technologies, because it is necessary to respond appropriately to rapid changes in market liberalization and increased foreign competition (Jurjević, Bogićević, Đokić, Matkovski, 2019).

Observed according to the average arable land by farm, the Vojvodina Region has the most average arable land 12.39 ha, Serbia North 10.94 ha, Belgrade Region 4.84 ha, Serbia South 4.31 ha (Statistical Office of the Republic of Serbia, 2022). As farms in Vojvodina are larger farms, it can be concluded that this region is particularly suitable for the adoption of digital technology, because mostly large farms invest in new technologies.

The adoption of modern approaches, concepts and models in agriculture of the Republic of Serbia requires a realistic assessment of the resource potential and limitations for each development option individually. An assessment is especially needed for each local community and, if necessary, for each farm. However, although there are opportunities for the introduction of certain innovations, they may prove to be unacceptable, if apart from economic benefits, they do not provide other necessary benefits, such as socio-cultural, ecological, health or institutional (Ristić, Knežević, Bošković, 2020).

Bearing in mind the above, the introduction of new approaches and modern digital technologies in agriculture must be accompanied by appropriate activities of competent institutions, with the establishment of partnerships for rural development, the preparation of local strategies for agricultural and rural development and the adoption of other necessary documents. Good preparation for the use of EU pre-accession funds intended for agriculture and rural development, in the process of accreditation of new IPARD measures (Instrument for Pre-Accession Assistance in Rural Development), is important for the Republic of Serbia. Therefore, it is necessary that the national program

for agriculture and rural development for the period 2022-2024 be complementary to the IPARD III program. Serbia should accelerate the implementation of an integrated management and control system (IACS), the transition from manual to electronic processing of requests, separation of payments from production and the connection of area payments with established standards. The Farm Accounting Data System (FADN) has been established, but its sample size and data quality need to be further improved to be fully representative (EC, 2022).

It is also of great importance to follow the Common Agricultural Policy of the EU - CAP (Common Agricultural Policy) for the latest program period, 2021-2027. year, with projections of the EU market for food and beverages until 2030. Projections in the field of food are significant planning of production intended for export and maintenance of food security. The OECD-FAO forecasts for the period 2019-2028 should also be taken into account, especially when it comes to food prices, production, expected consumption and trade in the world. Therefore, it is necessary to monitor the future projections of international organizations and institutions in this area, as well as technological changes relevant to the agricultural sector and the rural economy (Ristić, Knežević, Bošković, 2020).

Materials and Methods

As part of the research, a survey was conducted on 46 representative farms from the territory of AP Vojvodina. The research instrument was a questionnaire, which was created for the purposes of this research. The first part of the questionnaire covered the general questions about the surveyed members of the agricultural holdings, and the second part covered the questions about the application of digital technology in agriculture.

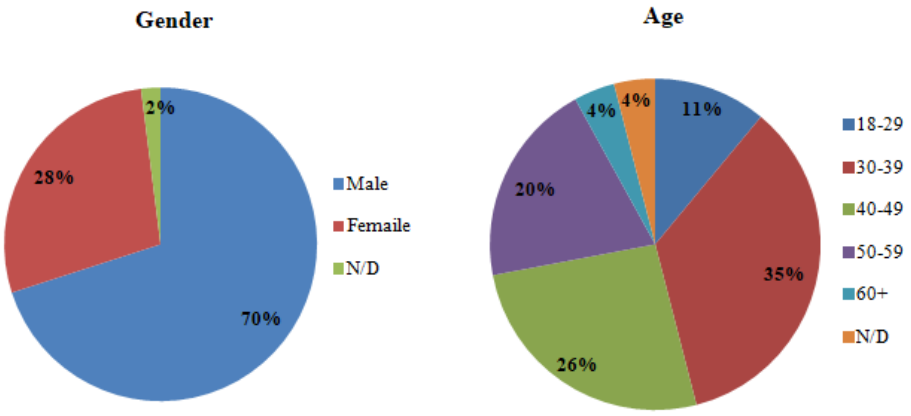
Empirical research consisted of a questionnaire prepared for members of agricultural farms and data was collected by visiting agricultural farms, surveying at fairs and similar events on the territory of the APV where members of agricultural farms gather or by submitting their filled questionnaires to provided e-mails addresses.

The data were analyzed qualitatively, i.e. through the analysis of the frequency of respondents' answers, i.e. using descriptive statistics. It is especially pointed out that even if complex statistics were not implemented, the paper importance is reflected in the subject and the covered sample of research (scope, structure and distribution).

Results of research

In the continuation of the paper, the frequencies of respondents' answers to the questions about the application of digital technology in agriculture are presented.

Figure 1. Basic characteristics of the sample

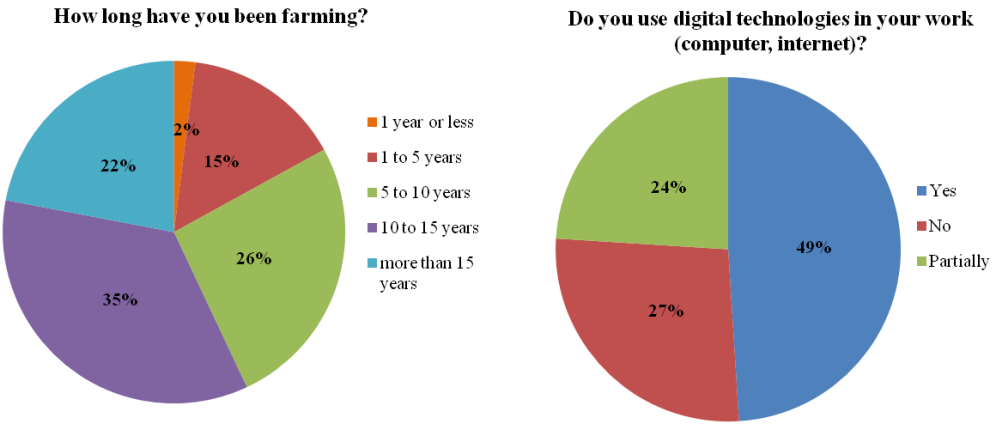


*N/D unanswered questions

Source: Author based on the conducted research

Based on *Figure 1*, the research results showed that the majority of farm respondents are men (men 70%; women 28%) and that the majority of respondents are aged 30-39 (35%).

Figure 2. Use of digital technology in agriculture

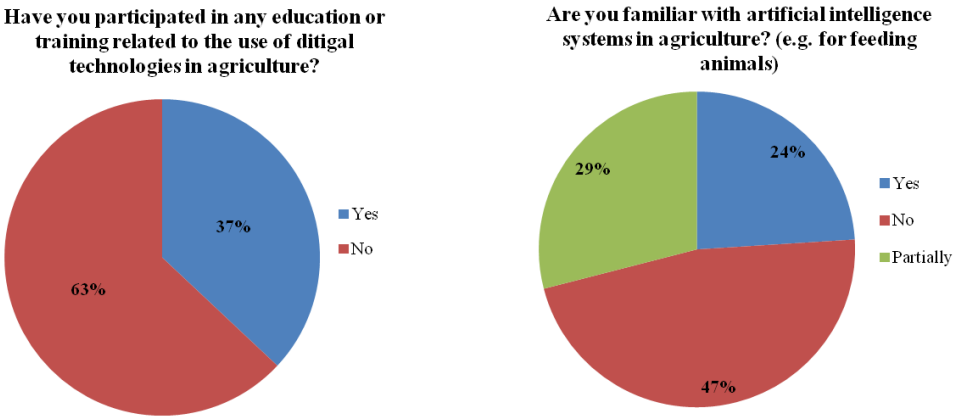


*N/D unanswered questions

Source: Author based on the conducted research

Regarding the application of digital technology (*Figure 2*), the results showed that large number of respondents have been engaged in agriculture for 10 to 15 years, and a greater number of them use digital technology (49%).

Figure 3. Education about digital technology in agriculture

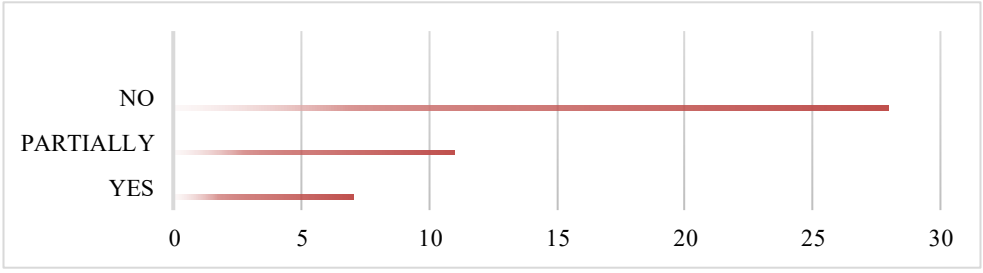


*N/D unanswered questions

Source: Author based on the conducted research

Figure 3 shows that the majority of respondents (63%) did not have education or training related to the use of digital technology in agriculture and a large number of respondents (47%) are not familiar with the application of artificial intelligence in agriculture.

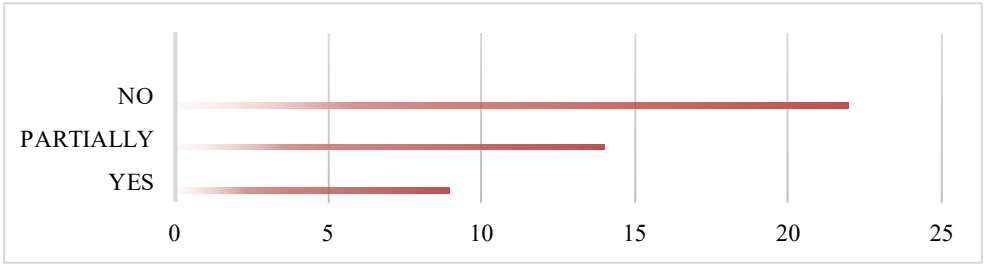
Figure 4. Do you think that the government/state provides sufficient support for the application of digital technologies in agriculture? (e.g. financial support, availability of training, etc.)



Source: Author based on the conducted research

Figure 4 shows that the majority of respondents (28 respondents) think that government/state does not provide sufficient support for the application of digital technologies in agriculture (e.g. financial support, availability of training, etc.).

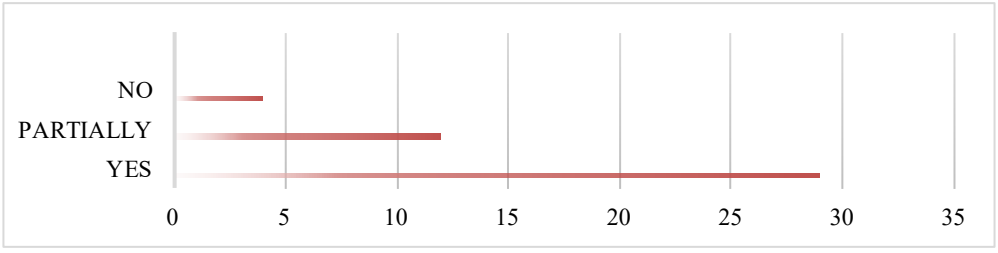
Figure 5. Do you think that rural environment is one of the obstacles for the use of digital technologies in your work?



Source: Author based on the conducted research

Figure 5 shows that the majority of respondents (22 respondents) think that rural environment is not one of the obstacles for the use of digital technologies in their work.

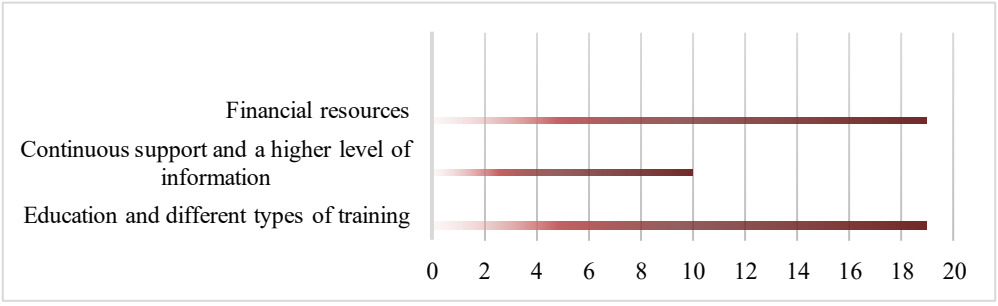
Figure 6. Have you had the opportunity to collaborate with other farmers who use digital technologies in their work?



Source: Author based on the conducted research

Regarding the opportunity to collaborate with other farmers *Figure 6* shows that the majority of respondents (29 respondents) have had the opportunity to collaborate with other farmers who use digital technologies in their work.

Figure 7. What do you need to introduce digital technologies in your work?



Source: Author based on the conducted research

Figure 7 shows that the same number of respondents (19 respondents) believe that financial resources and education and different types of training are needed in order to introduce digital technology into their work, while 10 respondents believe that continuous support and a higher level of information are needed in order to introduce digital technology into their work.

Discussion

The results of the conducted research showed the following:

- The majority of surveyed are male and belong to the population of working age (15-64 years old).
- The largest number of participants have been working in agriculture between 10 and 15 years, and over 80% for more than 5 years.
- The vast majority had the opportunity to cooperate with farmers who use digital technologies in their work.
- According to the results, rural environment is generally not one of the obstacles for the adoption of digital technologies.
- The opinion of the majority is that the government/state does not provide sufficient support for the application of digital technologies in agriculture.
- Most of surveyed use digital technologies (almost 50% - yes, 24% - partially), but 63% did not participate in education or training related to the adoption of digital technologies in agriculture.
- Almost 50% of participants are not familiar with artificial intelligence systems in agriculture (30% partially); they mostly do not know that the Institute for Artificial Intelligence was founded in the RS, so they are not sure whether the Institute's activities will be extended to agriculture.
- Fundings, education and various types of training are needed to use digital technologies.

The results of the research showed that the majority of farms from the territory of Vojvodina have been engaged in agriculture for many years (more than 10 years) and have had the opportunity to cooperate with farmers who apply digital technology. In this way, they are familiar with the benefits of applying this technology. However, the respondents are still not familiar with artificial intelligence systems in agriculture, which in today's business conditions have shown significant positive results during its application. Likewise, since larger farms are ready to adopt new digital technologies, the region of Vojvodina has the largest areas of arable land, so this region is particularly suitable for the application of digital technology in agriculture.

The results of the conducted research showed that less than 50% of respondents use digital technology and they are not familiar with the application of new technologies in agriculture. Also, results of the conducted research showed that more than 50%

did not have education or training related to the application of digital technology in agriculture. According to the surveyed respondents, the main limiting factors for the use of digital technology in agriculture are financial resources, education and different types of training. The importance of training/education and investments for the application of digital technology in agriculture is also confirmed in the papers Franklyn & Tukur (2012), Jurjević, Bogićević, Đokić, & Matkovski (2019) and Salemink, Strijker, & Bosworth (2017).

So, in order to resist future challenges and maintain an appropriate level of food security in Serbia, it is necessary to adopt digital technology in agriculture. Today the level of agricultural production depends on the availability of modern digital technologies of the new generation. Therefore, the transition to advanced intelligent technologies is the main vector for the improvement of agricultural production, which ensures an increase in production efficiency, an increase in productivity and quality of work, optimization of production costs and reduction of their losses (Marinchenko, 2021).

As specified, digital technologies provide numerous benefits, but there are also obstacles to the adoption of digital technologies in agriculture. Some of the main obstacles are high investment costs and a lack of education, training and advisory services for farmers, especially small and medium-sized farmers (Paustian and Theuvsen 2017; Rose and Chilvers 2018) and therefore, it is necessary to create appropriate policies that can help overcome these obstacles. By offering financial assistance to farmers in the form of tax credits and/or subsidies, short-term opportunity costs and long-term financial risks associated with technological innovation and investment would be compensated (Ehlers, Huber, Finger, 2021). Also, it is stated in the Farm to Fork Strategy (F2F), that providing agricultural training and advisory services could encourage greater application of digital technologies on farms. Therefore, it is necessary that there is a merger of advisory services with different forms of financial incentives which will increase application of digital technology. At the same time, these types of measures can help to avoid the digital divide between large and small farmers in the future (Mac Pherson, Voglhuber-Slavinsky, Olbrisch, Schöbel, Dönitz, Mouratiadou, Helming, 2022).

Conducted research is a pilot project and as such it presents a basis for future research which would include both larger number of agricultural producers and more different variables. We expect that concrete further steps that should be taken would be distinguish and thus contribute not just improvement of the digital literacy of the members of agricultural farms/producers, but also green and digital agriculture in general.

Conclusion

In AP Vojvodina, agriculture is of great social and economic importance, especially in emergency situations. In order to resist future challenges and maintain an adequate level of food security, it is necessary to invest in the agriculture development of the Republic of Serbia. However, agriculture development in modern conditions is a very complex

process and it is very difficult to make precise predictions in this area. Agriculture development is influenced by a number of economic-financial, legal-political, socio-cultural, as well as environmental and health-safety factors.

So, there needs to be efficient use of available resources, as well as encouraging those products and activities within the rural economy which have shown success in the market and are examples of good practice. Encouraging young people to engage in agricultural activities of the rural economy is necessary, with a more intensive introduction of modern technologies in agricultural practice and life in the countryside. The future agricultural development of the AP Vojvodina is significantly under the influence of internal factors and depends on the adoption of new digital technologies, adequate strategic directions of development, their implementation and the direct involvement of key actors.

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Conflict of interests

The authors declare no conflict of interest.

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INVESTMENTS IN SERBIAN PIG PRODUCTION – INFLUENCE OF REGIONAL DISPARITIES

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ABSTRACT

Pig production is one of the most important elements of Serbian livestock breeding sector. Although it faces numerous challenges, there is not enough research focused on its economic effectiveness. The goal of this research is to analyze influence of regional disparities on economic efficiency of investments in Serbian pig production. The main methodological approach was to determine the present value of investments in pig production (for Mačva and Šumadija regions). Authors applied sensitivity and scenario analysis, as well. Riskiness of investments is compared using standard deviation and coefficient of variation of the expected present value. The results indicated significant influence of labor costs on net cash flows (especially in Šumadija region). Analysis revealed that (in usual circumstances) investments in pig production in Mačva region are more economically efficient. Nevertheless, rather small increase in pig price could lead to equal present values in both regions. It was determined that investments are riskier in Šumadija region.

Introduction

Although pork is by far the most important type of meat production in Serbia (Statistical Yearbook of the Republic of Serbia, 2022), there is not enough research devoted to Serbian pig production (primarily from the economic standpoint). Having in mind the declining chain indices of pig breeding in 2021 (comparing to 2020), smaller number of pigs in 2021 (comparing to 2020) as well as extreme increase in number of imported pigs (in year 2021 comparing to previous years) (Statistical Yearbook of the Republic

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of Serbia, 2022), it is evident that economic effectiveness of pig production in Serbia requires additional research.

