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CONTENT

MULTICRITERIA APPROACH TO RURAL TOURISM DEVELOPMENT IN REPUBLIC OF SRPSKA

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A B S T R A C T

The purpose of this paper is to examine the current state of rural tourism in Republic of Srpska as well as to provide guidance and recommendations for the development of this form of tourism. The used model approach expert opinion and, on this occasion, the DEX method of multicriteria decision-making was used. With this model, an assessment of rural tourist capacities is carried out on a random sample of four tourist facilities. The reason for the results obtained in this way is that the observed facilities have adequately used the natural resources available to Republic of Srpska. In addition, recommendations and guidelines are given in order to further develop this type of tourism in Republic of Srpska. The presented model offers an innovative approach in the assessment of current and potential tourist facilities. For this reason, it should be used in future research.

Introduction

In modern tourism, it is necessary to take into account all the criteria that affect the development of the tourist offer. When considering the tourist offer, it is necessary to take into account the social, economic and ecological background of the local community on which the tourism service is reflected (Puška, et al., 2020). In that way, the perception of the tourist offer through sustainability is used. In the sustainable development of tourism, it is necessary to meet the following criteria: Economic, Environmental and Social criteria. In order to obtain an overall assessment of the sustainability of tourist facilities, additional sub-criteria should be included (Prevolšek, et al., 2020). Due to

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the importance of these criteria aimed at the development of tourism, it is necessary to apply a holistic approach to the evaluation of tourist facilities. The application of this evaluation approach is a classic decision-making problem that is solved by applying the methods of multi-criteria decision-making (hereinafter - MCDM). MCDM is used in a situation where it is necessary to decide among different alternatives that are available, and all these alternatives are evaluated using different criteria (Rozman, et al., 2017).

When assessing sustainable rural offer in the Republic of Srpska (hereinafter - RS), complex decision-making will be applied with the application of the DEX method. The DEX method applies operations to the linguistic values of the criteria, and the result is also in the form of a linguistic value, bringing the decision closer to the human way of thinking (Rozman, et al., 2016; Stanković et al., 2020). The aim of the decision-making model is to perform an analysis of the existing facilities of the rural tourist offer in selected rural households where rural tourism services are offered.

The goal of the decision support model is to offer a tool for improving the sustainable development of rural tourism in RS, in order to improve the quality of this tourist offer. The methodological model consists of assessing Economic, Social and Environmental criteria. These criteria will be used to assess the current state of sustainable rural tourism in the RS. In that way, the advantages and disadvantages of the tourist offer in RS will be seen. In doing so, the assessment will be performed using expertly defined decision-making rules, whereby a new methodology in the assessment of the tourist offer will be presented. Based on the assessment of the tourist offer, guidelines for the development of this type of tourism will be given.

The managerial implications of this research are reflected in the fact that the current state of rural tourist facilities will be considered, and guidelines will be given for the sustainable development of this tourist offer. These guidelines will serve managers to improve the business of their capacities through the development of the tourist offer based on the given recommendations obtained from the research (Dakić et al., 2021). Of course, this will have implications for the development of the local community as well as the development of a certain country, because tourists are one of the promoters of the country's economic development.

In addition to the introduction, this paper will discuss the concept of rural tourism and its importance for the development of the tourist offer of a country, then the methodology will explain the applied DEX method. The results will analyse rural tourist offers and compare them to see the pros and cons of this tourist offer. Through the discussion, the obtained results will be analysed in more detail in order to give the most important results, as well as the advantages and disadvantages of the used decision-making model.

Literature overview

Rural tourism thus becomes a promoter of rural development (Puška, et al., 2021). Tourism has become one of the primary industries in the development of rural communities (Puška, et al., 2019). However, rural tourism can create negative effects for the rural development of the local community. Therefore, it is necessary to take an appropriate position on the tourist map of the region by choosing an appropriate program for sustainable tourism development and applying adequate strategic directions as key positioning instruments, but at the same time contribute to the revival and development of rural areas, increase profits of agricultural produces and environmental protection (Maksimović, et al., 2017).

Rural tourism represents the rural way of life and the values provided by this form of tourism are all in a natural setting, so that tourists are offered alternatives to the urban way of life (Zolfani, et al., 2015; Sagić et al, 2019). Based on that, rural tourism has become a favourable and convenient alternative among tourists, because it offers a natural environment for relaxation and enjoyment of natural beauty. By building large hotels, entertainment centres, etc. the identity of the area is lost because rural areas offer the same content. It is necessary to use the opportunity of the local community in order to use the potentials they have to strengthen the identity of the tourist offer in the area. Only in that way is it possible to disperse and build a recognizable image in order to attract tourists. The increase in demand for tourism services that occurs in any rural tourist offer allows people living in this local community to earn income from selling their products and performing various services throughout the year (Sanagustin Fons et al., 2011).

When observing tourism in rural areas, it is necessary to distinguish between terms rural tourism and farm tourism, because these two terms are not always synonymous (Ghaderi and Henderson, 2012). Agriculture is practiced on tourist estates, but it does not mean that it is in the tourist offer of rural tourism. In farm tourism, it is quite logical that agriculture is in the tourist offer because it is the basis of the offer. Therefore, rural tourism can be defined as a form of tourism that includes tourist activities organized and conducted in the rural area by the local population, and a form that exploits local tourist resources such as natural, cultural-historical and human resources (Ogarlaci, 2015).

In order for the tourism product of rural tourism to contribute to the sustainable development of tourism, it needs to be locally controlled, small-scaled, based on authenticity, with a price that should maximize the economic effects for the local population (Maksimović, et al., 2017). On this basis, the living standard of the local population can be improved because domestic products can be sold to tourists, also the outflow of young people from villages can be prevented, infrastructure strengthened, trade, traffic and services developed, cultural contents and ethno events revived in these rural areas (Cvijanović, 2014). It is necessary that the tourism potentials of rural tourism in RS are sustainable in order to contribute to the development of the rural community in the area. Therefore, the focus of this paper is on providing information on the current state of the tourist offer of rural tourism on the example of rural households, and what needs to be corrected in order to improve this tourist offer.

In order to meet the sustainability criteria, it is necessary to apply a multi-criteria analysis of the existing rural tourist offer. In obtaining information on individual tourist destinations, many papers used MCDM methods, where decisions were based on decision support systems. The decision support model has a wide application in tourism. Park et al. (2017) used the Delphi method and the AHP (Analytic Hierarchy Process) method to assess the quality of accommodation in farm tourism, and to improve accommodation capacity and quality. Nikolić et al. (2015) used the SWOT (Strengths, Weaknesses, Opportunities, and Threats method) and AHP method to provide guidelines for the development of the Stara Planina tourist destination using rural tourism. Rifle et al. (2019) used the FUCOM (Full Consistency Method) and ARAS (Additive Ratio Assessment) methods to determine sustainable rural potentials in the Brčko District of Bosnia and Herzegovina. Park and Yoon (2011) used AHP and Delphi methods to identify indicators that measure the sustainable development of rural tourism. Muhacir and Tazebay, (2017) used the AHP method to link the application of rural tourism in the ecosystem. Anabestani (2016) used the expert opinion and methods of Fuzzy AHP and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) to identify the most favourable rural area to create a rural tourism brand.

Mahboban and Talebi (2015) used the TOPSIS method to explore tourist attractions and capacities for the development of rural mountain tourism. Zheng and Liu (2013) applied the ANP (Analytical Network Process) method to tourism activities and tourist satisfaction to improve the quality of rural development and tourism development planning through environmental management. Jeong et al. (2016) used a hybrid Fuzzy DEMATEL (Decision Making Trial and Evaluation Laboratory) and a geographic information system to evaluate tourist locations and select the best location for the use of rural tourism. Based on these and similar papers, it can be concluded that MCDM methods are used in the evaluation of rural tourism. The DEX method was also used in the evaluation of rural tourism. Rozman et al. (2009) used this method to rank farm tourism facilities according to the quality of service they provide. Pažek and Rozman (2010) created a model using the DEX method and evaluated farm tourism facilities with regard to the quality of the tourist offer. Prevolšek et al. (2020) used this method to assess the current state of the tourist offer in ethno villages in Bosnia and Herzegovina. Rifle et al. (2020) used this method to evaluate the current supply of rural tourism in Bosnia and Herzegovina. Based on this, it can be concluded that the application of the MCDA method and thus the DEX method is justified in the management of rural tourist offer.

The review of the literature to date imposes the hypothesis that the paper represents the elimination of lacks in the deficiencies of the literature offered on this topic, which would also be one of the aims achieved by this research.

Due to the nature of the research, one of the obstacles in this paper could be the inability of comprehensive research on this topic, so that the paper represents a kind of pilot study in this field.

Materials and methods

When creating the model of sustainable development of rural tourism in RS, we started from the model that requires a multidisciplinary approach because the qualitative assessment of the state of rural tourism does not provide enough information.

Therefore, the basic sustainability criteria are included, namely: Economic, Social and Environmental criteria. The aim of this paper is to examine the current state of rural tourism in RS in order to provide guidelines for sustainable development of this type of tourism. At the same time, four tourist facilities in the form of rural households were selected from a random sample, 12 of which were presented on the turizamrs.org website. Using a random number generator, 4 tourist facilities were selected to be considered in this paper as alternatives.

In order to analyse alternatives to the tourist offer of rural tourism, a model for evaluation and analysis based on the DEX method was developed. DEX is a method for qualitative multicriteria modelling, consisting of attributes that are hierarchically structured. The DEX method allows the description of attributes in the model and the aggregation of rules between attributes that are applied to real decision-making problems (Kontić, et al., 2006). The DEX method combines traditional methods for multicriteria decision making (MADM) with elements of the expert system (Pavlović et al. 2011).

Ranking using preferences is the most commonly used method in making multi-criteria decisions (Durkalić et al., 2019; Lakićević et al., 2021). Expert assessment is the use of expert knowledge in order to predict future conditions, i.e. phenomena (Rozman, et al., 2017). In this paper, the expert assessment will be used for the evaluation of 4 alternative rural tourist facilities in RS, and based on the obtained model, recommendations on the improvement of this type of tourism will be given. A panel survey was used, which included four experts in the field of tourism in cooperation with the competent ministry in the RS, who assessed the current state of rural tourism in the RS.

The most important characteristic of the DEX method is the ability to use qualitative variables that give descriptive judgments and whose values are: low, high, acceptable, unacceptable, etc. and the application of different scales of qualitative variables (Rozman, et al, 2016). By applying the "if-then" decision-making rule, it is possible to transform quantitative variables into qualitative ones, and use them in the DEX method. The application of the DEX method is done using the DEXi program.

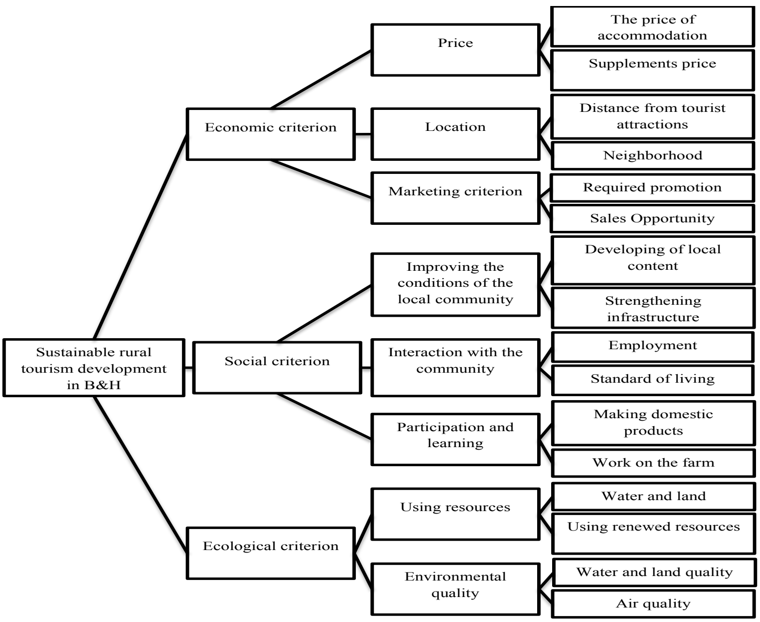
The DEX model is usually built through the following phases (Bohanec and Zupan, 2004):

- The hierarchical decision-making model is broken down into less complex problems that are represented by an attribute tree. In the attribute tree, the tree nodes represent the input, while the root nodes represent the main output of the model.
- Each subproblem is represented by a scale of values, which compares the setting criteria.
- Affiliation functions are defined for each attribute, which represents the cumulative score of the sub-criteria.

The model for managing the sustainable development of rural tourism in Bosnia and Herzegovina consists of 28 hierarchical structured attributes (Figure 1). The basic criteria for this model are: Economic, Social and Environmental criteria (Park and Yoon, 2011). These basic criteria are then decomposed into secondary criteria which are further decomposed into terminal levels. These attributes are represented as follows:

1. The Economic criterion consists of the following sub-criteria:
    a. Price - aims to examine the amount of monetary compensation for the use of rural tourism capacity.
    b. Location - aims to examine the spatial accommodation of the tourist offer and the environment in which these alternatives are located.
    c. Marketing criterion - assesses whether the promotion of these tourist offers is necessary and what is the possibility of selling primarily domestic products.
2. The Social criterion consists of the following sub-criteria:
    a. Improving local community conditions - aims to examine whether this offer affects the development of local content and strengthening the infrastructure of the local community.
    b. Interaction with the community - aims to examine whether employment and living standards of the population in this area have improved.
    c. Participation and learning - aims to examine whether tourists participate in the production of domestic products, and whether they work on the farm as part of the tourist offer.
3. The Ecological criterion consists of the following sub-criteria:
    a. Resource use - aims to examine how natural resources are used and whether renewable resources are used
    b. Environmental quality - aims to examine the quality of water, land and air in the alternatives used in the tourist offer of rural tourism.

Figure 1. Management structure for sustainable development of rural tourism in Bosnia and Herzegovina



Source: Authors

All these criteria and sub-criteria in the model are described by discrete and symbolic scales of values. The maximum scale of value for the main rating of the model consisted of four levels of values from "unacceptable" to "very good". Other criteria were evaluated with a value scale of three levels, which is presented in Table 1. The way in which other criteria are defined, and which measurement scales were used in them, is shown in Figure 2.

Table 1. Value scale used in the model

	Value scale
1.	**unacceptable;** middle; ***good; very good***
2.	**unacceptable**; middle; ***good***
3.	**bad**; middle; ***good***
4.	**high**; middle; ***low***
5.	**necessary**; few necessary; ***not necessary***
6.	**small**; medium; ***high***
7.	**does not participate**; partially participates; ***participates***

Source: Authors

When using these value scales, it was necessary to define the decision rules for each criterion. On the example of the final node Sustainable rural tourism developer in Bosnia and Herzegovina will be explained on the basis of three criteria: Economic, Social and Ecological criterion. A value scale is formed by using decision-making rules and decision-making functions (Table 2). The following rules are used in this function:

- The value of the final node will be "unacceptable", if the value of two or more criteria is "unacceptable", or if two criteria have the value "middle" and the third criterion the value "unacceptable".
- The value of the final node will be "middle", if the value of one criterion is "unacceptable", the second criterion is "middle", and the third criterion is "good", i.e. if the value of all criteria is "middle".
- The value of the final node will be "good" if the value of one criterion is "unacceptable", while the value of the other criteria is "good", i.e. if the value of the two criteria is "middle" while the value of the third criterion is "good".
- The value of the final node will be "very good" if the values of the two criteria are "good" while the value of the third criterion is "middle". The value of this criterion cannot be "very good" if any of the criteria has the value "unacceptable".

In a similar way, other decision-making rules and decision-making functions for other criteria were formed. Using these rules, a decision-making support model that assesses the sustainability of 4 rural tourist facilities was developed.

Figure 2. Value scale for attributes

Attribute	Scale
Rural tourism in RS	**unacceptable**; middle; ***good***; ***very good***
Economic criterion	**unacceptable**; middle; ***good***
Price	**bad**; middle; ***good***
The price of accommodation	**high**; middle; ***low***
Supplements price	**high**; middle; ***low***
Location	**bad**; middle; ***good***
Distance from tourist attractions	**bad**; middle; ***good***
Neighborhood	**bad**; middle; ***good***
Marketing criterion	**bad**; middle; ***good***
Required promotion	**necessary**; few necessary; ***not necessary***
Sales Opportunity	**bad**; middle; ***good***
Social criterion	**unacceptable**; middle; ***good***
Improving the conditions of the local community	**bad**; middle; ***good***
Developing of local content	**small**; medium; ***high***
Strengthening infrastructure	**small**; medium; ***high***
Interaction with the community	**bad**; middle; ***good***
Employment	**small**; medium; ***high***
Standard of living	**small**; medium; ***high***
Participation and learning	**bad**; middle; ***good***
Making domestic products	**does not participate**; partially participates; ***participates***
Work on the farm	**does not participate**; partially participates; ***participates***
Ecological criterion	**unacceptable**; middle; ***good***
Using resources	**bad**; middle; ***good***
Water and land	**bad**; middle; ***good***
Using renewed resources	**bad**; middle; ***good***
Environmental quality	**bad**; middle; ***good***
Water and land quality	**bad**; middle; ***good***
Air quality	**bad**; middle; ***good***

Source: Authors

Based on the available data, the experts assessed the values of certain criteria on 4 rural tourist facilities, namely rural households: Ubović (Sunny Hill), Spasojević, Kovačević and Ziličina. The Delphi method was used when collecting data from the experts. First, each of the experts gave their assessments of the facilities. These assessments were then systematized and resubmitted to experts for approval. The experts then corrected their grades with consistent ratings. The procedure was repeated two more times to obtain uniform assessments from all experts.

Table 2. Example of decision-making rules

	Economic criterion	Social criterion	Ecological criterion	Rural tourism in RS
	37%	33%	30%	
1	**unacceptable**	**unacceptable**	*	**unacceptable**
2	**unacceptable**	<=middle	<=middle	**unacceptable**
3	**unacceptable**	*	**unacceptable**	**unacceptable**
4	<=middle	**unacceptable**	<=middle	**unacceptable**
5	<=middle	<=middle	**unacceptable**	**unacceptable**
6	*	**unacceptable**	**unacceptable**	**unacceptable**
7	**unacceptable**	middle	***good***	middle
8	**unacceptable**	***good***	middle	middle
9	middle	**unacceptable**	***good***	middle
10	middle	middle	middle	middle
11	middle	***good***	**unacceptable**	middle
12	***good***	**unacceptable**	middle	middle
13	**unacceptable**	***good***	***good***	***good***
14	middle	middle	***good***	***good***
15	middle	***good***	middle	***good***
16	***good***	**unacceptable**	***good***	***good***
17	***good***	>=middle	**unacceptable**	***good***
18	>=middle	***good***	***good***	***very good***
19	***good***	>=middle	>=middle	***very good***

Source: Authors

Results

The evaluation model of 4 rural tourist facilities in RS gave the results presented in Table 3. Based on these results, it can be concluded that the rural households Ubović and Spasojević were rated as "very good", while the facilities Kovačević and Ziličina were rated as "good". However, each of these facilities has its advantages and disadvantages, so this research will not select the best rural tourist facility, but will consider the current state of all facilities and give recommendations for improving the sustainability of this tourist offer in RS.

Table 3 shows a detailed analysis of the criteria and attributes used in the model, so it is possible to compare the used rural tourist facilities in RS. Of the 27 sub-criteria, the Ubović facility had a "medium" grade in 6 criteria, while it had a "good" grade in the other criteria. The Spasojević facility had 4 "medium" grades for the criteria, while the other criteria had a "good" grade. The Kovačević facility had a "bad" grade in 6 criteria, it had a "medium" grade in 8 criteria, and a "good" grade was obtained in the other 13 criteria. The Ziličina building had a "bad" grade in 3 criteria, it had a "good" grade in 8 criteria, while it had a "medium" grade in the other criteria.

Radar charts created using the DEXi software tool will be used for a detailed assessment of individual tourist facilities. The main graphs are in the shape of a triangle, while for all secondary criteria, graphs in the shape of an octagon were formed, since eight secondary criteria were used. Based on that, it can be concluded that the way of representation depends on the number of sub-criteria, so if there are three sub-criteria, the results will be represented by a triangle, if there are four sub-criteria, the results will be represented by a trapezoid, etc. External boundaries represent the best values of the corresponding criterion, so if the values of the sub-criteria decrease, it is graphically represented by approaching the middle of the image. If the sub-criterion has the value "bad" then it is presented in the middle of the radar chart. Based on this, it can be concluded that a better alternative should have the value of all sub-criteria at the outer boundaries of the chart.

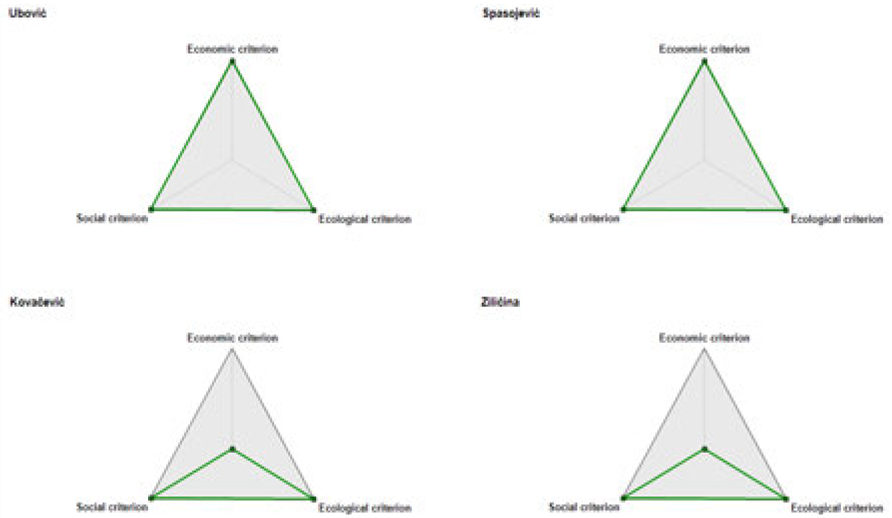
Table 3. Assessment of used rural tourist capacities in Bosnia and Herzegovina

Attribute	Ubović	Spasojević	Kovačević	Ziličina
Rural tourism in RS	very good	very good	good	good
Economic criterion	good	good	unacceptable	unacceptable
Price	good	good	bad	bad
The price of accommodation	low	low	middle	high
Supplements price	middle	low	high	middle
Location	good	good	middle	middle
Distance from tourist attractions	good	good	bad	middle
Neighborhood	good	good	good	middle
Marketing criterion	good	middle	bad	middle
Required promotion	not necessary	few necessary	few necessary	few necessary
Sales Opportunity	good	middle	bad	middle
Social criterion	good	good	good	good
Improving the conditions of the local community	middle	good	good	middle
Developing of local content	medium	high	high	medium
Strengthening infrastructure	medium	high	medium	medium
Interaction with the community	good	good	middle	good
Employment	high	high	medium	high
Standard of living	medium	high	medium	medium
Participation and learning	good	good	good	good
Making domestic products	participates	partially participates	participates	partially participates
Work on the farm	participates	participates	participates	participates
Ecological criterion	good	good	good	good
Using resources	good	good	good	middle
Water and land	good	good	middle	middle
Using renewed resources	middle	good	good	middle
Environmental quality	good	good	good	good
Water and land quality	good	good	good	good
Air quality	good	good	good	good

Source: Authors

When evaluating alternatives for sustainable development of rural tourism using three main criteria, it can be concluded that the facilities Ubović and Spasojević have all the "good" values. In the case of the Kovačević and Ziličina facilities, the value of the Economic criterion was "bad", while in the case of the Social and Ecological criteria, they were graded as "good". Based on these obtained results, it can be concluded that the Kovačević and Ziličina facilities must improve the Economic criteria in order to have better sustainability results.

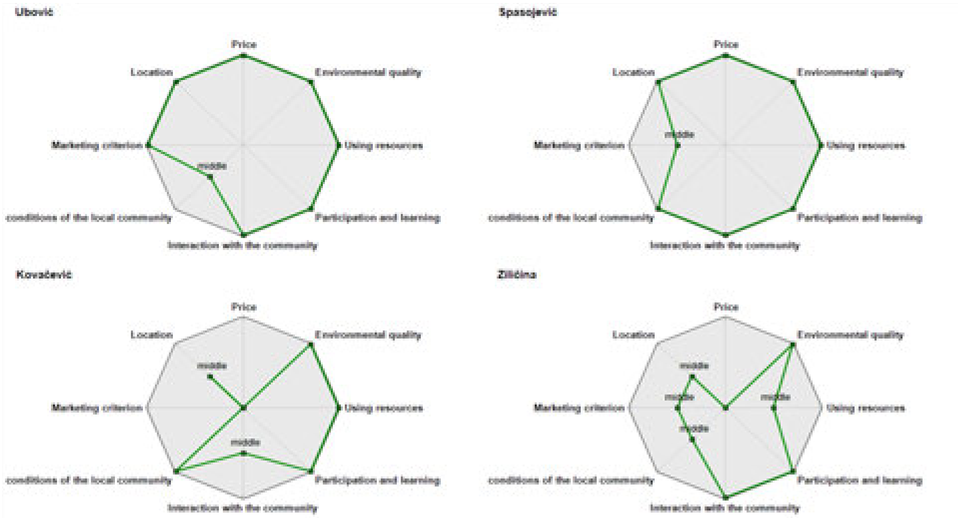
Figure 3. Evaluation of rural tourist facilities by the main criterion



Source: Authors

However, which of the individual criteria are good and which are not, are presented in Figure 4. Using this graph, a more detailed analysis of the value of the sub-criteria can be given. Based on a detailed analysis of individual sub-criteria, it can be concluded that the facilities Ubović and Spasojević have a "middle" value in one sub-criterion, and the "good" value in the other sub-criteria. The Ubović facility had a "medium" value in the sub-criteria of "improving the conditions of the local community", while Spasojević had a "medium" value in the Marketing sub-criteria. The Kovačević facility had a "bad" grade in two sub-criteria, namely in the Price and Marketing sub-criteria; in the two sub-criteria: Interaction with the community and Location, it had a medium grade, while for the other sub-criteria it had a good grade. The Ziličina facility had a poor grade for one sub-criterion, for the Price; for four sub-criteria it had a medium grade, while for the sub-criteria Environmental quality, Interaction with the community and Participation and Learning it had a good grade.

Figure 4. Evaluation of rural tourist facilities with secondary sub-criteria



Source: Authors

Based on these assessments, it can be concluded that all facilities have good environmental conditions and participation and learning; however, other sub-criteria need to be improved in order to apply sustainability in their business. When using sustainability in business, it is necessary to have good characteristics in all criteria and sub-criteria in order to be able to use it in the promotion of these tourist facilities.

Conclusion

In this paper, the application of a multi-criteria model for the assessment of rural tourism in the RS is shown on a practical example of rural households, using the DEX method of multi-criteria decision-making. The model used is quite flexible, so it can be applied in any branch of tourism, not only in rural tourism. By applying expert opinion, the evaluation of rural tourism alternatives was performed on the example of 4 tourist facilities in RS. Since they were taken at random, they represent this tourist offer in RS.