Discussing importance and export potential of Serbian livestock production, Madžar (2014) concluded that there is a decrease in livestock number followed by an increasing import of livestock products. Research covering period from 2001 to 2014 (Mirilović et al., 2015) determined that during the observed period there were five years with negative economic performance of pig production (years 2002, 2003, 2006, 2007 and 2010). Having in mind variability of market prices, Zekić et al. (2007) stated that pig producers have an uncertain position, while the supply of processing industry is unstable. Zekić et al. (2008) determined economic and technological challenges related to the production of piglets and fattened pigs on family farms. Ivanović et al. (2015) indicated that economic evaluation of investments in pig production requires application of modified internal rate of return – MIRR (instead of traditional internal rate of return approach) due to a significant variation of net cash flow in pig fattening operation.

Discussing possibilities for improving pork production, Sviben (2001) focused on prices (pork and pig prices), pig breeds and production process. Zekić et al. (2014) applied simulation methods to analyze economic parameters of pig production, concluding that there is a high level of riskiness related to this production (and consequently there is a need for risk reduction). Ivanović (2013) performed an analysis of economic efficiency of investments in pig production and compared it with beef production, while Jeločnik et al. (2021) calculated gross margin in pig production (pig fattening) and discussed its sensitivity (concerning a decrease of pig price and an increase of variable costs).

Analysing economic performance of various types of livestock production in the EU, Nastić et al. (2017) determined that granivores production (comprising of pigs and poultry production) dominates over the other production types concerning average level of total output and value of total assets. Malak-Rawlikowska et al. (2021) analyzed a new approach to pig farms economic sustainability oriented towards long – term perspective (instead of usually observed short – term span). Authors tested the hypothesis that "closed-cycle farms might be more economically sustainable than those farms that are specialized in piglet production (breeding) or growing–finishing". As a result, it was concluded that "closed-cycle farms do indeed have advantages in terms of raising healthy animals and having slightly better overall resilience of resources, however breeding and finishing farms appeared to be more sustainable in the areas of profitability, risk management, and reproductive efficiency". Ruckli et al. (2022) discussed multi-criteria sustainability assessment tool for various types of pig farms (breeding, breeding to finishing and finishing farms). According to the authors, "multi-criteria analysis is a suitable method for assessing the sustainability of pig farms as it allows the coverage of a wide range of topics relevant to sustainability". Alves et al. (2022) made an effort to develop a standard tool (method) for calculation of costs in pig production (for different production systems). Apart from variable and fixed costs, authors discussed opportunity costs of capital and land, as well.

Besides, there was some research focused on producing pork product with protected origin. Such research is based on the comparison of traditional (Mangalitsa) and modern pig breeds – such are Yorkshire (Large White) (Zekić et al., 2012) or Landrace (Zekić et al., 2012). Discussing gastronomic tourism of Vojvodina, Banjac et al. (2016) mentioned meat – based protected products such as Kulen, Domestic sausage and Salami sausage (all of them from Srem region known by its pork production), Slovakian sausage, Ham from Vršac and Sausage from Svetozar Miletić.

Pig production is currently dominated by the widespread conventional indoor system (Delsart et al., 2020). Conventional indoor systems are less socially acceptable and there is a tendency to replace them with the alternative ones. These alternatives have real advantages, as stated by the authors, but they also have weaknesses which represent major challenges to be faced. Research conducted by Renner et al. (2021) indicates that technologies are on average well adapted to local natural conditions of production with little potential for increasing efficiency and productivity.

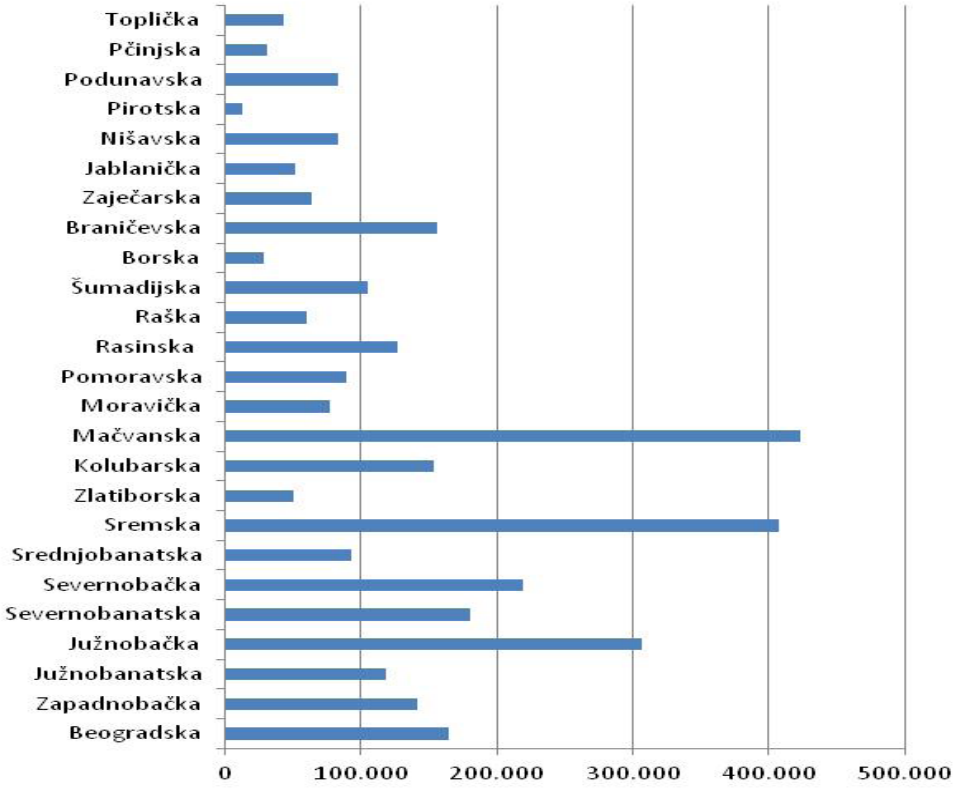
Intensive production is based on an indoor system that functions according to the "all-in all-out" principle, which ensures high animal hygiene conditions, good production results and good management. Depending on the area, there are differences in the intensity of production, which are reflected in the size of the farm, the structure of the farm, breeding and selection, farm technology and equipment, as well as the production results. Economic results in pig production depend on numerous genetic and non-genetic factors, whether it is the production and rearing of breeding pigs, or the production of fattening pigs with a large proportion of meat in the carcass and good physico-chemical and technological properties of the meat (Radović et al., 2018).

The state of pig production in Serbia is not satisfactory and is a consequence of the lack of differentiation in terms of structure, openness of the pig population, non-continuous breeding and selection work, weak productivity control, poor technical and technological solutions, transition and instability of the market (Savić, 2014). Besides, there is a problem of unclassified carcass in Serbia, with all the negative consequences for pig farming, but also for the meat industry (Radović et al., 2018).

The highest number of pigs is present in Serbian lowland regions. According to the data from Farm Structure Survey (which was conducted in 2018), pig production is the most important in regions of Mačva and Srem (Figure 1) (Statistical Office of the Republic of Serbia, 2022). On the other hand, there are some other areas in which pig production is less present, while cattle, sheep or poultry production are dominant.

Authors used data from two regions – Mačva and Šumadija in this analysis. Mačva is the region with the highest level of pig production (due to favorable natural conditions), while Šumadija region is hilly area situated in central Serbia. Considering the number of animals (recorded in Agricultural census in 2012), in Šumadija region sheep and cattle productions are more important than pig production (Statistical Office of the Republic of Serbia, 2013). Therefore, Mačva and Šumadija present regions with different natural conditions and consequently different importance of pig production.

Figure 1. Number of pigs per areas in Serbia in 2018



Source: SORS, 2022

The goal of the paper is to determine how regional differences influence investments in pig production and its riskiness. At the same time, the research covered other important factors related to investments, such as the level of discount rate and labor costs.

Materials and methods

In order to present the importance of pig production of individual regions in Serbia (in the introductory part of the paper) authors used data published by Statistical Office of the Republic of Serbia (which includes data from Agricultural census conducted in 2012 and Farm Structure Survey conducted in 2018). Authors analyzed pig production in two regions – Mačva and Šumadija. The decision to perform the analysis for these regions is based not only on their importance for pig production in Vojvodina and Central Serbia, but also on the availability of data in STIPS database for the analysis.

Authors used STIPS database to acquire data (on monthly basis) regarding prices of pigs, piglets and mercantile corn in analyzed regions. Average prices of these variables for 2022 are applied in the calculations of net cash flows. The analysis was performed on the model of family (finishing) farm producing 300 fattened pigs per year (three

production cycles per 100 pigs). One fattening cycle lasts for 100 days, while pigs are fattened from an initial weight of 25 kg to a final weight of 105 kg. The pigs are sold to the meat processing facilities, which provides eligibility for state subsidies.

Investment analysis is based on an average yearly cash inflow and outflow of pig fattening operation, providing necessary elements for the determination of the present value. The present value indicates a maximal level of investment which is economically acceptable (Gogić, 2014; Ivanović, 2013). Observed economic life of investments in pig production is 40 years. To determine the present value, authors applied various discount rates (2.5%, 5.0% and 7.5%). Apart from the variation of discount rate, authors analyzed an influence of labor costs (as opportunity costs related to the pig production on family farms) on the present value of investment. To analyze the present value of investments in risky circumstances, authors performed sensitivity analysis and scenario analysis. The research conducted by Barjaktarović et al. (2020) indicated that sensitivity analysis is sometimes or always used by a certain number of companies in Serbian agribusiness industry (although the majority of companies in the sample use it very rarely). Scenario analysis was performed assuming three scenarios – pessimistic, optimistic and the most probable one (Ivanović and Marković, 2018). The scenarios differ concerning prices of the above mentioned factors of the analysis (price of pigs, piglets and mercantile corn). Scenario analysis resulted in indicators such as the expected present value and its coefficient of variation. The importance of sensitivity analysis and scenario analysis approach for investment analysis in theory and practice was discussed by a number of authors (Karanovic et al., 2010; Kengatharan, 2016; Gogić, 2021).

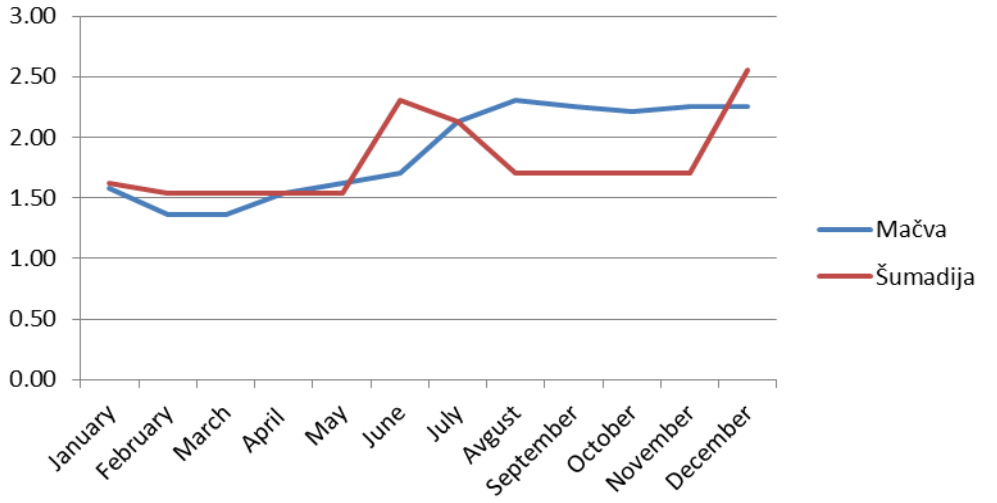
Results and Discussion

Data analysis indicated that average market prices of the most important outputs and inputs in 2022 were lower in Šumadija comparing to Mačva region:

- an average pig price in Šumadija was 4.26% lower than in Mačva region,
- an average piglet price in Šumadija was 2.51% lower than in Mačva region,
- an average corn price in Šumadija was 2.86% lower than in Mačva region.

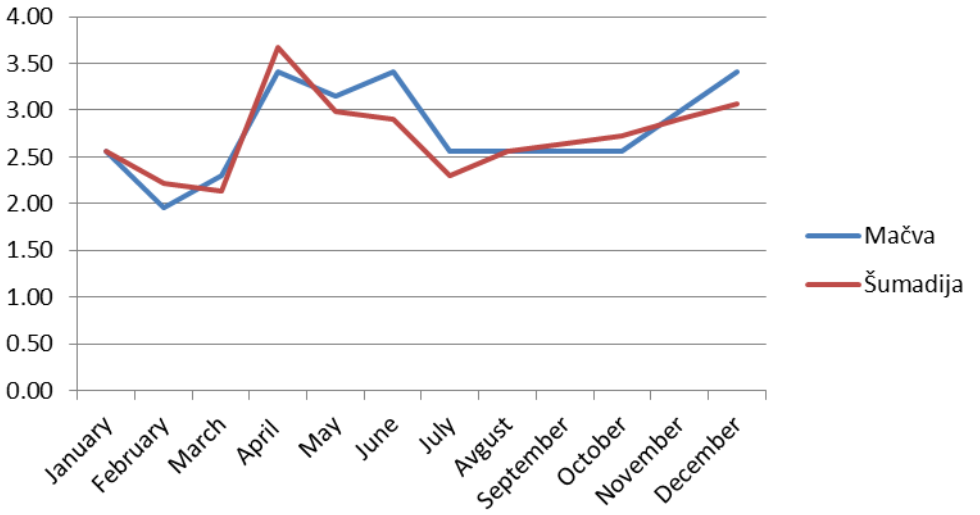
Market price of pigs in Mačva region fluctuated during year 2022 from 1.36 to 2.30 EUR/kg (Figure 2), while an average price was 1.88 EUR/kg. In Šumadija region, market price of pigs varied from 1.53 to 2.56 EUR/kg, while an average price was 1.80 EUR/kg. When it comes to the price of piglets in Mačva region – it was between 1.96 and 3.41 EUR/kg, while an average price was 2.79 EUR/kg (Figure 3). In Šumadija region, prices of piglets varied from 2.13 to 3.67 EUR/kg, while an average market price was 2.72 EUR/kg.

Figure 2. Prices of pigs in Mačva and Šumadija region in 2022



Source: STIPS database

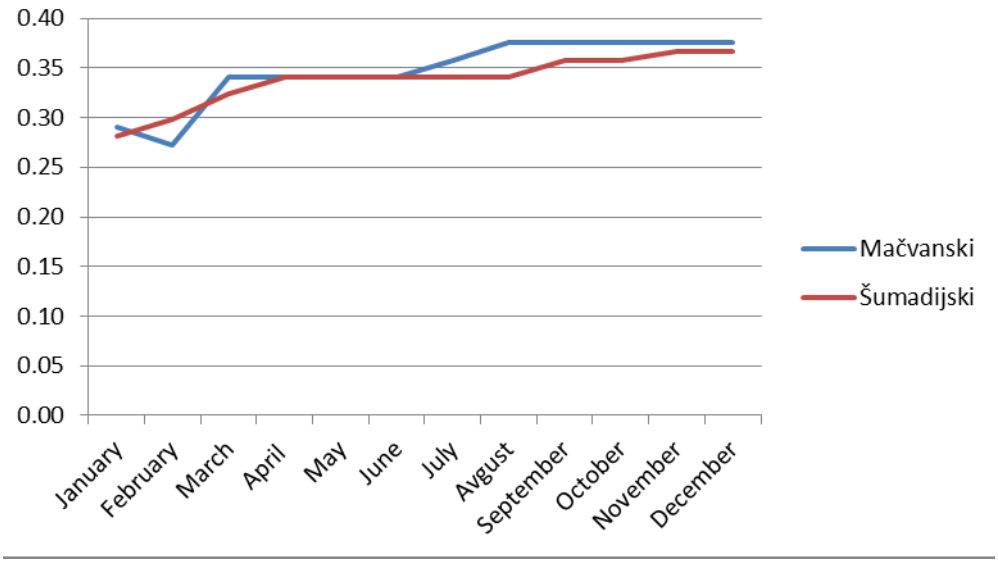
Figure 3. Prices of piglets in Mačva and Šumadija region in 2022



Source: STIPS database

The price of mercantile corn is very important for pig production, because corn participates in feed for pig fattening somewhere around 70%. The analysis revealed that mercantile corn prices were very similar in both regions (Figure 4). Corn price in Mačva region varied from 0,27 to 0,38 EUR/kg in 2022 with an average price of 0,35 EUR/kg. Similarly, corn prices in Šumadija region varied from 0,28 to 0,37 EUR/kg, while an average price in 2022 was 0,34 EUR/kg.

Figure 4. Prices of corn in Mačva and Šumadija region in 2022



Source: STIPS database

The results of investment analysis are influenced not only by the differences in prices between the observed regions, but also by other factors (the most important of them are labor costs). When labor costs (which are equal to minimal net salary in Serbia) are included as an element of cash outflow (Table 1), net cash flow is positive in Mačva region, while it is negative in Šumadija region. Therefore, an assumption that labor costs are included in the analysis implies that an investment in Šumadija region is not economically efficient.

Table 1. Net cash flow if labor costs are taken into account (EUR)

Elements of net cash flow	Mačva	Šumadija
Cash revenues	**61.779,00**	**59.259,00**
Fattened pigs	59.220,00	56.700,00
State subsidies	2.559,00	2.559,00
Cash expenses	**60.655,61**	**59.631,40**
Feed costs	33.552,96	33.077,52
Water costs	200,00	200,00
Cost of piglets	20.925,00	20.400,00
Veterinary services and medicaments	1.677,65	1.653,88
Electricity costs	700,00	700,00
Labor costs	3.600,00	3.600,00
Net cash flow	**1.123,39**	**-372,40**

Source: Authors` calculation

If labor costs are excluded from the analysis (Table 2), net cash flow is positive in both regions, while it is 46.34% higher in Mačva (which provides possibility for a much higher level of investments in pig production).

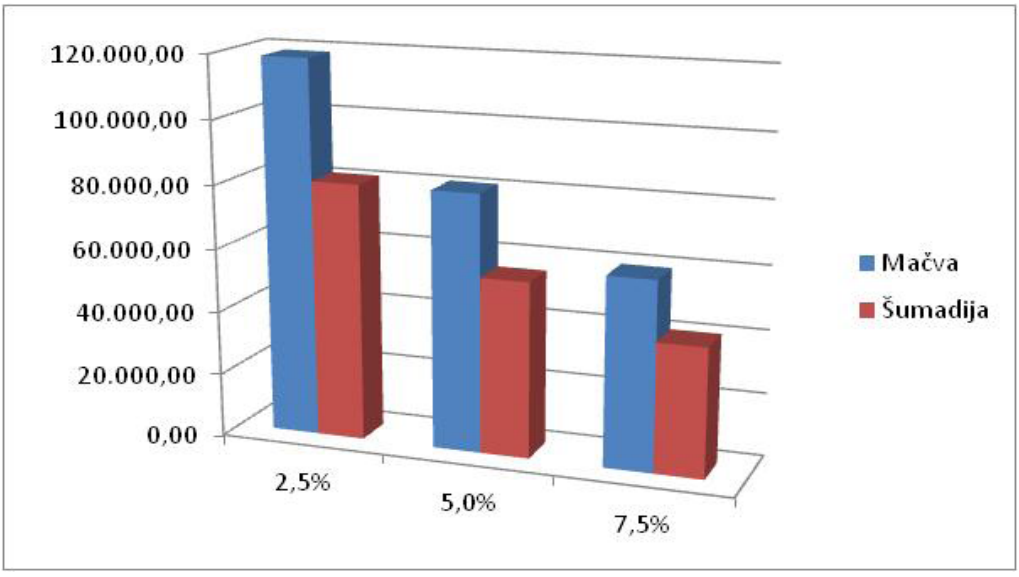
Table 2. Net cash flow if labor costs are not taken into account

Elements of net cash flow	Mačva	Šumadija
Cash revenues	**61.779,00**	**59.259,00**
Fattened pigs	59.220,00	56.700,00
State subsidies	2.559,00	2.559,00
Cash expenses	**57.055,61**	**56.031,40**
Feed costs	33.552,96	33.077,52
Water costs	200,00	200,00
Cost of piglets	20.925,00	20.400,00
Veterinary services and medicaments	1.677,65	1.653,88
Electricity costs	700,00	700,00
Labor costs	-	-
Net cash flow	**4.723,39**	**3.227,60**

Source: Authors` calculation

Having the above mentioned in mind, the present value is determined (Figure 5) for two investment options – investments in Mačva region and investments in Šumadija region when labor costs are excluded from the analysis. The analysis revealed that the present value of investments in pig production is higher in Mačva region for all observed discount rates. Such results explain higher concentration of pig production in Mačva region.

Figure 5. Present value for different regions and discount rates (EUR)



Source: Authors` calculation

Application of sensitivity analysis approach enabled authors to determine the prices of pigs, piglets and corn in Šumadija region needed to achieve the same level of the present value as it is in Mačva region (Table 3). The basic assumption of the sensitivity analysis is that one factor changes, while all other factors are fixed. According to the results of this analysis, the easiest way to increase the present value of investments in pig production in Šumadija region (and make it equal to the present value in Mačva region) is a slight increase of pig price (only 2.67%). On the other hand, the present value is less sensitive to the changes of other prices relevant to the research.

Table 3. Necessary variation of prices in Šumadija region

Indicator	Present level (EUR/kg)	Necessary level (EUR/kg)	Necessary change
Price of pigs	1.80	1.848	+2.67%
Price of piglets	2.72	2.52	-7.35%
Price of corn	0.34	0,31	-8.82%

Source: Authors` calculation

To explore an economic efficiency of investments in risky circumstances applying scenario analysis, three scenarios were established (pessimistic, the most probable one, optimistic). Different prices (of pigs, piglets and corn) were assumed for each scenario (while other factors were constant) (Table 4).

Table 4. Prices used for scenario analysis

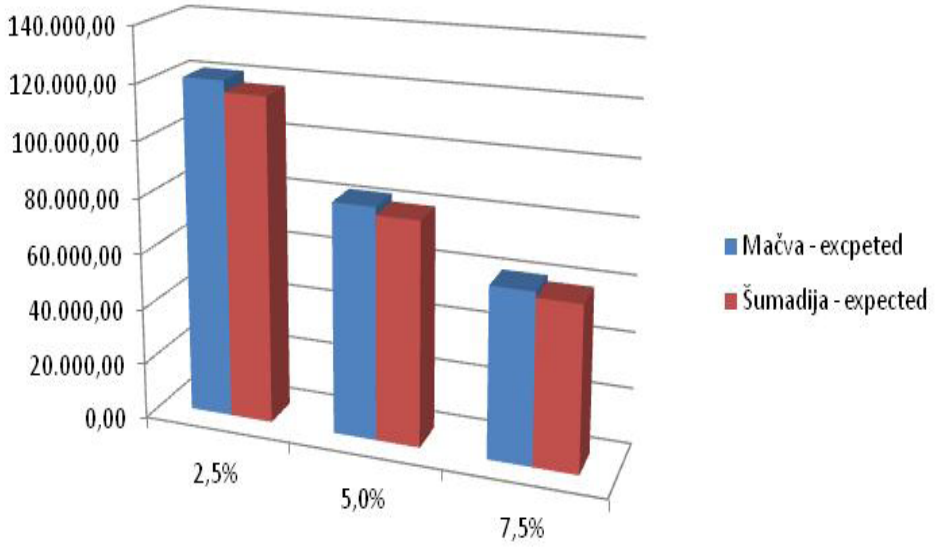
Scenario	Pig price (EUR/kg)		Piglet price (EUR/kg)		Corn price (EUR/kg)	
	Mačva	Šumadija	Mačva	Šumadija	Mačva	Šumadija
Pessimistic	1.36	1.53	3.41	3.67	0.38	0.37
The most probable	1.88	1.80	2.79	2.72	0.35	0.34
Optimistic	2.30	2.56	1.96	2.13	0.27	0.28

Source: Authors` calculation

To perform scenario analysis, it was needed to determine probabilities of occurrence of these three scenarios. Having in mind a low level of probability for pessimistic and optimistic scenarios, their probability was assumed to be only 10% each. On the other hand, probability of the third scenario is 80% (which reflects average pig, piglet and corn prices). The scenario analysis was performed only for net cash flow without labor costs (which enabled the comparison of results between two regions). The expected present values of the investments (for various discount rates) were determined as the result of scenario analysis (Figure 6).

The result of scenario analysis indicated almost the same levels of the expected present values in Mačva and Šumadija regions. i.e., in risky circumstances the performance of investments in Mačva region is not as dominant as it was concerning the standard present value approach.

Figure 6. The expected present value for different regions and discount rates (EUR)



Source: Authors` calculation

Nevertheless, appropriate risk indicators (such as standard deviation and coefficient of variation) have a lower value for Mačva region (considering all discount rates) (Table 5).

Table 5. Standard deviation and coefficient of variation for the expected present value

Discount rate	Standard deviation		CV	
	Mačva	Šumadija	Mačva	Šumadija
2,5%	258.113,78	281.393,96	2,14	2,41
5,0%	176.434,36	192.347,61		
7,5%	129.499,03	141.179,00		

Source: Authors` calculation

The results lead to a conclusion that investments in pig production are riskier in Šumadija region comparing to Mačva region, although their expected net present values are very similar. Therefore, it could be concluded that even in risky business environment the advantage should be given to investments in pig production situated in traditional pig production regions.

Conclusions

The use of the present value methodology offers flexibility within the process of investment analysis, providing information on the highest level of investments (in fixed and working assets) which is acceptable for investors. Traditional approach to the analysis (which assumes average business conditions) indicated that it is possible to invest more in pig production in Mačva region, comparing to Šumadija region

(which provides producers in Mačva with more opportunities to invest in technical and technological development). On the other hand, the present value of investments is most sensitive to pig market prices. Therefore, even a slight increase of pig prices in Šumadija can improve their level of the present value to the level recorded for Mačva region. This is why the expected present values of investments in both regions are very similar (although investments in Šumadija region are a bit riskier). The results of the analysis indicated that farm managers in Šumadija have to work not only on achieving a higher pig price, but also on keeping all the prices more stable, to provide investment performance on the level of Mačva region.

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Conflict of interests

The authors declare no conflict of interest.

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BEHAVIOR OF ROMANIAN BREAD CONSUMERS

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ABSTRACT

The food segment is diversified and renewed due to the needs, desires, and increased demands of consumers. In the evolution of society, a defining role is the issue of nutrition which is quite complex, wide-ranging and contradictory. The purpose of this study is to identify the behavior of the Romanian bread consumer. It was used as a research method for conducting the case study opinion survey, the research tool being the questionnaire, in online format. In order to make the research as rigorous as possible, it was calculated by means of χ^2 whether certain variables such as sex, environment, income and age influence consumption.

Introduction

Bread should not be absent from our daily diet, due to the content of nutrients, thus covering a fairly large part of the caloric and carbohydrate portion of the day. All types of bread, whether made up of rye flour or wheat flour, can be in line with the notion of a healthy preparation, which is intended to be targeted at consumers in different categories. According to the nutrition specialists, "we need to consume 50% of bread and bakery products from the total of cereal products necessary for the body" (Popa C.N., 2021).

In the agricultural year 2021, the wheat harvest was 11.3 million tons, a figure remarkable for Romania. With this in mind, the question is on everyone's lips: "how

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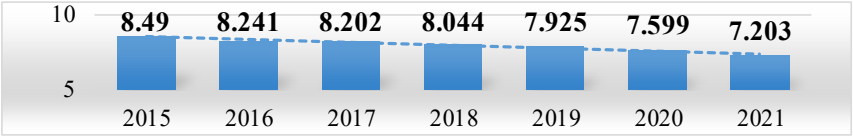
has it come to the situation that after a year with record wheat production, bread is more expensive by 30%?" (Briziday, 2021). The year 2022 brought with it significant price increases, so the sliced white bread reached over 10 lei/kg, compared to the same period last year, prices increased by a range of 3% to 30%, depending on the producer, the type of bread or the grammage (Nițu, F., 2022). As a result, a number of producers have initiated a diversification of their products, thus responding to the needs of consumers. The consumption of the loaf is decreasing in recent years, which has led to an increase in the consumption of specialty foods (black bread, bread with bran, bread without salt, multicereal bread, graham bread, bread with seeds, bread with milk, bread with basil and tomatoes). As a consequence, the refinement of consumption has occurred, leading to increased demand for products with a surplus of fiber, but also for bread types, which do not contain antioxidants, food additives, preservatives, thus food without E-caps. Regarding bread with seeds and black bread, they have an increased amount of fiber and vitamins, so their nutritional value is much higher than that of white bread (Florea N.V., Duica M.C., Ionescu C.A., Duică A., Ibinceanu M.C.O., Stănescu S. G., 2021). As for the offers in hypermarkets, they are adapted to the type of customer in each store, but not limited only to traditional bread, in their offers appeared a category of special products such as: graham, kornspitz, onion bread, olives, corn or potatoes. So, we are currently witnessing the strong impact of the increasing demands of consumers on the assortment structure and quality level of products (Catoiu I., Oancea O., Pandelica A., 2011). An example of a premium product is the bread "10 seeds" produced by "Oltina Impex Prod Com", which was awarded as the best product in the bakery products segment in Romania. The awards ceremony of the contest called "The Chosen Taste 2021" was held online on 27.11.2021, the competition being organized annually by Roaliment (Popa C.N., 2021). Looking at the average monthly consumption in the last years, i.e. 2015-2021, it can be seen that Romanians gradually consume per year less bread and bakery products (Figure 1).

Figure 1. Average monthly consumption of bread and beakery products expressed in kg/ inhabitant



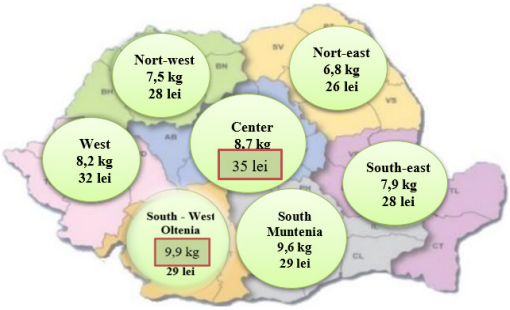
Source: Adapted from https://insse.ro/cms/

In 2015, the average monthly consumption of Romanians was 8.49 kg/person, and every year it has continuously decreased, reaching 7.203 kg/person in 2021. From 2015 to 2021 consumption decreased by 1,287 kg/person (National Institute of Statistics, 2021).

Although the consumption of bread was reduced at national level and continued to show a downward trend in 2018, as evidenced by data provided by the National Institute of Statistics, significant differences in consumption behavior are noted by region (Figure

2), occupation (Figure 3), environment of provenance (Figure 8), but also by sex and age (Table 1). According to the 2019 market study published on the website of the „White Art" (which is a source of information for bakers), the following information was obtained (Florescu C., 2019 9).

Figure 2. Average monthly consumption of bread and bakery products and value allocated, by region, in 2018



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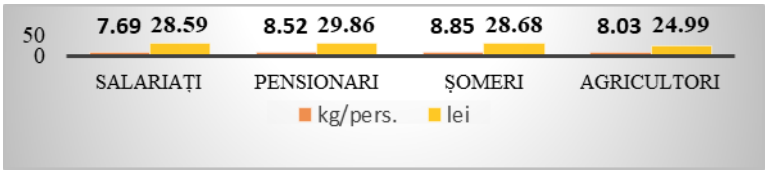
The Oltenia region is the area with the highest consumption of bread, namely 9.9 kg/ inhabitant, and the price of bread consumed in this region is 29 lei per month/inhabitant. In the North East of the country, it can be stated that there is also the lowest bread consumption, that is 6.8 kg per inhabitant, but also the lowest price allocated to bread, 26 lei per inhabitant/month. In the center of the country it can be observed that although the consumption of bread is lower, 8.7 kg /inhabitant, they pay the highest price in the whole country to consume this food, about 35 lei/inhabitant/month.

Figure 3. Average monthly bread consumption and value allocated by consumer occupation



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Looking at Figure 3 it can be seen that among unemployed people is the highest consumption of bread, 8.85 kg/person, and the allocated expenses for these products is 28.68 lei person/month. they consume less bread, 7.69 kg/person, but the price allocated on this food is close, 28.59 lei person/month.

Farmers consume the smallest amount of bread, 8.03kg person/month, but also allocate the smallest amount of money on it.

The geographical structure analysis (Figure 4) also shows that urban people consume less (7.27 kg/person) bread than rural people who consume 8.72 kg/person.

Figure 4. Average monthly consumption by background

Source: https://artaalba.ro/piata-painii-intre-traditie-si-inovatie/

According to the information published by the National Institute of Statistics (INS), in Romania, in 2021 the amount of bread consumed differs depending on the age segment and the sex of the consumers as follows (National Institute of Statistics):

Table 1. Bread consumption in Romania by age group and sex

Age	Sex	
	Female	**Male**
	Average daily consumption	
16-24 years	72 g	107 g
25-34 years	84 g	118 g
35-44 years	95 g	138 g
45-54 years	105 g	148 g
55-64 years	104 g	144 g
>65 years	96 g	130 g

Source: The National Institute of Statistics

According to the data presented, it is noted that female people consume a lower amount of bread than men in all specified age categories. The largest differences in the amount consumed between male and female sex are in the age groups 35-44 and 45-54 and 43 grams, respectively. As a result of the analysis of the data, it can also be found that with advancing age, the consumption of bread increases in the case of women aged between 16 and 24 years consumes 74 grams, a few years later at the interval of 45-54 years they get to consume on average 105 grams daily of bread (table 1).

According to a study carried out by iSense Solutions in 2022, white bread is the most consumed by 43% of Romanians in the city, a large proportion of them choosing this type of bread daily, but also several times a day. In the pandemic, the Romanians remained faithful to this type of bread, but opted for sliced to the detriment of the simple one, being more protected (Popa S., 2022). Romanians occupy the third place in Europe in terms of bread consumption, with 90 kg inhabitant/year, after the European countries of Albania and Bulgaria. Because for Romanians, bread is a staple food, annual consumption per inhabitant exceeds by about 40% the average in European countries.

Faced with a significant increase in the import of bakery products and also the increase in the market share of what were once considered niche products, the Romanian producers want to relaunch the traditional bread as the "basic product" in the consumption of Romanians.

Currently, bread is brought to our market from Germany, Austria, Bulgaria and even Hungary. The price of bread in our country is currently close to the price level in the

Czech Republic, Poland, Hungary, but at the same time it is 40% lower compared to the European average. The lowest bread prices are in Bulgaria, where they are 60% lower than the EU average, and the highest are in Norway and Sweden 40-65% higher than the European average (Matei R.M., Matetovici E., Mihai R.M., Murariu A.M., 2022).

The bread market in Romania is extremely strong, with a wide variety of manufacturers and suppliers offering consumers a wide variety of bakery products. Suppliers have begun to create their own bread brands, and consumers enjoy lower prices. Local and regional producers occupy a significant position, but there are also international firms on the bread market in Romania. Bread manufacturers include both large factories and small bakeries producing fresh bread.

Materials and methods

We used as a research method for conducting the case study the opinion survey, the research tool being the questionnaire, in online format. This method seemed to me to be the most suitable for reaching all types of people in several regions of the country.

The purpose of this study is to obtain information necessary to identify the behavior of the Romanian bread consumer. As part of the research, we aimed to identify the reasons that influence him/her to consume/not consume this food, if he/she intends to change his/her tabs, as well as the impressions formed about the product. The objectives of the research are:

- Identifying the most consumed type of bread;
- Reasons for the respondent consuming/not eating bread;
- Determining the percentage of respondents who intend to change their consumption habits as a result of the price increases;
- Formed opinion about bread, how satisfied they are with the quality-price ratio.

The research hypotheses are :

- More than 20% of Romanian consumers would change their eating habits if the price of bread increased considerably;
- More than 50% of Romanian consumers eat white bread;
- Less than 10% of Romanian consumers are dissatisfied with the quality of the bread on the market;
- More than 30% of Romanian consumers choose to eat bread because it gives them the feeling of satiety.
- Most consumers of bread are male;

The questionnaire on the behavior and preferences of bread consumers was distributed online for completion in the period 26.07.2022-27.02.2023 and is composed of 2 sets of questions. After respondents answered the first question, where they were asked

whether or not to eat bread, they were redirected to the answer, to a set of questions for people who said they were eating bread, it contained specific questions, and those who answered that they did not eat bread were redirected to another set of questions The questionnaire contains 21 closed questions, 1 open question and 6 mixed questions. The questionnaire was carried out online using the Google Forms platform and was carried out on a sample of 120 people. The results were analyzed with the help of Google Forms, and personally processed into Word diagrams. After analyzing the information we found that all questionnaires are completed in full, without any questionnaire being rejected, so the final sample is 120 respondents, and the response rate is 100%.

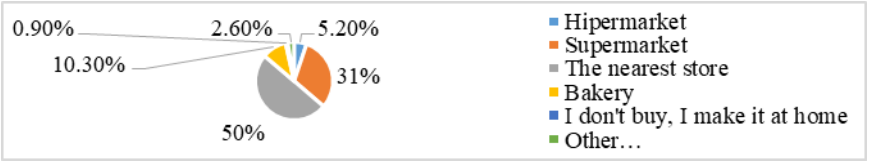
Results

Of the 120 respondents, 116 people and 96.7% are bread consumers, only 4 people said they do not eat this food, the percentage being 3.3%.

The reasons for which bread consumers choose to consume this food are because people feel that they do not get enough without eating and bread at the table, respectively 40.5%, 36.2% of respondents said that they like the taste, while 22.4% of respondents consume only from the usual food. One person opted for the „Other" option, adding in his own response that certain foods are consumed with bread. 69% of respondents viewed bread as a healthy food, while 31% denied it.

Ask where they buy bread most often? Most respondents buy the bread from the nearest shop, with a share of 50% for this category (Figure 5).