The obtained results showed that the rural households Ubović and Spasojević were rated as "very good", while the Kovačević and Ziličina facilities were rated as "good". However, each of the facilities has its shortcomings that should be improved. Only with the improvement of the offer can this type of tourism be improved. Due to the importance of ecology in modern business, it is necessary to apply the sustainable development of this type of tourism in order to preserve the natural beauties that RS has at its disposal. Republic of Srpska must actively take part in the promotion of these tourist potentials because they are not sufficiently promoted.

In future research, the model used here should be improved in order to be applied in other branches of tourism. Also, it is necessary to compare the rural tourist offer with the offer in other countries in order to determine the level of development of rural tourism. Also, when creating similar models in future research, it is possible to apply other MCDM methods so that more precise guidelines can be given based on the obtained results. In addition, future research should cover the entire territory of the Republic of Srpska in order to try to get answers to questions concerning the general development of rural tourism in this area.

Conflict of interests

The authors declare no conflict of interest.

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MOTIVES FOR THE INTRODUCTION OF AGRICULTURAL INNOVATIONS IN SERBIA WITH PARTICULAR ACCENT ON BEEKEEPERS: THE APPLICATION OF LOGISTIC REGRESSION

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ABSTRACT

The aim of this paper is to explore the motives of Serbian farmers for introducing innovations from the aspect of Rogers` main attributes of innovations. The outcomes of the applied method of binary logistic regression show that these agricultural producers are not so much driven by personal motives in introducing innovations, especially not by their observability and compatibility with farmers` adopted values. The findings also point out that there are impulses and desires of Serbian farmers for introducing innovations, but that the still unfavourable and uncertain market environment hinders them. Since there is no economic progress without innovations and technological progress, the state should provide them with a favourable environment by actively investing in appropriate legal, financial, rural, corporate, educational, and research infrastructure. In addition, it is necessary for farmers to adopt the principles of market orientation and entrepreneurial activities that would help them to increase their productivity, innovations and competitiveness.

Introduction

The capability to innovate and introduce new ideas and practices has always been one of the key factors contributing to the success of every farm production, and thus to the agricultural productiveness and competitiveness and the country`s economy. Contemporary agricultural enterprises and farms that have access to necessary financial, material and intangible resources, as well as those that have a strong motivation and incentive to introduce and develop innovations belong to the group of successful innovators, especially in an appropriate supportive environmental climate and infrastructural conditions. Therefore, the capacity of every, even agricultural organization to introduce innovations depends on its ability to continuously develop new ideas, knowledge and skills, with the aim to create new products, services

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and organizational processes, as basic sources of its competitive advantage locally, nationally, regionally and globally. At the same time, the way of defining and perception of innovation determines its degree, nature and scope of application in a certain organization (Popa, Preda, & Boldea, 2010). Innovation is the use of new ideas related to products, processes and any other features of organizational activities. As such, innovation refers to the process of commercialization or the use of values, arising from a particular novel idea (Rogers, 1998).

Agricultural innovations primary relate to the need to boost the production of nourishment, crops, feed and agricultural by-products, as well as to rise the quality of agricultural goods, productivity, output efficiency, growth and to improve cultivation conditions (Van der Veen, 2010). Back in 1974, Robert E. Evenson provided a detailed classification of the agricultural areas in which agricultural innovations usually occur (Evenson, 1974):

- Crops cultivation – biological and/or genetic modifications of crops, such as the use of new breeds or more productive species, that are more renitent to certain atmospheric or land conditions; then the use of new species that thrive in various seasons or new types of farming; new agricultural production methods (for example, inoculation, replanting techniques, etc.); new techniques for turning plant products into final products (cash crops) and the like.
- Animal breeding – already mentioned biological and/or genetic modifications; new or improved modes of animal breeding and using animals for agricultural purposes in a way that raises their productivity (for example, the use of animals for obtaining their by-products such as wool, milk, traction, leather, etc.).
- Crops` and animals` growing conditions – adding compost or other types of fertilizers; increasing soil deepness; draining and watering; increased intensity of work on the ground (digging, ploughing, etc.); construction of terraces in order to avoid soil erosion; use of sun and wind renewable potentials; fodder supply or improved pasture of animals; etc.
- Agricultural machinery and equipment – more effective plows or plows that can be used on different sorts of land; harvesting machines and powdering equipment; devices that regulate water level; devices for irrigation and drainage of soil; etc.
- Practices of running agricultural business – include alters in the agricultural production technique, proprietorship and inheritance of land; the extent of the plot being cultivated; labour availability; surplus production; etc.

Robert E. Evenson and Timothy Swanson, in their unpublished paper from Internet, emphasize the importance of suitable investment in the diffusion of innovations and dynamic technological change for the introduction and growth of agricultural innovations. Ownership rights in agriculture also have an important role in this process, as they function as a mechanism for further encouragement and adaption of innovations. Finally, agricultural innovations mainly focus on the technological frontier and are characterised by gradual adoption and diffusion. To the above list of agricultural innovations, should be added somewhat newer types of them, such as (Inter-American Institute for Cooperation on Agriculture, 2014):

- Organizational or institutional innovations – that include changes in organizational structure, agricultural activities or services; than changes in their processes and methods, as well as in their relations with other stakeholders in agriculture.
- Marketing innovations – are changes in the marketing methods, conditions and advertising of an agricultural good or service and/or changes in its target group.
- Social innovations – which are related to the evolution or major improvements of strategies, concepts, abstractions, organizational business politics, agricultural products and services with the aim of creating favourable social evolution, meeting broader social demands or serving social interests and aims.

Agricultural innovations are crucial in resolving contemporary problems, such as global population growth, security of food supply and the negative effects of climate change, contributing to increased productivity and efficiency, improving competitiveness, sustainability and all forms of equality in agriculture, and thus sustainable economic development. These innovations have their own specific features. At first, they are very complex since they often demand investments of large financial resources in labour and capital, their yields can be very uncertain, and since investments in them can pay-off in the long run. In that sense, the importance of the trial period of any agricultural innovation comes to the fore before it will be widely applied in practice. The process of their diffusion also requires significant financial resources from farmers, as well as the meeting of appropriate economic, social, cultural, ideological and psychological preconditions. Finally, they are often characterised by the impossibility of accurately identifying the time of their occurrence, which is why the moment of their emergence is usually taken as the one in which they began to be widely used in practice and incorporated into agricultural communities (Van der Veen, 2010).

Empirical literature and researchers emphasize other features of agricultural innovations such as sensitivity to environmental and climate change and their conditionality by smart technological change (Senyolo, Long, Blok, & Omta, 2018); profitability, high investment costs, compatibility with prevailing norms and values, complexity and communicability from the aspect of adaption of favourable agricultural practices (Roy, & Jaiswal, 1968). Their characteristics also include the kind of agricultural household assets, psychological characteristics of innovators and their endogenous and exogenous environment (Nguthi, 2007). Finally, agricultural innovations also depend on the properties of innovators themselves, such as prejudices and bias towards innovations, characteristics, i.e. types of innovators (Rogers, 1983), the courage, responsibility, rationality and imaginativeness of innovators, their pragmatism, openness to science, versatility and social awareness, their attitude to risk, educational level, their social networks, etc.

When it comes to the state of agricultural innovations in Serbia, the current system of knowledge and innovation is not sufficiently harmonized with the accelerated technical and technological changes. While there are difficulties in agricultural extension and farmers' access to adequate information, Serbia also lags significantly behind the European average in the quality of equipment and research techniques (Mihailović, & Cvijanović, 2016). Studying the impact of matured clusters and human capital on Serbia's country competitiveness and general capacity for adopting innovations, Domazet and Paraušic (2018) pointed to several weaknesses and problems of its science and innovation system. These problems mainly encompass: a) low level of investment in research and development (R&D) activities (below 1% of GDP); b) lack of high-quality research in practice; c) weak cooperation between the private business sector and science in terms of concretization of research conducted; d) small R&D investments in the business sector; e) phenomenon of *brain drain* and relatively poor quantity of researchers and scientists; and f) the lack of adequate infrastructure. These authors also pointed out the problems of dominance of small-scale farms and low agricultural productivity, impermanent agricultural policy and deficient financing opportunities, lack of contemporary developed technology, as well as of adequate technical assistance and analytical support. Besides, the competitiveness of domestic agricultural producers is based on low prices and exploitation of personal and natural capital, as well as the poor development of clusters, human and relating financial resources.

Despotović, Ristić and Dimitrijević (2019) also discussed the state of innovation capacities in Serbian agriculture. They emphasized that Serbia lags far behind innovative leaders and other countries of Southeast Europe in terms of agricultural productivity, as well as behind other domestic economic operations in terms of agricultural innovations. In addition, there is no sufficient investment in agricultural R&D and sciences, while insufficient agricultural innovation is one of the key factors of the lagging behind in agricultural productivity. These authors therefore conclude that the development of agricultural innovations could make a significant contribution to rising the efficiency and sustainability of the domestic agricultural sector. Finally, the Strategy of Agricultural and Rural Development of the Republic of Serbia (RS) for the period from 2014 to 2014, which recognizes the need for reducing the country`s gap in technological development behind competing countries, also confirms these findings. This document especially emphasizes the importance of technological advancement, investment in new expertise and production techniques, as well as their transmission to farmers to reduce the technological backwardness of Serbian agriculture. In this sense, the Strategy recognizes the role of the state itself in terms of dealing with the effects of climate change, the introduction and improvement of modern production practices, as well as the enhancement of innovations in agriculture and related sectors.

The goal of this paper is to explore the motives for the agricultural innovation introduction in Serbia from the aspect of some Rogers` attributes. The second section of this article explains in detail the conducted research and the basic methodological steps of the applied logistic regression. The third section of the paper describes the obtained results with their possible explanations. Finally, the last section gives a conclusion with some recommendations for encouraging and developing the policy of agricultural innovations in Serbia.

Materials and methodology

The research of attitudes, motives and inclinations of Serbian agricultural producers towards the introduction of innovations was carried out in the period from the end of June to the beginning of August 2021. For the purpose of this analysis, a Google form survey was made, which was announced and the content of which was sent to over 400 e-mail addresses of domestic registered agricultural holdings. Only 55 individuals responded to this survey. This survey encompassed registered agricultural entrepreneurs, including vegetable and fruit growers, anglers, wine producers, beekeepers and producers of organic products, mostly from the Republic of Serbia. The aim of this research was to determine, based on the given sample, whether domestic farmers are committed to innovations, whether they apply them in practice, what were their reasons for adopting them, as well as what were the specific outcomes of their innovation ventures. The answers received from agricultural producers were assessed by categorical grades (Yes/No/I do not know).

The collected sample consisted of 51 males (92.7%) and 4 females (7.3%). In the observed sample, there were by far the most owners of agricultural farms (81.8%), and to much lesser extent members of agricultural farms (12.7%), agricultural entrepreneurs (3.6%) and owners of large agricultural companies (1.18%). Respondents were mostly engaged in beekeeping (69.1%), farming (9.1%) and fruit growing (9.1%). The following table (*Table 1*) provides a detailed overview of their received answers to the remaining questions from the survey.

Table 1. Proportions of the obtained responses to the questions asked

Questions	Answers		
	Yes	**No**	**I don`t know**
Engagement in the organic production	29.1%	70.9%	-
Introduction and implementation of one or more agricultural innovations so far	52.7%	34.5%	12.7%
Consistency of agricultural innovation with the adopted values, beliefs, experience and needs of farmers	62.5%	14.6%	22.9%
Visibility and recognisability of agricultural innovation in the environment	53.2%	29.8%	17%
The relative advantage of agricultural innovation over the ideas and practices of competitors	50%	29.2%	20.8%
Challenge and relative complexity in applying agricultural innovation	23.4%	51.1%	25.5%
Possibility of trying and experimenting with agricultural innovation	60.9%	21.7%	17.4%

Questions	Answers		
	Yes	No	I don`t know
The function of the state in further encouragement of agricultural innovations	61.1%	16.7%	22.2%
Plans related to the adoption of agricultural innovations in the future	80.4%	3.9%	15.7%

Source: Authors' calculations

Respondents listed some of the following agricultural innovations that they have introduced so far: patenting wax smelters; use of bee sms scales and innovative multifunctional beehives; digitalization of irrigation systems, and a crop protection sprinkler that controls the amount and intensity of spraying. They also practiced and introduced vacuuming machine; inter-row foil in the vineyard; elimination of the chemical agents` use; preparations and supplements, and the use of medicines of exclusively organic origin. Among other mentioned innovations, respondents pointed out: an innovative approach to defending bees from ticks without the use of chemicals; moving hive trucks, using of bee shakers and honey centrifuges; and warming and heat storage system in the spring development of bee colonies. Respondents also mentioned the production of the bee perga in virgin honeycombs without the use of a beeswax foundation sheet; special canvas pots for seedlings, modern anti-hail net and drop-by-drop irrigation system; and the use and control of bee scales remotely. Finally, they also introduced platforms for the bee colonies` migration, practiced the use of honey de-crystallization sticks, and the use of contemporary pollen collector system; application of special beekeeping techniques; new modern agricultural machinery with satellite-based guidance systems, computerized sprayers and computerized machinery for tillage; cultivation of Honey Phacelia "NS Priora"; germinator soil machine; and machines with GPS navigation.

A similar study was conducted in Cambodia in 2013, in which the method of assessing the use of *Rhizobium* by potential innovators was analysed from the aspect of Rogers` crucial factors of introducing innovations. *Rhizobium* is a root nodule bacterial symbiont of legume plants that fixes nitrogen. This land bacterium also induces natural and occasionally very useful endophytic symbioses with different cereals (Dazzo, & Ganter, 2009). This alternative ecological species is often used in sustainable and organic production in the form of efficient bio fertilizer, which is why someone can consider it a type of agricultural innovation. Everett M. Rogers in his epochal book *Diffusion of Innovations* states five key attributes of innovations that affect the rate of their adoption in practice (Rogers, 1983): a) relative advantage of innovation over the idea and practice of competitors; b) compatibility of innovation with adopted values, beliefs, needs of innovators and their previously realized ideas; c) complexity of given innovation as a degree in which it is conceived as relatively demanding to understand and apply; d) the possibility of trying and experimenting with a given innovation; and e) observability of a given innovation in the environment. Starting from the described attributes, this study concluded that the relative advantage was the trait that most influenced the adoption of a given agricultural innovation, observability proved to be moderately significant, while other features were not significant (Farqouharson et al., 2013).

In this analysis, the method of logistic regression was applied because all observed variables were categorical in their nature. In order for this statistical model to be implemented at all, it was first necessary to recode the answers of the respondents in the following manner: 1 - affirmative answer (favourable outcome of the event) and 0 - negative answer (unfavourable outcome of the event). Appropriate sample size is the first important requirement for the application of this statistical procedure. The easiest way to calculate the sample size in the context of logistic regression is based on a smaller number of binary results, i.e. a smaller proportion of positive or negative scores from a given sample (Peduzzi et al., 1996). Using this method, the data on the smallest allowed sample size for logistic regression implementation could be calculated based on the next formula (Park, 2013):

$$N = 10k/p \qquad (1)$$

of which p is the smallest value of the shares of positive or negative observations in the population, while k is the allowed number of independent variables that can be employed in the analysis. Based on the presented formula, due to the relatively small sample size $n = 55$ and the value of lower share of cases of $p = 0.47$, it was possible to consider the impact of only two predictors ($k = 2.59$) on the choice of domestic farmers to adopt any agricultural innovation. The author of this article opted for the analyses of the predictive abilities and impact of following Rogers` predictors: a) Compatibility of innovation with the adopted values, beliefs and needs of innovators, and b) Observability of a given innovation in the environment on the outcome variable Introduction of agricultural innovations in Serbia.

Preliminary analyses indicated that all assumptions for the use of direct binary logistic regression model were satisfied, including the absence of multicollinearity between predictors. In this type of statistical model, the dependent variable appears as a binary categorical variable, commonly taking form of a binary case, which can imply success (code 1) or the failure (code 0). The odds of an observed event are defined as the quotient between the possibility of its appearance and the possibility of its non-appearance. If we mark the probability of that event appearance with the letter p, and the possibility of its non-appearance with the mathematical expression $1 - p$, then the odds are calculated based on the next formula (Park, 2013):

$$odds\ of\ an\ event = p/(1 - p) \qquad (2)$$

Following two predictors were observed in this analysis: a) Compatibility of innovation with the innovator`s adopted values, beliefs and needs (X_1) and b) Observability of an innovation in the environment (X_2). Due to the fact that in this research the collected sample size amounted to $n = 55$, the influence and forecasting ability of only two predictors could be checked. In addition, as at the same time the given outcome variable Y was binary in nature, the formula of the logistic equation has taken the next form (Madžar, 2021):

$$y = P = \frac{p}{1-p} = \frac{e^{\alpha+\beta_1 x_1+\beta_2 x_2+\varepsilon}}{1+e^{\alpha+\beta_1 x_1+\beta_2 x_2+\varepsilon}} = \frac{1}{1+e^{-(\alpha+\beta_1 x_1+\beta_2 x_2+\varepsilon)}} \qquad (3)$$

where p is a possibility of the event appearance, $1-p$ is the possibility that the observed event will not occur, e is the basis of the natural logarithm ($e \approx 2.718$), α, β_1 and β_2 are the values of parameters, i.e. coefficients of the model, while ε is an error term.

The paper`s initial hypothesis $H_0$ is that the predictors $x_1$ and $x_2$ do not have predictive power and that are not able to predict the possibility of the agricultural innovations` adoption by Serbian farmers. This further means that this starting hypothesis assumes that the regressive coefficients values are $\beta_1 = 0$ and $\beta_2 = 0$, i.e. that the odds can be represented by the following formula: $odds = e^{\alpha}$. In contrast, the alternative hypothesis H_1 asserts that the predictors x_1 and x_2 have predictive power, i.e. the ability to forecast the possibility of adopting innovations in Serbia by domestic agricultural producers. This further means that the alternate hypothesis assumes that the values of the regressive coefficients are $\beta_1 \neq 0$ and $\beta_2 \neq 0$, and that the odds formula has the following form: $e^{\alpha+\beta_1 x_1+\beta_2 x_2}$. Based on the above, the null and alternate hypotheses take the following form (Madžar, 2021):

$H_0: \beta_1 = 0 \; and \; \beta_2 = 0 \Longrightarrow \ln(odds) = \alpha \Longrightarrow odds = e^{\alpha}$ and

$H_1: \beta_1 \neq 0 \; and \; \beta_2 \neq 0 \Longrightarrow \ln(odds) = \alpha + \beta_1 x_1 + \beta_2 x_2 \Longrightarrow odds = e^{\alpha+\beta_1 x_1+\beta_2 x_2}$

Results and discussions

IBM SPSS computer software was used in the implementation of this analysis. This article applied the method of direct binary logistic regression in order to determine the impact of explanatory variables Compatibility of innovation with values, beliefs and needs of innovators and Visibility of innovation in the environment on the possibility of their introducing by surveyed farmers. While this statistical method included and traced two predictors (Compatibility and Observability), it was generally a good and reliable model because it was statistically significant, correctly predicting the results of the performed analysis, Chi-square $\chi^2\,(df = 2,\; N = 55) = 47.775$

$Sig. = 0.000 < 0.001$. These data further pointed to the fact that the overall model quite successfully distinguished between farmers who gave a positive and farmers who gave a negative answer related to the adoption of a certain agricultural innovation. Further results of the Hosmer and Lemeshow test also indicated the fact that it was a well-fitted model of strong predictive power, Chi-square $\chi^2\ (df = 2, N = 55) = 0.000$, $Sig. = 1.000 > 0.05$. The overall model described between 58.7% (Cox's & Snell's R Square) and 78.6% (Nagelkerke's R Square) variance of outcome variables, while at the same time it accurately classified 92.6% of observations. The sensitivity of the obtained statistical model was $Sensitivity = 93.3\%$, while its specificity amounted to $Specificity = 91.7\%$. In addition, no predictors from the model were statistically significant (*Table 2*). The odds ratio of an otherwise stronger, but also statistically insignificant (Sig. = 0.998) predictor Compatibility of innovation with values, beliefs and needs of innovators was 1.535E10. On the other hand, the odds ratio of the weaker and also statistically insignificant explanatory variable (Sig. = 0.999) related to the Observability of innovation in the environment amounted to 0.000.

Table 2. Coefficients of variables from the equation

		B	Standard Error	Wald.	df	Sig.	Exp(B) Odds	95% C.I. for EXP (B)	
								Lower	Upper
Step 1[a]	Compatibility	23.454	11602.711	0.000	1	0.998	1.535E10	0.000	-
	Observability	-18.952	11602.711	0.000	1	0.999	0.000	0.000	-
	Constant	-2.251*	0.743	9.171	1	0.002*	0.105	-	-

Source: Authors' calculations

The analysis of independent variables indicated that none of them was statistically significant ($Sig. (\beta_1) = 0.998$ and $Sig. (\beta_2) = 0.999$), showing that none of them contributed significantly to the model, i.e. that they did not explain or influence the Serbian farmers` decision to introduce innovation (*Table 2*). This further meant that the initial hypothesis H_0 that these predictors are not able to forecast the possibility of adopting agricultural innovations in Serbia could not be rejected. However, despite this, the analysis also showed that the coefficient of the variable Compatibility of innovation with the adopted values, beliefs and needs of innovators was positive $\beta_1 = 23.454$, while the coefficient of Observability of a given innovation in the environment was negative $\beta_2 = -18.952$. At the same time, the constant was the only statistically significant value ($Sig. = 0.002 < 0.05$) and amounted to $\alpha = -2.251$.

Based on the obtained results, it followed that the value of the outcome variable Y could be calculated using the succeeding equation:

$$y = \frac{e^{-2.251+23.454x_1-18.952x_2+\varepsilon}}{1+e^{-2.251+23.454x_1-18.952x_2+\varepsilon}} = \frac{1}{1+e^{-(-2.251+23.454x_1-18.952x_2+\varepsilon)}} \qquad (4)$$

An objective limitation of this survey relates to the relatively small sample size given that only 55 of the mo re than 400 asked individuals responded to this survey. Contemporary literature indicates many reasons and motives for the introduction of agricultural innovations. Nguthi (2007), in addition to personal characteristics in terms of Roger`s attributes, among the most important motives that determine their introduction states the communication process, the farm`s property status, as well as the endogenous and exogenous environment. This author also cites land size, technology characteristics, health status, skills and knowledge of farmers, level of ownership and type of agricultural activities as important determinants of their adoption. In their attempt to explain the low level of adoption of seemingly useful agricultural technologies, Ruzzante, Labarta and Bilton (2021) identified differences between the characteristics of adopters and non-adopters in the developing countries. This study found a positive correlation among the level of education of farmers, household size, disposal of credit facilities, land ownership, use of extension services and organisational membership with the introduction of many contemporary technologies. Eventually, the adoption of agricultural innovations takes place under the strong influence of seemingly unobserved cultural, contextual, environmental, local, national, regional, and policy factors. However, based on the received results, it seems that farmers from Serbia are not sufficiently driven by personal reasons and motives when they introduce innovations in their practice. Namely, from the aspect of Rogers` attributes, it seems that the compatibility of the observed innovation with their adopted values, beliefs and intentions, as well as the observability of that innovation in the environment are not a good enough reason for Serbian farmers to introduce them in their practice. This further means that they most likely rely on the state when they introduce and develop their innovations, expecting initiative, more concreate support, assistance and advices from it. This explanation is supported by the fact that when asked if they think that the government can help them to introduce and expand agricultural innovations, as many as 33 respondents (61.6%) gave a positive answer, 9 people (16.7%) gave a negative answer, while 12 respondents (22.2%) did not know how to answer to this question. This trend could be a legacy of socialism, given the fact that farmers in those times largely relied and depended on subsidies, levies, soft loans and other forms of state aid. More precisely, in addition to the limitations of the agrarian policy and the economic environment, as well as the difficulties in adapting to the market economy, Serbian agriculture is burdened by the aftereffects of the socialist centrally planned economy in terms of land ownership and use (Mihailović, & Cvijanović, 2016). In addition, domestic agriculture today is burdened by the unfavourable age structure of farmers and the prevalence of small-scale farms, as well as the lack of a strategic approach to agricultural development policy. Instead of encouraging the entrepreneurial spirit, which is very important for the introduction and development of innovations, the support of the state is much more concentrated on providing incentives, causing numerous negative effects, especially in Serbian rural areas (Aničić, & Paraušić, 2020). Without an appropriate stimulating environment, as well as without the improvement of entrepreneurship and the development of entrepreneurial spirit, there can be no increase in labour productivity, innovation, farm competitiveness and a change in the structure of production towards higher value-added products.

In addition, today the inefficient systems of transfer of knowledge and technological solutions into practice, as well as the lack of appropriate investments also present limiting factors for the growth of agricultural production, labour productivity and competitiveness. Much of agricultural production is still based on technologically low input uses and low investment in equipment, leading to lagging behind in technological progress. In such circumstances, there are not enough skills, motivation and knowledge of agricultural producers to accept innovative technological solutions. Therefore, entrepreneurial initiative, innovation and motivation of all actors in the agricultural sector are the basic preconditions for their market operations and sustainable development of agriculture (Strategy of Agriculture and Rural Development of the Republic of Serbia for the period from 2014-2024, 2014). The unexpected results of this study also show that it is possible that Serbian farmers are still not sufficiently aware and familiar with the significance of agricultural innovations for improving their business, and thus for the development of society, economy and agriculture. Besides, domestic farmers often receive information about modern technologies with restraints and rarely dare to invest their own financial resources in obtaining new knowledge and skills. Additionally, the transfer of knowledge process itself, which is carried out with the aim of promoting new products and technological solutions, can be biased, also contributing to their uncertainty (Strategy of Agriculture and Rural Development of the Republic of Serbia for the period from 2014-2024, 2014). Serbia is the country that lags behind in development in relation to almost all Central and Eastern European countries. The country is growing slowly and it could be said that it has not coped with the processes of reforms and transition well. This situation inevitably reflects on the educational structure of population, and thus on the awareness of the citizens and farmers about the importance and role of investing in innovations, R&D and education, digitalization, vocational training, agricultural extension, developing of innovative products, etc. for the success of their business operations. Perhaps, in this context, changing the awareness and mentality of domestic farmers would be for them of the greatest importance. That would help them in understanding their own mistakes, hidden problems, failures, missed opportunities, as well as the need for more marketable behaviour in order to develop their entrepreneurial and competitive spirit (Paraušić, & Cvijanović, 2014).

Conclusions

Since this research showed that farmers from Serbia are probably not driven by personal motives and goals in developing their innovative activities, it is concluded that they in this regard most likely rely on the initiative, assistance and support from the state. They are also probably not familiar with the importance of introducing agricultural innovations for their business, and thus for the economic, agricultural and social development. It is well known that innovations are a major tool for social and economic development, as well as agricultural innovations and investments in contemporary technology can significantly affect the efficiency of natural resources` use, economic prosperity, the upturn of agriculture, poverty alleviation and rural advancement. Therefore, without innovations and technological progress, there is no economic progress. A system without technological progress, as the theory of growth shows, tends to grow at the rate of the slowest growing production factor, and in such circumstances, there is no economic progress defined as growth in per capita income. Namely, this means if the population, i.e. the labour force is the slowest growing factor, than economic stagnation occurs in such a system. Moreover, if some other factor is the slowest growing, the system grows at the rate of growth of that factor, which is slower than the growth of the population. This further implies a drop in per capita income and economic decline with no innovations and technological advancement.