Figure 5. Place of purchase of bread

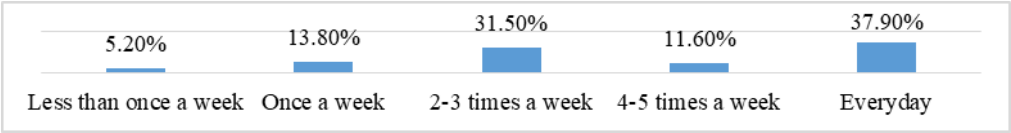


Source: drafted by the authors

The next point in getting bread is the supermarket, which is 31% of people said they were buying bread in the supermarket. Bakeries are chosen by 10.3% of people to buy bread, only one person does it personally in the house, and 2.6% of people checked for „Other", and their response was that depending on where they are they decide where to buy the bread.

As regards the frequency of purchase, it is noted that most people purchase bread on a daily basis, i.e. 37.9% of those surveyed (Figure 6).

Figure 6. Frequency of purchasing bread



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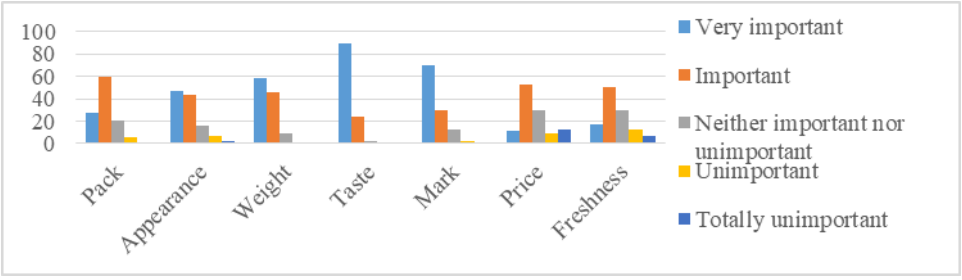
It also stands out at a high rate of 31.5% among those who buy bread 4-5 times a week, less often than once a week buy only 5.2% of those questioned.

Respondents specified the importance of the following criteria: packaging, appearance, weight, taste, brand, price and freshness when buying bread (Figure 7).

Figure 7. Importance of criteria in choosing bread



Source: drafted by the authors

From the very beginning, there are differences of opinion, so we calculated the average score for each attribute using the method of semantic differential scaling.

$$P_{Pack} = \frac{28 \times 5 + 60 \times 4 + 21 \times 3 + 6 \times 2 + 1 \times 1}{116} = \mathbf{3,9}$$

$$P_{Apearance} = \frac{47 \times 5 + 44 \times 4 + 16 \times 3 + 7 \times 2 + 2 \times 1}{116} = \mathbf{4,1}$$

$$P_{Weight} = \frac{59 \times 5 + 46 \times 4 + 9 \times 3 + 1 \times 2 + 1 \times 1}{116} = \mathbf{4,4}$$

$$P_{Taste} = \frac{89 \times 5 + 24 \times 4 + 2 \times 3 + 1 \times 2 + 0 \times 1}{116} = \mathbf{4,7}$$

$$P_{Mark} = \frac{70 \times 5 + 30 \times 4 + 13 \times 3 + 2 \times 2 + 1 \times 1}{116} = \mathbf{4,4}$$

$$P_{Price} = \frac{11 \times 5 + 53 \times 4 + 30 \times 3 + 9 \times 2 + 13 \times 1}{116} = \mathbf{3,3}$$

$$P_{Freshness} = \frac{17 \times 5 + 50 \times 4 + 30 \times 3 + 12 \times 2 + 7 \times 1}{116} = \mathbf{3,5}$$

$$P_{aggregate} = \frac{P_{Pack} + P_{Apearance} + P_{Weight} + P_{Taste} + P_{Mark} + P_{Pret} + P_{Freshness}}{7}$$
$$= \frac{3,9 + 4,1 + 4,4 + 4,7 + 4,4 + 3,3 + 3,5}{7} = \mathbf{4,04}$$

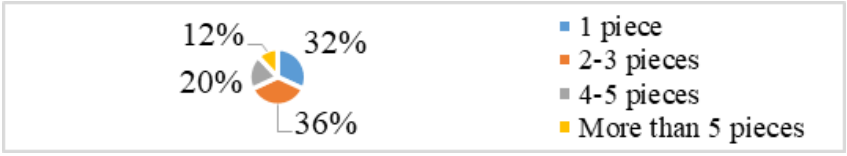
The packaging is appreciated as relatively important, the average 3,9 being very close to 4 which is important, in terms of appearance it is also an appreciation as important, with an average of 4,1. The respondents' view about grammage is that it is between „ important" and „very important" with an average of 4.4, and the taste is in a similar situation only that it is closer to „very important" with an average of 4.7. On the brand, an average of 4.4 was obtained, and surprisingly, the price has the lowest average of 3.3, proof that the price is not in the first criteria when respondents buy the bread. We found that freshness has an average of 3.5 located between „not important, not important" and „important".

The overall average score is 4.04, that is, between „Not important, not important" and „Important".

Appearance, weight, taste and brand have higher average scores than overall average, while packaging, price and freshness have lower average scores than overall average. Overall, respondents take the most into account the taste of the bread and the price of the bread.

Respondents prefer to buy a smaller amount of bread, 36.6% of them buy 2-3 pieces at a shopping session, probably to always buy fresh bread, but there are people who buy 5 pieces at a time, that is 12.1% of the people surveyed have this habit (figure 8).

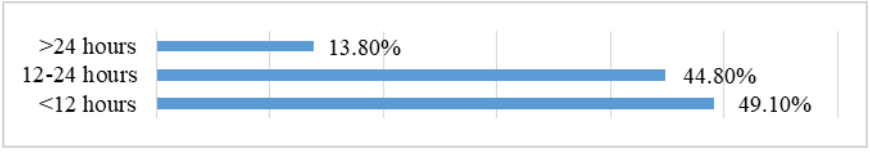
Figure 8. Quantity of bread purchased



Source: drafted by the authors

Most of the people surveyed claimed to enjoy the bread within 12 hours of the time of purchase (Figure 9).

Figure 9. Time of consumption

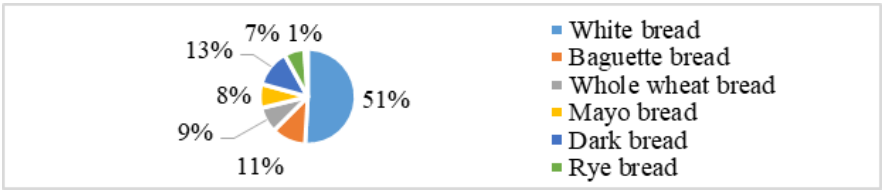


Source: drafted by the authors

The type of bread consumed by more than half of the people surveyed, namely 50.9%, is white bread. The next type of bread consumed is black bread, 12.7% of respondents,

but a considerable difference from white bread. Rye bread is not consumed by many people, only 6.9% of respondents. There were people who ticked „Other" and added that the seed bread is on their table (Figure 10). As assortments they say they prefer sliced bread,and unsliced breadis chosen by 37.1% of people.

Figure 10. Type of bread consumed, 44% of respondents



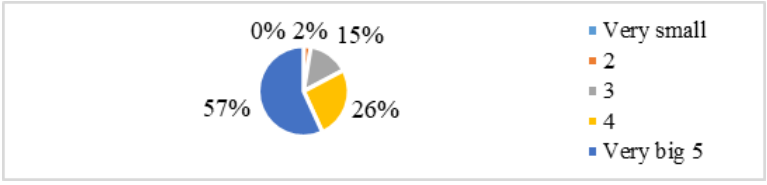
Source: drafted by the authors

As a favorite bread brand, „VelPitar" is obviously the most purchased bread brand, with 54.3% answers, followed by „Three Bakers" with 25%, but the difference between them is significant. Last place is the Galmopan brand with 0.9%. People were present who did not find themselves in the exhibits and used the „Other" version to express their opinion, and revealed that they prefer bread from the bakeries of Kaufland/Lidl, the simple lunch from the store or the bread from the bakery on the way home. We found that people questioned are not hindered by the price to choose black/graham bread, 49.6% of people mentioned that if the price of black/graham bread were lower than that of white bread, they would still not consume such bread.

Opposing opinions have emerged, with 34.8% saying they would choose such bread if the price were lower.

In relation to the price of bread, we found that 56.9% of respondents consider the current prices of bread very high compared to previous years, 25.9% of people chose the figure 4 which is close to a very high price, which means that they are heading towards the variant that the price is high, only 14.7 of people ticked the figure 1 and 2 which shows that the price is low, somewhere at 2.6% of people (figure 11).

Figure 11. The price of bread

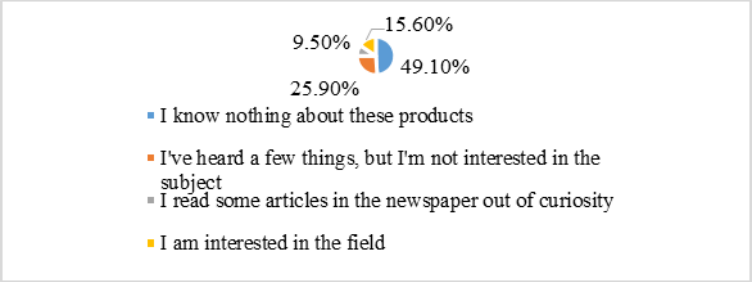


Source: drafted by the authors

Also, it is noted that respondents do not look for even the lowest price of bread, those who buy bread under 2 lei are 11.2%. Most people would like to buy bread between 2 and 4 lei, that is 45.7% people. The lowest percentage of respondents, 6.9%, would be willing to pay for a bread of 500 grams over 7 lei.

49.1% of respondents do not even know about the existence of organic bread, while 15.6% of respondents are interested in this area (Figure 12).

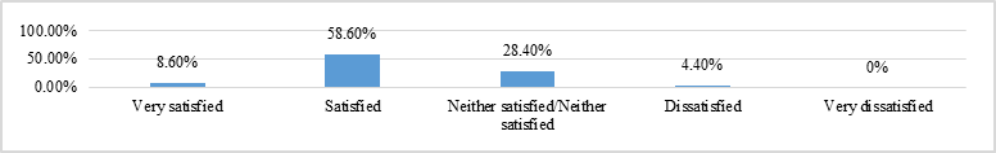
Figure 12. Knowledge of organic bread



Source: drafted by the authors

The average score of 3.71, shows that the respondents' satisfaction with the quality of the bread on the market in our country is between „Neither satisfied nor dissatisfied" and „Satisfied". But the score of 3.71 is not a big one, it could be even better. In other words, there is still room for improvement in the Romanian bread market for people to be fully satisfied. It is worth noting that no one has confessed that he is totally dissatisfied with the quality of the bread on the current market (Figure 13).

Figure 13. Thanks to respondents for the quality of the bread



Source: drafted by the authors

$$P_{medium} = 10 \times 5 + 68 \times 4 + 33 \times 3 + 5 \times 2 + 0 \times 1 = \mathbf{3,71}$$

35.7% of respondents would give up eating bread if the price of the bread became too high. Hygiene standards, too, would be a reason for dropping 32.1% of respondents from bread consumption (Figure 14).

16.1% of the respondents responded with other variants than those mentioned,

including: health, diet, taste and unpleasant appearance, diabetes.

Figure 14. Structure of the sample reason for refusing to eat bread

Source: drafted by the authors

Among the reasons why individuals do not eat bread were listed by 75% of respondents to the diet and believe that this food can bring them extra pounds. There are also people who simply do not like the taste of bread, namely 25% people. Individuals could start eating bread if they stopped following a diet, entourage would influence them to consume, but also people who would not start consuming this food regardless of its influence factor and intensity.

Table 2. Profile of respondents bread consumers

Revenue	Percentage	Occupation	Percentage	Civil status	Percentage
0-1000 lei	25,2	Pupil	6,1	Unmarried	49,6
1001-2000 lei	19,1	Student	28,9	Married	49,6
2001-3000 lei	22,6	Employee	57	Divorced	0,8
3001-4000 lei	14,7	Household	7,9	Widower	0
Over 4000 lei	18,2	Retired	0		

Source: drafted by the authors

It is noted that female people eat 69.8% of bread, while only 28.4% of respondents consuming bread were male. 1.7% of respondents felt the need not to answer this question. As regards the age of respondents, it is clear that people between 21 and 30 years of age consume this food the most, with a percentage of 50%. The fewest consumers of bread are those over the age of 60, at a rate of 0.9%. The results on revenues were surprising, most bread consumers having low incomes, ranging between 0 and 1000 lei, respectively 25.2%. The lowest percentage is held by people with incomes between 3001-4000 lei, namely 14.7% of consumer respondents are within this range. Bread consumers can also be said to be employed persons and with a diversified civil status, both unmarried and married persons are bread consumers (Table 2). The last 2 questions of the questionnaire referred to the environment and region where the respondents live and the results were structured in the following table (Table 3).

Table 3. Background and respondent region

Environment	Procentage	Region	Procentage
Urban	46,2	North-East	7,6
Rural	53,8	South-East	9,3
		South-Muntenia	65,3
		South-West Oltenia	4,2
		West	6,8
		Nord-West	0
		Centet	1,7
		Bucharest-Ilfov	5,1

Source: drafted by the author

It is noted that there is no large difference between the consumer environment, but there were more respondents from rural areas who stated the consumption of bread and more specifically 53.8%. Most consumers are from South-Muntenia, with a significant difference from the other regions of the country, namely 65.3%, the next highest percentage being the South-East of the country with 9.3% respondents from this area.

In order to make the research as rigorous as possible, we calculated with the help of χ^2 whether sex, environment of provenance, income and age influence consumption. Since 2 people replied with „I prefer not to say" to the question of sex we will have a sample of 118 people on this hypothesis (table 4).

Null hypothesis 1: Sex does not influence the consumption of bread by consumers.

Table 4. Distribution by sex

Sex / Category	Male	Femate	Total
Consume	33 (31,9)	81 (82,1)	114
It does not consume	0 (1,1)	4 (2,9)	4
Total	33	85	118

Source: drafted by the authors

To apply the test formula,
calculate the expected values:

$$A_{11} = \frac{114 \times 33}{118} = 31,9 \qquad A_{21} = \frac{4 \times 33}{118} = 1,1 \quad A_{22} = \frac{4 \times 85}{118} = 2,9$$

$$A_{12} = \frac{114 \times 85}{118} = 82,1$$

Expected values are passed in the table next to the real ones.

$\chi 2calc = \sum_{i=1}^{r}\sum_{j=1}^{k}\frac{(Oij-Aij)^2}{Aij} \sum_{i=1}^{r}\sum_{j=1}^{k}\frac{(Oij-Aij)^2}{Aij}$, where O-values obtained, A-values expected,

$$\chi^2_{Cal.} = \frac{(33-31,9)^2}{31,9} + \frac{(81-82,1)^2}{82,1} + \frac{(0-1,1)^2}{1,1} + \frac{(4-2,29)^2}{2,29} = 2,5$$

It is considered (r-1)(k-1) degrees of freedom, as well as a 95% probability of guaranteeing the result. 2 theoretically for (2-1)(2-1)=1 is 3.84 (according to table „Chi-Square Probabilities")

$\chi^2_{Calc.} < \chi^2_{Teoretic} \chi^2_{Calc.} < \chi^2_{Teoretic}$ ➔2,5<3,84➔ null hypothesis is accepted so sex does not influence the consumption of bread of consumers.

Null hypothesis 2: The environment of provenance does not influence the bread consumption of Romanians (table 5)

Table 5. Distribution by background

Environment / Category	Urban	Rural	Total
Consume	54 (54,1)	62 (61,9)	116
It does not consume	2 (1,9)	2 (2,1)	4
Total	56	64	120

Source: drafted by the authors

$$A_{11} = \frac{116 \times 56}{120} = 54,1$$

$$A_{12} = \frac{116 \times 64}{120} = 61,9$$

$$A_{21} = \frac{4 \times 56}{120} = 1,9 \qquad A_{22} = \frac{4 \times 64}{120} = 2,13$$

$$\chi^2_{Cal.} = \frac{(54 - 54,1)^2}{54,1} + \frac{(62 - 61,9)^2}{61,9} + \frac{(2 - 1,9)^2}{1,9} + \frac{(2 - 2,1)^2}{2,1} = 0,01$$

It is considered (r-1)(k-1) degrees of freedom, as w.ell as a 95% probability of guaranteeing the result. 2 theoretically for (2-1)(2-1)=1 is 3.84 (according to table „Chi-Square Probabilities").

$\chi^2_{Calc.} < \chi^2_{Teoretic}$ ➔0,01<3,68➔ null hypothesis is accepted so the environment of provenance does not influence consumption.

Null hypothesis 3: Income does not influence the bread consumption of Romanians

Table 6. Distribution by respondents' income

Income / Category	0-1000 lei	1001-2000 lei	2001-3000 lei	3001-4000 lei	>4000 lei	Total
Consume	29 (30)	22 (22,2)	26 (25,1)	17 (17,4)	22 (21,3)	116
It does not consume	2 (1,03)	1 (0,8)	0 (0,9)	1 (0,6)	0 (0,7)	4
Total	31	23	26	18	22	120

Source: drafted by the authors

It is considered (r-1)(k-1) degrees of freedom, as well as a 95% probability of guaranteeing the result. χ2 theoretically for (2-1)(5-1)=4 is 9.48 (table „Chi-Square Probabilities") (table 6).

$$A_{11} = \frac{116 \times 31}{120} = 30$$

$$A_{12} = \frac{116 \times 23}{120} = 22,2$$

$$A_{13} = \frac{116 \times 26}{120} = 25,1$$

$$A_{14} = \frac{116 \times 18}{120} = 17,4$$

$$A_{15} = \frac{116 \times 22}{120} = 21,3$$

$$A_{21} = \frac{4 \times 31}{120} = 1,03$$

$$A_{22} = \frac{4 \times 23}{120} = 0,8$$

$$A_{23} = \frac{4 \times 26}{120} = 0,9$$

$$\chi^2_{Cal.} = \frac{(29 - 30)^2}{30} + \frac{(22 - 22,2)^2}{22,2} + \frac{(26 - 25,1)^2}{25,1} + \frac{(17 - 17,4)^2}{17,4} + \frac{(22 - 21,3)^2}{21,3} + \frac{(2 - 1,03)^2}{1,03} + \frac{(1 - 0,8)^2}{0,8} + \frac{(0 - 0,9)^2}{0,9} + \frac{(1 - 0,6)^2}{0,6} + \frac{(0 - 0,7)^2}{0,7} = 2,9$$

$\chi^2_{Calc.} < \chi^2_{Teoretic}$ ➔2,9<9,48➔

null hypothesis

is accepted so income does not influence consumption.

Null hypothesis 4: Age does not influence the bread consumption of Romanians.