It would be natural to expect that the predictors from this study will take positive values, i.e. values that reflect the readiness of farmers to introduce innovations and for all changes that contribute to the growth of agricultural production. This follows from the fact that they are entrepreneurially oriented. Although the obtained coefficients were not statistically significant, they are very indicative, pointing out that there are impulses and desires of farmers from Serbia to introduce innovations, but also that the still unfavourable and legally uncertain environment for agricultural innovations hampers them. Although the conducted research shows that there are indications of their positive motives, these aspirations have unfortunately not been realized yet because there are other obstacles and threats from the business environment that should be removed. Besides, in order for contemporary farmers to survive in an increasingly competitive and demanding global market, it is necessary to adopt the principles of market orientation and entrepreneurial activity, as well as to abandon the socialist legacy. Entering and successfully operating in the agricultural market requires the increase of agricultural production competitiveness, which cannot only be driven by cheap inputs, but also by acquiring new knowledge, technologies and innovations. Therefore, the central government, municipalities and local town administrations should create a stimulating societal, institutional and business environment for rural development and agricultural advancement, particularly in underdeveloped regions (Aničić, Obradović, & Vukotić, 2018). Other authors such as Ševarlić, Raičević, & Glomazić (2012) also point out the importance of the government, civil society, agricultural cooperatives and business itself in the development of a sustainable economy and agriculture.

In this sense, the role of the state is expressed, which should first build the appropriate infrastructure for the agricultural innovations` advancement, by defining the necessary financial and legal framework, introducing appropriate incentives, tax reliefs, rural credits, soft loans and other forms of state aid, as well as by defining the agricultural corporate structure that would encourage their development. The state should also work on conducting intensive media campaigns and investing in extension activities in order to raise the awareness of the population and develop an appropriate mental framework for the introduction and development of agricultural innovations, and especially for the use of contemporary agricultural technology. The state could also consider developing appropriate knowledge-intensive agricultural enterprises and institutions such as agribusiness incubators, agricultural clusters and the like. Finally, it should invest intensively and continuously in science, R&D and innovation growth in order to increase agricultural productivity and farmers' incomes in general.

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Conflict of Interests

The author declares no conflict of interest.

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AWARENESS OF THE POPULATION IN RURAL REGIONS OF SERBIA ABOUT RENEWABLE ENERGY SOURCES

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A B S T R A C T

Public awareness about renewable sources can contribute to social acceptance of sustainable development projects. The purpose of this study was to determine attitudes and level of awareness of the population of rural regions of Serbia about renewable energy sources. The research method included the random sampling of 400+ respondents in Southern, Eastern and Central Serbia. A questionnaire with closed-ended questions for expressing attitudes (Likert scale) was used. Collected data have been analyzed with SPSS. The results of this study clearly show that the citizens of rural regions of Serbia are relatively poorly informed not only of general aspects of energy production and consumption, but of specific aspects related to the use of renewable energy sources. This investigation emphasizes the need for intensive public information campaign about the advantages and benefits of renewable energy in order to have broader public support for the implementation of this form of energy into energy sector of Serbia.

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Introduction

The shift of the world economy which is based on fossil energy sources towards renewable energy sources requires the engagement of a wide range of participants.

The main actors are state governments and competent ministries whose main role is to create the most favorable conditions for more intensive use and investments in renewable energy sources providing favorable legal regulations and effective legislative framework. Additionally, it is necessary to establish an effective institutional and organizational framework and to strengthen administrative capacities through sustainable use of renewable energy.

Numerous research shows that today renewable energy sources are used to a greater extent in those countries where wider public support has been provided, created or received (Celikler, 2013; Zakaria , 2018; Szakály 2020; Haber , 2021). Renewable energy can solve numerous environmental problems, reduce poverty rate and increase energy efficiency, but various financial obstacles and investment risks of potential investors hinder its rapid growth (Panaitescu, et al., 2020). These facts represent a great challenge for state and local administration, because they have to provide the most favorable political and financial conditions that will enable renewable energy sources to become permanently present on the energy market. (Vojinović, , et al., 2017). In addition, above -mentioned actors must be as flexible as possible and ready to remove numerous obstacles that prevent the renewable energy sector from growing. The state faces numerous social and technical barriers when developing the renewable energy sector. These barriers and obstacles require prompt actions in the areas of financial incentives, developing infrastructure and technologies, regulatory reforms, development of local communities, information and education programs (Taqvia et al., 2021; McGreevy et al., 2021).

Generally speaking, sustainable development cannot be achieved without active participation and mobilization of citizens. Since renewable energy sources represent an important segment of sustainable development it is necessary to have greater participation of citizens for a broader support and implementation of renewable energy sources. Citizens have an important role through their own choice of greater use of renewable energy sources in their homes, clear and expressed support given to social actors for promoting renewable energy, as well as active engagement within environmental organizations of the civil sector. Numerous experiences show that it is very important, especially at the beginning, to provide public support for the implementation of renewable energy sources into energy system of a country and to educate citizens about all possibilities and benefits of such a complex and demanding process (Piwowar , 2020; Pawłowski, 2017). In most counties of the EU participation of the public in decision-making regarding the energy sector is inevitable (Bovan et al., 2015). Public awareness about renewable sources can contribute to social acceptance of projects from this energy sector and overall improvement of consumers' behavior towards energy. Demographic and socio-economic factors can determine someone's knowledge about different forms of renewable energy (Spyridon, 2014; Assali et al., 2019; Szakály et al., 2020). Implementation development of renewable energy sources depends on geographical location, support and awareness of citizens as well as on policy and strategic decisions made by state and local administration. The studies also indicate that promotion of renewable energy sources should be directed much more towards the local population (Thellufsen et al., 2020; Jelti et al., 2021).

Citizens can take significant participation in supporting the use of renewable energy sources by financing some projects from this energy sector. Financing decentralized infrastructures of renewable energy is a complex issue due to the fact that state organs do not have enough money, while private investors generally have aversion toward limitations such as high transaction costs and financial uncertainty. Consequently, alternative concepts for financing through the participation of citizens have been developed. These concepts mean that individuals can contribute to the realization of infrastructural projects by investing in renewable energy projects through various business models of financing (Özgür Y., 2014; Wheatcroft E. et al., 2020; Brown et. al, 2019).

Serbia has good energy potential in the field of renewable energy sources. It is nearly 4 Mtoe per year and can meet one fourth of annual energy needs in Serbia (Petkovic, 2009). That potential is great, especially if it is compared with potential from some European countries that are lacking renewable energy sources. Biomass is considered to be the biggest potential.

Broader implementation of renewable energy sources that allows reaching principles of sustainable development concept is a big challenge for Serbia (Žikić et al., 2017) One of the relevant characteristics of renewable energy sources in Serbia is their availability within specific and distinctive locations. When discussing their efficient use in Serbia, one should primarily take into account their potential at local level and their exploitation in order to meet the needs of the local community. Generally speaking, economically undeveloped, rural parts of Serbia have greater unused potential when renewable energy sources are concerned. So, for example, the cities in the southern part of Serbia (Nis, Kursumlija, Vranje) have the greatest capacities for the use of solar energy, while half of small water courses are located in the southern and western region. Wind energy can be used to the greatest extent in the region of windy area of southern Banat, areas in eastern Serbia, Kopaonik, Zlatibor and Pester. Accelerated development of renewable energy represents a significant opportunity for economic development of these regions that can greatly contribute to balanced regional development of Serbia (Marjanović, 2019).

In the terms of regional economic and social development of Serbia, biomass, which has a share of 63% in the total potential of renewable energy sources, is very attractive. Great potential of biomass lies in agricultural residue and wood biomass (Ratknić, et al., 2010).

Lalic et al. (2011) stated that Western Balkan countries have great potential for the development of energy production from renewable energy sources such as: biomass, geothermal, solar, wind and hydro energy. It is emphasized that renewable energy is a critical foundation for economic growth and social progress of all the Western Balkan countries. Also, unused potential for energy production from renewable sources, together with an adequately set institutional framework, could create great possibilities for foreign investments (Golusin, 2010). Despite many challenges, Serbia's goal is to increase the share of energy from renewable sources in energy consumption, which is its obligation arising from its membership in The Energy Community of South East Europe, as a framework for the integration into the EU energy market (Djurišić-Mladenović N. et al., 2018; Maricic Karovic V. et al., 2018; Ristić D. et al., 2019).

Methodology

The research goals of this study were to determine attitudes and level of awareness of the population of rural regions of Serbia about renewable energy sources. The research was done in the cities of Kragujevac, Nis and Zajecar by random sampling of 400+ respondents, but the number was downsized to 400. These cities had been chosen for the research due to the fact that they represent administrative centers of central, southern and eastern rural regions and have great potential for the use of renewable energy sources. The sample consisted of 196 female and 204 male respondents. 2% (8) of the respondents have finished only elementary school, 232 respondents or 58% are with secondary school qualifications, while 160 respondents (40%), have high school education or have university degrees. A questionnaire with closed-ended questions for expressing attitudes (Likert scale) was used.

Collected data have been analyzed with SPSS. At the level of descriptive statistics, measures of central tendency (mean, median) and measures of variables (standard deviation) have been used. The following nonparametric tests have been used: Kolmogorov–Smirnov test, Mann-Whitney U test and Kruskal Wallis test. Post–hoc test (LSD) was also used. Processed data and obtained results are shown in tables.

The following hypotheses are tested in the research:

H1: Citizens are relatively poorly informed not only about general aspects of energy production and consumption but also about some specific aspects related to the use of renewable energy sources.

H2: Despite a relatively low awareness level of positive effects of sustainable development, people in rural regions of Serbia believe that renewable energy sources have greater economic, environmental and social importance than conventional fossil sources.

H3: The population supports the use of renewable energy sources that have the least negative impact on the environment, even in the case of high production costs of electricity.

H4: Citizens of rural regions of Serbia believe that the main causes of insufficient use of renewable energy sources lie in poorly informed population, complex administration procedures during the construction of facilities for the utilization of renewable energy, as well as the lack of state incentives.

Results

The questionnaire (Q1) starts by introducing respondents to the topics, asking them to assess their own knowledge about issues related to energy production and consumption (Table 1).

Table 1. Q1 - The respondents assessment of the own level of information about : Q1.1 - Plans of RS concerning electricity production in the future; Q1.2 - The impact of existing installation for electricity production on environment; Q1.3 - Economical use of energy in different areas of human activity

Q1	Extremly poorly	Poorly	Moderately	Well	Very well
Q1.1	16,0%	46,5%	31,0%	5,5%	0%
Q1.2	7,5%	56,0%	25,0%	11,5%	0%
Q1.3	12,5%	50,5%	27,0%	9,5%	0,5%

Source: Author's illustration based on research

In the second question (Table 2), the respondents were asked to assess their awareness about various forms of renewable energy sources. The respondents were best informed about solar energy whereby 12% of the respondents declared that they were well informed while 58% said that they were badly or extremely badly informed about this issue.

Table 2. Q2 - The respondents are asked how much are they personally informed about the following energy sources:

Q2		Extremly poorly	Poorly	Moderately	Well	Very Well
Q2.1.	Biomass	19,5%	55,0%	20,0%	5,5%	0%
Q2.2.	Geothermal energy	20,0%	51,5%	23,0%	5,5%	0%
Q2.3.	Wind energy	15,5%	48,0%	26,5%	9,0%	1,0%
Q2.4.	Solar energy	13,5%	44,5%	29,0%	12,0%	1,0%
Q2.5.	Hydro energy	12,0%	53,0%	21,5%	12,0%	1,5%

Sources: Author's illustration based on research

Opinions on the impact of the energy sector on the environment are expressed in the question that asked the respondents to assess the risk to the environment resulting from the production of electricity from some energy sources (Table 3).

Table 3. Q3 - The respondents are asked about their opinion concerning the danger on the environment of producing electricity from the following energy sources:

Q3	Source	Negligible small	Small	Moderate	Great	Extremely great
Q3.1.	Biomass	22,5%	47,5%	25,0%	5,0%	0%
Q3.2.	Geothermal energy	22,0%	53,0%	23,0%	1,5%	0,5%
Q3.3.	Wind energy	44,2%	36,7%	13,6%	5,5%	0%
Q3.4.	Solar energy	43,5%	35,0%	18,0%	3,5%	0%
Q3.5.	Hydro energy	21,0%	45,0%	25,0%	6,0%	3,0%
Q3.6.	Fossil fuels	0%	6,5%	15,0%	38,0%	40,5%

Sources: Author's illustration based on research

In the next question the respondents were asked to link different forms of energy to some characteristics and properties. Obtained results are shown in Table 4:

Table 4. Q4 - The respondents are asked to connect energy sources with their qualities: Q4.1 - the best for the environment; Q4.2 - the safest; Q4.3 - gives most energy; Q4.4 - gives cheapest energy; Q4.5 – most encourages economic development Q4.6 - creates the greatest number of new jobs; Q4.7 – best contributes to local community; Q4.8 – best contributes to energy independence and efficiency.

Q4	**Biomass**	**Geo-thermal energy**	**Wind energy**	**Solar energy**	**Hydro energy**	**Fossil fuels**	**Mean**	**Std. dev.**
Q4.1	*12,5%*	*14,0%*	*31,0%*	*32,0%*	*10,0%*	*0,5%*	3,1	1,18
Q4.2	*6,5%*	*11,5%*	*31,5%*	*30,5%*	*18,0%*	*2,0%*	3,5	1,16
Q4.3	*6,0%*	*4,5%*	*25,0%*	*22,5%*	*24,5%*	*17,5%*	4,1	1,38
Q4.4	*8,0%*	*8,5%*	*31,0%*	*35,5%*	*13,5%*	*3,5%*	3,5	1,18
Q4.5	*12,5%*	*17,5%*	*15,5%*	*26,5%*	*18,5%*	*9,5%*	3,5	1,52
Q4.6	*17,5%*	*17,0%*	*13,5%*	*17,0%*	*22,0%*	*13,0%*	3,5	1,69
Q4.7	*16,5%*	*17,5%*	*14,0%*	*19,5%*	*28,0%*	*4,5%*	3,4	1,55
Q4.8	*15,0%*	*12,0%*	*20,0%*	*24,5%*	*23,0%*	*5,5%*	3,5	1,48

Sources: Author's illustration based on research

On the basis of obtained mean values and standard deviation for all renewable energy sources, the respondents opt, in the first place, for those sources that can provide most energy, that are safest, provide the cheapest energy and give the greatest contribution to energy independence and energy efficiency (Table 4). By checking deviations from mean values, we can conclude that there is an increasing homogeneity regarding this issue (Tables 4 and 5). In the next question (Q5) the respondents are asked to what extent renewable energy sources should be used for electricity production in Serbia. (Table 5).

Table 5. Q5 - The respondents answer to what extent renewable energy sources should be used for electricity production in Serbia.

Q5		No.	%
1.	less than today	6	1,5
2.	as much as today	32	8,0
3.	more than today	346	86,5
4.	should not be used	16	4,0

Sources: Author's illustration based on research

Serbia's economic development will inevitably lead to higher consumption of all forms of energy. The respondents are asked to give their opinion on adequate resources to fulfill the requirement (Table 6).

Table 6. Q6 – Respondents opinion on adequate resources
Q6.1- Preference should be given to sources that have the least negative impact on the environment even if more expensive; Q6.2 - Preference should be given to the sources that generates cheaper energy, but they have a greater negative impact on the environment; Q6.3 - Preference should be given to higher price for electricity from renewable energy sources despite the fact that in most cases it is more expensive than the energy produced from conventional sources (oil, gas, coal).

Q6	**Disagreed**	**Partially agreed**	**Neither agreed or disagreed**	**Agreed**	**Fully agreed**
Q6.1	6,0%	16,0%	21,5%	45,0%	11,5%
Q6.2	34,0%	37,0%	19,5%	8,5%	1,0%
Q6.3	7,0%	20,0%	33,0%	26,5%	13,5%

Sources: Author's illustration based on research

When asked to assess the cause of insufficient use of renewable energy sources in Serbia, the respondents gave the following answers (Table 7):

Table 7. Q7 - The responds when asked to identify the cause of poor use of renewable energy in Serbia: Q7.1 - All fossil fuels haven't been consumed yet; Q7.2 - Their inconstant availability throughout a year; Q7.3 - Economically unprofitable; Q7.4 - Poor awareness of the population about the benefits of renewable energy; Q7.5 - Administrative procedures during the construction of facilities for the exploitation of renewable energy are complex; Q7.6 - Lack of incentives from the state.

Q7	**Disagreed**	**Partially agreed**	**Neither agreed or disagreed**	**Agreed**	**Fully agreed**
Q7.1	*14,0%*	*27,0%*	*26,0%*	*26,0%*	*7,0%*
Q7.2.	*12,5%*	*28,5%*	*29,5%*	*25,5%*	*4,0%*
Q7.3.	*10,5%*	*28,0%*	*25,5%*	*26,0%*	*10,0%*
Q7.4.	*4,0%*	*10,0%*	*11,0%*	*50,0%*	*25,0%*
Q7.5.	*3,0%*	*10,5%*	*14,0%*	*54,0%*	*18,5%*
Q7.6.	*3,5%*	*4,5%*	*14,5%*	*47,5%*	*30,0%*

Sources: Author's illustration based on research

On the basis of mean and median, with 95% certainty, the respondents consider mentioned causes as very significant regarding insufficient use of renewable energy sources in Serbia.

Assessing the importance of certain facts related to renewable sources, the following results have been obtained (Table 8):

Table 8. Q8 - The respondents opinion on importance of renewable energy: Q8.1 - Reduce environmental pollution; Q8.2 - Reduce greenhouse gas emissions; Q8.3 - They are inexhaustible; Q8.4 - Contribute to energy independence; Q8.5 - Contribute to job creation and community development

Q8	Negligible small	Small	Moderate	Great	Extremely great
Q8.1	*3,5%*	*8,5%*	*22,0%*	*37,0%*	*29,0%*
Q8.2	*2,0%*	*8,5%*	*23,0%*	*43,0%*	*23,5%*
Q8.3	*2,0%*	*9,0%*	*20,5%*	*46,0%*	*22,5%*
Q8.4	*2,0%*	*9,0%*	*18,0%*	*50,0%*	*21,0%*
Q8.5	*1,5%*	*4,5%*	*20,0%*	*50,5%*	*23,5%*

Sources: Author's illustration based on research

Further analysis based on mean and median values, with 95% certainty, shows that the respondents consider mentioned facts related to renewable energy sources to be extremely significant. All general variables were tested for normality of distribution using Kolmogorov–Smirnov test and so brought into dependence (Tables 9 and 10). All general variables with 99% of certainty differ from theoretical normal distribution which implies the use of nonparametric statistical tests (Mann-Whitney U and Kruskal Wallis). By using Mann–Whitney U test we have concluded that there is no statistically significant difference ($p>0.05$) in obtained answers regarding the sex of the respondents (Table s 11 and 12).

Table 9. Statistical processing of the obtained answers

	Kolmogorov-Smirnov test		
	Statistic	**df**	**Sig.**
Q1	0,153	398	0,000
Q2	0,164	398	0,000
Q3	0,104	398	0,000
Q6	0,151	398	0,000
Q7	0,086	398	0,000
Q8	0,144	398	0,000

Sources: Author's illustration based on research

Table 10. Statistical results of the obtained answers

Variables	Gender			
	Male		Female	
	Average	Std. deviation	Average	Std. deviation
Q1	7,0	2,01	7,0	1,97
Q2	11,6	3,26	11,2	3,57
Q3	14,1	2,73	14,2	2,89
Q6	8,8	2,00	8,5	1,78
Q7	20,3	3,60	20,0	4,11
Q8	19,0	3,49	19,1	3,87

Sources: Author's illustration based on research

Table 11. Statistical results of the obtained answers

	Q1	Q2	Q3	Q6	Q7	Q8
Mann-Whitney test	19798,0	18454,0	19586,0	18580,0	19332,0	19674,0
p	0,865	0,177	0,854	0,215	0,567	0,782

Sources: Author's illustration based on research

Table 12. Statistical results of the obtained answers

Variables	**Degree**					
	Elementary school education		Secondary school education		Higher / University degree	
	Average	Std. deviation	Average	Std. deviation	Average	Std. deviation
Q1	6,4	1,84	7,2	2,01	6,8	1,96
Q2	12,2	3,22	11,6	3,51	11,0	3,27
Q3	14,6	3,37	14,2	2,76	14,1	2,85
Q6	9,2	1,69	8,4	1,95	8,9	1,79
Q7	19,4	3,17	20,0	3,60	20,4	4,24
Q8	19,0	4,00	19,1	3,61	19,0	3,78

Sources: Author's illustration based on research

According to Kruskal Wallis test there is a statistically significant difference ($p < 0.05$) in mean assessments of answers regarding individual awareness about the topics related to the production of electricity, as well as questions related to the willingness to pay a higher price for the electricity produced from renewable sources. There is also statistically significant difference ($p < 0.05$) in answers to the question whether the preference should be given to those energy sources that have less negative impact on environment although the energy from those sources is more expensive, or preference should be given to those sources that produce cheaper energy, although their negative impact on the environment is great (Table 13).

Since we have concluded that there is a statistically significant difference, we have proceeded to further analysis using Post Hoc test (LSD) and concluded that there is a statistically significant difference ($p < 0.05$) in those answers given by the respondents with secondary and high (university degree) education (Table 14).

Table 13. Statistical results of the obtained answers

	Q1	Q2	Q3	Q6	Q7	Q8
Kruskal Wallis test	5,982	5,149	0,540	8,417	2,074	0,143
df	2	2	2	2	2	2
p	0,049	0,076	0,763	0,015	0,355	0,931

Sources: Author's illustration based on research

Table 14. Statistical results of the obtained answers - Post Hoc test (LSD)

Variables	(I)	(J)	Average differences	p	95% confidence interval	
					Lower	Upper
Q1	Elementary	Secondary	-0,781	0,223	-2,04	0,48
		University	-0,359	0,579	-1,63	0,91
	Secondary	Elementary	0,781	0,223	-0,48	2,04
		University	0,422	0,040	0,02	0,82
	University	Elementary	0,359	0,579	-0,91	1,63
		Secondary	-0,422	0,040	-0,82	-0,02
Q6	Elementary	Secondary	0,769	0,207	-0,43	1,97
		University	0,263	0,669	-0,95	1,47
	Secondary	Elementary	-0,769	0,207	-10,97	0,43
		University	-0,506	0,010	0,89	-0,12
	University	Elementary	-0,263	0,669	-1,47	0,95
		Secondary	0,506*	0,010	0,12	0,89

Sources: Author's illustration based on research

Discussion

Our first hypothesis (H1) was that citizens are relatively poorly informed not only about general aspects of energy production and consumption but also about some specific aspects related to the use of renewable energy sources. The results in Table 1 show that the respondents believe they are badly informed both about issues related to the plans of Serbia regarding production of electricity and energy savings and about the impact that existing installations for electricity production have on the environment (62,5% and 63,5%). The answer to the question in this group, about economic issues of energy in different areas of human activity is in the middle with 63%. Also, Table 2 reveals that lack of information about biomass, geothermal energy, wind energy, solar and hydro energy are expressed from 63,5 up to 74,5% of the respondents. Therefore, answers received for Q1 and Q2 support H1.

The second hypothesis (H2) was that despite a relatively low awareness level of positive effects of sustainable development, people in rural regions of Serbia believe that renewable energy sources have greater economic, environmental and social importance than conventional fossil sources. When we analyze Table 3, it is obvious that respondents have clear attitude upon danger of producing electricity from the following energy sources, because biomass, geothermal energy, wind energy and solar energy are widely considered safe (in range 70-80%), hydro energy is following with 66% in contrast to the attitude expressed toward fossil fuels (great danger 38, 0% and extremely great danger 40, 5%-together 78, 5%). Again, in Q4 (Table 4), fossil fuels are considered least safe, just like with answers to questions that follow: encouraging economic development, contribution to local community and contribution to energy independence and efficiency. So, we conclude that H2 is fully proven.

The third hypothesis (H3) was that population in rural regions of Serbia supports the use of renewable energy sources that have the least negative impact on the environment, even in the case of high production costs of electricity. This hypothesis is not confirmed, because 40% of the respondents support this idea, 33% neither agree nor disagree, while 27% disagree or strongly disagree. Although in the future more and more information about renewable energy sources, the energy prices cannot be predicted easily in cases of small countries that are not independent considering energy, so the support for such an idea can easily shift from one attitude to another because one third of the respondents are neutral.

The forth hypothesis (H4) was that citizens of rural regions in Serbia believe that the main causes of insufficient use of renewable energy sources lie in poorly informed population, complex administration procedures during the construction of facilities for the utilization of renewable energy, as well as the lack of state incentives. H4 is partly confirmed, since economic unprofitability is said to be one of the reasons for insufficient use of renewable sources (26% of the respondents agree with such statement, 10% fully agrees, while 38,5% disagrees or fully disagrees and 25.5% are neutral); half of the respondents agree, while exactly quarter of them fully agree that poorly informed population has led to insufficient exploitation of renewable sources; too complex administrative procedures during the construction of facilities for exploitation of renewable sources for most of the respondents represents a cause of insufficient use of renewable sources (54%), while 25,5% are neutral; 47.5% of the respondents agree and 30% fully agree that lack of incentives by the state is a cause of insufficient use of renewable energy (Table 7 - Q7 group of questions)

When assessing the impact of the energy sector on the environment, the respondents have recognized fossil fuels as particularly dangerous, while all forms of renewable energy have been assessed for little or extremely little dangerous by more than 70% of the respondents. On the basis of obtained answers, the respondents are primarily in favor of those sources that can produce the greatest quantities of energy (wind and hydro energy), that are the safest (wind and solar energy), can provide the cheapest energy or give the greatest contribution to the energy independence and its efficiency (solar and hydro energy). Considering mean values deviation, there is pronounced homogeneity on this issue.

It is interesting that the respondents hardly connect mentioned characteristics to fossil and nuclear sources of energy. The respondents supported to a great extent the use of renewable energy sources, because the majority of them (86.5%) believe that these sources should be used more than they are used today.

Conclusion

Since renewable energy sources are an important segment of sustainable development that cannot be achieved without mobilization of citizens, their greater participation in supporting and using renewable energy sources is necessary. Numerous experiences show that, at the beginning of the implementation of renewable energy sources into the energy system of a country, it is important to obtain public support, conduct a program to inform and educate citizens and familiarize them with all possible benefits and costs of such a complex and demanding process. Broader implementation of renewable energy sources which enables achieving the principles of sustainable development concept represents a great challenge for Serbia. In addition to numerous obstacles to the increased use of renewable energy sources in Serbia, a prominent place is taken by social barriers, that is, lack of knowledge and information.