Table 7. Distribution by age group

Age / Category	<20 age	21-30 age	31-40 age	41-50 age	51-60 age	>60 age	Total
Consume	13(14,5)	58 (56,1)	28 (28)	14(14,5)	2 (1,9)	1 (1)	116
It does not consume	2 (0,5)	0 (1,9)	1 (1)	1 (0,5)	0 (0,1)	0 (0,03)	4

Source: drafted by the authors

$$A_{11} = \frac{116 \times 15}{120} = 14{,}5 \qquad A_{15} = \frac{116 \times 2}{120} = 1{,}9 \qquad A_{23} = \frac{4 \times 29}{120} = 1$$

$$A_{12} = \frac{116 \times 58}{120} = 56{,}1 \qquad A_{16} = \frac{116 \times 1}{120} = 1 \qquad A_{24} = \frac{4 \times 15}{120} = 0{,}5$$

$$A_{13} = \frac{116 \times 29}{120} = 28 \qquad A_{21} = \frac{4 \times 15}{120} = 0{,}5 \qquad A_{25} = \frac{4 \times 2}{120} = 0{,}1$$

$$A_{14} = \frac{116 \times 15}{120} = 14{,}5 \qquad A_{22} = \frac{4 \times 58}{120} = 1{,}9 \qquad A_{26} = \frac{4 \times 1}{120} = 0{,}03$$

$$\chi^2_{Cal.} = \frac{(13-14{,}5)^2}{14{,}5} + \frac{(58-56{,}1)^2}{56{,}1} + \frac{(28-28)^2}{28} + \frac{(14-14{,}5)^2}{14{,}5} + \frac{(2-1{,}9)^2}{1{,}9} + \frac{(1-1)^2}{1} + \frac{(2-0{,}5)^2}{0{,}5} + \frac{(0-1{,}9)^2}{1{,}9} + \frac{(1-1)^2}{1} + \frac{(1-0{,}5)^2}{0{,}5} + \frac{(0-0{,}1)^2}{0{,}1} + \frac{(0-0{,}03)^2}{0{,}03} = 15{,}3$$

$\chi 2$ theoretically for (2-1)(6-1)=5 it is11,07 (according to the table „Chi-Square Probabilities"), therefore $\chi^2_{Calc.} > \chi^2_{Teoretic}$ ➔15,3>11,07➔ the null hypothesis is rejected, so age influences consumption (table 7).

Cramer's coefficient V

To find out how much age influences the consumption of bread, I'll use Cramer's association coefficient V. (We chose this coefficient because the table has more than 2 lines or columns).

$$V = \sqrt{\frac{\chi 2 calculat}{n(s-1)}} = \sqrt{\frac{15{,}3}{120(2-1)}} = 0{,}36$$

Age influences rather poorly, (but not very poorly), the consumption of bread of respondents.

Discussions

All assumptions were verified except for the last assumption related to the sex of bread consumers. It seems that female personal are the most in number of bread-consuming, but not the men as expected.

Starting from the purpose of research, identifying the behavior of the Romanian bread consumer, the objectives set were achieved, as follows:

- Identifying the most consumed type of bread. We found that sliced white bread is the most preferred by the Romanian respondents who eat bread. In addition, the analysis of the data revealed how much influence the purchase criteria, such as taste, freshness and price, respondents being asked to attach importance to this topic from „very important" to „totally unimportant" to each criterion.
- Reasons why the respondent consumes/does not consume bread are: because of habit or because the food does not have the same taste without bread, but also because there are respondents for whom the diet is a hindrance to eat bread, who are convinced that the bread is fat and do not want to take this risk, preferring not to consume this food.
- Determining the percentage of respondents who intend to change their consumption habits as a result of the price increases. It was found that 35.7% of respondents could give up the habit of eating bread, due to the exaggerated costs.
- Formed opinion about bread, how satisfied they are with the quality-price ratio. Respondents mainly have a good opinion of bread in terms of quality and taste, but are unhappy with the prices of bread in the present day. However, they are trying not to buy the cheapest bread in the bidders' range.

Conclusions

Following the opinion poll, we discovered what are the reasons why there are non-consumers of bread but also the reasons that would make the current consumers to give up this food. All this information will be taken into account in order to develop ideas for a more effective response to the Romanian bread consumer. From the research carried out, we have observed that diet and health are two factors often mentioned by non-consumers as obstacles that they cannot overcome to eat bread, but even consumers who feed on this food worry about the extra pounds. In short, bread and diet are causes of bread not being eaten. Therefore, I propose for them the following types of healthy and suitable for the diet, already existing on the Romanian market: rye bread, whole wheat bread, linseed bread, gluten-free bread, oat bread.

Many people are not aware, however, that there are already special types of bread on the market that do not gain weight, that are intended for those who follow a diet, and that are much healthier.

Conflict of interests

The authors declare no conflict of interest.

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CORRELATION OF ECONOMIC INDICATORS OF PROCUREMENT OF AGRICULTURAL PRODUCTS FOR THE NEEDS OF THE DEFENCE SYSTEM

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ABSTRACT

In the current situation of war conflicts, but also as a consequence of the COVID-19 pandemics, the economic crisis caused by the lack of goods, primarily food, energy sources, weapons and military equipment and multiple other products and services, has induced price increases and inflation. In this regard, there are substantial challenges present in the field of procurement of agricultural products. In that sense, we methodologically included analysis and synthesis, compilations, inductions and deductions of "military budgets", GDP and some other indicators in several currently most significant countries and in the Republic of Serbia, in the context of compromised global security. The aim is to attain relevant indicators and conclusions which will provide certain guidelines for improvement of procurement of agricultural products for the needs of the defense system in the future.

Introduction

Procurement of agricultural products in the Republic of Serbia is regulated mostly by the Public Procurement Law (PPL) and numerous bylaws which represent this area as very complex and demanding in the sense of expertise of personnel who deal with tasks of public procurement. All state bodies, i.e., budget users, are obliged to comply with the said regulations, including the Ministry of Defense which places the emphasis on the application of rules and specificities which apply to procurement in the defense and security sector.

Along with the legal norms, the key deciding factor for procurement of agricultural products is the level of funds allocated for "military budgets" for defense needs. It is entirely

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expected that in the conditions of compromised security and ongoing war conflicts in the world these funds are being increased, as our research will demonstrate. However, even the allocated funds od not fully guarantee the realization of all necessary procurement, due to the presence of major risks and uncertainties in many fields of the global level, which alter and multiply on a daily basis following the decline of the security situation. It is precisely due to the decline of security and intensification of war conflicts in the world, along with other much larger risks, that it is necessary to increase both audit and control of public procurement of agricultural products in comparison to the normal state of affairs in peace.

Based on research results and experiences of other countries, the aim is to improve public procurement of agricultural products for the defense system needs.

Increase of "military budgets" in the world for the needs of defense system

Along with legal regulations, every military faces essential limitations expressed in funds allocated by the state. The issues of the amount of budget funds allocated for defense needs is particularly important in conditions of compromised security – imminent war danger and war conflicts (Adepoju & Obialo, 2022). The current situation of war conflicts in the world and the economic crisis and inflation, have pushed many countries into drastically increasing their "military budgets", i.e., the allocation of budget funds for military needs. Allocation of more funds is also affected by the lack of goods, increase of prices and the problem of price setting, primarily food, agricultural products, energy sources, armament and military equipment and many other products and services. Hence, along with reduced capabilities of suppliers, we find that it is necessary to analyze the budget expenditure for defense needs. Despite the existence of a certain balance in budget funds regarding the costs of personal, operational and investment expenditure, conditions of compromised security cause the increase of funds allocated for defense needs. Data regarding countries with the highest defense budgets in 2020 and 2021, shown in the table, demonstrate this trend:

Table 1. Top 10 countries in 2020 and 2021

	Country	Defense budget US$bn	
		2020	2021
1.	USA	738.0	754
2.	China	193.3	207.3
3.	India	64.1	65.1
4.	Russia	60.6	62.2
5.	UK	56.5	66.6
6.	France	55.0	59.3
7.	Germany	51.3	56.1
8.	Japan	49.7	49.3
9.	Saudi Arabia	48.5	46.7
10.	South Korea	40.4	46.7

Source: Krstić et al. (2022)

Comparative of data indicates the following:

- From a chronological perspective, the largest military expenditure is seen in USA, China, India and only then Russia,
- For the sake of comparison, USA has a military budget twice as large as China, India, and Russia combined, or 12 times larger of a budget than Russia,
- The data indicating that USA is spending multiple times more than others does not indicate that they have multiple times more weapons or that it is the most advanced in comparison with other global powers. Namely, a certain portion of this money is spent on financing procurement of agricultural products. China and Russia have significantly less procurement of agricultural products that USA,
- A global increase of military budgets in 2021 in comparison with 2020 is evident,
- Larger expenditure is visible in developed countries and countries with objectively compromised security,
- Even the smallest of countries inevitably must invest in procurement of agricultural products for the defence system needs,
- In the period from 2020 till today, the overall global military expenditure has reached two trillion dollars (2.112 billion dollars) for the first time, breaking another infamous record,
- Increase of global military expenditure can be seen starting from 2018, resulting in the overall increase of 17%, with 2021 being the seventh consecutive year marked by an increase of military budgets in over 100 countries.

Expenditure for the defence system needs in 2021 exceeded 2.000 billion dollars with USA, China, India, Great Britain and Russia spending the most, as reported by SIPRI (Kuhe & Uba, 2018). Everything indicates a global "military race".

Besides the discussed data, based on the available information for 2022, it can be concluded that a drastic increase of "military budgets" in multiple countries is evident, primarily due to the current war conflicts and worsened global security situation. We present some dominant examples.

The current year of 2022 has primarily been marked by the conflict of Russia and Ukraine. The phenomenon of aiding warring sides is evident, and it is particularly visible in the case of NATO aiding Ukraine, primarily in arms and military equipment, measured in tens of billions of dollars. USA dominates this process, and its aid to Ukraine represents one of the largest military aids to a foreign country in US history. Ukraine is also being aided by many European countries, heavily pressured by USA. This indicates the intentions of NATO countries, as large powers invest in wars only with certain goals and interests. The conflict in Ukraine demonstrates the great power and might of the military industry, as well as the fact that all arms sent to aid Ukraine are no gift – rather, it will be paid dearly. Looking back to the rise of US industry,

we point out one of the most significant moments in January 1961, when the 34th US president Dwight D. Eisenhower warned the US citizens of the "formation of a new military-industry complex, supported by the banking sector, whose main goal is to keep USA permanently militarily engaged all across the world" in his last TV address. His successor, president John F. Kennedy was also an adversary of excessive military spending and an advocate of diplomacy as he considered that the majority of global conflicts can be settled with negotiations – we all know how that ended. Numerous war conflicts followed, mostly financed by USA. Significant increase of oil and petroleum products export from Kuwait, mostly to the North American markets, contributed to the development of US military industry. These cheap energy sources were the main trigger of the consumer-boom in the US in the period between 1975 and 1990. Economists often stated that "US economy is progressing fueled by the Middle East". Today, USA has by far the largest military budget in the world (around 750 billion dollars) which additionally increases during the year through special projects brought to life by presidential decrees or Congress votes – which is currently being done in order to secure aid to Ukraine.

China holds second place, with 252 billion dollars allocated for the military. However, due to China's political system, other economy sectors can promptly be placed in the service of military industry. In the context of the growing tensions between Taiwan and China, on August 25th Taiwan proposed that 19 billion dollars are to be spent on defence next year, representing a twofold increase in comparison to 2022. (Govdeli, 2022).

An increase of defence budget by 13,9%, to a record level of 586,3 billion Taiwanese dollars or 19, 41 billion US dollars, has been proposed. These funds are planned for fighter planes and other equipment and means of the defence ministry. For years now Taiwan has been increasing the defence funds. In March, China announced that it will spend 7,1% more on defence in 2022, i.e., 1,45 trillion Yuans (211,62 billion dollars), while many experts consider this to be not an accurate figure. Chief security challenges of Beijing are the dispute with Taiwan and the disputes in the South Chinese Sea. China is spending money on advanced equipment, including invisible fighter jets and aircraft carriers, while Taiwan is trying to counter that by investing more in armament like missiles which can reach far into China's territory. Taiwan prioritizes further modernization of its armed force. The Stockholm International Peace Research Institute (SIPRI) stated that China is now among the largest weapons producers in the world. Shipments of arms to the Middle East have been at record levels for years (Milanović et al., 2023; Temelkov, 2022).

India comes third, spending 72 billion dollars. It also plans to increase military expenditure by 2025, mostly for air force modernization, creation of cosmic forces, utilization of its own launch vehicles GSLV-3 for military satellites launch.

Russia is placed fourth, with 61,7 billion dollars allocated for the military. Once compared, USA has a military budget twice as large as China, India, and Russia combined, or 12 times larger of a budget than Russia. However, the data indicating

that USA is spending multiple times more than others does not indicate that they have multiple times more weapons or that it is the most advanced in comparison with other global powers. Namely, substantial dispersions of US troops in military bases around the world demands huge funds for financing. On the other hand, Russia is rich in natural resources and energy which enable industrial and military-industrial development. The Russian military industry consists of around 3,000 companies, employing some two million people. Russia is the world's second weapons exporter, following USA, and it covers 20% of overall arms sale. Russia has especially modernized and strengthened its military in the past two decades. Both Russia and China are greatly developing their militaries as they plan to dominate and increase their military presence in the world.

Germany announced that it will increase its military budget by roughly 100 billion euros in 2022.

All circumstances and global developments indicate that even the smallest countries must invest in the military. If we observe the Balkan countries, data shows that Bosnia and Herzegovina has a 165 million dollars military budget, Montenegro around 65 million, Croatia (a NATO member) around 800 million, while Serbia has a military budget between 850 and 900 million dollars. Weapons procurement done by Serbia and other countries, both from East and West, are always pervaded by political influence, interest and money.

Officials of the most powerful countries in the world openly compete and lobby for acquisition of their weapons, directly incentivizing development of their military industry (Vukša et al., 2022). The most obvious example is the influence of USA on EU countries in the context of aid to Ukraine. Competition between great powers is evident in weapons trade. The most striking example can be seen in 2021, when the Australian government cancelled its order of nuclear submarines from France (worth some 56 billion euros) and instead opted for American nuclear submarines. Reasons are mostly directed towards countering the Chinese expansion in the Pacific region which foresees the formation of a tripartite alliance between Australia, USA and Great Britain (Odhiambo, 2009; Pantić et al., 2022). American president Biden declared US's rivalry with China as top priority of foreign policy.

Increased military expenditure is expected to continue in the future. Estimates indicate that the planned US budget for development and improvement will be 24% higher by 2025 and that USA will focus on weapons of new generation – stealth aircrafts of the fifth generation, satellite enemy-tracking and cyber warfare via computer networks. Asides from weapons procurement, the plan is to procure agricultural products as well. China and other powerful countries have similar plans. Along with the increase of expenditure of defence needs, higher expenditure for energy and food are also evident, mostly due to the shortage of these goods and price increase. Wars are fought not only with weapons, but also with good logistical support. The so-called "media war" has been dominating and becoming increasing important in recent years, with tremendous funds and other resources being allocated for it. Therefore, immense changes are occurring on

the global level, both in politics and economy. Due to disturbed relations, the economy is restructuring. Scarcity of many raw materials is evident, production is hindered and decelerated, export-import trade is impeded, suppliers are no longer capable or do not wish to meet the demands of buyers causing the entire market to drastically change all over the world. In addition to the current inflation and skyrocketing prices, impeded supply of energy and food is particularly evident. Certain countries which are caught in war don't even ask for the price of weapons causing the "black market" arms trade to grow. Even with allocated budget funds, there are no guarantees that the necessary goods and services will be acquired (Zekić & Brajković, 2022; Micić et al., 2022).

If we observe the humanitarian side, the UN and international humanitarian agencies estimate that only several billion dollars a year could significantly decrease, or completely alleviate the problem of hunger in the world. This represents only a fragment of the money being spent on the military. Unfortunately, the interests of the rich and powerful dominate over the humanitarian needs of the poor, weak and famished. Obviously, risks and uncertainty are present on the global level, primarily in regards to the functioning of agricultural production, trade, security of devaluation and meeting of basic needs, along with the risk of securing world peace.

Economic indicators of procurement of agricultural products for the needs of defense systems in developed countries and in the Republic of Serbia

Despite the fact that many countries both developed and those in development allocate a certain segment of budgetary funds for procurement of agricultural products for defense needs, this research uses the Republic of Serbia and the following countries as sample: USA, China, India, and Russia. The reason for such a selection of countries is the fact that they top the list of countries which spend the most budgetary funds on procurement of agricultural products for defense needs (Table 1). The following economic indicators were used in the research:

- Budgetary spending for defense needs,
- Gross Domestic Product (GDP),
- GDP per Capita,
- Direct foreign investments,
- Unemployment rate and
- Inflation rate.

The majority of these indicators can be considered as factors of economic development (Durkalić et al., 2019; Janjetović, 2021), in the sense that they create a favorable atmosphere for growth, but are foremost a result of developmental and stabilization policy. Data regarding these indicators in said countries, in the period between 2013 and 2021, are represented in Table 2.