The results of the survey clearly show that the citizens of rural regions in Southern, Eastern and Central Serbia are relatively poorly informed not only of general aspects of energy production and consumption, but of specific aspects related to the use of renewable energy sources. When assessing the impact of the energy sector on the environment, the respondents have recognized fossil fuels as particularly dangerous, while all forms of renewable energy have been assessed for little or extremely little dangerous by more than 70% of the respondents. It is interesting that the respondents hardly connect mentioned characteristics to fossil and nuclear sources of energy. The respondents supported to a great extent the use of renewable energy sources, because the majority of them (86.5%) believe that these sources should be used more than they are used today. Based on obtained answers we can conclude that the respondents support the use of those renewable energy sources that have less negative impact on the environment, despite the fact that the energy obtained from these sources is more expensive. Asked to assess the cause of insufficient use of renewable energy sources in Serbia, majority of the respondents agree that the causes are poorly informed population, too complex administration procedures during the construction of facilities for the exploitation of renewable energy and the lack of state incentives.

Although the research was organized in certain rural regions in Serbia and therefore the sample is not representative on national level, these results undoubtedly show poor awareness of the population regarding renewable energy sources and point to the need to inform the public more intensively about the advantages and benefits of renewable energy in order to have a broader public support for the implementation of this form of energy into energy sector of Serbia. Further investigation should follow research on national level and the optimal ways to inform and mobilize the public in order to create a stable public opinion on this subject.

Conflict of interests

The authors declare no conflict of interest.

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MARKET OF AGRICULTURAL AND FOOD PRODUCTS IN THE REPUBLIC OF SERBIA: POSSIBILITIES AND IMPLICATIONS

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A B S T R A C T

The main topic is Serbian agro-food potential. Serbia possesses exceptional natural resources having in mind it is located in the most favourable region of the north latitude. If this potential is used in an optimal measure, it would bring exceptional results. According to agriculture census in 2018 in Serbia there was registered 628.552 family agricultural farms, and 562 896 are family households. By adequate strategic planning, agriculture can provide a significant contribution to the economic development of a country. Agriculture encourages employment, takes a significant part in foreign trade, provides food security for citizens, contributes to the rural development and ecological balance. Therefore, it affects the development of entire country by being related to different sectors.

Introduction

Countries that have reached a high level of development also have a well-developed agricultural production, although this sector does not take a significant part in total emploment and creation of gross domestic product. In that aspect, developing countries spot an opportunity for agriculture development to bring them the reduction of import dependance, increase of exports and economic growth rate. In that aspect, significant funds are provided for the import of energy sources, capital equipment and other industrial products.

Agricultural and food products represent the basis of population's nutrition. FAO[4] estimates that in 2050. in the world there will be between ten and twelve billion people,

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4 FAO (Food and Agriculture Organization).

which will result in a need for a greater amount of food. Main task of agricultural production is to provide sufficient amounts of food for the population (Vlahovic, 2015; Stanković et al., 2020; Đorđević & Mitić, 2020).

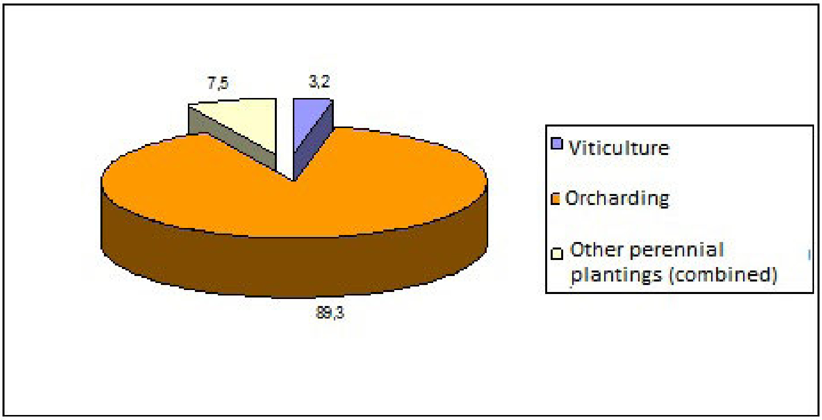
The goal is to point out that greater investments in this area it would be achieved significant economic effects, revival of rural areas and ecological balance. Secondary data sources were used for this article, statistical data processing and analysis, as well as modern literature about agricultural potential and rural development. Taking into account the extraordinary natural resources of Serbia, agriculture represents a development opportunity which can be presented trough the following link: agriculture-economic progress-rural areas-ecologic equilibrium. From the presented relations arises the basic hypothesis which reads, HO: *Greater investments in agricultural holdings in Serbia can lead to positive economic effect, encourage empoyment in rural areas and ecological balance.*

Structure of agricultural households in our country in 2018

According to agriculture census in 2018 in Serbia there was registered 628.552 family agricultural farms, and 562 896 are family households. However, the data of the Republic Bureau of Statistics show that age structure of household holders is such that even 42,5% are older than 65, then there is a category of those aged between 55 and 64 (27,9%), while 17,8% of agricultural household holders are between 45 and 54. It can be concluded that population who are engaged in agriculture belong to the category of old people. The exception from the above-mentioned in the region of Sumadija and Western Serbia, which has the greatest number of young holders of households (up to 40 years).

In the structure of households specialized for perennial plantings, the ones specialized for fruit production are the ones that dominate (89,3%), while 3,2% of households are specialized in viticulture sector (Figure 1).

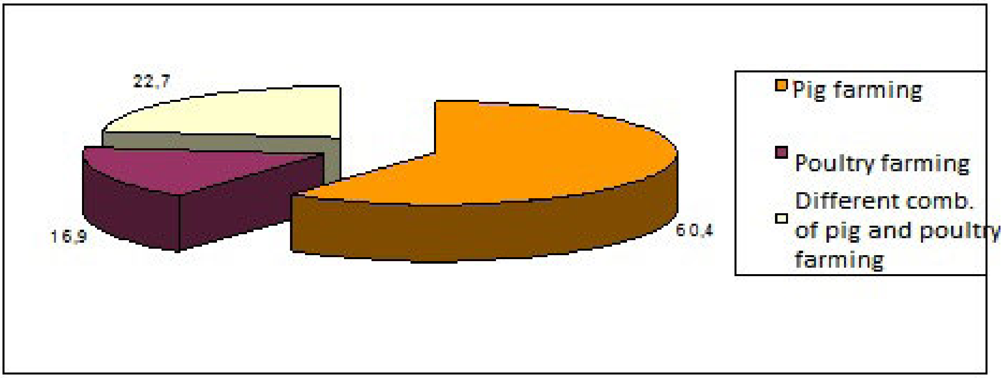
Figure 1. Structure of agricultural households specialized for perennial plantings



Source: Presentation of the author based on RBS, Statistical base, Agriculture, Forestry and Fishing, survey, 2018. (expressed in %)

Based on the data presented in Figure 1, we can see that in the structure of households specialized for perennial plantings there dominate households specialized for fruit production (89,3%), while only 3,2% of households are specialized in the sector of viticulture.

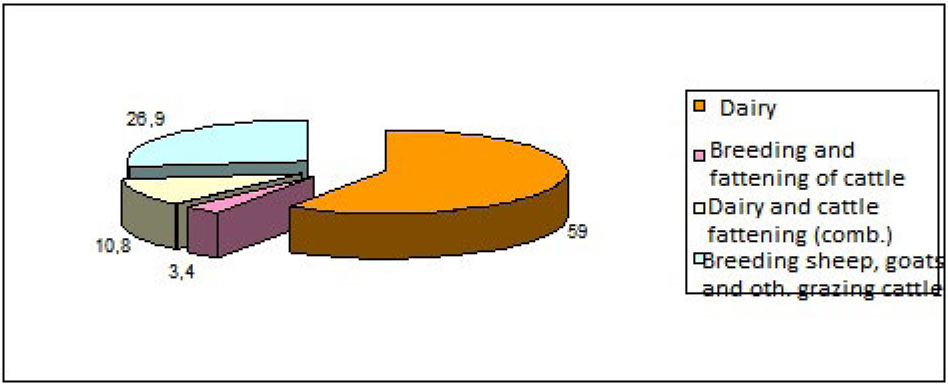
Figure 2. Structure of agricultural households specialized within cattle breeding – pigs and poultry breeding



Source: Presentation of the author based on data from RBS, Statistical base, Agriculture, Forestry and Fishing, survey, 2018 (expressed in %)

Figure 2 shows the structure of households specialized in pigs and poultry breeding. Data show that agricultural households are dominantly oriented on breeding and fattening of pigs (60,4%), while 16,9% of them are engaged in poultry breeding.

Figure 3. Structure of agricultural households specialized in cattle breeding sector – breeding of cattle, sheep and goats



Source: Presentation of the author based on data from RBS, Statistical base, Agriculture, Forestry and Fishing, survey, 2018 (expressed in %)

Of the total number of agricultural households specialized for breeding cattle, sheep and goats, 59% deal with milk production and only 3,4% with breeding and fattening the cattle (Figure 3).

Cultivate crops in arable lands and gardens in 2018.

In our country, corn and wheat are traditionally most widely spread crops. Among them, in our country, there are also rye, barley and oats. Each of the corns mentioned is useful in nutrition, both of people and animals.

Table 1. Total production of grain in the Republic of Serbia, during 2018 – presentation according to regions

	Republic of Serbia		Region of Belgrade		Region of Vojvodina		Region of Sumadija and Western Serbia		Region of Southern and Eastern Serbia	
	(ha)	(t)	(ha)	(t)	(ha)	(t)	(ha)	(t)	(ha)	(t)
Wheat and corn	369566	2941601	29042	121304	315925	1917446	148284	1796142	146315	1024155
rye	4408	13418	529	788	1146	5631	2003	4843	730	7787
barley	102125	410138	8485	29309	45032	201246	29125	171937	19483	208892
oats	27174	74707	2690	6346	1983	15588	16525	9242	5978	59119
Corn for grain	900047	6964770	36868	213319	201296	4870664	203990	4657345	157893	2094106
Other crops for grain	29507	10986	1876	1652	13894	3571	9858	1981	3879	7415

Source: Presentation of the author based on data of RBS, Survey on agricultural households structure, 2018– What is confirmed, what is denied and what is pointed at, Republic Bureau of Statistics, Belgrade 2019.

Note: Region of Kosovo and Metohija is left out from the presentation of total production

Based on data presented in Table 1, we can conclude that at the level of entire country the greatest yield was achieved by corn (6.964.770 t). Second place according to the amount of yield in tons is occupied by wheat with the achieved yield of 2.941.601 t, while third place is occupied by barley yield in the amount of 410.138t.

The greatest yield of corn in 2018 expressed in tons is achieved in the region of Vojvodina and it is 4.870.664 tons. In the region of Belgrade, corn is most widely spread and the achieved production in 2018 is 213319 t. In the region of Vojvodina, corn is also most frequently cultivated, with an important difference that the yield is by far higher in this region, i.e. it is the highest in entire country.

Region of Sumadija and Western Serbia (4.657.345 t) and region of Southern and Eastern Serbia also record the highest production of corn for grain (2094106 t). Based on the above mentioned, we can conclude that in 2018, as well as in previous years, the highest frequency of total corn production for grain was recorded in region of Vojvodina.

Table 2. Total production of vegetables in the Republic of Serbia, during 2018 – overview according to the regions

	Republic of Serbia		**Region of Belgrade**		**Region of Vojvodina**		**Region of Sumadija and Western Serbia**		**Region of Southern and Eastern Serbia**	
	(ha)	(t)	(ha)	(t)	(ha)	(t)	(ha)	(t)	(ha)	(t)
Potato	27701	487909	361	17186	3881	95704	17394=63%	239391=50%	6062	135628
Tomato	8629	131868	977	18526	2241	19728=38%	2966	37342	2445	26273
Cabbage	8251	209353	601	12148	1313	40560	3449	94189=45%	2888	62456
Paprika	12016	135072	593	4449	1421	21137	5225	57647=43%	4777	51839
Onion	3618	27967	188	773	1335	16108=58%	996	5620	1099	5466
Garlic	1441	3615	82	154	461	1524	714	1616=45%	184	321
Carrot	1385	22203	71	1001	708	15468	522	4974	84	760
Peas	6736	29261	783	3166	3609	17991	1361	5023	983	3081
Cucumber	3220	42539	142	1588	569	7624	1320	18782	1189	14545
cauliflower	347	4817	33	444	134	2172	99	1289	81	913

Source: Presentation of the author based on data from RBS, Survey on agricultural households structure, 2018 - What is confirmed, what is denied and what is pointed at, Republic Bureau of Statistics, Belgrade 2019.

Note: Region of Kosovo and Metohija is left out from the presentation of total production

The data presented in Table 2 show that according to the size of planted surface, potato occupies the first place, it is planted on 27.701 ha, then paprika which is planted on 12.016 ha, as well as tomato whose crops occupy the surface of 8.629 ha, as well as cabbage that is planted on 8.251 ha.

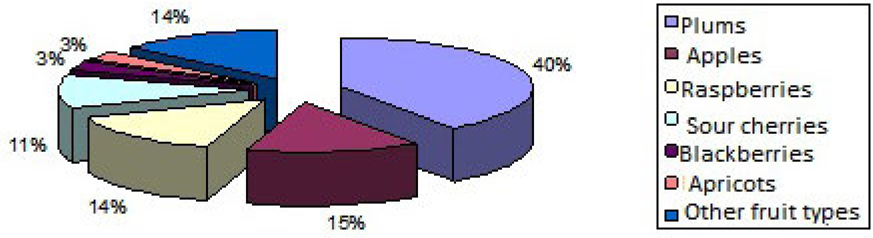
In total production of vegetables in entire country during 2018, the greatest yield was achieved by potato (487.909t). Even a half of the mentioned potato yield (239.391t) is recorded in the region of Sumadija and Western Serbia. A crop that occupies second place is cabbage, with a yield of 209.353t at the state level, and the greatest part of yield comes from the region of Sumadija and Western Serbia, where 45% of the total yield of cabbage was achieved. Although it is planted on smaller surface, cabbage has achieved greater yield in relation to tomato.

The next crop is paprika whose production reached 135.072 tons, and the highest yield (62.456 t) is achieved in the region of Southern and Eastern Serbia. Fouth place according to the recorded rate of yield is tomato with the achieved 131.868 tons in entire country, i.e. for the greatest part from the region of Sumadija and Western Serbia. Almost 60% of the total achieved production of onion comes from the region of Vojvodina, while garlic is the most cultivated crop in the region of Sumadija and Western Serbia whose share is 45% in total production of this culture.

When we observe the surface planted with carrot, peas, cucumber and cauliflower, based on data given in Table 2, we can conclude that among these four crops the greater surface is planted with peas, two times less with cucumber and five times less with carrot. However, in spite of differences in surfaces, much greater yield has cucumber, 42.000 t, and peas about 29.000 t.

Fruit production makes approximately one tenth of agricultural production, and thus in that small scope it represents one important branch of agricultural production. Most widely spread and, in some aspect, most significant for agricultural production are, traditionally, plums, apples, sour cherries and raspberries, as it is presented in Figure 4.

Figure 4. Structure of surfaces under fruit types, 2018. (expressed in %)



Source: Presentation of the author based on data from RBS, Survey on agricultural households structure, 2018 - What is confirmed, what is denied and what is pointed at, Republic Bureau of Statistics, Belgrade 2019.

Data from the Figure 4 show the dominance of plums production, which occupy 40% of the total surface under fruit types.

In order to have a more adequate presentation of the achieved fruit production in our country during 2018, we have analyzed the surfaces with: stone fruit (apples, pears, peaches, nectarines, apricots, cherries, sour cherries, plums and quinces), berry fruit (raspberries, blackberries, blueberries, etc), as well as surfaces and yields planted with kernel fruit (nuts and hazelnuts).

When it comes to stone fruit, greatest surface is occupied by apples (26.658 ha), and thus they have the greatest production recorded. According to the total surface (orchards and plantation orchards), apples occupy 26.658 ha, i.e. 0,8% of the total available land. In 2018, there was produced 460.404 t of apples, i.e. about 66 kg per capita. Pears occupy 4.977 ha, i.e. 0,14% of the total available land.

Table 3. Total production of fruit in the Republic of Serbia, during 2018 – overview per regions

Fruit types	Republic of Serbia		Region of Belgrade		Region of Vojvodina		Region of Sumadija and Western Serbia		Region of Southern and Eastern Serbia	
	(ha)	(t)	(ha)	(t)	(ha)	(t)	(ha)	(t)	(ha)	(t)
Stone fruit										
Apples	26658	490404	1561	26390	7131	178266	11402	144784	6564	110964
Pears	4977	53905	369	3965	1114	9535	2262	24598	1232	15808
Quinces	1947	12318	65	5255	228	1336	605	3919	1049	7063
Plums	72923	430199	2289	25829	2559	32816	48682	267665	19393	103890
Sour Cherries	19579	128023	718	24338	1705	8811	3895	15527	13261	103685
Peaches	5176	50249	1949	28734	1003	16935	615	11800	1609	21515
Apricots	6040	25414	2784	11193	1030	6121	1566	5030	660	3070
Cherries	4335	19153	2095	8846	465	7429	1078	1417	698	10307
Berry fruit										
Raspberries	24901	127010	146	13731	733	5051	21413	113279	2609	8680
Blackberries	6055	35062	33	1461	23	676	5245	33601	754	785
Other berry fruit	495	5109	22	527	69	271	252	4583	152	256
Kernel fruit										
Nut	2796	9266	95	484	418	2478	1069	2499	1214	4985
Hazelnut	4564	5678	196	254	2335	3274	1006	1068	1028	1194

Source: Presentation of the author based on data from RBS, Survey on agricultural households structure, 2018 - What is confirmed, what is denied and what is pointed at, Republic Bureau of Statistics, Belgrade 2019.

Note: Region of Kosovo and Metohija is left out from the presentation of total production

Berry fruit in the territory of our country is planted on 31.451 ha and total yield of 167.181 tons was achieved. Most widely spread crop among berry fruit is raspberry, whose yield in total territory is 127.010 tons and the highest yield comes from the region of Sumadija and Western Serbia where 113.279 tons of this culture was recorded. As for the kernel fruit, in our country we have nuts and hazelnuts. Total yield of nuts is 9.266 tons, and the greatest part comes from the region of Southern and Eastern Serbia (4.985 t). The data of the Survey on agricultural households structure, 2018, show that the types mentioned are dominant in the year 2018 as well, and they are followed by apricots, peaches, pears, cherries and blackberries. Blueberry, chokeberry, currant and kiwi are also cultivated in our country.

Table 4. Agricultural products in Serbia - 2017 и 2018. (in thousands tons)

	2017	2018	Index 2017=100
Wheat	2275	2943	129,2
Corn	4018	6964	173,3
Sunflower	540	733	135,7
Soy	461	645	140,0
Sugar beet	2513	2325	117,3

	2017	2018	Index 2017=100
Cheery	91	128	92,5
Apricot	41	25	61,5
Raspberry	109	127	115,7
Apple	378	460	92,3
Pear	52	53	121,6
Plum	330	430	130,1
Grapes	165	149	90,5

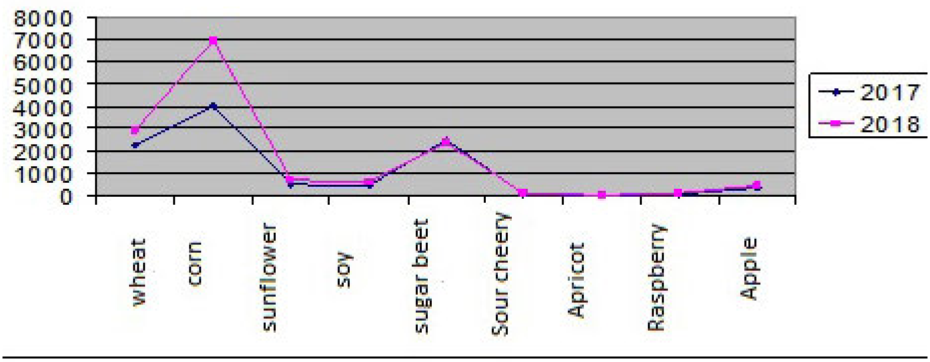
Source: RBS, Statistical base, Agriculture, Forestry and Fishing, Agriculture census. Note: Data presented are rounded to an integer.

When with the help of comparative approach we observe the total yield of particular agricultural and food products in 2017 and 2018 (Table 4) we can conclude that in 2018 there is a growth by 73,30% in relation to 2017 when it comes to corn cultivation. The next product is soy bean, which has achieved greater yield in 2018 by 40% in relation to the previous year, as well as sunflower which has recorded a growth of 35,7%. Therefore, we can conclude that the top of the list is occupied by livestock products, as well as that they show growth tendency, which is an encouraging facts. However, it is inevitable to mention that in 2018, compared to 2017, the production of sour cherries, apples and apricots was reduced.

In total production of fruit in 2018, pear occupies 3,2% and therefore it is on the sixth position. Total production of pears in 2018 is 53.905 t, so that would mean that at state level there was produced about 8 kg of pears per capita. According to the total surface (orchards and plantation orchards), quinces occupy 1.947 ha, i.e. about 0,1% of the total land available. Total production of quinces in 2018 was 12.318, i.e. 1,8 kg per capita. Quince occupies 0,7% and it is on the twelfth position.

Plums occupy 72.923 ha, i.e. about 2,1% of the total land available. Total production of plums in 2018 was 430.199 t, i.e. about 61 kg per capita. In total production of fruit in 2018, plum occupies 25,7% and therefore it is on the second place. In 2018, the greatest amount of plum is produced in region of Sumadija and Western Serbia (267665t). Sour cherries are in 2018 produced in the greatest amount in the region of Southern and Eastern Serbia (10.307t), while peaches (28.734 t) and apricots (11.193 t) have achieved the greatest yield in the region of Belgrade.

Figure 5. Structure of agricultural production in the Republic of Serbia, 2018

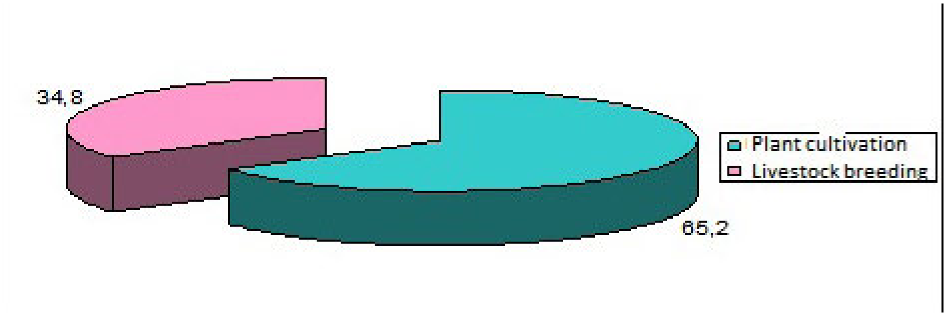


Source: Presentation of the author based on data of RBS, Statistical base, Agriculture, Forestry and Fishing, Survey, 2018. (expressed in thousand tons)

Data from the Figure 5 show that in 2018 there was an increase of production of wheat and corn in relation to 2017. The greatest difference, i.e. the greatest yield in 2018 in relation to 2017 is achieved in the yield of corn.

In the production of other observed agricultural products (sunflower, sugar beet, sour cherry, apricot, raspberry and apple) there were no significant changes, thus on this occasion we will not consider and analyze them in details.

Figure 6. Structure of agricultural production in the Republic of Serbia, 2018



Source: Presentation of the author based on data from RBS, Statistical base, Agriculture, Forestry and Fishing, Survey, 2018 (expressed in %)

Farmers in our country most frequently deal with plant production (65,2%) in relation to cattle breeding (34,8%). Within plant production, a special place in share in total value belongs to field and vegetables cultivation, which takes place in the surface of more than 3,3 million of hectares in the Republic of Serbia. In 2018, in a realized physical scope of agricultural production in Serbia, field production along with vegetables production had a share of 79.3%, and in total realized value of agricultural production with 51,67% (RBS, 2019). The significance of field products is reflected primarily in nutrition of people and cattle, which further points to the need of continuous improvement and development of an organized market for these products. Industrial plants is cultivated on a surface of 400-440 thousand hectares, with an expressed variations of surfaces, for all the crops from this group. The production of industrial plants makes about 8% of the total value of agricultural production of the Republic of Serbia (Strategy of agriculture and rural development of the Republic of Serbia for the period 2014-2024.).

Share of agricultural and food products in total export of the Republic of Serbia

Some studies (Gollin, Parente & Rogerson, 2002) and main economic indicators point to a big significance of agricultural production and export of agricultural products for the economic growth of developing countries, which include our country as well. Central European Free Trade Agreement (CEFTA) and Customs Union (Russia, Kazakhstan and Belarus) are the most important trade partners for Serbia.

Sector of agriculture and food products is a very important sector of Serbian economy according to the resources available. Agriculture represents a development chance having in mind the growing tendency of food prices at global market (Puskaric, et al., 2009). Having in mind that agriculture is a significant activity in the Republic of Serbia, the state lead the policy of its encouragement through agrarian budget, in order to develop and bring even greater effects (Kuzman, et al., 2017).

In the period January-October 2017, the total export of agricultural food in Serbia has reached the value of 2,40 billion $, which is a drop by 14% in relation to the same period in 2016. Total import of agricultural food in Serbia for the period January – October 2017 was estimated to 1,25 billion dollars, which is a drop by 17% in comparison to the same period 2016.

Export of agricultural food from Serbia consists mainly of grain, sugar, fruit and vegetables (fresh and frozen), confectionery products and drink. During the period January – March 2019, there was achieved the value of export 834,4 million $, which is a growth of 12% in relation to the same period previous year (it was 745,3 million $), with a share in total merchandize export of 18%. In addition, value of import (514,6 million $) is by 1,9% less than the achieved in the period January-March 2018 (when it was 524,4 million $), with a share in total merchandize import of 8,2%. Foreign trade exchange of agricultural and food products in the period January-March 2019., records a surplus of 44,8%, i.e. by 98,9 million $ higher in relation to the observed period January-March 2018 and it amounts 319,8 million $, with a rate of import coverage by export of 162,1%.

The most significant agricultural and food products in export in the period January-March 2019 are: mercantile corn (120 mil. $), frozen raspberry (55 mil. $), cigarettes (42 mil. $), fresh apples (34, mil. $), hybrid seed corn (33 mil. $), as well other food products: mercantile wheat (22 mil. $) and crude sunflower oil (19 mil. $).

Table 5. Export and import of agricultural food products in the Republic of Serbia for the period 2018 and January-July 2019.

	Export		**Import**		**Share in total export in %**		**Share in total import in %**	
	2018	2019	2018	2019	2018	2019	2018	2019
Total	-	-	-	-	100,0	100,0	100,0	100,0
0 Food and livestock	138,8	159,4	81,0	92,4	12,4	13,3	5,5	5,7
00 Livestock, except animals from the section 03	3,1	2,5	2,4	1,7	0,3	0,2	0,2	0,1
01 Meat and processed meat products	7,1	6,8	9,1	9,5	0,6	0,6	0,6	0,6
02 Dairy products and eggs	8,2	10,5	5,1	8,6	0,7	0,9	0,3	0,5
03 Fish, crustaceans, mollusks and processed products from them	0,9	1,1	5,0	5,9	0,1	0,1	0,3	0,4
04 Grains and products based on grains	37,5	54,3	5,4	7,6	3,4	4,5	0,4	0,5
05 Vegetables and fruit	50,7	49,2	22,3	27,5	4,5	4,1	1,5	1,7
06 Sugar, sugar products and honey	3,7	5,1	2,6	2,6	0,3	0,4	0,2	0,2
07 Coffee, tea, coffee, spices and products made of them	5,7	6,1	11,7	13,3	0,5	0,5	0,8	0,8
08 Fodder (except corn in grains)	11,1	12,9	6,9	4,9	1,0	1,1	0,5	0,3
09 Various food products and processed products	10,7	10,9	10,4	10,7	1,0	0,9	0,7	0,7
1 Drinks and tobacco	31,6	33,7	20,4	24,3	2,8	2,8	1,4	1,5
11 Drinks	14,3	15,6	6,2	6,7	1,3	1,3	0,4	0,4
12 Tobacco and tobacco products	17,3	18,0	14,2	17,6	1,5	1,5	1,0	1,1
4 Animal and vegetable oils, fats and waxes	8,8	12,3	3,9	2,8	0,8	1,0	0,3	0,2
41 Animal oils and fats	0,2	0,2	0,7	0,6	0,0	0,0	0,0	0,0
42 Solid vegetable fats and oils, crude, refined	8,3	11,8	3,0	2,0	0,7	1,0	0,2	0,1
43 Animal and vegetables fats and oils, processed	0,3	0,3	0,2	0,2	0,0	0,0	0,0	0,0

Source: Republic Bureau of Statistics, Foreign Trade Statistics, Report, no. 236, LXIX, 30.08.2019.

Data presented in Table 5. show that the greatest share (4,5%) in total export was for fruit and vegetables, as well as grain, 4,5%. In the period observed, the greatest share in total import was achieved in case of products such as coffee, tea, cocoa, spices and their products in the amount of 0,8%. It is concluded that the yields are relatively lower in relation to more developed countries and record significant oscillations. The analysis of yield dynamics change expressed by ten-year average values in the last three decades, points that only industrial plants and some types of fruit (plums and raspberries) have a permanent growth of yield. Seed material that is produced in the Republic of Serbia does not cover the needs of domestic market, thus significant amounts of vegetable seeds are imported.

Production of fruit took part in the last decade on a surface of almost 270 thousand hectares and it is about 9% of the value of agriculture production of the Republic of Serbia. Production mainly takes place in private agricultural households. In this sector, a significant progress in achieved in improvement of standards in primary production and processing, as well as the domain of business connection.

Variations in production scope are great, because the sector is still at relatively low technological level and its production is susceptible to the impact of weather conditions. Viticulture is present in the whole country with an average production of 350.000 tons of table and wine grapes. A greater part of grapes production is used for wine production. During the last five years, there has been a mild increase in the scope of planted surfaces and also a physical scope of production (Strategy of Agricultural and Rural Development of the Republic of Serbia for the period 2014-2024.).

Share of agricultural and food products in total import of the Republic of Serbia

When we observe the import side of agricultural and food products, we conclude that milled tobacco dominates (21 mil. $), fresh bananas (18 mil. $), raw coffee (14 mil. $) cigarettes containing tobacco (14 mil. $) and frozen pork (14 mil. $).

According to the report of the Republic Bureau of Statistics (Table 5), our country has achieved the highest export of grain and products based on grain (54,3%), in current year (sex-month period January-July 2019), while in 2018 it was the export of fruit and vegetables (50,7%).

The circulation of agricultural and food products on domestic market

Total value of the circulation of agricultural products on the markets in the Republic of Serbia for the first six months in 2019, in relation to the same period last year, expressed in current prices, is higher by 16,4% (RBS, 2019).

In the structure of values of agricultural products' circulation on the markets for the first six months in 2019, most widely present are the following groups of products: vegetables (34,6%), fruit and grapes (19,2%), milk and dairy products (14,6%) and poultry and eggs (13,2%), (RBS, 2019).

Some authors (Puškarić, et al., 2016) stress the significance of promotional activities for the development of the market of indigenous food products. The authors mentioned state that development of rural areas is encouraged by production and sale of indigenous food products, with the preservation of national identity and they enrich the procurement of the region. Indigenous food products, in addition to sociological, also have economic significance, which is reflected in competitiveness, profitability of producers, who experience the performances from the aspect of consumers' satisfaction.

Specific institutions (traditional, domestic, natural, etc.) can create additional value when placing on domestic market. Based on the added value, these products achieve higher prices in the market, while consumers are satisfied with their consumption. Greater production and supply increase competitiveness, which has a positive impact on quality increase.

Foreign trade exchange of agricultural and food products of the Republic of Serbia

Foreign trade exchange of agricultural and food products of the Republic of Serbia mainly takes place with European Union and CEFTA countries, as well as Russian Federation by a smaller part. According to the data from the study of Markovic (2016), Serbia has placed about a half of the total food export to the countries of European Union (49,05%). Then, to the countries of CEFTA 33,38%, and 10,17% to Russia. To other countries it exports the remaining 7,4%. From the above-mentioned, there results a rather low geographic diversification of export and enormous dependence from economic and political circumstances in European Union, as the most significant foreign trade partner of the Republic of Serbia.

In tabular overview, the year 2001 was taken as base year (Table 6) in order to have a detailed overview and an insight to export-import of agricultural and food products of our country. We can see that in the initial year observed the balance is negative, and after that there is a growth recorded year after year, which points to the fact that in our country there is greater export than import, over a long period of time. In the last part of the table, there is an overview of the first quarter in 2018 and 2019, in order to make conditions for comparison. The results achieved in foreign trade exchange of agricultural and food products in the period January-March 2019., based on the data presented in Table 6, can be rated as positive. This is because the export shows a tendency of growth and import drops in relation to the same period previous year. In addition, we can notice the increase of export, both to EU and CEFTA and Russian Federation. Namely, import is reduced by EU and Russian Federation, while it remained the same in case of CEFTA countries.

Table 6. Regional structure of foreign trade exchange of agriculture and food industry of the Republic of Serbia 2001-(first quarter) 2019. (value in million $)

	Total			**EU**			**CEFTA**			**Russian Federation**		
	Export	**Import**	**Balance**	**Export**	**Import**	**Balance**	**Export**	**Import**	**Balance**	**Export**	**Import**	**Balance**
2001	317	453	-136	170	168	2	114	124	-10	-	-	-
2002	534	549	-15	216	215	1	208	84	124	-	-	-
2003	651	582	-69	285	228	57	228	93	135	-	-	-
2004	866	823	42	441	390	51	360	116	244	2	1	1
2005	943	790	153	495	257	238	420	125	295	2	1	1

	Total			EU			CEFTA			Russian Federation		
	Export	Import	Balance	Export	Import	Balance	Export	Import	Balance	Export	Import	Balance
2006	1.265	905	360	580	363	217	613	220	393	7	3	4
2007	1686	1116	570	727	647	80	760	563	563	55	35	20
2008	1957	1468	489	796	641	155	1022	308	714	79	26	33
2009	1945	1308	637	629	551	375	895	288	607	65	33	32
2010	2241	1036	1205	1099	431	668	964	254	710	129	21	105
2011	2700	1400	1300	1296	658	638	1161	280	881	165	47	118
2012	2718	1473	1245	1396	744	652	1047	317	730	164	44	120
2013	2800	1564	1236	1351	831	520	1084	306	778	189	57	132
2014	3068	1639	1429	1505	1027	478	1024	201	823	312	60	252
2015	2865	1489	1376	1367	948	419	920	173	747	270	46	224
2016	3211	1551	1660	1541	941	600	1252	140	1112	321	48	273
2017	3179	1830	1349	1622	864	758	890	146	744	318	37	281
2018	3364	3026	1138	1716	1297	419	941	162	779	370	41	329
2018 (I-III)	745	524	221	381	335	46	209	42	167	82	10	72
2019 (I-III)	834	515	319	425	330	95	234	42	192	92	6	51

Source: Republic Bureau of Statistics, Foreign Trade Statistics, Report, no. 116, year LXIX, 30.04.2019.

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. They also need a greater impact in making decisions related to agricultural development and development of rural infrastructure.

As for the purchase of agricultural and food products in our country, in the study (Kovljenić, et al., 2016) there were analyzed the predictors that affect the purchase of these products. The sample of 201 respondents from the territory of the Republic of Serbia and the results of the study show that gender, financial situation and price represent a significant predictor of the purchase of agricultural and food products in the Republic of Serbia.

In a survey carried out by researchers *Slow Food* from Velika Plana during December 2018, there were 67 agricultural producers interviewed who are engaged in production and processing of agricultural and food products in the region of Branicevo-Podunavlje. The producers interviewed mainly get inputs/raw material from the producers from the places they live in (71,62%), exclusively from own production capacities or from the nature. There is 13,51% of them who obtain raw materials for production from the producers from the region (or up to 200km distance). In addition, Serbia was mentioned as supply market by 13,51% of the respondents. Raw materials for product are imported by 1,35% interviewed producers only. When it comes to the technology of production that the respondents in the study mentioned apply, it was found that producers who use traditional technology and machines are the ones who dominate (68,7%). Partially modern process with modern machines is present in case of 16,4% interviewed producers, technology and machines that are old 10 years or more are present in case of 7,5% producers, and the same number of producers possess entirely modern process with modern machines (Radić-Jean &Mihajlović, 2019). 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 his 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 have a 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) show that farmers are mainly interested in Facebook and YouTybe, 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.

Conclusion

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 (Maksimović et al., 2019; Dašić et. al, 2020; Leković et al., 2020) and ecological balance. Having in mind that Serbia is rich in agricultural land it has a required precondition for an enormous potential of growth of export of agricultural food products, although the situation for many years was such that our country was mainly the country of the import. With an insight to the available relevant statistical data and by the analysis of empirical studies in our country, we believe that the main direction of future development of agriculture and food industry of Serbia must be directed towards optimal usage and preservation of available production capacities, increase of the scope of agricultural production, as well as change of production structure in favour of intensive productions meant for the export, production of high-final and high-quality products. All of this due to settle domestic supply and significantly increase the export of high quality agricultural and food products.

Subsidizing the inputs in agricultural production is a condition for cheapening of production, and thus a more competitive export. Therefore, it is required to strengthen the farmers and give them greater stimulants in the aspect of different tax reliefs and cheap long-term loans and subsidies, in order to keep people in the villages and thus prevent the village from dying. The increase of export in our country in addition to everything above-mentioned is reflected in the possibility to form a recognizable "product brand" "Made in", i.e. "Product of" which will guarantee a high quality of products and by which the products of our country will be recognized in foreign markets. In that context, some agricultural and food products of the Republic of Serbia who have this potential, among other things are: plum brandy, wine, plums, raspberries, sour cherries, mushrooms, greaves, kaymak, Zlatibor prossciutto, etc. however, in order to achieve that and for our products to be well-known and available to all countries in region, and widely, we must continuously work on quality because that is precisely the path to brand creation.

The next step refers to the increase of the level of agricultural production by applying modern technologies and tracking trends in the world. Here we primarily refer to the application of innovative procedures in agriculture and application of modern marketing concepts, such as application of Internet and social networks, and all of that in order to promote agricultural products and understanding their importance for nutrition of both people and animals.

The sector of agriculture and food products has an exceptionally important role in the development of a country and the creation of competitive agricultural market can greatly contribute to strengthening of export potential of domestic economy. The export can be increased only by greater production, and it will also reduce the import. Since the Republic of Serbia faces a long-term deficit of trade balance, the improvement of foreign trade with agricultural and food products becomes necessary. In this manner, it is required to radically change the structure of export in order to increase the competitiveness of these products and eliminate the constraints that are the result of low work productivity, inadequate agricultural policy in the last decade and lack of funds to invest in the sector of agriculture. The mentioned measures would affect the growth of gross domestic product (GDP), aggregate demand, as well as total export of agricultural products. The hypothesis that with bigger investments in agricultural holdings Srbia will acheive significant economic growth, increase employment in rural areas and provide ecological equilibrium is proven with all cited above.

Conflict of interests

The authors declare no conflict of interest.

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RURAL DEVELOPMENT POLICY ON AREAS WITH NATURAL CONSTRAINTS IN THE REPUBLIC OF SERBIA

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A R T I C L E I N F O

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A B S T R A C T

The aim of the research is to present the main challenges of Serbian agricultural policy towards areas with natural constraints in terms of delimitation, available measures and budgetary support. The methodological framework includes: descriptive statistics of areas with natural constraints, a qualitative analysis of strategic and programming documents and a quantitative analysis of budgetary transfers to agriculture. The results have revealed that a significant share of agricultural resources are concentrated in the areas with natural constraints, but, despite this fact, there is no specific measure for farms located in these areas. The implemented support measures are more oriented towards economic aspects, while other aspects such as promotion of sustainable farming practices and maintenance of the countryside are neglected. The Serbian policy towards areas with natural constraints needs to be more harmonized with the European policy (in terms of delimitation and support), and tailored to the specific needs of farmers in these areas.

Introduction

Problems related to the development of agriculture and rural areas in the areas with natural constraints have been in the focus of policy makers, as well as scientists for decades. Poor quality of soil, isolation, difficult market access, are some of unfavourable spatial factors that have negative impact on number, structure and economic performance of family farms in the areas with natural constraints. Areas with natural constraints face depopulation, abandonment of agricultural land with an accompanying risk of biodiversity loss (Giesecke et al., 2010; Keenleyside, Tucker, 2010). Since the mid-1970s, the European Union (EU) has provided special support schemes for farmers in the areas with less favourable conditions for farming (Less Favoured Areas – LFA). The original objectives of the LFA policy were aimed at solving socio-economic problems of rural areas (primarily migration and income disparities). In the early 2000s the focus has shifted to the environmental and sustainable

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development goals (sustainable agricultural practices and preservation of villages with a continued use of agricultural land) (Council Regulation (EC) No 1698/2005; IEEP, 2006). The view that LFA policies should give priority to sustainable agricultural practices rather than socio-economic dimensions has remained relevant in the following programming periods. The reviews of the LFA policy highlight the unequal treatment of beneficiaries arising from diversity of delimitation criteria of LFA across countries (Zawalińska et al., 2013). This criticism influenced the need for uniformity of delimitation criteria in the new programming period of the Common Agricultural policy – CAP (2014-2020). In this context, in 2013 the LFA areas were renamed to areas with natural constraints (Areas Facing Natural or Other Specific Constraints – ANC) and classified into three groups: a) mountain areas; b) areas with biophysical constraints and c) areas with specific constraints (Council Regulation (EC) No. 1305/2013).

In Serbia, the regional characteristics of agriculture, heterogeneity of natural resources and diversity of farm types are inconsistently treated by agricultural policy. The support schemes have not had clear objectives, procedures and mechanisms, so their effects have remained modest (Bogdanov, 2014). In order to prevent the socio-economic marginalization of rural areas, degradation of rural landscape, as well as to harmonize the Serbian agricultural policy with modern EU practices, the strategic and program documents which regulate the current agricultural policy of Serbia provide special solutions for farms in areas with difficult working conditions in agriculture (ADWCA). However, the rural development policy towards ADWCA is not without controversy, both in terms of the chosen support schemes and in terms of the current delimitation of the areas.

The aim of the paper is to overview the key challenges of the agricultural and rural policy in Serbia towards areas with natural constraints, in the following manner:

a) analysis of the current criteria for delimitation of ADWCA in Serbia;
b) determining the importance of ADWCA for Serbian agriculture;
c) analysis of the agricultural policy measures aimed at ADWCA in the 2013-2018 period; and
d) analysis of budgetary transfers for agriculture by pillars and groups of measures (changes in the amount and structure of the budget) in the 2013-2018 period.

Materials and methods

In order to achieve the set of research goals, the methodological approach included:

a) Descriptive statistical analysis used for describing the importance of ADWCA for Serbian agriculture. The analysis was based on the available data[2] of the 2012 Census of Agriculture at the settlement level.

2 Some data of the 2012 Census of Agriculture at the settlement level were not fully available for analysis (number of farms with different types of livestock, data on livestock units – LSU and data on farms with other profitable activities) because the data for settlements with three or fewer than three farms were not published.

b) Qualitative content analysis of the strategic and program documents regulating the current agricultural policy framework. Attention was primarily focused on the contents of the annual regulations on the allocation of subsidies in agriculture and rural development and rulebooks on conditions and way of exercising the right to support for particular measures for the 2013–2018 period.

c) Quantitative analysis of budgetary transfers by policy pillars and groups of measures was based on the data on the agricultural policy measures implemented in Serbia (Agricultural Policy Measures Database – APM)[3] in the 2013–2018 period.

Results and discussion

Definition and delimitation of ADWCA in Serbia

Serbia has a long tradition of policy towards the areas of natural constraints. In the era of the Socialist Federal Republic of Yugoslavia (SFRY), there were numerous funds, programs and political documents that recognized regional disparities and heterogeneities regarding natural resources, organizational and economic characteristics of agricultural production[4]. However, the effects of these programs were failed to create a significant impact. Namely, the mechanisms for the implementation of policies related to rural and balanced territorial development were not sufficiently coherent, stable and sustained (Bogdanov, 2007).

The ADWCA in Serbia were defined in 2010 Regulation on Areas with difficult working conditions in agriculture (ADWCA) as: "… *areas where due to natural, social or legal constraints there are no conditions for intensive development of agricultural production*" (Official Gazette of RS, No. 3/2010; 6/2010; 13/2010). The criteria used for the ADWCA delimitation included three categories: 1.settlements above 500 ma.m.s.l. according to the data of the Republic Geodetic Authority; 2. settlements within natural parks determined by the Law on National Parks; 3.settlements in the territory of municipalities with fewer than 100 employees/1,000 inhabitants according to the data from the publication Municipalities and Regions of the Republic of Serbia in 2015, published by the Statistical Office of the Republic of Serbia (SORS) (Official Gazette of RS, No. 39/16). Based on these criteria ADWCA covered settlements of 93 municipalities, which are grouped into two groups – mountain and other ADWCA.

The third criterion for the delimitation of ADWCA was changed in 2018 (Official Gazette of RS, No. 102/18), and now covers the territory of devastated municipalities

3 The classification of measures according to the APM system is a combination of the EU program of measure classification and the classification of the Organization for Economic Development and Cooperation (OECD) (Rednak et al., 2013). Data for Serbia were collected by Bogdanov et al. (2017).

4 Fund for the development of undeveloped regions of the SFRY (1965); Green plan (the early 1980s); Programme for Enhancing Agricultural Production and Rural Living Standards (1988) in 1992 renamed to the Programme for the Revitalisation of the Villages.

in accordance with the *Decree* on *establishing* the *unique list* of *development* of the *region* and *local self-government units* for *2014* (Official Gazette of RS, No. 104/14). ADWCA now cover the territory of 90 municipalities and they are divided into two groups (mountain areas and other areas).

The delimitation of ADWCA in Serbia is not in line with the EU methodology for the demarcation of ANC. Namely, only the criteria related to the delimitation of mountain areas in Serbia is equivalent to the EU criteria. Recent studies have examined the possibility of applying biophysical criteria for the delimitation of ANC in Serbia. Zdruli et al. (2017) argued that before applying the EU methodology in Serbia it was necessary to check the availability and quality of data. On the basis of these analyses, it is possible to require changes in the EU methodology and to take into account the specifics of every country.

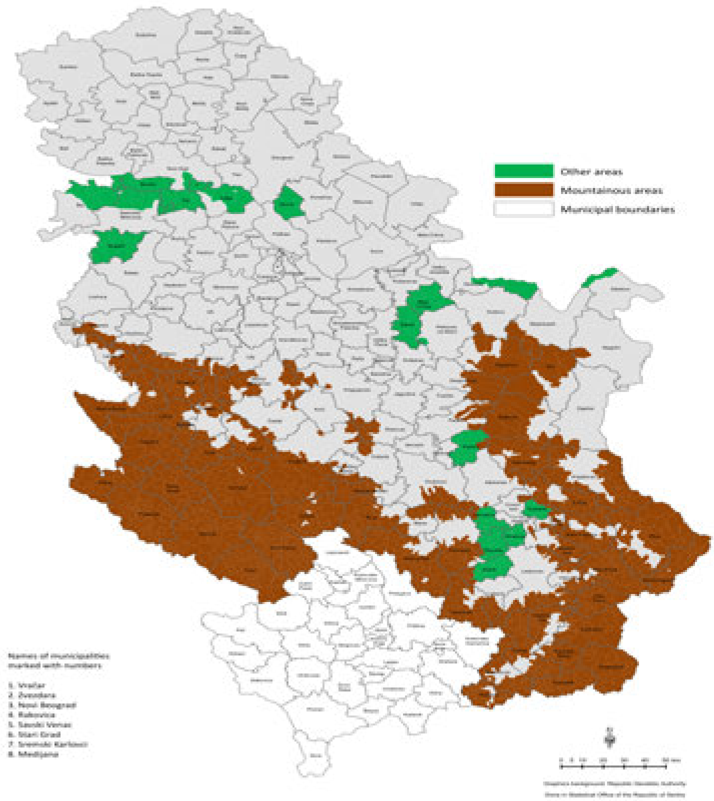
In this paper, the delimitation of ADWCA in Serbia was based on the list of settlements defined by the Regulation from 2016 (Figure 1). The Current Regulation for defining ADWCA came into force in 2019, when the mapping had already been completed. Changes from the new Regulations are mainly related to other settlements[5] whose delimitation criteria are not equivalent to the European ones. Also, the largest percentage of the ADWCA territory in Serbia belongs to mountain settlements (89%)[6].

Map 1 show that ADWCA are dominant in the region of Šumadija and Western Serbia and in the region of Southern and Eastern Serbia. In the region of Šumadija and Western Serbia, the total territory of three districts belongs to mountain areas (Zlatiborski, Raški and Moravički), while in the region of Southern and Eastern Serbia, ADWCA have been identified in all districts (Figure 1).

5 Other areas now include the entire territory of the devastated municipalities, and the following municipalities have been removed from the previous list: Bogatić, Doljevac, Žabari, Malo Crniće, Niš - Pantelej, Opovo and Ražanj (Official Gazette of RS, No. 102/18).

6 In the Regulation, some settlements are grouped into mountainous, as well as into other settlements. On the map, these settlements are marked as mountainous, given that mountainous areas are in line with the EU delimitation.

Figure 1. Areas with difficult working conditions in agriculture in Serbia (Official Gazette of RS, No. 39/16)



Source: Graphics background: Republic Geodetic Authority, done in SORS; Papić (2021)

Significance of ADWCA for Serbian agriculture

In Serbia 28.6% of farms are located in ADWCA and they used 22.8 % of the utilized agricultural area (UAA). More than half of the Serbian UAA under permanent grasslands is concentrated in ADWCA (53.0%), which indicates that these areas are characterized by low-intensity farming systems and the preserved ecosystem (*Table 1*). A significant percentage of the areas under permanent crops (35.2%) is registered in ADWCA (*Table 1*). Around 69.0% of the total area under permanent crops is under raspberries, which gives special importance to ADWCA, considering that raspberry is the most represented fruit species in the structure of Serbian agricultural exports (Census of Agriculture 2012; Božić, Nikolić, 2016). Farms in ADWCA are characterized by a low share of leased land, especially the land that is paid in cash or in kind (*Table 1*). The land in hilly and mountainous areas is not suitable for crop production, therefore it is less attractive for agricultural activities. Also, due to the fragmented area, there is not much interest in leasing land for perennial crops in these areas (Ševarlić, 2012).

In ADWCA is concentrated 37.1% of the total number of sheep[7] and 30.3% of the total number of goats in Serbia (*Table 1*). These data are expected considering that the traditional centers of sheep and goat production are mountainous areas whose land structure is dominated by meadows and pastures. A cattle breeding is the most important branch of animal husbandry in Serbia, especially for small and medium family farms. Therefore, it is important to note that ADWCA encompass 29.6% of the total cattle number in Serbia (Table 1). Also, significant capacities for beekeeping are registered in these areas, while pig and poultry production are less represented in ADWCA (*Table 1*).

In 2012, the total percentage of people employed on farms in ADWCA was 36.7%, i.e. 28.8% annual working units (AWU) (*Table 1*). Also, a quarter of the seasonal labour force (expressed in AWU) was concentrated in ADWCA (Census of Agriculture, 2012).

Table 1. Significance of ADWCA by share in agricultural resources, 2012

Indicators	Serbia	ADWCA	% ADWCA Serbia=100%
Number of farms			
Total number of farms (000)	631.6	180.2	28.6
Farms with livestock (000)	497.8	138.4	27.8
Land resources			
Total available area (000 ha)	5,346.6	1,394.4	26.1
Unutilized agricultural area (000 ha)	424.1	172.2	40.6
Wooded area (000 ha)	1,023.0	386.2	37.8
Utilized agricultural area (000 ha)	3,437.4	784.9	22.8
of which: Arable land and kitchen gardens (000 ha)	2,513.2	335.4	13.4
Permanent crops (000 ha)	187.3	66.0	35.2
Permanent grassland (000 ha)	713.2	377.9	53.0
Leased land (000 ha)	1,019.0	131.1	12.9
Land lease in cash or in kind (000 ha)	875.2	86.1	9.8
Land lease for free and others models of use (000 ha)	143.8	45.0	31.3
Livestock fund			
Cattle (000)	908.1	268.3	29.5
Goat (000)	231.8	70.3	30.3
Sheep (000)	1,736.4	644.3	37.1
Hives (000)	668.1	205.7	30.8
Horses (000)	16.9	5.3	31.2
Pigs (000)	3,407.3	532.7	15.6
Poultry (000)	26,710	2,984	11.2
Indicators	**Serbia**	**ADWCA**	**% ADWCA Serbia=100%**
Agricultural labour			
Number of persons (000)	1,442.6	529.8	36.7
Annual work units - AWU (000)	646.3	186.2	28.8

Source: The author's calculation based on the Census of Agriculture 2012; Papić, 2021

7 The only data at the settlement level that provide insight into the livestock fund in ADWCA are data on the physical number of livestock.

The policy response to challenges in ADWCA

The first attempts to adapt agricultural and rural policy measures to the European practices towards areas with natural constraints started by introducing incentives to “marginal areas” as the equivalent of ANC (Bogdanov, 2014). In the 2006-2013 period farms were supported by a bigger share of grants in the total value of the investment in the modernization of agricultural holdings, restructuring of permanent crop plantations and creation of new businesses, i.e.by 10-20% more than farmers outside ADWCA. In addition, farmers from ADWCA were constantly supported through the dairy premium[8].Until 2008, they received higher amounts of dairy premiums than farms located in lowland areas. After 2008, a lower threshold for milk delivered to dairies was introduced for farmers in ADWCA. According to Bogdanov (2014), the implemented measures were aimed more at the economic objectives than at social objectives, while environmental objectives were not in focus at all. Also, the measures were not focused on specific regional problems, and the projected amount of own financial contribution was too high for most farms in ADWCA, which resulted in a small number of applications from these areas (Bogdanov, 2014).