Table 2. Economic indicators of procurement of agricultural products in developed countries and in the Republic of Serbia

Year	Economic indicators	Serbia	USA	China	India	Russia
2013	Expenditure for defence (in 000 $)	496.452,3	586.000.000,0	188.150.000,0	59.300.000,0	60.000.000,0
	GDP (in 000 $)	48.390.000,0	16.840.000.000,0	9.570.000.000,0	1.857.000.000,0	2.292.000.000,0
	GDP per Capita	6.755,1	53.291,1	7.020,34	1.438,1	15.974,6
	Direct foreign investments	2.412.000,00	92.101.458,22	53.888.992,0	8.000.000,0	8.754.222,1
	Unemployment rate	7,1	3,5	10,4	12,8	14,5
	Inflation rate	2,2	2,1	2,0	1,4	1,7
2014	Expenditure for defence (in 000 $)	497.820,4	591.000.000,0	192.000.000,0	57.800.000,0	58.500.000,0
	GDP (in 000 $)	47.060.000,0	17.550.000.000,0	10.480.000.000,0	2.039.000.000,0	2.059.000.000,0
	GDP per Capita	6.600,1	55.123,8	7.636,12	1.559,86	14.095,65
	Direct foreign investments	2.752.000,0	92.567.564,6	54.804.151,3	3.659.000,0	9.236.133,0
	Unemployment rate	7,2	4,0	10,2	13,3	13,1
	Inflation rate	1,7	1,2	1,3	1,1	1,9
2015	Expenditure for defence (in 000 $)	497.284,6	590.000.000,0	190.000.000,0	58.000.000,0	58.200.000,0
	GDP (in 000 $)	39.660.000,0	18.210.000.000,0	11.060.000.000,0	2.104.000.000,0	1.363.000.000,0
	GDP per Capita	5.588,9	56.762,7	8.016,43	1.590,17	9.313,0
	Direct foreign investments	2.965.000,0	94.987.679,1	62.778.479,3	9.343.000,0	12.053.488,9
	Unemployment rate	6,9	8,8	6,4	16,1	18,8
	Inflation rate	1,5	1,4	1,8	1,7	2,0
2016	Expenditure for defence (in 000 $)	493.785,6	587.000.000,0	189.500.000,0	59.500.000,0	57.900.000,0
	GDP (in 000 $)	40.690.000,0	18.700.000.000,0	11.230.000.000,0	2.295.000.000,0	1.277.000.000,0
	GDP per Capita	5.765,2	57.866,7	8.094,36	1.714,28	8.704,9
	Direct foreign investments	3.425.000,0	101.601.977,3	68.505.362,8	11.051.000,0	15.998.307,0
	Unemployment rate	6,5	7,9	7,2	17,7	16,2
	Inflation rate	1,6	1,8	1,6	2,1	1,7
2017	Expenditure for defence (in 000 $)	582.820,5	618.000.000,0	189.000.000,0	61.200.000,0	58.100.000,0
	GDP (in 000 $)	44.080.000,0	19.480.000.000,0	23.310.000.000,0	2.651.000.000,0	1.574.000.000,0
	GDP per Capita	6.292,5	59.907,7	8.816,99	1.957,97	10.720,3
	Direct foreign investments	3.145.000,0	100.167.834,4	69.508.134,0	8.145.000,0	13.117.516,3
	Unemployment rate	7,2	7,3	11,2	9,6	14,4
	Inflation rate	3,0	2,4	1,9	1,7	2,0
2018	Expenditure for defence (in 000 $)	736.681,8	685.000.000,0	191.540.000,0	60.850.000,0	58.400.000,0
	GDP (in 000 $)	50.640.000,0	20.530.000.000,0	13.890.000.000,0	2.703.000.000,0	1.657.000.000,0
	GDP per Capita	7.252,4	62.823,3	9.905,34	1.974,38	11.287,36
	Direct foreign investments	3.425.000,1	89.433.199,8	70.635.272,7	7.189.000,0	12.527.246,2
	Unemployment rate	8,8	7,0	10,9	10,1	13,9
	Inflation rate	2,0	3,3	1,7	1,6	1,6
2019	Expenditure for defence (in 000 $)	852.025,8	701.000.000,0	195.920.000,0	62.000.000,0	59.600.000,0
	GDP (in 000 $)	51.510.000,0	21.380.000.000,0	14.280.000.000,0	2.832.000.000,0	1.693.000.000,0
	GDP per Capita	7.417,2	65.120,4	10.143,84	2.047,23	11.536,2
	Direct foreign investments	3.702.000,0	94.870.792,8	78.525.275,0	12.100.000,0	12.896.179,4
	Unemployment rate	10,1	6,6	8,2	10,0	13,9
	Inflation rate	1,9	1,3	1,2	1,1	1,1
2020	Expenditure for defence (in 000 $)	930.842,7	738.000.000,0	193.300.000,0	64.100.000,0	60.600.000,0
	GDP (in 000 $)	53.360.000,0	21.060.000.000,0	14.690.000.000,0	2.668.000.000,0	1.489.000.000,0
	GDP per Capita	7.733,8	63.530,6	10.408,67	1.910,42	10.169,09
	Direct foreign investments	3.845.000,0	99.815.000,0	74.753.000,0	15.690.000,0	11.805.000,0
	Unemployment rate	8,4	4,3	5,9	6,7	10,4
	Inflation rate	1,6	1,1	1,4	1,9	1,2
2021	Expenditure for defence (in 000 $)	1.327.774,9	754.000.000,0	207.300.000,0	65.100.000,0	62.200.000,0
	GDP (in 000 $)	63.080.000,0	23.320.000.000,0	17.730.000.000,0	3.176.000.000,0	1.779.000.000,0
	GDP per Capita	9.203,1	70.248,6	12.556,33	2.256,59	12.194,78
	Direct foreign investments	3.900.000,0	108.000.000,0	75.000.000,0	13.000.000,0	11.000.000,0
	Unemployment rate	9,0	2,4	3,8	4,1	7,3
	Inflation rate	7,9	7,5	7,3	6,6	7,0

Source: Vo et al. (2019)

If we compare the **budgetary expenditure for procurement of agricultural products for defense needs,** we shall identify a growing trend in the analyzed countries after 2015. In 2015, budgetary spending for the needs of defense of the Republic of Serbia were 497 million dollars, while the least expenditure among developed countries were observed in India (58 billion dollars). In 2017, the most budgetary funds for the needs of defense were allocated by USA (618 billion dollars), while the least were allocated by Serbia (583 million), followed by Russia (58 billion dollars), India (61 billion dollars) and China (189 billion dollars). In the period from 2012 to 2016, recession of budgetary spending for defense needs was recorder in China (2019 – 195,92 billion dollars; 2020 – 193,3 billion dollars) while it grew in other countries. In 2020, budgetary funds for defense needs were the highest in USA and the lowest in the Republic of Serbia, followed by Russia. By comparing budgetary spending on defense in the period 2015-2020, a growth trend was observed in all countries, which was expected due to the growth of consumer prices and due to the consequences of the pandemic caused by the COVID-19 virus.

By comparing the starting positions of GDP in 2013, it can be noted that USA, China, India, and Russia had significantly higher levels in comparison to the Republic of Serbia which is not surprising having in mind the size and population of these countries. On the other hand, it is interesting to observe the narrowing of the gap between Serbia's GPD and that of developed countries in the period between 2013 and 2021. GDP of the Republic of Serbia grew 0.5 times in the period between 2013 and 2021 (and 0,4 time in the period 2020-2021 where a sharp rise in GDP in all countries is evident). The said data indicated that Serbia's GDP rose less than it rose in other developed countries. For example, China's GDP rose 1,1 times from 2013 to 2021 (0,5 times from 2020 to 2021). India's GDP rose 1,2 times from 2013 to 2021 and 0,4 times from 2020 to 2021. USA's GDP rose 0,4 times in the period 2013-2021 (and 0,1 times from 2020-2021). Unlike these countries, Russia's GDP recorded a decrease of 0,4 times from 2013-2021, and a decrease of 0,2 times in the period 2020-2021. Based on this analysis and comparison, we can conclude that GDP growth was the slowest in the Republic of Serbia, and that there was no growth in Russia. In other words, other countries (USA, China, and India) developed faster in regards to these indicators, which is also apparent in 2021 marked by COVID-19.

When comparing **GDP per Capita** of the said countries, we discovered that Serbia's GDP per Capita grew 0,4 times in the period 2013-2021; it grew 0,3 times in USA, 0,5 times in China and 0,4 times in India, while it decreased 0,1 times in Russia. By comparing the trend of GDP per Capita in the last to analyzed years (2020-2021), it grew in the Republic of Serbia by 0,2 times, 0,1 times in USA, 0,2 times in China and 0,1 times in India while it decreased in Russia 0,2 times. In this contest, it can be said that the Republic of Serbia has been progressing fairly well, or even better than developed countries (USA, China, India, and Russia).

Direct foreign investments are relatively considered to be key indicator of efficiency of realization of the process of procurement of agricultural products in a country and a precondition of economic stability. Also, direct foreign investments are even more

important because they spur developmental potentials and lessen the gap between developed countries and those that are in development. However, it should be noted that not all countries in development have the necessary legal and economic bases for the influx of foreign investments. Some countries in transition created attractive and efficient conditions for foreign investments (for example, Poland) which improved the results of transition and its success because it contributed to development, revitalization of economy and industry, modernization of technological production, etc. (Gioia, 2017). The main preconditions for direct foreign investments are specific competitive advantages for locations (manufacturing costs, marketing factors, government policies, etc.) and internalization advantages which differ from country to country (Bekiros et al., 2017). In addition, the most important factor for direct foreign investment is access to new markets (Gövdeli, 2019), making direct foreign investments an indication of social and political situation in a country, as investors prefer to invest in countries with stable political, social, and economic situation. Also, investments can alleviate and contribute to economic growth and prosperity. From the perspective of the Republic of Serbia, they were never on a very high level, in comparison to other countries, especially in the period between 2013 and 2017. However, it is pivotal to highlight the negative trend of direct foreign investments in Russia after 2019, which can be observe as a reason for the following war conflict.

When we analyze the **unemployment rate** in developed countries, it can be seen that this trend differs greatly. In 2014 the lowest unemployment rate was observed in USA (4,0%) while the highest was observed in Poland (13,3%) and Slovakia (13,1%). In 2015, the lowest unemployment rate was seen in China (6,4%), followed by Serbia (6,9%), while it increased in Russia (18,8%). In 2016 the unemployment rate was the highest in India (17,7%) and the lowest in Serbia (6,5%). Serbia (7,2%) and USA (7,3%) had the lowest unemployment rate in 2017, with the highest being recorded in Russia (14,4%). Unemployment rate in 2018 and 2019 was the lowest in USA (7,0% and 6,6%) while it was again the highest in Russia (13,9%). In 2020 and 2021, the lowest unemployment rate was observed in USA (4,3% and 2,4%) and the highest in Russia (10,4%, 7,3%) and Serbia (8,4%, 9,0%). These countries faced high unemployment in industry (due to the decline of GDP) while recording an increase in employment in service and tertiary sectors. Despite the quick recovery of GDP in the following periods, opening of new jobs in these countries was very slow (except in the service sector). Comparing unemployment between 2013 and 2021, we can conclude that it decreased in all countries (USA 1,4%, China 6,4%, India 9,2% and Russia 5,8%) expect in Serbia, where it increased by 1,9%. According to the analyzed data, we can conclude that the total unemployment rate was the highest in Serbia and Russia, while it was the lowest in USA. Research of low unemployment rate in the Republic of Serbia in comparison to other developed countries revealed that extremely low unemployment rates reflect negative consequences of economic reforms and measures (Tasić et al., 2021). Actually, low unemployment rate is a result of negative measures adopted by the government – low minimal wages, less generous fee for unemployment insurance, etc.

By analyzing data regarding **inflation rates** in observed countries, we discovered that India and Russia had the lowest rates of inflations in all analyzed years. In all analyzed years the rate of inflation was very low, except in 2021 when it sharply grew. In fact, inflation rates in all countries after 2020 grew as a result of the COVID-19 pandemics.

Correlation between economic indicators of procurement of agricultural products for the needs of the defense system

Managing economic indicators in the process of procurement of agricultural products for the needs of the defense system has a powerful effect on a county's system. Analysis of economic indicators aims to determine the extent to which one set of indicators affects others in the context of observed developed countries and the Republic of Serbia.

In this section we shall analyze the correlation of economic indicators of procurement of agricultural products for the needs of the defense system in the selected countries (Serbia, USA, China, India, and Russia) in the period of nine years, observing the years 2013, 2017 and 2021.

Correlation was determined with the use of correlation analysis, namely using Pearson correlation coefficient. Correlation coefficient is the unit used for measuring the correlation between certain variables. Pearson correlation coefficient is used in cases when there is linear correlation between variables in the observed model, along with continuous normal distribution. The value of Pearson correlation coefficient ranges from +1 (perfect positive correlation) to -1 (perfect negative correlation). It is marked by the lowercase letter *r* and it is calculated using the following formula:

$$r = \frac{SSxy}{\sqrt{\mathrm{SSxx} \cdot SSyy}}$$

Correlation coefficients of economic indicators of procurement of agricultural products for the needs of the defense system in analyzed countries are shown in Table 3 (bellow).

Table 3. Correlation coefficients of economic indicators of procurement of agricultural products in developed countries and in the Republic of Serbia

Year	Macroeconomic indicators	Defense expenditure	GDP	GDP per Capita	Direct foreign investments	Unemployment rate	Inflation rate
2013	**Defence expenditure**	1	0,48	-0,58	0,57	0,34	0,60
2017		1	0,34	-0,59	-0,20	-0,14	0,14
2021		1	0,51	**-0,76**	**0,81**	-0,41	0,08
2013	**GDP**	0,48	1	0,001	-0,53	0,03	-0,42
2017		0,34	1	-0,27	-0,58	0,58	-0,58
2021		0,51	1	-0,56	0,16	-0,39	**-0,73**
2013	**GDP per Capita**	-0,58	0,001	1	-0,64	--0,54	-0,46
2017		-0,59	-0,27	1	-0,49	-0,55	-0,60
2021		**-0,76**	-0,56	1	-0,32	0,24	0,36

Year	Macroeconomic indicators	Defense expenditure	GDP	GDP per Capita	Direct foreign investments	Unemploy-ment rate	Inflation rate
2013	**Direct foreign investments**	0,57	-0,53	-0,64	1	0,09	**0,80**
2017		-0,20	-0,58	-0,49	1	0,23	0,91
2021		**0,81**	0,16	-0,32	1	-0,61	0,46
2013	**Unemployment rate**	0,34	0,03	--0,54	0,09	1	0,49
2017		-0,14	0,58	-0,55	0,23	1	0,06
2021		-0,41	-0,39	0,24	-0,61	1	0,19
2013	**Inflation rate**	0,60	-0,42	-0,46	**0,80**	0,49	1
2017		0,14	-0,58	-0,60	0,91	0,06	1
2021		0,08	**-0,73**	0,36	0,46	0,19	1

Source: Author's calculation

Coefficients of multiple correlation of economic indicators of procurement of agricultural products for the needs of the defense system from Table 2 are the following: 2013 = 0,44; 2017 = 0,42; 2021 = 0,44. Based on the coefficients we can assert that there is a statistically significant correlation. When considering partial coefficients, we used the following scale:

0,00 - ±0,20 – low or no correlation,

±0,20 - ±0,40 – slight correlation,

±0,40 - ±0,70 – significant correlation,

±0,70 - ±1,00 – high or extremely high correlation.

Observing partial coefficients from the table marked by the color red, we can conclude that there is statistically high correlation between the indicators in Table 2. Therefore, we can claim that there was statistically high correlation in 2013 between direct foreign investments and inflation rate, and in 2021 between budgetary funds for defense and GDP per Capita, budgetary funds for defense and direct foreign investments and GDP and inflation rate. Based on the analysis of data show in Table 2, we can conclude that there are many economic indicators where the calculated correlation coefficient shows statistically high correlation.

Audit and controls as a method of improving the process of procurement of agricultural products

The highest state body in the Republic of Serbia which is responsible for auditing the budget of the Republic of Serbia, including the audit of public procurement, is the State Audit Institution (Ivanova & Ristić, 2020). In all countries, the money allocated for state institutions, except for personal expenses, is indented for operational costs, provision and investments. It is precisely those funds that are mostly spent in the process of public procurement of goods, works, and services. Accordingly, it makes sense that SAI focuses on auditing public procurements, especially the procurement of agricultural products for the needs of the defense system. SAI has vast experience

in auditing the procurement of agricultural products and the recommendations issued by this institution, as the highest body of control of state's budget, are mandatory for all budget users (Durkalić & Ćurčić, 2019; Koprivica, 2021). These recommendations simultaneously help state institutions in their efforts to improve public procurement of agricultural products. Besides experience with the regular state, here we can also observe significant experience and recommendations regarding procurement in the state of current worsened global security and all other presented problems following such a state. Along with SAI, the procurement of agricultural produces is also controlled by internal audit, inspection and various internal controls, regulated by the Budget System Law (118/21).

We systemized the indicators from the consolidated annual reports on the state of internal financial controls in the public sector of the Republic of Serbia for the past five years (2016-2020) in the following fashion:

Table 4. Indicators of the state of internal financial control in the process of public procurement of agricultural products

SECTOR	RECOMMENRATIONS PER YEAR					%
	2016	2017	2018	2019	2020	2020/2016
Public procurements and contracting	598	741	595	637	450	75,25

Source: Author's calculation

By analyzing the methodologically represented indications, we have reached the following conclusions:

- It is worrying that similar indicators were determined in research regarding the given recommendations 10 years ago (Issa et al., 2022),
- Public procurement of agricultural products holds second place by the number of given recommendations among all controlled segments (internal rules and procedures, bookkeeping, salaries and payments),
- The highest number of recommendations was given in 2017, and the lowest in 2020, which is an indicator of improvement in the area of public procurement. In 2020, 75,25% less recommendations were given when comparing to 2016,
- Reduction in the number of recommendations given in the last five years (2016-2020), demonstrates that managers and personnel in charge of procurement of agricultural products accepted and implemented the recommendation that were agreed upon (Krstić, 2020).

As of recently, the Ministry of Finance of the Republic of Serbia, based on the Decision of the Government, introduced an obligation for all budget users to seek consent for all public procurements, including the procurement of agricultural products, which exceed a certain value from the Ministry of Finance (originally it the value was set at one million, but soon risen to two million dinars) along with certain additional guidance (Stanojević & Milunović, 2020). We remind that a similar obligation regarding public procurement

was introduced during COVID-19, which placed public procurement under control to a certain extent, especially during the state of emergency at the beginning of pandemics.

Also, the Ministry of Finance plans to introduce software for monitoring contracting outside the public procurement portal. The aim is to improve the software for monitoring the realization of public procurements which is intended to include all public procurements to which the PPL in not applied, i.e., to all those for which data is not available at the Public Procurement Portal with the exception of procurement of agricultural products for the needs of defense and security. As stated by the Ministry of Finance, "the said procurement should significantly contribute to a more efficient and effective realization of all jurisdictions of this ministry determined by law, regarding the subject in matter" (Đurić et al., 2020). The stated demonstrates that there is a need to monitor and publish contracts concluded outside the Public Procurement Portal, above certain value, in a unified manner. Among numerous other problems in the field of procurement of agricultural products, such an approach could contribute to a more comprehensive perception and better control of procurement of agricultural products. Along with unification of data regarding public procurement, it would also greatly enable the analysis of participation of all procurement in planned budgetary means of a budget user. The effect would certainly be complete if it would include all procurements to which the law is not applicable, not just those above a certain value.

In the current situation of worsened security in the world many relations in general have become disturbed – in politics, economy, diplomacy, and other areas (Lepojević & Samardžić, 2022). We are witnessing many problems in our own country, when it comes to securing energy sources before the winter in order to secure functioning of the economy and in order to satisfy the needs of our population. Satisfaction of defence needs in such conditions also faces multiple challenges. If we observe from the budget perspective, the funds in the budget approved at the beginning of the year are insufficient due to the inflation and price increases. Even when allocated, they are no guarantee that all planed and unplanned procurements of agricultural products will be realized due to a series of abovementioned problems. Therefore, disturbed and decelerated functioning of economy and disturbed relations on the global market reflect on all areas, including the defence sector. Adjustment of procurement of agricultural products in such conditions is very difficult and complex, especially in the field of defence and security.

Strengthening of national defence industry should definitely be the priority of the Republic of Serbia in the coming period, with a special focus on its modernization in order to justify its existence and in order to satisfy the modern military needs. When importing, it is vital to rely on experiences and good contacts of state companies and national defence industry which deal with import of weapons, equipment and raw materials. Also, involvement of the highest state officials is becoming increasingly necessary in order to procure some sophisticated weapons (Anti-aircraft systems, drones, airplanes, etc.). At the level of the Sector for Public Procurement of the Republic of Serbia, it is necessary to conduct research which should primarily aim to analyze the

effects of the application of the PPL till date, its good and bad sides and to formulate measures and solutions in order to overcome the limitations and problems present in the process of public procurement of agricultural products. The said research should include all state institutions, which would provide their experiences as suppliers in the process of procurement of agricultural products, which would in turn contribute to the research subject.