In the Strategy of Agriculture and Rural Development of the Republic of Serbia for the period 2014-2024, one of the priority areas of agricultural and rural policy is preservation of agriculture production, natural resources and population in ADWCA. The priorities related to ADWCA are: a) preserving and strengthening the social vital structure in ADWCA; b) achieving equal economic conditions for farmers in ADWCA and farmers outside ADWCA; c) preserving pastures as a critical component of the agricultural landscape (Official Gazette RS, No. 85/2014).

Review of the measures of the agricultural and rural policy in the 2013-2018 period (*Table 2*) shows that farmers in ADWCA are support by a lower threshold when they apply for direct payments and by higher returns on investment when they apply for the rural development support. Also, the scoring scale used in evaluation of rural development project predicts special benefits for the applications from ADWCA.

Regarding *direct payments*, farmers in ADWCA were supported by the dairy premium and payments for quality breeding sheep and goats (*Table 2*). Regarding the *rural development support*, farmers were supported by a bigger share of grants in the total value of the investment (15-20% more than farmers outside ADWCA). This refers to the measures for improving competitiveness of agro-food sector and measures for supporting rural economy and population. Also, farmers from ADWCA had additional points when applying for measures related to rural economy and population (*Table 2*). By reviewing the rural development support, we can notice that farmers in ADWCA were not supported by the measures aimed at providing environmental and societal benefits. In addition, these groups of measures were not diverse in Serbia. Measures for organic production and measures for the preservation of plant and animal genetic resources were the only measures implemented by the Directorate for Agrarian Payments.

8 This measure was implemented in Serbia in 1970 and was intended for farmers in marginal (hilly and mountainous) areas.

Since 2017 and 2018, special benefits for farmers in ADWCA have been provided by *credit support* and *IPARD* (Instrument for Pre-Accession Assistance for Rural Development). Although the IPARD measures were not implemented in 2018, they provided benefits for farmers in these areas. Farmers could return 70% of the investment costs if the investment place was in the mountainous area (Measure 1) and applications from mountainous areas had additional points (Measure 1 and Measure 3) (*Table 2*).

Table 2. Agricultural and rural development support targeting ADWCA

Measures	Description	2013	2014	2015	2016	2017	2018
Direct payments							
Dairy premium	Lower threshold of milk delivered to dairies	Min. 1500 l per quarter	Min. 1500 l per quarter	Min. 1500 l per quarter	Min. 1500 l per quarter	Min. 1500 l per quarter	Min. 1500 l per quarter
Incentives on quality breeding sheep	Lower threshold for minimal number of animals on farm	-	-	-	-	-	Min.10 sheep
Incentives on quality breeding goats	Lower threshold for minimal number of animals on farm	-	-	-	-	-	Min. 5 goats
Rural development support							
Measures for improving competitiveness of agro-food sector							
Investments in physical assets	Grant for raising new perennial plantation	45%	55%	55%; 65%*	55% ; 65%*	55%	65%
	Grants for improvement primary agriculture production (new tractor, mechanization, farm buildings, equipment, breeding animals, etc.)	55 %	55 %	55 %; 65%*	55 %; 65%*	65 %	65 %
Investment in processing and marketing of agricultural products	Grants for improving the quality of wine and brandy	45%	45%	55%; 65%*	55%; 65%*	55%	55%
	Grants for control stamps for agro-food products and wine registration stamps	45%	/	55%; 65%*	55%; 65%*	55%	65%
Investment in processing and marketing of agricultural products	Grants for purchase equipment – meat, milk, fruit, vegetables and grapes sector	/	45%	55% ; 65%*	55% ; 65%*	65%	65%

Measures	Description	2013	2014	2015	2016	2017	2018
Insurance premium subsidy on crops, fruit crops, perennial plantations, nurseries and animals	Reimbursement of insurance premium costs	-	-	-	45%	45%	45%
Measures supporting rural economy and population							
Non-agricultural activities	Grants for facilities and equipment	45%	45%	55%	55%	65%	65%
	Additional points	-	-	-	10	10	10
Young farmers	Additional points	/	/	/	/	20	20
Adding value to agricultural products	Grants for introduction and certification of food safety and food quality systems, organic products and products with geographical indication	-	45%	55%	55%	65%	65%
Credit support	Subsidized interest rate	/	-	-	-	+	+
IPARD							
Measure 1	Reimbursement of investment costs	/	/	/	/	70%	70%
	Additional points	/	/	/	/	25	25
Measure 3	Additional points	/	/	/	/	20	20

Note: (-) No special treatment for farms in ADWCA; (/) Measure did not exist or was abolished; (*) For authorized users of geographical indications or certified organic production.

Source: The author's elaboration based on regulations and rulebooks governing the implementation of agricultural and rural policy measures; Papić (2021)

The analysis of the agricultural and rural development support showed that in the 2013-2018 period a number of measures aimed at ADWCA increased in relation to the period before 2013.This indicates that policy makers were trying to take into account the difficult situation of farmers in these areas. However, a specific measure for farmers in ADWCA does not exist, which is a big failure of the Serbian agricultural policy from the perspective of the balanced territorial development. The introduction of a specific measure for farmers in ADWCA could fulfill not only economic objectives but also other objectives such as environmental protection and maintenance of the population.

In order to achieve such complex goals, it will be necessary to adapt the ADWCA support to the prevailing types of production in these areas, location of the farm, as well as the ability of farmers to create additional activities (Doucha et al, 2012). Zdruli et al. (2017) highlight that decision makers need to set certain priorities when creating and implementing ANC payment schemes (based on natural and socio-economic conditions) and that it is necessary to pay attention to areas with a high risk of abandonment.

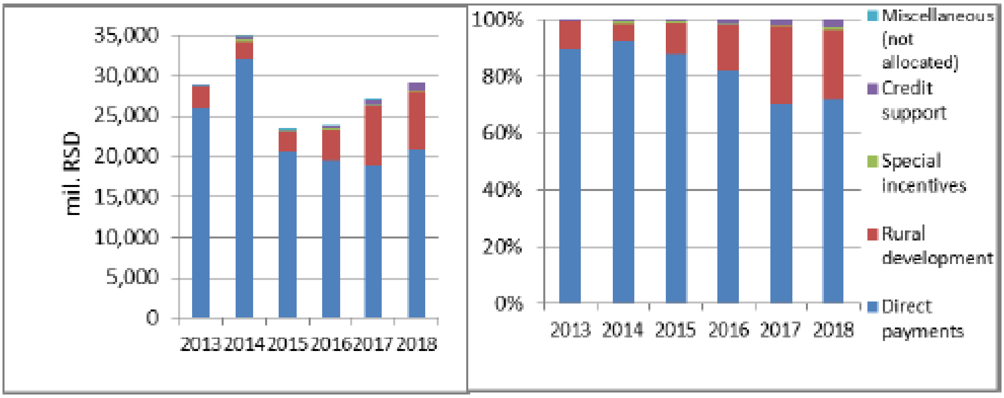
Previous research emphasizes that different forms of payments related to the preservation of the environment (agri-environmental payments, Natura 2000, cross-compliance requirements, etc.) have a positive effect on income, land use and maintenance of population in the ANC (IEEP, 2006; Klepacka-Kołodziejska, 2010; Štolbová, Molčanová, 2009). Keenelyside et al. (2010) highlight that the support for the renewal of traditional pastoral systems and maintenance of High Nature Value (HNV) farming could improve biodiversity and landscape in mountainous areas and therefore should be introduced in Serbia.

Budgetary support for agricultural and rural development

In Serbia there is no the evidence on amount of agricultural and rural development budgetary funds allocated for the ADWCA farmers. However, trough the analyses of budget allocation by pillars and groups of measures we can indirectly examine use of measures targeting ADWCA farmers.

The structure of the *total budgetary support to agriculture* in Serbia indicates that the approach on which the agricultural policy is based has not been fully implemented (*Figure* 2). Namely, up to 2016, the largest part of budgetary funds was realized on the basis of the direct payments support (70-90%), while the share of rural development support was extremely modest (it did not exceed 16.0%). The share of rural development measures in the total budget increased in 2017 and 2018 (27.3% in 2017 and 24.2% in 2018). This was caused by the increase in the funding of new measures for improving the competitiveness (purchase of tractors, equipment, machinery and quality breeding heads). The funds implemented for the credit support and special incentives accounted for less than 5.0% of the agricultural budget, but their share was constantly growing during the analyzed period (*Figure 2*).

Figure 2. Budgetary support for agriculture and rural development in Serbia, 2013-2018



Source: The author’s calculation based on the APM database - Serbia

Up to 2016 the structure of *direct payments* most commonly included the incentives for production and input subsides. In 2018 there were no more realized funds for input subsidies, and the incentives for livestock production (46.0%) had the biggest share in the direct payments support followed by payments for crop production (29.0%) and milk premiums (25.0%). It is obvious that in the analyzed period the share of support for crop production was reduced, while the share of support to livestock producers increased (Figure 3).

Figure 3. Budgetary expenditure for direct payments in Serbia, 2013–2018.

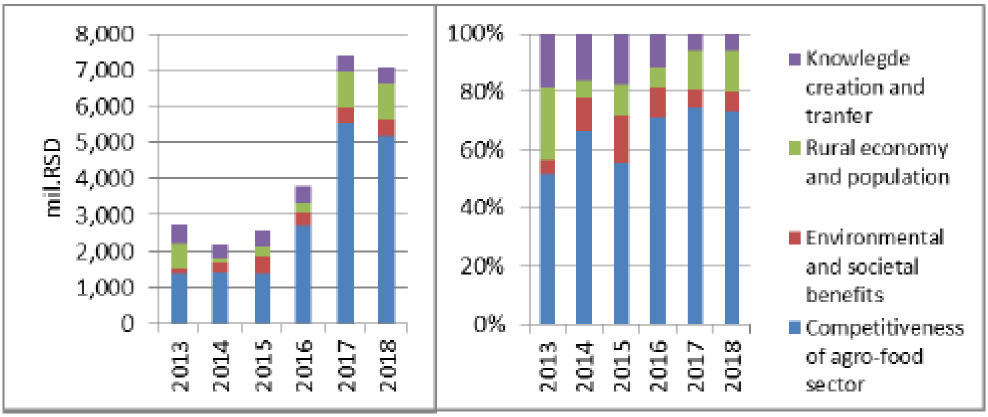
Source: The author's calculation based on the APM database - Serbia

The realized funds *for rural development measures* increased significantly in the analyzed period, especially in 2017 .and 2018 (186.0%; 172.0% in relation to 2013) (*Figure 4*). This was caused by the increased funding of measures for improving competitiveness. The structure of the realized funds indicates that in the whole period the measures for improving competitiveness were dominant (from 51.5% in 2013 to 73.0% in 2018), especially those related to the investments in physical assets. The composition of funding for the rural development policy in Serbia is incompatible with the composition in the EU, where measures for improving competitiveness represent less than a third of funds for rural development (Volk et al, 2019). The realized funds for providing environmental and societal benefits increased in the analyzed period, and their share in the total funds for rural development varied from 5.0% to 17.0%. Implemented by the Directorate for Agricultural Land and the Forest Directorate, the measures for sustainable land use (mainly land fertility control measures) and measures for sustainable forest use (mainly measures for planting forest trees) had the largest share in the funds for improving the environment and countryside. Regarding the measures implemented by the Directorate for Agrarian Payments, up to 2017 the measures for organic production were more frequently implemented than the measures for the preservation of genetic resources. After 2017, the share of both measures in the structure of the realized funds became equal (around 25%) (APM database – Serbia). The current implementation of rural policy measures shows that the environmental aspects of rural areas are marginally supported by the Serbian policy, which is a contrast to the EU policy. In the EU, more than half of the total rural development policy funds are devoted to the measures for improving the environment and countryside and about half of these are ANC measures (Volk et al., 2019).

The realized funds for supporting rural economy and population increased in the analyzed period, and their share in the total rural development support varied between 5.0 and 25.0%. Up to 2017 over 65% of the realized funds were aimed at the measures for the improvement of the dual-purpose sewage system and measures for forest roads, which were implemented by the Directorate for Agricultural Land and the Forest Directorate. After 2017 the support for young farmers had the biggest share in the realized funds (46.0% in 2017 and 52.0% in 2018) (APM database – Serbia). Implementation of the budgetary support showed that these measures were not sufficiently represented in the current implementation of policy support. Therefore, in the future more attention should be paid to mechanisms that will improve the implementation of this support.

The share of incentives for improving the system of knowledge creation and transfer in the total funds for rural development decreased from 18.0% to 6.0% (*Figure 3*). The measure aimed at improving advisory and professional work had the largest share in the realized funds (*Figure 4)*.

Figure 4. Budgetary expenditure for rural development support in Serbia, 2013-2018



Source: The author's calculation based on the APM database – Serbia

Implementation of the budgetary support for agriculture and rural development showed that rural development measures are not used on a large scale, especially those that aim to address social and environmental problems. The same was shown in the previous research conducted by Bogdanov et al. (2017) and Volk et al. (2019). The low implementation of the mentioned rural development support indicates that the criteria and thresholds for achieving this development support are probably set at a high level and not adapted to the specific needs of farmers (especially those in ADWCA). In ADWCA where infrastructure is not developed and farm holders do not have enough skills and resources, it is difficult to implement measures for rural economy and population. The support for young farmers is intended for farmers under the age of 40, which makes this support unavailable for farm holders in ADWCA facing rapid population aging. The current measures for providing environmental and societal benefits are not focused on the preservation of pastures, which is inconvenient for farms in ADWCA where half of Serbian permanent grasslands is concentrated. Also, previous research indicates that complicated procedures and lack of funds to co-finance the rural development investment discourage farmers (especially those from ADWCA) from applying for the rural development support (Kotevska et al., 2015; Papić, 2021).

Conclusion

The research results showed that delimitation criteria of ADWCA align with the EU approach in just one criterion – mountain areas. Considering that these areas occupy the biggest parts of ADWCA in Serbia, it is expected that numerous farms would benefit from the ANC support. For the same reason we can conclude that the creation of the ANC policy is one of crucial challenges for the Serbian agriculture.

The analysis of the current strategic and program documents of agricultural and rural policies in Serbia showed that preservation of farming, provision of public goods associated with environment, and retention of population in ADWCA were one of the priority areas, as well as that certain agricultural and rural measures provided special benefits for farms in ADWCA. However, the lack of a specific measure to support farmers in ADWCA is still a big deficiency of the Serbian agricultural policy having in mind the regional diversity in the country, unfavorable production conditions in mountainous areas, depopulation and negative changes to the ecosystems in rural areas.

Implementation of the agricultural and rural budgetary support indicates that environmental and societal concerns are marginally supported by means of the existing measures. This finding is unfavorable for ADWCA where these types of measures are necessary for the promotion of land use, agricultural employment and preservation of rural landscape. In order to create adequate ANC policies, it is necessary to consider the country's specifics and to tailor the policy support to different characteristics of farm types, farming practices and potential for diversification in ADWCA. Also, it is requisite to simplify the application procedures and facilitate the access to finance in order to increase the use of the existing rural development funds.

Conflict of interests

The author declares no conflict of interest.

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AN INTERNATIONAL SURVEY ON FACTORS AFFECTING SELF-EMPLOYMENT INTENTIONS AMONG STUDENTS OF AGRICULTURE AND LIFE SCIENCES

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ABSTRACT

In this study, we investigated the dependence of self-employment intention (SEINT) level in agricultural students from Croatia, Poland, Slovakia and Serbia on selected personal traits and country macroeconomic indicators. The results show that the SEINT level depends on student's perceived desirability of self-employment and perceived self-efficacy. Previous experience with entrepreneurship also affects SEINT. In terms of macroeconomic indicators, higher GDP per capita has been shown to have a positive effect on SEINT, while unfavorable conditions of starting a business have a negative impact.

Students from Novi Sad (Serbia) showed higher average SEINT level compared to students from Croatia (Zagreb) and Slovakia (Nitra).

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Introduction

Entrepreneurship is a direct consequence of the self-employment, an act of individuals who chose to create employment and income for themselves. Although self-employment and entrepreneurship are closely related and often used as synonyms, these concepts differ in their meaning. The main difference is that entrepreneurship, in the narrow sense, is a special form of self-employment characterized by innovation and high long-term growth rate. This is important to emphasize in order to understand the high level of self-employment in less developed countries where people go for self-employment because they have no alternative. Due to the relationship between the level of self-employment, entrepreneurship and economic growth, all developed societies seek to create a favourable climate, and to encourage self-employment and entrepreneurship. In doing so, a special attention is paid to young people, some of whom are entrepreneurs of the future. In this context, the Council of the European Union (2014) also points out in its conclusions that entrepreneurship of young generations, based on creativity and innovation, promotes economic growth and alleviates the problem of unemployment.

There are several reasons why students are often the subject of entrepreneurial behaviour research. The first is the fact that today's students are the future leaders of social and business developments and as such, they are the subject of interest in entrepreneurship research. Second, and not least, higher education institutions are largely engaged in research work. Therefore, student questioning is a convenient choice for them.

The main objective of this research is to examine the relationship between students' self-employment intention and two predictors: personal desirability of self-employment and perceived self-confidence in self-employment abilities. The research is based on the modified intention model developed by McStay (2008), who refers to models of Shapero and Sokol, and Ajzen. These models have been used in similar researches (Shapero, Sokol, 1982; Ajzen, 1991; Gardner, Pierce, 1998; Venesaaret al., 2007; Juračak, Tica, 2016). In addition we use the results of the survey to compare students of different gender as well as from different countries with respect to their self-employment intention.

In addition to the main objective, we upgrade the model to test if variations in the level of self-employment intention are caused by selected social and economic variables, namely:

- Previous experience in entrepreneurship or self-employment;
- The national GDP per capita;
- The national unemployment level;
- The conditions for starting a business venture in a country.

Related to the stated goals, the following research hypotheses were tested:

- There are significant differences among students from different countries with respect to the self-employment intentions;

- Perceived desirability of self-employment and perceived personal efficacy with respect to self-employment are significantly correlated with self-employment intention.

Socio-economic factors like previous entrepreneurial experience and economic situation in a country influences students' self-employment intentions.

Literature review

A number of studies and publications over the past few decades, confirms the importance of entrepreneurship and small businesses for economic growth and income (Hisrichet al., 2008, Forsman, 2011, McKeever et al., 2014). Self-employment and entrepreneurship are specific forms of human behaviour. That is why these phenomena have been the subject of research for decades by psychologists, sociologists, and economists who seek to understand and explain them. In this respect, a number of behavioural models, mainly based on the Theory of Planed Behaviour (TPB), have been developed to find out how and why certain behaviour occurs in individuals. These are cognitive models that are largely used to explain the connection between attitudes, norms, intentions and actual behaviour (Shapero, Sokol, 1982; Ajzen, 1991; Kolvereid, Isaksen, 2006; McStay, 2008). One of the main premises of such models is that expressed behavioural intention is a good predictor of an individual's actual behaviour. Accordingly, a self-employment should be linked to the previous intention of such behaviour.

The intention and the intensity of a particular behaviour with an individual are conditioned by different influences. In his theory of planned behaviour, Ajzen (1991) identifies three major predictors of intention and then behaviour: attitude toward the behaviour, subjective norms, and perceived behavioural control. Shapero's Entrepreneurial Event Model (Shapero, Sokol, 1982), which is more related to this research by topic, defines the following key predictors of an entrepreneurial event: perceptions of desirability, perceptions of feasibility and displacement. In both models, we can see the importance of attitude and perception of feasibility or control, to create behavioural intentional in an individual. In some studies these two factors have been found to be positively correlated with the self-employment intention (Shapero, Sokol, 1982; Gardner, Pierce, 1998; Tretten, 2005; Venesaaret al., 2007; McStay, 2008; Juračak, Tica, 2016). We may say that a person will exhibit a higher level of intent on a particular behaviour if he or she deems it desirable and considered fit to undertake a particular activity.

With regard to other influential variables, authors mainly prove the link between self-employment intention and previous entrepreneurial experience, either personally or through role models (Tkachev, Kolvereid, 1999; Delmar, Davidsson, 2000; Martz et al., 2003; Shaper, Volery, 2004; Tretten, 2005; Majagoro, Mgabo, 2012; Kedmenecet al., 2014; Juračak, Tica, 2016; Siegeret al., 2016). Namely, such experience positively influences the perception of one's own ability but also the perception of entrepreneurship as desirable behaviour.

The correlation between gender and propensity for self-employment has been the subject of several researches. A good number of authors find that men predominate with respect to self-employment (Vecianaet al., 2005; Teixeira, Davey, 2008; Nabi, Walmsley, 2010; Shneoret al., 2013; Buchta, Jakubiak, 2014; Siegeret al., 2016), but there are also those who argue the opposite (Tkachev, Kolvereid, 1999; Hisrichet al., 2008; Stamatovićet al., 2012). However, it seems that the self-employment misbalance by gender decreases continuously during years.

Most of researches conducted so far showed that a relatively large proportion of students have a positive perception of self-employment, high perceived self-efficacy, and a high level of stated intention to self-employment. However, the differences in established proportions are very large from research to research (Tretten, 2005; Venesaaret al., 2007; Teixeira, Davey, 2008; Nabi, Walmsley, 2010; Buchta, Jakubiak, 2014; Łuczka, Rembiasz, 2016; Siegeret al., 2016).

In this research we surveyed students from Croatia, Poland, Serbia and Slovakia. Although they all belong to the same geographical circle, we expect variations in results due to differences in countries' historical developments. This is especially true of recent history, i.e. since the late 1980s. The three countries are EU members, but there is a difference even among them since Croatia only joined the EU in 2013, and Poland and Slovakia in 2004. Serbia has the status of candidate for EU membership. The impact of socio-economic conditions on entrepreneurship stems from the relationship between the expected benefits of self-employment and the best long-term employment alternative. Thus, it is even possible that in less developed countries, the self-employment rate will be similar to that in highly developed countries due to the high opportunity cost of self-employment in the latter (Kedmenecet al., 2014).

In terms of the economic situation, macroeconomic indicators confirm that the situation in Poland and Slovakia is better than in Croatia and Serbia. In terms of GDP per capita, the difference between Poland and Croatia is not large (USD 13,800 to 13,300, respectively), but this indicator is quite higher in Slovakia and lower in Serbia (World Bank, 2018). Another indicator of development is unemployment rate, which is below 10% in Poland and Slovakia and above 10% in Croatia and Serbia.

Furthermore, it is to be expected that a stimulating environment will encourage individuals to become entrepreneurs. According to the World Bank (2018), it is the easiest to start a business in Serbia among the four countries. It means that the regulatory environment is the most conducive to the starting of a local firm in Serbia. The World Bank ranks 190 countries annually with respect to the ease of starting a business. Serbia was ranked the highest among the four countries in 2017 (World Bank, 2018). Accordingly, the highest level of adult self-employment intention was found also in Serbia (GEM, 2017). There is also the highest proportion of self-employed in the total employed in Serbia among the four surveyed countries (World Bank, 2019).

Materials and methods

The data were collected using self-completion questionnaire. The survey was conducted in 2017 on a random sample from four universities in the field of agriculture and related sciences: University of Zagreb Faculty of Agriculture (UNIZG, Croatia); University of Novi Sad Faculty of Agriculture (UNINS, Serbia); Slovak Agricultural University in Nitra (UNINR, Slovakia) and Warsaw Life Science University (UNIWA, Poland). The survey population included all full-time undergraduate and graduate students in each country, and the sample was randomly selected using the systematic sampling technique. The sample structure by university is given in the next table (*Table 1.*).

Table 1. The survey sample size and structure by university

Unversity, Country	Sample size	Proportion in the total sample (%)
University of Zagreb Faculty of Agriculture, Croatia	230	20.07
Warsaw Life Science University, Poland	302	26.35
Slovak Agricultural University in Nitra, Slovakia	429	37.43
University of Novi Sad Faculty of Agriculture, Serbia	185	16.14
Total sample size	1,146	100.00

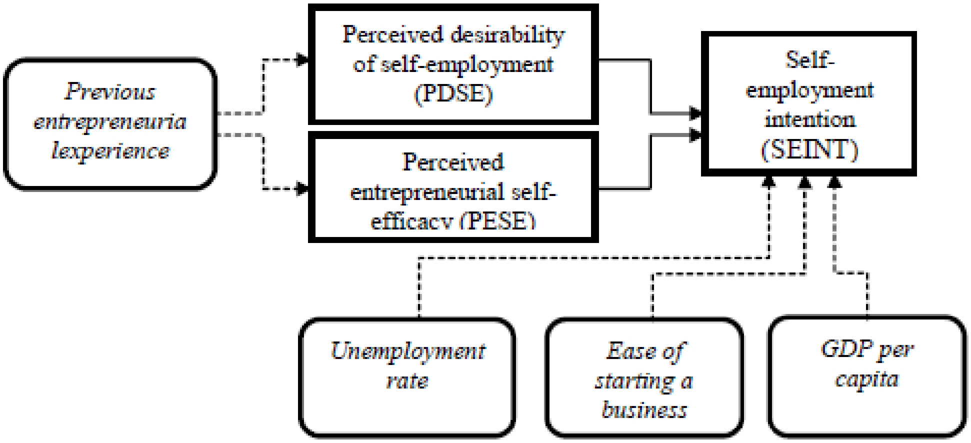
Source: Authors' calculations

The Intention model applied in this paper does not include all the variables used by Shapero and Sokol (1982) andAjzen (1991) in their predictor – behaviour relationship models. Following McStay (2008), in this research we used the basic model consisting of the following three elements:

1. Stated intention for self-employment as a dependent variable (SEINT),
2. Perceived desirability of self-employment as a predictor (PDSE)
3. Perceived entrepreneurial self-efficacy as a predictor (PESE).

The first predictor (PDSE) corresponds to the factor Perceptions of desirability in Shapero's model (1982), and the factor Attitude toward the behaviour in Ajzen's model (1991). The second predictor (PESE) replaces the factor Perceptions of feasibility in Shapero's, and the factor Perceived behavioural control in Ajzen's model. The justification for applying the second factor we can find in the work of Armitage and Conner who found that self-efficacy is more strongly related to behavioural intention than perceived behavioural control.

Figure 1. The applied self-employment intention model diagram



Source: Authors' preparations

In the second step we used the basic model to examine the impact of background factors that are assumed to be related to the predictors of the dependent variable or may have a direct effect on the level of self-employment intention. The following dummy variables are included as background factors:

- Previous experience with entrepreneurship (PEE): high-low;
- National GDP per capita: high - medium – low;
- Unemployment rate: high - medium – low;
- The World Bank Starting a Business Rank: high - medium - low.

The last three variables are included to help explain differences in results between subsamples (i.e. countries). Different statistical procedures explained further in the text were used in accordance with the research problem. Initial analyses concerning the psychometric characteristics of the scales and the description of the sample and the association between the variables were made in SPSS 19.

Measuring instruments

Main three elements of the basic model (perceived desirability of self-employment - PDSE, perceived entrepreneurial self-efficacy - PESE, and self-employment intention - SEINT) we measured using a questionnaire developed according to similar research (McStay, 2008; Juračak, Tica, 2016), which has been translated into local languages for the purpose of this research. Given the possible loss of measurement properties due to translation, particular attention was paid to the psychometric characteristics of the scales and certain adjustments were made to ensure construct validity and internal consistency of the measures used. Construct validity refers to the empirical conclusion about whether a scale measures the target construct, and factor analysis was used as one of ways of testing (Petz, 1981). In doing so, the structure of a homogeneous questionnaire should be one-factor, while for heterogeneous one should obtain as many factors as there are constructs or subscales. In this case the principal component analysis (with varimax rotation) was performed taking into account the Kaiser-Guttman criterion when extracting the factors, and the results were compared with the structure obtained in other studies. The reliability of the internal consistency type examines the particle intercorrelations in the questionnaire, and the Cronbach's α coefficient of internal consistency indicates the percentage of variance explained by the true result with respect to the variance caused by random factors originating from the questionnaire construct (Krkovićet al., 1966). In the case where some particles did not have a high correlation with the total result (meaning they did not have the same object of measurement), they were dropped from the analysis, which increased α coefficient, that is, the homogeneity of the scale.

For all three constructs (PESE, PDSE and SEINT) we used a 1-5 Likert scale, where 1 represents complete disagreement with the assertion while 5 represents complete agreement. The PESE construct initially consists of 16 items, and after adjustments items 2, 4, 13 and 16 were eliminated from the analysis due to impaired homogeneity resulting in a high Chrombach α=0.897 (*Table 2*.). The PDSE construct initially consists of six items. Following the same procedure like with the PESE, items 1, 6, and 4 were ejected, which resulted in the Chrombach α coefficient of α=0.839. The SEINT construct initially had a five-factor. Items 1 and 5 were ejected to get a clear three-factor structure and the Chrombach α coefficient of 0.755 was obtained.

Table 2. Basic statistics for the scales used in the research

Scale	**No. of items**	**Range**	***Me***	***Sd***	***Crombach α***
Perceived self-employment efficacy (PESE)	12	12 – 60	3.63	0.20	0.897
Perceived desirability of self-employment (PDSE)	3	3 – 15	3.98	0.21	0.839
Self-employment intention (SEINT)	3	3 – 15	2.58	0.35	0.755

Source: Authors' calculations

A t-tests was conducted to examine the characteristics of the sample in more details and to obtain information on differences in results with respect to gender. Also, an analysis of variance and a post-hoc Sheffe test were conducted to examine eventual differences with respect country. In order to gain an initial insight into the interrelationship of the variables fitted to the model, as well as to verify another form of scale validity (convergent validity), the correlation analysis among the observed variables was performed.

However, the answers about the causal relationships (direct and indirect) among variables in the model can only be provided by structural equation modelling (SEM). This statistical technique is based on testing the assumptions of particular phenomena (Byrne, 2010), that is, structural modelling theory represents informal processes that observe multiple variables simultaneously (Bentler, 1988). These processes are represented by a series of structural, i.e. regression equations, and are presented in a pictorial way to enable a clearer understanding of the model under consideration. The assumed model is then statistically tested by simultaneous analysis of the entire model to determine the impact strengths and consistency with the data. A key aspect that helps distinguish structural modelling from conventional analysis is that structural modelling is oriented solely to inferential statistics, which is different from most other descriptive processes (e.g. exploratory factor analysis) where hypothesis testing is difficult. Structural modelling makes it possible to test the appropriateness of the data and the hypothesized model in order to more specifically clarify the nature of impact, the significance of the impact, as well as the strength of these impacts among variables (Bentler, Bonette, 1980). Some of the key indicators of model fit are the fit index (NFI) and the mean squared error (SRMR). The above measures represent the criteria for determining the suitability of models and data. Accordingly, the data will be appropriate for the observed model if the fit index is greater than or equal to 0.9, the corrected fit index is greater than or equal to 0.8, and the mean square error is less than 0.08 (Hayduk, 1987). The SmartPLS statistical program (v.3) was used to test the impact and relationships in the model using SEM.

Results and Discussions

Empirical data analysis

In the first step, a comparison of subsamples by gender was performed using the t-test for differences in means. The differences between two gender groups are statistically significant for all three constructs (*Table 3.*). Male subjects have greater average values than female subjects for PDSE (Md=-0.72; t=-4.33; $p<0.05$, PESE (Md=-1.68; t=3.55; $p<0.05$) and SEINT (Md=-1.44; t=-7.33; $p<0.05$). The results of the analysis described above are in line with results of majority of reviewed studies.

Table 3. Results of testing for differences between sub-samples by gender, male (n=439) and female (n=699)

Variable/Gender		**N**	**Me**	**Sd**	**Md**	***t***	***p***
SEINT	Female	699	7.19	3.21	-1.44	-7.33	<0.05
	Male	439	8.63	3.23			
PDSE	Female	700	11.66	2.71	-0.72	-4.33	<0.05
	Male	443	12.37	2.74			
PESE	Female	690	43.04	7.82	-1.68	-3.55	<0.05

Source: Authors' calculations

With respect to the country of study, students from Serbia (UNINS) were found to have the highest mean for SEINT among the respondents (F=7.57; $p<0.05$) (*Table 4.*). Viewed by sub-sample pairs based on the Scheffe post hoc test, the differences were significant between students at UNIZG and UNINS (Md =-1.46; $p<0.05$) as well as students at UNINR and UNINS (Md=-1.07; $p<0.05$). This proves our hypothesis about significant differences with respect to country. Statistically significant differences among universities were also found for the PESE variable (F=15.02; p<0.05). According to the post-hoc test, UNINS students have higher PESEs than UNINR students (Md=-3.45; p<0.05), and UNIWA students have higher PESEs than UNINR students (Md=-3.00; p<0. 05) and UNIZG (Md=-3.02; p<0.05). There is no significant difference between universities in the PDSE variable.

Table 4. Results of testing for differences between subsamples by country: Croatia (n=225), Poland (n=302), Slovakia (n=428) and Serbia (n=185)

Variable / Country		N	Me	Sd	*F*	*p*
SEINT	Slovakia	428	7.67	3.20	7.57	<0.05
	Serbia	185	8.74	3.62		
	Poland	302	7.58	3.20		
	Croatia	225	7.28	3.15		
PDSE	Slovakia	429	11.92	2.83	1.39	>0.05
	Serbia	185	12.16	2.59		
	Poland	301	11.70	2.75		
	Croatia	230	12.08	2.71		
PESE	Slovakia	425	41.72	8.16	15.02	<0.05
	Serbia	185	45.18	7.24		
	Poland	302	44.72	7.70		
	Croatia	216	44.75	6.62		

Source: Authors' calculations

Correlation matrix of variables in the entrepreneurial intention model

A correlation analysis was performed to check for statistically significant correlation between the variables in the entrepreneurial intention model. The analysis showed that the correlation is highest between PDSE and SEINT constructs (*Table 5.*). The observed correlation coefficient is positive in direction and moderate in strength (r=0.59; p<0.01). Therefore, we can conclude that an individual who considers self-employment more desirable will also have a more pronounced intention for such behaviour. Also, the PESE is significantly correlated with self-employment intention (r=0.53; p<0.01). Thus, if a person has a higher perception of self-efficacy with respect to self-employment, he or she also has a higher level of self-employment intention. The correlation coefficient between PESE and PDSE is statistically significant and positive (r=0.48; p<0.01).

Table 5. Correlation coefficients in the basic entrepreneurial intention model

Variable	PDSE	PESE	SEINT
PDSE	1	.477**	.591**
PESE		1	.533**
SEINT			1

** Statistically significant, p<0.01
Source: Authors' calculations

Model testing results

Based on the results of the model testing, it can be concluded that both predictors of self-employment intention are significantly related to this construct. The PESE positively and moderately influences the intention of self-employment or SEINT ($t=3.40$; $p<0.05$), as well as the PDSE ($t=2.40$; $p<0.05$). The higher the predictors, the level of self-employment intention are higher (*Table 6.*).

Table 6. Coefficients and the significance of impact

Basic model effects	Standard estimate	*t*	*p*
PESE => SEINT	0.459	3.398	0.001
PDSE => SEINT	0.228	2.397	0.017

Source: Authors' calculations

Model performance indicators

The reliability indicators are covered in the next table (*Table 7.*) and the next figure (*Figure 2.*). All variables are highly reliable. The composite reliability indicator for two of the three observed variables assumes a high value (Crombach alpha >0.7 for PDSE and SEINT), while for PESE it achieves a value less than marginal but sufficient (>0.6) according to Bentler and Bonette (1980).

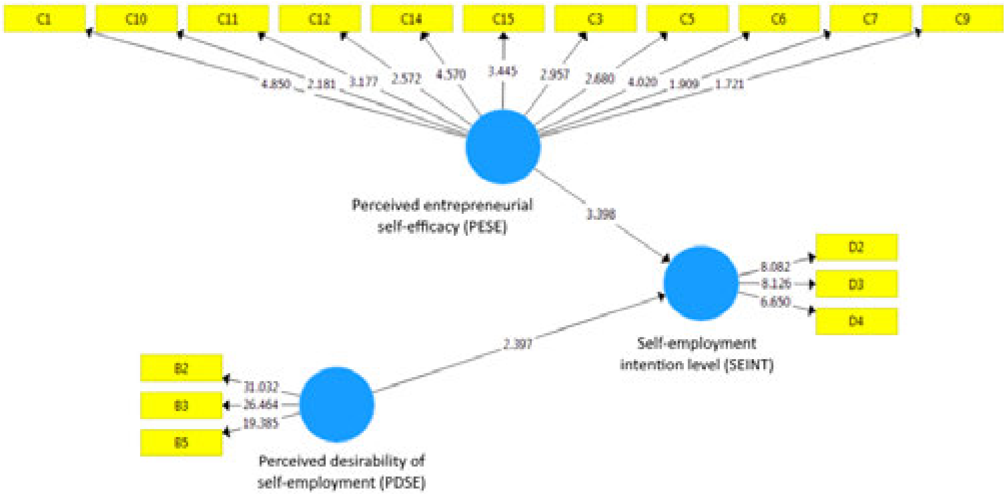
Table 7. Model performance indicators

Indicators	The model of self-employment intention
SRMR	0.067
NFI	0.862

Source: Authors' calculations

The results of the average extracted variance are lower than the marginal limits (<0.5) on two of three variables (SEINT and PESE), and the value for PDSE is considered sufficient (>0.4). The problem of multi-collinearity is not present in the model because all VIF indicators for the observed items are lower than 5. Likewise, the indicators of model compliance are satisfactory. The SRMR achieves values lower than 0.08, while the NFI is at a satisfactory value (>0.8) although it is not at the optimum (>0.9).

Figure 2. The graphical representation of results of testing the basic SEINT model



Source: Authors' calculations

In the next step, the model was varied with introduction of dummy variables to test it regarding to the following factors: the entrepreneurial background of the respondent, the GDP level of the country of respondent, the unemployment rate of the country, and the ranking of the country with respect to ease of starting a new business.

Table 8. The previous entrepreneurial experience level: coefficients of impact

The effects	Standard estimate	*t*	*p*
Entrepreneurial experience (EE, low) => PESE	-0.244	7.053	0.000
Entrepreneurial experience (EE, low) => PDSE	-0.173	5.670	0.000
PESE (EE, low) => SEINT	0.429	3.186	0.002
PDSE (EE, low) => SEINT	0.242	2.568	0.011
Entrepreneurial experience (EE, high) => PESE	0.244	7.050	0.000
Entrepreneurial experience (EE, high) => PDSE	0.173	5.820	0.000
PESE (EE, high) => SEINT	0.429	3.194	0.001
PDSE (EE, high) => SEINT	0.242	2.614	0.009

Source: Authors' calculations

In the previous table (*Table 8.*) are given results for the model with the dummy variable previous entrepreneurial experience (PEE). It is a dichotomous variable with values 'high' for respondents with more contacts or experience with entrepreneurship, or 'low' for those with less. All impact coefficients are statistically significant and the values of the coefficients in the basic model are changed. The results let us to conclude that low PEE has marginal but negative effect on PESE and PDSE. That is, a person with less entrepreneurial experience will have a lower PESE ($t=7.05$; $p<0.05$), and PDSE ($t=5.67$; $p<0.05$). The opposite is true for high entrepreneurial experience: the impact is marginal, but it is positive for PESE ($t=7.05$; $p<0.05$) as well as for PDSE ($t=5.82$; $p<0.05$).

In conclusion, respondents with less entrepreneurial experience will have unfavourable predictors for self-employment, while for those with high entrepreneurship experience the predictors will be favourable.

In the following step (*Table 9.*) a dummy variable of the GDP level was added to the basic model and three sub-samples were constructed for this purpose: (1) high GDP per capita (i.e. Slovakia), (2) medium GDP per capita (i.e. Croatia and Poland, and (3) low GDP per capita (i.e. Serbia). The results show a more pronounced intention to self-employment if the GDP is high ($t=3.39$; $p<0.05$). Model testing results for medium GDP per capita indicate statistically significant but negative impact of medium GDP per capita on SEINT. Thus, respondents from countries with medium GDP will have 14.6% less intention to self-employ than in the basic model ($t=4{,}539$; $p<0.05$). The coefficient for the case with a low level of GDP per capita is insignificant for self-employment intention.

Table 9. The level of BDP per capita: coefficients of impact

The effects	Standard estimate	*t*	*p*
BDP per capita (high) => SEINT	0.128	3.391	0.001
BDP per capita (medium) => SEINT	-0.146	4.539	0.000
BDP per capita (low) => SEINT	0.030	1.006	0.315

Source: Authors' calculations

The model was modified to check the impact of the unemployment level as a dummy variable. For that purpose, respondents were divided in two groups regarding to the unemployment rate of a countJry: less than 10% (Poland and Slovakia), and higher than 10% (Croatia and Serbia). However, the results do not indicate significant effect of unemployment level on self-employment intention.

Table 10. The ranking by country conditions for starting a business: coefficients of impact

The effects	Standard estimate	*t*	*p*
Rank 1-50 => SEINT	0.030	1.073	0.284
Rank 50-100 => SEINT	0.057	1.803	0.072
Rank below 100 => SEINT	-0.090	3.355	0.001

Source: Authors' calculations

Then a dummy variable based on the country rank according to the ease of starting a business among 190 countries of the world was introduced to the basic model (World Bank, 2018). The higher the rank (closer to 1) the more conducive regulatory environment is to the starting of a business. Three groups were formed based on the rank: high (Serbia, ranked 0-50), medium (Croatia and Slovakia, ranked 51-100) and low (Poland, ranked below 100). Results of the analysis indicate that only for the 'low rank' case the impact is significant and negative: the self-employment intention tends to be lower for 9% if the country is ranked below 100 with respect to starting a business conditions ($t=3.36$; $p<0.05$) (*Table 10.*).

Conclusions

In this paper we firstly investigated the extent to which perceived attractiveness of self-employment (PDSE) and perceived ability for self-employment (PESE) as predictors are related to the intention to self-employment (SEINT) among life science students from four countries of Central and Eastern Europe. Assuming that these predictors are influenced by different socio-economic factors, we also examined how previous experience with entrepreneurship (PEE), and selected economic development indicators affect the model results. The results confirmed significant causal and positive relation between SEINT as dependent variable, and the two predictors: PDSE and PESE. Significant differences in SEINT are among respondents with respect to gender and country. The level of self-employment intention is higher among male students, while students from Serbia (Novi Sad) expressed higher SEINT than their colleagues from Croatia and Slovakia (Zagreb and Nitra).

Given the socio-economic variables examined, a higher level of previous experience with entrepreneurship - either directly or through a role model - has been shown to have a positive effect on both: the predictors and intention of self-employment. As for the GDP per capita level, only the higher and medium levels have a significant impact on SEINT: positive in the first and negative in the second case. In addition, self-employment intention also seems to be affected by the conditions for starting a business in a particular country. If the country is ranked low in terms of ease of starting a job the self-employment intention among students is lower.

This paper validates of many similar studies based on the Theory of Planned Behaviour confirming causal relation between behavioural intention and predictors in the form of perceived desirability of behaviour and perceived personal self-efficacy with respect to. However, we found that socio-economic factors such as past experience related to the investigated intention, and macroeconomic conditions (GDP per capita, business start-up conditions) may influence students' intentions and/or predictors of the intentions. These findings make a contribution to the explanation of differences in the stated self-employment intentions in different countries.

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Conflict of interests

The authors declare no conflict of interest.

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A SHORT REVIEW ON EUROPEAN DEVELOPMENTS IN AGRICULTURAL OUTPUT PRICE INDICES DURING 2008-2017: ARE THERE SIGNIFICANT CHANGES?

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ABSTRACT

The evolution of the indices of the outputs of the production processes in agriculture could be considered proactive markers in understanding the effectiveness of the agricultural policies implementation and the functionality of the European Agricultural Model. The main aim of the research is centered on the analyzing the evolution of the European developments, in agricultural output price indices during 208-2017, from the Romanian perspective. The main findings describe the long-term changes regarding the evolution of the agricultural sector in the analyzed countries.

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Introduction

In the current context of the global economic transformations and of the rethinking of agricultural policies, including the European one, the agriculture continues to represent an economic domain (Andrei and Dragoi, 2019; Constantin et al., 2019) with high values and implications both for ensuring the food security and safety of the population and the need for raw materials supplies for secondary and tertiary economic sectors and as the beneficiary of inputs from the entire national economy. According to Dos Santos and Ahmad, (2020), the agricultural sector has an important contribution to meet the requirements of food security, both in the European Union (EU) and globally, and also being an essential element in the conservation of rural landscapes and providing essential goods for the rural population. Starting from these realities but also from some opinions expressed in the literature (Lerman et al., 2004; Balaceanu and Apostol, 2012; Loizou et al., 2019; Brada and Wadekin, 2019; Choi et al., 2021; Luković et al., 2021; Milojević et al., 2020; Živković et al., 2019), the agriculture is defined as an economy domain with multiple implications at different levels of aggregation that requires a deep and long-term understanding of the mechanism it forms and it sets in motion at the global economic level.

The optimization of agricultural production structures and, as a result, the application of appropriate agricultural policy measures in accordance with the requirements of the European Agricultural Model must take consideration not only obtaining higher production efficiency and production volumes to meet market requirements but also to obtain low prices. These must be relevant and sustainable for as long as possible.

Chen et al., (2020); Anríquez et al., (2013) as well as it's mentioned in previous works such as (Shumway et al., 1988) suggested that the setting of stable prices for agricultural products requires not only an intimate understanding of the specific mechanism of the agricultural production sector but also of the market, therefore the agricultural policies should concretize production relations in the supply.

The measures adopted to improve and increase the efficiency and effectiveness of the food production and supply chain, in the context of the need to increase sectoral competition should not only focus on obtaining the lowest possible price, input or highest output, but to pursue sustainability of the value chains throughout the entire agricultural sector. On the other hand, as (Helming and Tabeau, 2018) said in their study, although agricultural production prices fell during their analysis period of time, they continued to led to a slowing down in the upward trend in production and also in agriculture labour force.

Achieving the targets of a long-term sustainable and safe agriculture for everyone requires, not only the providing access to resources (to encourage the most efficient adaptation to existing market conditions), but also promotinge more environmentally friendly practices and guarantee quantities and qualities for products that are placed on the market. As Suh and Moss, 2021 noted, promoting a policy that ignores the potential sectoral effects of rising prices can be problematic, creating long-term unknown consequences in related sectors.

The levels and the rapidity of the evolution of the prices of the agricultural outputs registered in the last period of time have generated complex phenomena with significant, irreversible negative influences, causing serious macroeconomic disequilibrium. Massive increases in global and European reference prices have forced a rethinking of the functioning mechanisms of the agricultural market. The slowdown in cereal production, the restrain of cropland and the reduce interest of European agricultural producers, plus an insufficient investment in agriculture, but also the decrease in financial support, all these partly reflect into a period of increasing agricultural prices in the EU.

As can be reamrked in European Commission Agriculture Report, 2008, the development of agricultural commodity prices are the result of a complex combination of structural and many temporary factors that doubles a significant, steady increase in demand for agricultural commodities, for basic raw materials and food products with a high degree of processing in emerging economies, which do nothing but complete the picture of the factors that determined an accelerate, long-term increase in the prices of agricultural products.

Starting from the reality expressed in the literature (Tsakok, 2019; Nazlioglu and Soytas, 2011) that prices for agricultural products as well as other prices in the economy are subject to cyclical fluctuations, the essential question that transcends is whether the high level of product prices will persist for a long period of time or is only temporary, reflecting only the disequilibrium between the dynamic growth of demand and supply in this specific market. Abokyi et al., (2018) underline the fact that the inelasticity of the supply of agricultural products is one of the fundamental causes in generating imbalances in agricultural production markets, with a direct effect in inducing the increase in volatility of production prices. The main objective of this study is therefore to conduct an investigation on the evaluation of real price indices of agricultural outputs in Romania and the European Union in the period 2008-2017.

Data and methodology

The understanding of the determining role, but especially of the impact that agriculture has on the economic system, can be achieved on the others o from the perspective of the evolution of the price indices of agricultural outputs. The evolution of prices therefore reflects, in addition to the effort made in the production flow, the resources mobilized and processed and the necessary supply. It is constituting an active resonance picture of a fundamental economic domain, both in ensuring the welfare and food security of citizens, and in terms of added value, also keeping and developing essential economic flows.

For the analysis of the evolution of the prices of the outputs of the agricultural production processes, the main source of documentation of the data used in the analysis process was a database of the European Union - Eurostat, from which was accessed the data series “Price indices of the means of agricultural production, input (2010 = 100) - annual data [apri_pi10_ina] ”and“ Price indices of agricultural products, output (2010 = 100) - annual data [apri_pi10_outa] ”and refers to two indicators as described in the table below (Table 1). Thus, the descriptive analysis was used from the perspective of the evolution of the indices of the outputs of the production processes in agriculture.

Considering both the availability of data series and the evolution of the two indicators used, we chose to open up to our analysis the period 2008-2017, respectively the first year after Romania’s integration into the European Union and the year for which we identified the consolidated data series. Thus, from the analysis of period of time we underlined the characteristics of the years 2008, 2012 and 2017. The evolution of the two indicators at the level of the European Union was taken into consideration from the perspective of the average values of the variables registered at EU28 level. This analysis interval was chosen also due to the fact that during this period the United Kingdom was a member of the EU, and the level of average values of the analyzed variables also reflects the impact of United Kingdom on the evolution of prices of agricultural production outputs.

Table 1. Variables description and measurement units

Variables	Significance of variables	UM
OPIPV_08	Index of real vegetable production prices, including fruit and vegetables (output_1), 2008, (initial year of analysis)	%
OPIPA_08	Real Livestock Price Index (output_2), 2008 (initial year of analysis)	%
OPIPA_12	Index of real prices of animal production, year 2012	%
OPIPA_17	Index of real prices of animal production, year 2017	%
OPIPV _12	Index of real prices of vegetable production, year 2012	%
OPIPV _17	Index of real prices of vegetable production, year 2017	%

Source: authors based Eurostat database

Discussions

European developments in agricultural output price indices

The first stage of the analysis of the evolutions and of Romania’s place in the EU from the point of view of the real price indices of vegetable production, including fruits and vegetables (OPIPV), as well as of the real price indices of animal production (OPIPA) was performed based on of the data series characteristics they are corresponding to them. (Table 2).

Analysis of the characteristics of the OPIPV data series as well as of the OPIPA at the level of all three years (Table 2), taking into account the values of the coefficient of variation (VC), as well as the values of dispersion (Simple Variance) and standard error (Standard Error), highlights, also in the case of outputs, that the averages (Mean) of the variables at the level of the states included in the analysis are representative. Regarding the shapes of the data series distributions, the values of the higher curve (Kurtosis) and the symmetry indicator (Skewness) show that, except for OPIPV_17, the other variables have a normal distribution, of platycurtic type for OPIPV_08, and leptocurtic for the others. On the other hand, given that for the variables OPIPV_08 the average is higher than the median, most of the values of the indices of the real prices of vegetable production, including fruits and vegetables corresponding to the year 2008 are in the area of lower values. Regarding OPIPA, given that the average is lower than the median, most of the values are in the area of higher values (asymmetry to the right).

The evolution of vegetable production prices, both in Romania and in the EU28, was affected by the economic crisis started in 2009. This generated increases in the price level so that in Romania, the index of real vegetable production prices, including fruits and vegetables (Figure 1) increased from a value of 92.2%, recorded in 2009 compared to the base year (2010 = 100%), to a value of 122.0%, recorded in 2013, which represents an increase of 29,8 percentage points, the highest increase being in 2011 (11.1% compared to the previous year).

Table 2 Main features of the data series on real price indices of agricultural outputs in 2008, 2012 and 2017

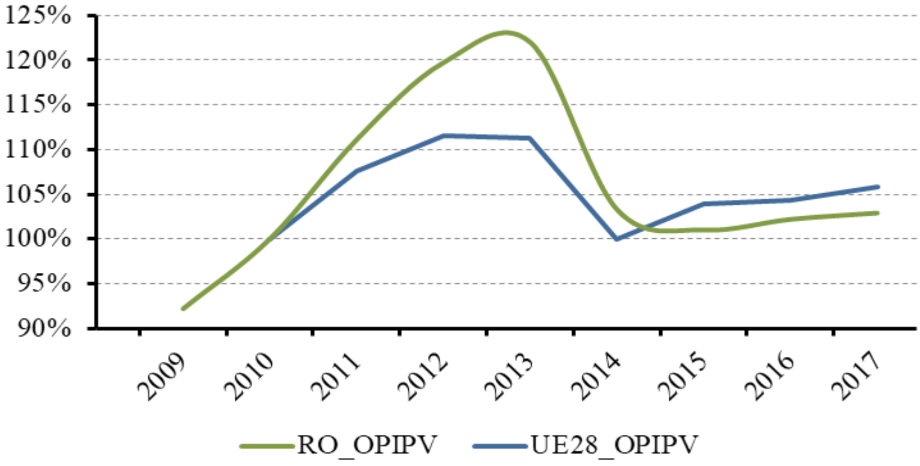
	OPIPA _08	OPIPA _12	OPIPA _17	OPIPV _08	OPIPV_12	OPIPV _17
Mean	113.08	114.94	104.13	110.94	108.85	105.17
Standard Error	2.45	2.29	2.03	1.50	0.85	1.13
Median	111.00	115.50	102.95	111.20	109.05	105.70
Standard Deviation	11.77	12.11	10.76	7.18	4.51	6.00
Sample Variance	138.42	146.68	115.74	51.53	20.30	35.97
Kurtosis	-0.37	0.98	7.33	0.27	0.81	0.09
Skewness	0.43	0.45	2.04	0.53	-0.32	-0.05
Minimum	42.50	57.10	58.40	28.50	19.80	26.10
Maximum	93.90	91.40	86.90	99.50	97.40	91.90
Cnf. Level (95.0%)	136.40	148.50	145.30	128.00	117.20	118.00
VC (%)	5.09	4.70	4.17	3.10	1.75	2.33

Source: calculated by the author using SPSS

At the same time, there has been a rise of prices in EU for vegetable production, including fruit and vegetables, but it has a lower intensity. Thus, in 2011 and 2012, compared to 2010, OPIPV reached 107.6% and 111.5%, while in Romania they were 3.5 and 8.2 percentage points higher. However, the biggest difference (10.8 percentage points) is registered in 2013, when the value of OPIPV at EU level decreases to 111.2%, while in Romania it increases to 122.2%.