We particularly highlight the role of the Ministry of Finance, which monitors and controls all public procurements of agricultural products through approval and monitoring of budget spending in the Republic of Serbia. All of the abovementioned accentuates the obligation of budget users to plan public procurement of agricultural products with even more precision, with comprehension of priorities and with constant care for the principles of economy, efficiency and effectiveness. Finally, the role of SAI, as well as all other subjects in charge of audit and control, is crucial as they must determine the omissions and provide recommendations which will oblige all state institutions to improve the sector of procurement of agricultural products. All of the abovementioned will make the procurement of agricultural products more transparent and budget users more responsible for improving public procurements and take responsibility for spending state money, i.e., for informing the public and citizens on how the tax payers' money is being spent.

Conclusion

Public procurement for defense needs primarily imply procurement of weapons and military equipment. However, despite the fact that procurement of weapons is dominant, war cannot be waged without good logistical support, which includes securing many other defense needs as well as procurement of agricultural products. In modern times we can perhaps place political and media preparation first, which also require many resources.

Our research has demonstrated that worsening of the security situation causes proportional growth of military expenditure and acceleration of armament, which is particularly evident in the most powerful nations, as well as those countries which are in conflict. Analyzed data regarding "military budget" expenditure in the world confirms that the arms race in accelerating. The identified indicators demonstrate the duty of our country to arm itself, primarily due to security reasons. Compromised security produces many disturbances, primarily economic crisis and other consequences: inflation, reduction of trade, decrease of production, increase of prices, deficiency of goods, primarily food, energy sources, weapons and military equipment and many other products and services.

Adjustment of procurement of agricultural products for the needs of the defense system in a state of compromised security and multiple disturbed relations and the global market becomes even more complex and challenging. In addition to the allocated budget funds, significant skill is also necessary. The import of weapons requires great diplomacy, even participation of the highest state officials. When it comes to procurement from

the national defense industry, it is much easier to conduct the process but only if the national production has been modernized and it is possible to import and secure the raw materials necessary for production.

Therefore, the challenges of procurement of agricultural products for the needs of the defense system in modern times are evidently tremendous. In addition to satisfying defense needs, it is also necessary to secure the functioning of the economy and society a whole. In times of crisis, it is of particular importance to keep in minded the priorities and economic justification of procurement.

Conflict of interests

The authors declare no conflict of interest.

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AGRICULTURAL BUDGET IN THE FUNCTION OF ORGANIC AGRICULTURE DEVELOPMENT IN SERBIA AND MONTENEGRO

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ABSTRACT

Organic agricultural production requires higher financial investments than conventional agricultural production. Seed prices are higher, labor costs are higher, and there is the additional cost of certification. That is why the existence of incentive measures of agricultural policy is necessary for organic agriculture. The aim of the paper is to present the incentives paid from the agricultural budget for organic agriculture in Serbia and Montenegro. The authors conclude that subsidies for organic agriculture, although they are paid continuously and are a significant incentive, have a small percentage share in the agricultural budget in both countries. In Serbia, 1% and 3% of registered farms in Montenegro practice organic agriculture.

Introduction

Organic agricultural production is a very current subject of research in the scientific works of researchers and scientists at the global level. Agricultural policy measures are necessary for organic agriculture. According to (Wu, Marette, 2020) the development of this production has seen an expansion in the last three decades, because "policy makers have tried to develop regulations for providing sufficient incentives to farmers to adopt organic farming".

In the literature, there are positions according to which organic production can be characterized as sustainable agricultural development, as well as that "the organic

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production is based on an essential connection between agriculture and nature, with a focus on respecting the natural balance" (Mihailović, Brzaković, 2018; p. 127).

The development of this method of agricultural production was conditioned by the need to preserve a healthy environment, as well as food safety. Some authors (Clark, 2020) present the results of their research, which say that "organic farming is more efficient in its use of non-renewable energy, maintains or improves soil quality, and has less of a detrimental effect on water quality and biodiversity". According to (Katic et al., 2008; p. 271) organic production is a type of production that ensures the harmony of environmental protection requirements and production based on natural processes. Bearing in mind that organic agriculture is a labor-intensive activity, its importance is also in the employment of residents of rural areas, especially women, which is also important for reducing the depopulation of these areas (Pejanović, 2013).

Organic agricultural production requires larger financial investments considering that it has higher production costs. First of all, labor costs are higher, input prices are higher, and the cost of certification puts an additional burden on producers. On the other hand, it is necessary to pass a minimum of three years, which is necessary for the conversion of the land, in order for the production to be considered organic. Only then can producers make their first income. In order for organic production to take place and develop in the correct way, continuous education of producers is also needed (Mihailović et al., 2007, p. 88). In addition to education about production methods, financial education is also important, because "the level of farmers' financial knowledge is low" (Zakić et al., 2017; p. 1651).

EU is a significant producer of organic food on a global scale. Financial support through the CAP also contributed to this. A group of authors (Krstić et al., 2017; p. 968) state "the assets meant for organic agriculture, from the European Agricultural Fund for Rural Development (EAFRD) for the period of 2014-2020 are 6.4% of the total EAFRD fund." The author (Ignatenko, 2020) points out that "the highest level of development of the organic agriculture was reached by Italy, France and Germany" ... "these three countries have been designated as the "countries of good practices" in the EU. According to (Sredojević et al., 2017), in order to encourage investment and improve the competitiveness of economic entities in the organic sector, better quality credit lines for investments are needed, as well as support from other agricultural policy measures, primarily stimulating tax relief.

In Serbia, according to researchers (Tomaš-Simin et al., 2019; p. 265), organic agricultural production "is legally a well-regulated area, but still not developed to the necessary and possible extent". The accelerated development of organic agriculture was recorded at the beginning of the 21st century, especially in Vojvodina, and this is also the result of well-organized producers (Pejanović, Njegovan, 2011). According to research data (Radović, Jeločnik, 2021; p. 22) "the share of organic farms in the total number of agricultural ventures is about 1%. Serbia's portion in the global supply of organic food and agricultural products is only 0.2%". Certainly, there are numerous

reasons for the underdevelopment of organic agriculture in Serbia, among which is the low level of incentives, which was a significant limitation for faster development (Radović et al, 2011). The authors (Roljević-Nikolić et al, 2017; 334) based their analysis on a comparison with the European Union and on that occasion came to the conclusion "intensive growth of organic farming in the EU provides a stable support both in terms of rate and financial resources, while in Serbia has been changed not only amount of support from year to year but also types of support". The financial support of the state is necessary for the development of organic agriculture in Serbia, given that most producers do not have their own accumulation, i.e., sources of self-financing, as well as the unfavorable lending conditions of commercial banks (Radović, 2018).

In Montenegro, organic agriculture is of vital interest to the state. Bearing in mind that organic agriculture is based on the principles of sustainable development and maximum environmental protection, it is clear why it is of strategic importance for this country, where ecology is of vital interest. Particularly favorable agro-ecological conditions exist in Bijelo Polje, Berane, Andrijevica and Plav. According to the author's assessment (Zejak, 2020), good agroecological conditions are also the result of the fact that due to the economic crisis, farmers use little artificial fertilizers and chemical agents even in conventional production. In the last ten years, the areas under organic certified production have increased by 30% (Bataković, Matavulj, 2022). As in other countries, in Montenegro, subsidies from the relevant ministry contribute significantly to the development of organic agriculture (Zejak et al, 2022).

Materials and metods

The aim of the paper is to present the incentives paid from the agricultural budget for organic agriculture in Serbia and Montenegro. For this purpose, the authors use the method of analysis and synthesis, as well as the descriptive and static method. The research uses available statistical data, as well as data from the relevant ministries on the amounts of subsidies for organic agriculture in both countries. For the purpose of the research, the current normative framework, i.e. laws, rules and regulations, is analyzed.

Research results

Organic production has existed in Serbia and Montenegro since the 1990s. Subsidies have been paid from the agricultural budget in Serbia since 2005, and in Montenegro since 2006. As part of the research, the level of these incentives, their percentage participation in the agricultural budget by individual years, as well in the entire analyzed period.

Serbia

The initial forms of organic agriculture appeared in Serbia in the 80s of the 20th century. More significant results were recorded during the 90s of the 20th century, when the first export of organic products was conducted. However, these products were sold in small quantities on the domestic market. Some authors are of the opinion that the mentioned

period can be ignored because organic agriculture was then minimally represented within the entire agricultural production (Sredojević et al, 2017). The organized making has existed since 2000. The first law was then passed for this type of production, which was harmonized with the regulations of the EU. Also, the necessary regulations and other normative acts were adopted at that time. In addition to state institutions, foreign development agencies, as well as the non-governmental sector, provided significant support for development. The current Law on Organic Production was adopted at the session of the Republic Assembly, held in May 2010, and entered into force on January 1, 2011 (Zakon RS, 2010).

A more precisely defined normative framework enabled a faster development of this type of production. For example, from 2010 to 2019, the total number of producers in the organic production system in Serbia increased by 45 times (Radović, Jeločnik, 2021). The development was also the result of the activities of the national association "Serbia Organika", which was founded in 2009.

In addition to the law, the current normative framework consists of rulebooks, the most important of which are: Rulebook on control and certification in organic production and methods of organic production (RS Rulebook, 2020) and Rulebook on documentation to be submitted to the authorized control organization for issuing a certificate, as well as conditions and the method of selling organic products (Regulations of the RS, 2016).

In the initial years, there were only individual certificate holders, while the organization of production through group certification has been developing since 2011. Then the Rulebook on control and certification in organic production and organic production methods was adopted (RS Rulebook, 2011). According to official data, there were a total of 6,261 producers in organic production in Serbia in 2019, of which as many as 5,727, i.e. 91%, were subcontractors, who were in the group production system (Simić 2020; p. 32). According to the last published official data, in 2021 there were a total of 6,421 producers involved in organic production, which represents about 1% of the total number of registered agricultural farms, according to the results of the last Agricultural Census (Cvijanović et al., 2012). In 2021, there were 23,527 hectares under organic production, and organic fruit growing was the most represented in the production structure, which covered 36% of the total areas. In the same year, 2021, an increase in the number of sheep, cattle and poultry was recorded in the system of organic livestock production (Organic News-63).

The institutions responsible for the organic agriculture in Serbia are: the Group for Organic Production at the Ministry of Agriculture, Forestry and Water Management and the Expert Council for Organic Production. The importance of the development of organic agriculture was also recognized by the Committee for the Village of the Serbian Academy of Sciences and Arts, which included this production in the development priorities within the National Program for the Revival of the Village of Serbia (National Team for the Revival of the Village, 2020).

Incentives from the agricultural budget

Subsidies for organic agriculture are defined every year by decrees on the distribution of incentives in agriculture and rural development, which are adopted by the Government of the Republic of Serbia. The method of realization of subsidies is defined by the rules, namely: the Rulebook on the use of incentives in organic plant production and the Rulebook on the use of incentives for organic livestock production. Only registered agricultural holdings are entitled to these incentives, which are also obliged to have a contract with an authorized organization for the certification of organic agricultural production.

Table 1. Agricultural budget and subsidies for organic agriculture 2013-2022

Year	Agrarian budget (in millions of RSD)	Subsidies for organic agriculture (in millions of RSD)	Participation of subsidies for organic agriculture in the agricultural budget (in %)
2013	44,699.5	200.0	0.45
2014	45,427.2	93.7	0.21
2015	45,308.2	92.0	0.20
2016	40,465.7	91.0	0.22
2017	43,787.6	90.0	0.21
2018	44,109.2	110.0	0.25
2019	54,614.7	108.0	0.20
2020	56,067.9	350.0	0.62
2021	60,271.3	200,0	0.33
2022	78,571.5	380.0	0.48
AVERAGE PARTICIPATION:			0.32

Source: Ministry of Agriculture, Forestry and Water Management of the RS, Regulations 2013-2022. Edited by the authors.

Annual allocations from the agricultural budget for subsidies for organic agriculture, as well as the average allocation for the analyzed period (2013-2022), were less than 1%. The total subsidies for organic production were the highest in absolute terms in the last analyzed year (*Table 1*). Specifically, in 2022, total incentives for organic production amounted to RSD 380 million. Of this amount, RSD 80 million was reserved for incentives for organic crop production, and RSD 300 million for incentives for organic livestock production (Regulation, 2022).

The amounts of incentives in organic crop and livestock production are higher compared to incentives in conventional production, and the percentage difference is shown in *Table 2* and *Table 3*.

Table 2. Subsidies for organic plant production 2014-2022

Year	Increase in subsidies for organic production compared to conventional production (in %)	Subsidies for organic production per hectare (in RSD)
2014	40%	8.400
2015	40%	8.400
2016	40%	2.800
2017	70%	3.400
2018	70%	6.800
2019	120%	11.440
2020	400%	26.000
2021	550%	26.000
2022	250%	31.500

Source: Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia

The biggest difference in the amounts of incentives in organic and conventional crop production was in 2021. The highest absolute amount of incentives per hectare was in the last analyzed year, i.e. in 2022 (*Table 2*). The maximum amount of incentive per user, for organic crop production, was RSD 630,000 in 2022. (Regulations of the RS, 2021).

Table 3. Subsidies for organic livestock production in 2020

Type of subsidies	Increase in subsidies for organic production compared to conventional production (in %)
Premium for milk produced by the organic production method	40%
Cattle fattening	40%
Fattening lambs	40%
Fattening kids	40%
Pig fattening	40%
Lactating cows	40%
Bee hives	40%
Production of edible fish	40%
Cows for raising calves for fattening	40%
Quality breeding dairy cows	40%
Quality breeding fattening cows and bulls	40%
Quality breeding sheep and rams, goats and male goats	40%
Quality breeding sows and boars	40%
Parent hens of heavy type	40%
Parent hens of light type	40%
Parent turkeys	40%
Quality breeding queens of carp fish	40%
Quality breeding queens of trout fish	40%

Source: Rulebook on the use of incentives for organic livestock production, Službeni glasnik RS number 25/2020.

In Serbia, the increase in subsidies for organic livestock production, compared to conventional production, according to current regulations, is 40% for all types of domestic animals *(Table 3).*

Montenegro

Organic production in Montenegro has existed since the beginning of the 90s of the 20th century.The development was supported by the realization of numerous projects, which were financed by international organizations, as well as the Ministry of Agriculture, Forestry and Water Management. Professional support was provided by the Biotechnical Faculty in Podgorica. Organic agriculture has been developing more rapidly since 2004, when the first law and by-laws in this area were adopted, and then the first producers were certified (Šebek, 2020). According to data (Zejak, 2010), the association "Production of healthy food" was founded in Nikšić in 2004, and the "Center for Agricultural Development" in Bijelo Polje, as the first in this area. According to (Mirecki, 2014) "in Montenegro, the Law on Organic Production currently in force was adopted in 2013 and was harmonized with the Council Regulation No. 834/2007". In the current period, the law, which was adopted in 2013 (Law of Montenegro, 2013), is in force, and the drafting of the new Law on organic production is underway.

In addition to the law, the current normative framework consists of rulebooks, the most important of which are: Rulebook on detailed rules and conditions for crop and livestock organic production (Regulations of Montenegro, 2014), Rulebook on detailed content, method of registration and management of the Register of entities in organic production (Regulations Montenegro, 2015), Rulebook on the method and methodology of professional control in organic production (Regulations of Montenegro, 2015a), Rulebook on the content and size of the organic production sign (Regulations of Montenegro, 2016), Rulebook on detailed conditions and rules for processing, packaging, transport and storage of organic products (Regulations of Montenegro, 2016a), Rulebook on closer rules and conditions of organic production for aquaculture animals and seaweed (Regulations of Montenegro, 2017).

In addition to the Ministry of Agriculture, Forestry and Water Management, institutions of importance for the development of organic agriculture in Montenegro are: National Certification and Control Body "Monteorganica", which was founded in 2005, and National Association of Organic Producers of Montenegro "Organic Montenegro". The association was founded in 2011.

In Montenegro, 255 hectares were under organic production in 2006, and 4822.77 hectares in 2020. There were only 15 producers in organic production in 2006, and 423 in 2020 (Zejak et al., 2022). According to "Monteorganica" data, in 2021 there were 424 producers in organic crop production, of which the most, 371 producers were engaged in fruit growing. Other producers were engaged in farming, production of medicinal herbs and vegetables, while 64 producers were engaged in organic livestock production, among which the most, as many as 56, engaged in beekeeping (Bataković,

Matavulj, 2022). Based on the above, it can be concluded that in Montenegro, in 2021, there were a total of 488 producers in organic production, which represents 3.29% of the total number of registered agricultural farms in this country. Specifically, according to statistical data of the Ministry of Agriculture, Forestry and Water Management in Montenegro, there were 14,831 registered agricultural farms in July 2021 (https://www.gov.me/mpsv).

Incentives from the agricultural budget

Subsidies for organic farming are paid per hectare and head. The costs of organic certificates, as well as the placement of organic products, are also subsidized. Every year, the Directorate for Payments publishes a public call and criteria for support measures, and producers apply for support by submitting a control report, which was carried out by a certification body (Bataković, Matavulj, 2022).

Table 4. Agricultural budget and subsidies for organic agriculture 2006-2022

Year	Agrarian budget - without donations and credits (in millions of €)	Subsidies for organic agriculture (in 000 of €)	Participation of subsidies for organic agriculture in the agricultural budget (in %)
2006	7.9	120	1.52
2007	10.8	150	1.38
2008	14.8	165	1.12
2009	19.8	165	0.84
2010	18.7	350	1.87
2011	15.7	685	4.35
2012	14.6	568	3.90
2013	14.1	100	0.71
2014	14.0	150	1.07
2015	15.0	200	1.34
2016	16.2	250	1.54
2017	16.9	300	1.78
2018	18.8	350	1.86
2019	22.3	400	1.79
2020	24.4	400	1.64
2021	27.2	450	1.66
2022	41.9	450	1.07
AVERAGE PARTICIPATION:			1.73

Source: Ministry of Agriculture, Forestry and Water Management of the Montenegro https://www.gov.me/mpsv/agrobudzet. Edited by the authors.

The total amount of these subsidies had the largest share in the agricultural budget in 2011 (4.35%). In the following years, participation decreased, but it is important that continuity in this support has been maintained. The average share of subsidies for the development of organic production in the agricultural budget, from the first year of their introduction, and ending with 2022, was 1.73% (*Table 4*).

Agricultural producers registered in the Register of Agricultural Farms and the Register of Organic Production Subjects are entitled to subsidies paid from the agricultural budget as part of the measure for sustainable management of natural resources. The current amounts of subsidies in organic crop and livestock production are shown in *Table 5*.

Table 5. Subsidies in organic crop and livestock production in 2022

Type of subsidies	Subsidy amount (in €)
for perennial crops	400 €/ha
for agricultural production	250 €/ha
for vegetable production	350 €/ha
for conditional head of cows and heifers	100 €/head
for conditional head of sheep and goats	100 €/ head
for poultry	2 €/ head
for bee colonies	40 €/colony

Source: Bataković, Matavulj, 2022, p.10. Edited by the authors.

The largest amount of subsidies in organic production, in 2022, was in fruit growing. In Montenegro, the largest number of producers in organic agriculture is engaged in fruit growing.

Table 6. Types and amounts of subsidies for the placement of organic products in 2022

Type of subsidies	Subsidy amount (in €/kg/lit/pc.)
for stone fruits, for apples	0.25
for berries	0.50
for southern fruit	0.70
for vegetables	0.30 - 0.80
for field crops	0.10 - 0.20
for confectionery products	0.40
for honey	2.00
for products of animal origin	2.30
for products of plant origin	1.50
for fruit juices	0.80
for alcoholic beverages	0.10
for eggs	0.10

Source: Bataković, Matavulj, 2022, p. 10, Edited by the authors.

In addition to subsidies for organic crop and livestock production, producers who are registered in the Register of Agricultural Farms and the Register of Organic Production Subjects are also entitled to subsidies for marketing, i.e. placement of organic products. In order to realize the right to subsidies, it is necessary to have a certificate issued by an accredited body for organic production, as well as to have relevant evidence of the placement of organic products on the market (Bataković, Matavulj, 2022). The types and amounts of subsidies for the placement of organic products are shown in *Table 6*.

In Montenegro, the right to subsidies can be achieved by certification and control bodies, if they meet the prescribed criteria defined by the public invitation. By exercising the right to subsidies, they are obliged to provide free services to producers. €85,332.12 was reserved for these incentives in the agricultural budget for 2022 (Bataković, Matavulj, 2022, p. 10).

Conclusion

Organic agriculture is a potential model of agricultural development in Serbia and Montenegro. In both countries, the majority of producers own small areas of agricultural land, and due to the lack of financial resources, they do not use chemical preparations and fertilizers, so that the land is suitable for organic production. Therefore, incentive measures of agricultural policy are needed in order to develop and maintain this production. Subsidies are necessary because organic agricultural production has higher costs compared to conventional production. The costs are primarily increased by labor costs, because this production is labor-intensive, that is, it requires a lot of manual work. There is also the additional cost of certification, which significantly burdens the total costs.

Incentive measures of agricultural policy for organic agriculture exist in Serbia and Montenegro and were introduced at approximately the same time. In Serbia in 2005, and in Montenegro in 2006. In both countries, there is a necessary normative framework, i.e. laws and regulations, as well as appropriate support from institutions, and there are also organizations responsible for the development of organic agriculture. Based on the conducted research, it can be concluded that, both in Serbia and Montenegro, subsidies, although they are a significant support for the development of organic agriculture, have a small percentage share in the agricultural budget and on an annual level, as well as an average percentage share in the entire analyzed period.

Conflict of interests

The authors declare no conflict of interest.

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IN MEMORIAM

проф. др Ђура Стевановић (1939-2022)

Топло и племенито срце поштованог и цењеног проф. др Ђуре Стевановића, мог пријатеља у Христу и нарави, престало је да куца 24. септембра 2022. године у његовом Београдском дому (стану). Потиче од земљорадничко-печелбарске породице од оца Светозара и мајке Десанке у селу Дејан код Власотинца. Село Дејан спада у сиромашна насеља овог краја, па се зато за човека сиромаха, који се у животу мучи каже: „Он се Дејани“, по чему је и село добило име Дејан, јер се са муком зарађује за живот, што није заобишло ни нашег Ђуру. Људи из Ђуриног села и краја су: вредни, оштроумни, бистри, брзо схватају, али су доста неповерљиви, а када задобију поверење других говорљиви су, повучени су, али у одсутним тренуцима кад њих нема одступања, нема попуштања. Таква обележја су и Ђурино оличење.

Основну школу завршио је у селу Свође, Учитељску школу у Пироту, а дипломирао је уз рад на Филозофском факултету Универзитета у Београду, Група за социологију. Докторирао је на престоничком Правном факултету 1988. године, тезом: „Друштвене последице индустријализације Југославије“ под менторством академика Радомира Лукића, а већ 2008. године објављена је његова књига под називом „Индустријализација пољопривреде и будућност сељака“. Доктор је правно-социолошких наука.

Учитељавао је од 1959. до 1961. године у Височкој Ржани на Старој планини и у власотиначкој Шишави. Касније се сели у Београд са запослењем у Пољопривредном комбинату Београд (ПКБ). Од краја 1961. године био је референт за културу у Крњачи. У ПКБ-у је најпре радио као истраживач-аналитичар самоуправљања и риковођења, као и руководилац, и истовремено је и покретач и главни и одговорни уредник недељног листа „Пољоиндустрија“, а потом и иницијатор оснивања и директор Завода за друштвене односе и информисање, у оквиру Института ПКБ „Агроекономик“ (једина институција те врсте у ондашњој Југославији). Председник је Општинског комитета Савеза комуниста Палилула и члан председништва Градске конференције ССРН Београд. У НИП „Привредни преглед“ обављао је послове главног уредника књига и часописа. Био је секретар Секције за социологију рада Социолошког друштва Србије, председник Издавачког савета „Борбе“ за Србију, члан Програмског савета „Студиа Б“, члан Програмског савета библиотеке „СР Србије“, Програмског савета Документарног програма РТБ, Програмског савета НОЛИТ-а, члан Уређивачког одбора часописа „Производња“, редакцијског Савета часописа „Пословна политика“, заменик председника Савета факултета Организационих наука у Београда, члан Савета Учитељског факултета у Врању, члан Савета Пољопривредног факултета у Земуну. Члан је Одбора за проучавање села

Српске академиије наука и уметности. Био је иницијатор оснивања и председник Југословенског и српског удружења за социологију села и пољопривреде и председник Балканске асоцијације за социологију села и пољопривреде. Покретач је и главни уредник часописа за рурални развој „Виђења“. Директор је Завода за социологију развоја села, сада Завода за проучавање села и члан Одбора за проучавање села. Био је члан научне редакције часописа „Регионална економика“, Националне академије наука Украјине. Члан је Међународног савета годишњака „Регионалани агросистеми - економија и социологија“, Института за аграрне проблеме Руске академије наука, у Саратову, и члан редакцијског одбора библиотеке Bulgaria rustycana, Института за проучавање друштва и знања, Бугарске академије наука. Члан је издавачког савета Хронике села (културно-просветне заједнице Србије).

Добитник је многих друштвених признања међу којима су: Ордена заслуга за народ са сребрном звездом, Плакете града Београда, дипломе Најбољи радник ООУР-а, Мајског цвета Савеза синдиката Београда, Плакете сусрета самоуправљача „Црвени барјак“, Октобарске награде Власотинца и Плакете Машинског факултета Универзитета у Нишу.

Наставна и научно-стручна активност

Проф. др Ђура Стевановић од 1988. године на Пољопривредном факултету у Земуну изводи наставу из предмета Социологија, а од 1994. године и из Социологије села чији је утемељивач на Агроекономском смеру. На Филозофском факултету у Нишу предавао је предмет Увод у социологију и социологију насеља (села и града), на Групи за социологију. На Пољопривредном факултету у Осијеку изводио је наставу из предмета Аграрна социологија, а на Учитељском факултету у Врању предавао је Социологију. Био је заменик руководиоца смера последипломских студија Социологије друштвеног развоја на Филозофском факултету у Нишу. Учествовао је на извођењу последипломске наставе на Пољопривредном факултету у Београду (Методологија научног истраживања), на Филозофском факултету у Нишу (Социологија руралног развоја) и на Учитељском факултету у Врања (Савремена схватања друштвених наука). По позиву је држао и предавања из области Социологије села на основним и последипломским студијама на Архитектонском факултету у Београду. Био је шеф Катедре за економску теорију, социологију и социологију села на Пољопривредном факултету у Земуну. Био је члан комисија за оцену и одбрану магистарских и докторских теза на Пољопривредном и Архитектонском факултету у Београду.

Научна делатност проф. др Ђуре Стевановића огледа се у оквиру социологије савременог друштва, аграрне социологије, социологије села и социологије друштвеног развоја. Објавио је и приредио око двадесетак књига и преко стотину радова у публикацијама. Учествовао је на конкресима руралних социолога Европе, међународним научним скуповима у Украјини, Бугарској, Грчкој и Бразилу...

Проф. др Ђура Стевановић је родоначелник „Власинских сусрета“ – истраживача села, човек научник, културни делатник, велики посвећеник селу и сељаштву. Дакле, Ђура је иницијатор и организатор, двадесет пет година за редом Међународног научног скупа „Власински сусрети“ посвећеног теоријским, методолошким и истраживачким проблемима социологије развоја села. У раду ових скупова сваке године је учествовалао преко 150 научних радника из наше земље и већег броја европских држава различитих научних профила (социолози, социолози села, демографи, географи, етнолози, историчари, психолози, педагози, учитељи, економисти, аграрни економисти, урбанисти, правници, пољопривредни инжењери). Међу учесницима скупа „Власински сусрети“ било их је из многих земаља: Босна и Херцеговине, Бугарске, Велика Британије, Грчке, Италије, Немачке. Мађарске, Пољске, Португалије, Румуније, Русије, Француске, Холандије, Словеније, Хрватске, Црне Горе, Чешке и Македоније. Учесници скупа су боравили у локалним сеоским насељима: Бољару, Гложану, Конопници, Крушевици, Стајковцу, Дејану, Тегошници, Шишави, Власини Стојковића и Клисури.

Под руководством проф. др Ђуре Стевановића одржана су три међународна семинара за истраживаче села и то: „Село – предмет научног истраживања“ (1996), „Друштвена функција социологије села – развој, стање и задаци“ (1997) и „Рурално-социолошка истраживања (шта се и како истражује у Пољској, Русији, Чешкој, Италији, Холандији, Бугарској, Македонији, Немачкој и Југославији)“ (1998), као и семинари за учеснике из Србије „Управљање иновацијама на породичним газдинствима“ (2007), „Управљање руралним развојем Србије“ (2008), „Управљање локалним руралним развојем“ (2009), и саветовања „Друштвено-патолошке појаве у селима Србије“ (2008), „Образовање и култура у селима Србије“ (2009), „Село и туризам“ (2010).

Проф. др Ђура је руководио научно-истраживачким пројектима (преко 50), као што су: „Друштвени положај сеоске омладине“, „Типологија сеоских насеља у Србији“, „Породично газдинство – обнова и развој села у Србији“, „Пројектовање потреба за учитељима у Србији до 2030“, „Роми у селима“.

Уверен је Ђура да се човек остварује или поништава у оквирима свакидашњег живота, чија је битна детерминанта радна активност. Проф. др Ђура Стевановић је двадесет пет година покретач, организатор и управљач „Власинских сусрета“. Показује како један човек успева да покрене и окупи толики број својих колега, да организује њихове интелектуалне и људске сусрете, да издаје зборнике радова и прати публикације. Одликује га смирена, тиха и витална енергија, интелектуално и самоуверено вођење, те и упорност у остваривању постављеног циља. Ђура јесте социолог села и неизмерно је волео своје село. Говорио је: „Човек мора да успе, тамо где је рођен. Кад ставите прст на глобус, ваше село је центар света. Овде је моја колевка.“

Ђуро Стевановић је досањао велике ствари, али је умео са својим пријатељима, колегама и друговима да ужива и у малим стварима. Знао је Ђура да је природност човека основа за задовољавање и истовремено за развијање људских потреба, јер што је већа цивилизација, то је мања природност и обрнуто. Ђура је својим интелектуалним напорима указивао на спашавање природности човека.

Знао је и хтео Ђура „Власинске сусрете“ да смести на свом завичајном подручју где атмосфера, амбијент, гостопримство и дружељубивост маме мноштво делатника који би хтели на југ који носи ауру живог темперамента, слободе, чулности, причљивости, гласног смејања, добро осунчаних плодова, врућих ритмова и допадљивих мелодија. Због свега тога југ остаје у срцу уграviран и зато многи хрле на југ не били макар на кратко себе „ојужили“. Власински сусрети, осим научног, стручног, образованог и друштвеног значаја, су и бринули о забави, дружењу кроз песму и игру и што да не, иће и пиће. Изводиле су се екскурзије, упознавање локалних заједница, села, сеоца и махала, уживајући у лепотама Власине. Зато су сусрети део нас, живе у нама и ми са њима. Радујемо им се јер сусрећемо добре пријатеље, уважене колеге и знане странце, сећајући се и ранијих учесника који нису више међу нама. Проф. др Ђура уме са људима, зна да подстакне оно скривено, а вредно у њима, спреман је да несебично пружи, увек стоји на услузи. У Власотинцу се зна, довољно је рећи професор Ђура...“Дошао је професор Ђура, звао је професор Ђура, рекао је професор Ђура“, јер прича о њему иде испред њега, као да због своје величине прераста у легенду. Његова пријатељска искреност, отвореност душе и срца, пленила је и инспирисала на нове доласке на ове сусрете. А оно што је остало записано и забележено у људском сећању и срцу има моћ да вечно траје. Захваљујући свему томе, Ђура својом стваралачком енергијом на прагу је доајена српске социологије села: Драгољуба Јовановића, Сретена Вукосављевића и Радомира Лукића.

Ђура је дарежљиве руке, чије позиве за сарадњу нико није одбијао, па су зато „Власински сусрети“ окупљали најбоље познаваоце села, различитих професија са Балкана, Европе и из белог света. То је могао да учини само човек коме социологија није само занат, него позив и начин живота. Највише је волео да му неко поклони своју књигу и био је веома срећан због дара. Ђура је алфа и омега свега подстицајног у српској социологији села, и ако је сеоско дете, сеоско ђаче, сеоски, Дејански момак. Он је сведок свог времена, посматрач новог доба и пророк будућности. Његово село је у његовом срцу.

Све у свему „Власински сусрети“ и Завод за проучавање села постали су социолошка задужбина Ђуре Стевановића. Посебно завичајни социолози и други са југа Србије, треба да преузму и у будућности понесу Ђурину социолошку штафету и тако подсете надлежне институције и професионалне социологе на њихову друштвену обавезу, да сачувају и унапређују „Власинске сусрете“.

Током две и по деценије формирана је једна институционална грађевина са четири темељна стуба:

1. Проф. др Ђура Стевановић,
2. „Власински сусрети“,
3. Завод за проучавање развоја села,
4. Балканска асоцијација за социологију села и пољопривреду.

А постао је и академик Бугарске академије науке и културе.

За сада „Дејанске свеске“ чувају успомену на овог неуморног научног прегаоца и племенитог човека. Професор Ђура је током читавог радног века и након одласка у пензију свој завичај носио у срцу, приближио га Србији и региону, учинио га препознатљивим у стручним круговима и учинио много тога да оживи ово некада животно село. Професор Ђура има шта потомству за науку да остави у области руралне социологије. Дао је велики допринос теоријским узлетима, истраживачким налазима, организаторским прегнућима и идавачком делатношћу. Зато ће његово име бити трајно учитано у хвале социологије села и неће се заборавити.

Узимам слободу да изразим лични пријатељски однос према проф. др Ђури Стевановићу. Ђура ми је био омиљени пријатељ у Христу и нарави. Захвалан сам му за дугогодишње дружење и пријатељство. Ово прво не знам да ли ћу моћи, а ово друго не знам да ли ћу умети? Дуг који у себи осећам и са тугом носим, дужан сам Ђури, а он је дужан мени само зато што нас је заувек напустио, и отишао у вечност. Није било довољно Ђуру знати, њега је требало упознати, а ја сам га добро познавао и од њега много сазнао и корисно научио.

Сабирање стечених животних искустава, натерало га је да гледа даље и дубље, зрелије и озбиљније, а сасвим довољно да уклони замагљене истине, заборављене чињенице, пресечена сведочења и прећутана збивања. За кабинетским и кафанским столом, свеједно, седећи са окупљеним друштвом, упијао је утиске, ослушкивао дијалоге, посматрао присутна лица, ловио згоде и анегдоте и користио их као срећно постављено огледалце у којем се преламају животне судбине и карактери, хватао истину, чак и онамо где је многи не виде, у шетњама и кафанским седељкама поштујући кафану као велику људску и друштвену институцију. У тој институцији испили смо много чашица ракије, чаша вина, не зато што нам се пило, већ зато што смо тако у миру могли да водимо и врло поверљиве разговоре.

Професор Ђура је са високом озбиљношћу и интелектуалним напорима преносио знања својим студентима, магистрантима и докторантима. Уверавао их је да се без континуираног учења и стицања знања неће лепо осећати. Говорио им је да

буду мислећи људи, да им живот буде испуњен делима, да буду радни и радознали и постану ковачи властите среће, поштени људи, украс својих родитеља, понос својих наставника и факултета и да умеју да цене праве људске вредности. Ђурин стваралачки пут је захтевао да се трпи и отрпи, где се ради са много интелектуалних напора и исчекивања, а да се при томе сачува достојанство, извлачећи себе из себе. Тим путем се не хода брзо, већ се жури полако, али се стиже на циљ са пуним покрићем, у коме је у потпуности душа испуњена са осећајем да све што је урадио и остварио његово је. Говорио је Ђура да је стицање знања узвишеност живљења и да се оно најбитније у људском животу дешава у сфери душе и ума. Науку није одвајао од свог живота, јер је за њега била страст и снага која помера границе напред.

Умео је Ђура да се дружи са људима свих доби, не правећи разлику између пријатеља, колега, познаника и пролазника и држао их је на окупу са уживањем да их што боље дочека, угости и разговори. Много пута смо домаћински и чазбенски угошћени од Ђурине верне супруге Катице и синова Владана и Дејана, са којима је правио своје породично гнездо, учећи их људским квалитетима, уграђујући им у мислима, срцу и души своју родитељску љубав.

Наш је Ђура је био сељачког рода, али је имао господско држање. Но, судбинско сечиво је било брже од Ђуриног животног трагања, пресекло је и угасило његов стас и глас, топли погед, корак, машту, планове, поглед у будућност и исшчекивања и тако нам задало бол и тугу. Црна Дејанска земља рађа и даје, али је узела много – нашег Ђуру. Нисам мом верном пријатељу Ђури на располагању рекао збогом, већ сам га у мислима замолио, кад закуца на небеска врата да му кажем до виђења, мој Ђуро, као и увек, али на лепшем Божијем месту где одлазе праведници. У миру вечне тишине и уз Божију милост и у царству небеском нека почива наш и мој вечни пријатељ Ђура Стевановић.

Проф. др Драгић Живковић
Пољопривредни факултет, Земун

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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
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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

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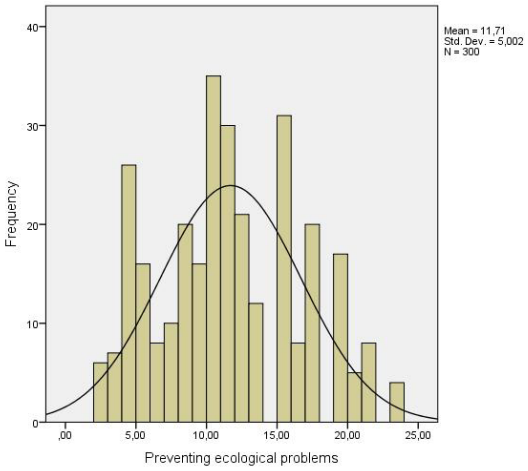
Figure 1. Agriculture, value added (% of GDP)



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