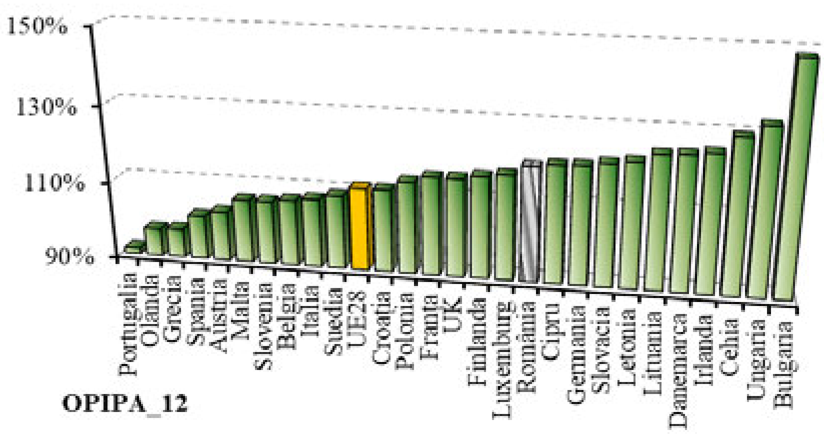
After 2013, the prices of vegetable production start to decrease in Romania as well, the OPIPV values tending to approach those registered in the EU, so that from a difference of 10.8 percentage points, in 2013, in 2014 it will be reduced to 3 , 4 percentage points. Finally, the period 2015-2017 is a positive one for Romania in terms of OPIPV values, its values being below the EU average by about three percentage points.

Figure 1. Evolutions of real crop production price indices, including fruits and vegetables (OPIPV) in Romania and at EU28 level in the period 2009-2017



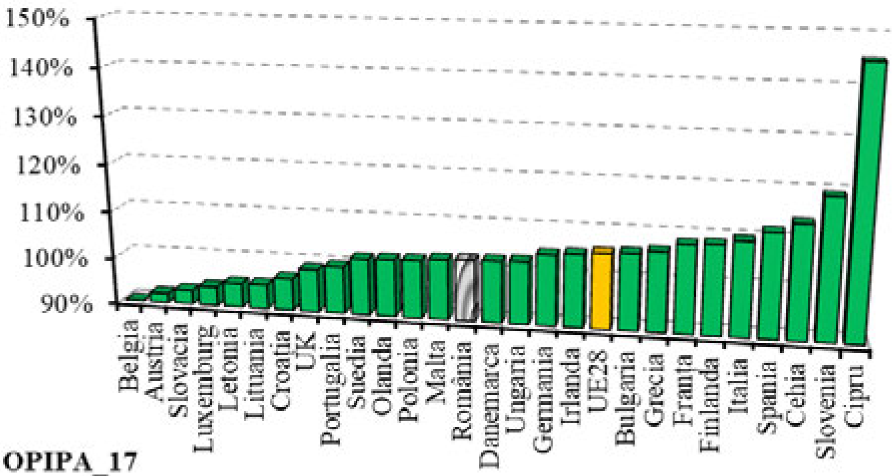
From the point of view of the place ranked by Romania among the EU member states, according to the values of the index of the real prices of the vegetal production, in 2012, with a value of OPIPV of 119.7% in relation to 2010, it ranked 17th in terms of performance (Figure 2), OPIPV in Romania being 28.3 percentage points higher than in Portugal, the member state that is in first place in terms of this indicator. It should be noted that our neighbors EU members, Hungary was on the penultimate and Bulgaria was the last place with the highest values of OPIPV, of 132.6% and 148.5% respectively.

Figure 2. Romania's position between EU member states and the EU28 average in 2012 in terms of values of real crop production price indices



Economic developments in 2012-2017 have led to significant changes in the hierarchy of EU Member States in terms of indices of the real crop production price (Figure 3). Thus, if in 2012, the OPIPV registered in Romania was 8.2 percentage points higher than the value of OPIPV registered at EU28 level, in 2017, with a value of OPIPV of 102.9%, it becomes 2.9 percentage points lower than the OPIPV registered at EU28 level (105.8%) placing Romania among the states with values of indices of the real crop production price below the European average.

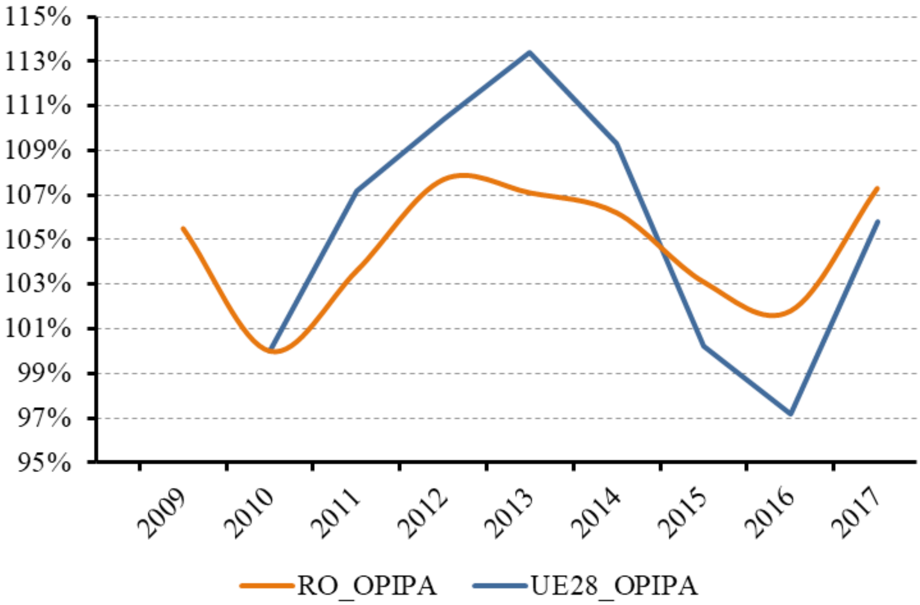
Figure 3. Romania's position between EU Member States and the EU28 average in 2017 in terms of the values of indices of the real crop production price



Although in 2017, Romania was ranked 14th in terms of performance on OPIPV, the difference between the value recorded in Romania and that recorded in Belgium (86.9%) which was ranked first in this hierarchy was 16.0 percentage points . It should also be noted that in the period 2012-2017, although the OPIPV registered in Romania decreased by 16.8 percentage points, in the case of Hungary the reduction of the OPIPV was 29.4 percentage points, and in Bulgaria by 42.4 percentage points. (almost a halving of crop production prices), which led them to move from the last two places in 2012, to 16th place, with a value of OPIPV of 103.2% in the case of Hungary (only 0.3 percentage points higher than in Romania) and 19th place in the case of Bulgaria, with a value of OPIPV of 106.1% (4.2 percentage points more than in Romania).

Unlike OPIPV evolutions, in the case of OPIPA the amplitude of their oscillations was higher, especially at EU28 level (Figure 4). The evolutions of the real prices of the animal production as in the case of those of the vegetal production were affected by the economic crisis, fact that generated their increases, so that in Romania the index of the real prices of the animal production, after a reduction of 5.5 percent in 2009-2010 recorded an increase of 107.7% in 2012 compared to 2010. However, this increase was lower than that recorded by OPIPA at EU28 level, which in 2012 had reached a value of 110, 4%, and in 2013, at 113.4% compared to 2010. These OPIPA values were 2.7 percentage points higher than the OPIPA value registered in Romania in 2012 and 6.6 percentage points higher than the OPIPA value registered in 2013.

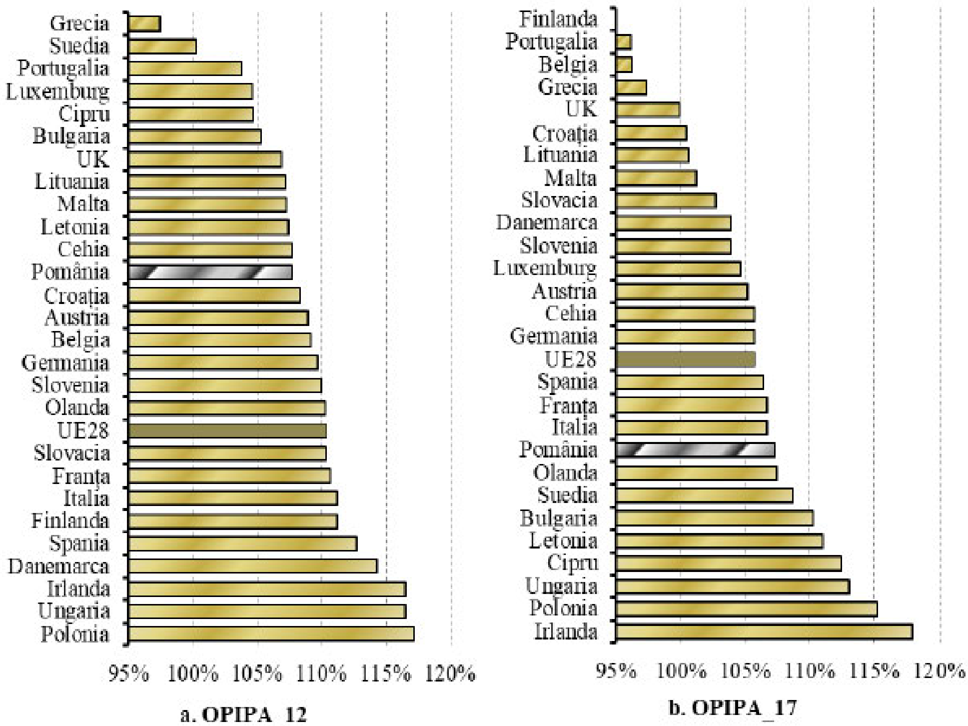
Figure 4. Evolutions of real animal production price indices (OPIPA) in Romania and at EU28 level in the period 2009-2017



The period 2013-2016 is characterized by significant reductions in OPIPA values. The reductions in the real prices of animal production, being much stronger at EU level than in Romania, result in the reversal of the ratios between the registered OPIPA values. Thus, while OPIPA at EU28 level is reduced by 16.2 percentage points, reaching 92.2% in 2016 compared to the value recorded in 2010, in Romania the reduction is only 5.9 percentage points, so that in 2016 OPIPA is 101.8% compared to 2010 (4.6 percentage points higher than at EU28).

However, the decreasing trend registered by the OPIPA values both in Romania and at the EU28 level is reversed in 2017, the OPIPA values registering increases by 8.6 percentage points at the EU28 level and by 5.5 percentage points in Romania. Under these conditions, in 2017, the OPIPA values, compared to 2010, were 105.8% at EU level and 107.3% in Romania. In 2012, Romania ranked 12th among EU states (figure 5a), as the performance of the values of the index of real prices of animal production, with a value of OPIPA of 107.7% compared to 2010, being at 10.3 percentage points of Greece, which was in the first place in terms of of this indicator with an OPIPA value of 97.4%. Compared to Romania, Bulgaria was in a better place (place 6) with an OPIPA value of 105.3%, while Hungary was in the penultimate place with an OPIPA value of 116.5%.

Figure 5. Romania's places in the hierarchy of the EU member states and compared to the value of OPIPA at European level in, 2012 and 2017



The period 2012-2017 also brought significant changes in the hierarchy of EU Member States in terms of indices of the real animal production price (Figure 5b). Although during this period the OPIPA value registered in Romania decreases by 0.4 percentage points, as a result of the economic developments in the other states, it lost 7 places, ranked the 19th place in 2017, with an OPIPA value of 107.3% compared to 2010, being above the EU average (105.8%).

The places occupied by Romania in 2017 both in terms of the real prices of vegetable production (14th place) and, especially, the index of real prices of animal production (19th place) highlight the fact that Romania must pay more attention to development agriculture both in terms of infrastructure, which is quite poor compared to other European countries, and by supporting producers by developing programs dedicated to them, supporting the absorption of European funds dedicated to this sector which is very important for Romanian economy.

Conclusions

The analysis of the evolution of the price indices of the agricultural outputs constitutes an elementary approach in understanding and deepening of the demanding-supplying working mechanism for agricultural products, and of the agricultural market in general.

Fluctuations of agriculture products prices, and especially in output prices, affect the economy as a whole, not limited to the agricultural sector. The unpredictability of agricultural markets with increasingly difficult-to-manage effects requires increased flexibility, often incompatible with the specificity, characteristics and potential of agricultural production. Ensuring a fair and sustainable distribution of agricultural production but also increasing the remuneration of each of the links in the supply chain of agricultural products is a complex process with extensive interference with market processes and production processes as well.

Considering the analyzed period (2012-2017), there are important, long-term changes regarding the evolution of indices of the real price of the animal and vegetable agricultural production in Romania compared to the EU. From this analysis it's been noticed the necessity of a constant deepening and with determined impact of some measures that have as objective the development of agriculture in Romania. Thus, we can see the downward trend of both OPIPA and OPIPA values in Romania but also in the economies of EU28, but which in the case of OPIPA is reversed in 2017. The values of this indicator increasing by 8.6 percentage points in EU28 and 5.5 percentage points in the case of Romania.

The accentuated increase of the price of food and of the raw materials and final products from agriculture, including the outputs as well is one of the strict problems that mark the European agricultural sector and those from Romania as well. The evolution of agricultural and food production is closely linked and often correlated with the evolution and transformation of the European agricultural model. If, at first, European agricultural policy was based on the existence of a strong, deeply consolidated and heavily regulated internal market, the promotion and application of subsidy schemes designed to stabilize food production and supply have altered (not always for the better) the subtle balances of the market.

Conflict of interests

The authors declare no conflict of interest.

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USE OF PERT (PROGRAM EVALUATION AND REVIEW TECHNIQUE) AND PDM (PRECEDENCE DIAGRAMMING METHOD) IN ORGANIZING MODERN VEGETABLE SEEDLING PRODUCTION

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ABSTRACT

Propagation of quality vegetable seedlings is a key of successful vegetable production in an open field and in protected areas. The research is aimed at the production process itself, analyzing it from technological and organizational aspects. Based on a detail calculation of time, means and costs, the researchers obtained the duration of production in days, regarding the propagation of pepper, tomato, cabbage and lettuce seedlings, taking into consideration different technological requirements of crops, ripening time, delivery time and an optimal use of the propagation area. The use of the Program Evaluation and Review Technique required more attention when making a production plan, resulting in the introduction of activities, the realization of which required only the flow of time to harmonize the monitoring of real activities. By using the Precedence Diagramming Method this problem was overcome with predefining the type of relationship between the interdependent activities (Finish-to-Start, Finish-to-Finish, Start-to-Start, and Start-to-Finish).

Introduction

One of the characteristics and specificities of vegetable production and vegetable seedlings outdoors is their seasonal character and mismatch in time of performing operations and time of production. Nevertheless, when it comes to indoor production, especially regarding the

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implementation of modern production technologies, production processes can be planned and adjusted more precisely. Like in outdoor production, indoor production requires more even use of capacities due to the fact multiple vegetable crops are grown at the same time. Adjusting and complementing the indoor production of several vegetable crops allows us to make full use of labor and means of production during most part of the year or all year round. It should be noted here that the structure of clients (farmers and other subjects) significantly affects the structure of production, depending on the production system (outdoor or indoor) and time of procuring quality seedlings.

Agritourism has received growing academic attention over the recent decades (Rokvić Knežić et al., 2020; Dimitrovski et al., 2021). From the aspects of yields, net profits and work productivity in agriculture, vegetable production is one of the most intensive part of plant production, providing 5 to 8 times higher value of outdoor production than wheat outdoor production, and 190 to 250 times higher value of indoor production (Vlahović et al., 2010; Milojević et al., 2020). Quality seedlings are a key to successful vegetable production, both in open fields and in protected areas (Moravčević, 2015). Demand is met with imports, since the domestic market is generally undeveloped and production of quality seedlings in Serbia is at low levels. Although the company in question has relatively modern glasshouse and technology, most of the highest quality seedlings of fruiting vegetables are imported from Hungary, Greece, and even from Bosnia and Herzegovina (Ilin et al., 2002).

Another part of the market comprises small domestic companies that seldomly produce seedlings for larger, specialized vegetable producers, but are mostly aimed to semi-commercialized farms and hobbyists who produce vegetables for their families in their yards. The largest part of commercial vegetable production, of course, is based on on-farm production of seedlings. Such farmers have put great effort lately to improve production technologies, by investing considerable amounts of money in heated facilities and fewer amounts in modern equipment.

The subject-matter of the research is organizational and technological aspects of production process in an organization that produces quality vegetable seedlings. The research was aimed at the production process itself, analyzing it from technological, organizational and economic aspects. The technological and organizational segment is the part that needs and can be improved and intensified to strengthen a competitive position and achieve production sustainability. The research was carried out in an organization that is categorized as a small and medium enterprise (SME). A modern approach to seedling production resulted from research has proved to be an adequate for implementation within SMEs, since it requires significant investments and expert knowledge. Small and medium enterprises are the ones acknowledged by the European Commission as the main business entities that encourage development and employment (EC, 2003). In Serbia, after the period of transition, this form of business entity has been confirmed as the most efficient economic segment and later, even until today, as a carrier of economic growth and development (Erić et al., 2012).

Nowadays, there are modern forms of managing agricultural production that considerably facilitate and speed up the managing process itself and making important decisions in a timely manner. In agricultural production, and especially in vegetable production, network planning is successfully used. Along with modern and practically proved software solutions, it allows permanent monitoring of the production process, making the most important information available at every moment, and enabling changes in the existing working processes in order to achieve more rational production. Network models, being at the same time mathematical models, apart from providing a visual overview of activities, also provide clients with a detailed analysis of project time and cost components. A network diagram or a network plan is a kind of a dynamics plan that graphically displays the dynamics of activities within a project. The activities are interlinked depending of a logical sequence, paths and time of realization, depending of a production technology. By making a network diagram, one can create a logical structure of project realization, an overview of a detailed analysis of time of realization of all activities and a project in general (Radulović et al., 1988).

Materials and methods

The methods applied in this research had been adjusted to the subject-matter and the goal of the research. The subject-matter was the production process of obtaining quality vegetable seedlings from peat blocks. Given that the subject-matter can be seen as one system, the researchers used the method of a study case as the main methodological framework. The focus of the research was put on technological and organizational aspects of the production process. This method was efficient for analyzing the dynamics of the organization that was determined by many criteria of technological, organizational, and economic character, as well as other internal and external factors. Having a thorough approach in analyzing causes and effects of the activities within the production process, the researchers dug into the operational dynamics and came to the essence of the relationships between the elements of the system.

A methodological basis of the research was a detailed calculations of performance rates of the production machine and human labor when sowing in peat blocks, calculated based on chronometric and chronographic recording of the whole operation. Two methods of network planning were used: PERT module of “WinQSB” and PDM of “MS-Project 2013”.

The characteristics of technological process, the structure of production, product characteristics, duration of certain stages of production and production capacity are the elements that define an organizational approach in terms of dynamics, use of resources, time and production capacity. During the research, the methods and techniques of project and process management were used, putting their focus on saving resources timewise and material wise, calculating slack, analyzing capacities and identifying bottlenecks in the process of production, creating network diagrams and Gantt charts, namely, monitoring the flexibility, efficiency and dynamics of the whole flow of production (Jovanović, 2015; Pantić et al., 2021). All factors of the production process were taken into consideration, making a reliable foundation for quality process of synthesis.

In this research, PERT (Program Evaluation and Review Technique) and PDM (Precedence Diagramming Methods) were used, but the preference was shown to PDM, due to certain advantages this method gives in terms of time distribution between the activities (Lock, 2007), which the author had studied by using the techniques in question when making a plan of spring operations for multiple field crops (Ljiljanic et al., 2016). Moreover, PDM allows additional flexibility during process modeling (Wiest, 1981; Radić et al., 2020). PDM is a prevailing method of network planning nowadays. Its continuous use is based on the flexibility of its models compared to other techniques, and an easily understandable mathematical model in the background (Hajdu, 2015).

Results with discussions

A model of technological and organizational plan of production was composed for a business entity with modern production of vegetable seedlings: pepper, tomato, cabbage and lettuce seedlings. The following factors were taken into consideration when composing the technological and organizational plan: (1) the enterprise in question had a highly sophisticated heated glasshouse and systems for nutrition and irrigation. Production area was 10,000 m^2 and its utilization depends on the time of the year, demand for a particular commodity and the client's profile in terms of good business practice. (2) Within the glasshouse, the enterprise had an office where the production line were situated, together with machines. Furthermore, there was a germination chamber in one part of the glasshouse. The production lines had enough production capacities for utilizing all the working area in case that the maximum capacities are required to be put in use. (3) Five was the optimal number of workers during the sowing to use the machines and put the crates into the germination chamber. (4) The seedlings were produced by using the peat blocks technology. The enterprise produced pepper, tomato, cabbage and lettuce seedlings. A peat blocks machine made by Unger, a German manufacturer, prepares blocks of different size for different vegetable crops. Uniform crates (size 42cm x 62cm) were used, in which different number of blocks of different size (7cm, 6cm, 5cm, 4cm and "speedy") can fit for a certain number of crops. When it comes to occupation of the working area, three crates could fit in 1 m^2. This information was very important from the aspect of planning and production limit one should have in mind. (5) The operations carried out in the process of obtaining the end products were seeding, germination and propagation.

The germination stage is carried out in the germination chamber with controlled humidity and temperature of air. The germination of peppers and tomatoes requires the temperature of 25 ^{0}C, lettuce 18-20 ^{0}C and cabbage 16 ^{0}C. This means that the germination chamber can hold only tomatoes and peppers at the same time, while cabbage and lettuce have to be germinated separately. It is an important thing to consider when planning the whole process.

The plan of organization of production, making of which included all the aforementioned factors, was described in detail through the following activities: (1) Activity "A"-Lettuce – Sowing of lettuce. Sowing begins on 1 Nov 202X and lettuce is sown in

4 cm peat blocks. The number of plants to be sown is 2,100,000, which is 15,000 uniform crates, occupying 5,000 m^2 of the propagation area. Time needed for sowing by machinery is 7.73 days. (2) Activity “B”– Lettuce - Germination. The process of germination begins when the chamber is filled up with crates after sowing is finished for that day. The chamber is then set on the appropriate humidity and temperature. It is filled up successfully, day by day, as long as the sowing takes place. Given that sowing lasts for less than eight days, and germination for two days, after two days the crates started to be moved to the area for propagation and the propagation process starts. The germination of all 2,100,000 plants lasts for nine days. (3) Activity “C” – Lettuce - Propagation. The propagation starts when the germination is finished and the plants are ready to be placed out of the chamber. This process last for 25 days. It starts two days after the germination process begins. The working area is successively filled out and it will be 50% occupied in the next nine days after the germination is completely finished. (4) Activity “D”– Cabbage - Sowing. The sowing of cabbage begins on 1 Dec 202x and it is sown in 7cm peat blocks. The number of plants to be sown is 600,000, in 15,000 crates, occupying 5,000 m^2 of the propagation area. Time needed for sowing is 3.03 days. (5) Activity “E” – Cabbage - Germination. The process of germination begins when the chamber is filled up with crates after sowing is finished for that day. The chamber is filled up successively for three days. Given that the sowing lasts for 3.03 days and germination for two days, after two days the crates started to be moved into the propagation area and the propagation starts. This activity lasts for 5 days. (6) Activity “F” – Cabbage - Propagation. The process begins after the germination is finished and the plants are ready to be moved out of the chamber on the propagation area. It lasts for 55 days. The process of propagation starts two days after the beginning of germination, by successively filling out the propagation area. The total duration of this activity is 59 days. (7) Activity “G” – Peppers – Sowing. The sowing begins on 8 Jan 202X+1 and peppers are sown in 7 cm peat blocks. The number of plants to be sown is 300,000, in 7,500 crates, occupying 2,500 m^2 of the propagation area. Time needed for sowing is 1.52 days. (8) Activity “H” – Peppers – Germination. The process of germination starts right after the sowing, when the chamber is filled up with the crates. The chamber is filled successively. Given that the sowing lasts for 1.52 days and germination for 7 days, after 7 days the crates are started to be moved into the propagation area and propagation starts. The total duration of this activity is 8.53 days. (9) Activity “I” – Peppers – Propagation. The process of propagation starts after germination is finished and the plants are ready to be taken out of the chamber. It lasts for 56 days. The process of propagation starts 7 days after the germination and the propagation area is successively filled out. The total duration of this activity is 63 days. (10) Activity “J” – Tomatoes – Sowing. The sowing of tomatoes starts on 09 Jan 202X+1, right after the sowing of peppers. Tomatoes are sown in 7 cm peat blocks. This is an example of technological compatibility of peppers and tomatoes in terms of their germination, which allows you to continue with sowing tomatoes right after peppers. The number of plants to be sown is 300,000, in 7,500 crates, occupying 2,500 m^2 of the propagation area. Time needed for sowing is 1.52 days. (11) Activity “K”

– Tomatoes – germination. The process of germination starts right after the sowing, when the chamber is filled up with the crates. The chamber is filled up successively. Given that the sowing lasts for 1.52 days and germination for 4 days, after 4 days the crates are started to be moved into the propagation area and the propagation starts. The total duration of this activity is 5.52 days. (12) Activity “L” – Tomatoes – Propagation. The process of propagation begins after germination and moving the plants out of the chamber into the propagation area. It lasts for 42 days. The process starts 4 days after the beginning of germination. The propagation area is filled out successively. The total duration of this activity is 46 days. (13) Activity “M” – Peppers – Sowing. The sowing begins on 01 Mar 202X+1 and in this period, peppers are sown in 5 cm peat blocks. The number of plants to be sown is 720,000, in 7,500 crates, occupying 2,500 m^2. Time needed for sowing is 2.69 days. The sowing can start right after the tomato propagation is finished. (14) Activity “N” – Peppers – Germination. The process of germination starts right after the sowing, when the chamber is filled up with the crates. The chamber is successively filled up with crates. Given that the sowing lasts for 2.69 days and germination 7 days, after 7 days the crates are started to be moved into the propagation area and the propagation starts. The total duration of this activity is 8.69 days. (15) Activity “O” – Peppers – Propagation. The process of propagation starts after the germination is finished and the plants are ready to be taken out of the chamber. It lasts for 49 days. The process of propagation starts 7 days after the germination begins and the propagation area is successively filled out. The total duration of this activity is 56 days. (16) Activity “P” – Tomatoes – Sowing. The sowing of tomatoes starts on 05 Mar 202X+1. Tomatoes are sown in 7 cm peat blocks. The number of plants to be sown is 300,000, in 7,500 crates, occupying 2,500 m^2 of the propagation area. Time needed for sowing is 1.52 days. The sowing starts when the propagation area starts clearing out from peppers. (17) Activity “Q” – Tomatoes – Germination. The process of germination begins right after the sowing, when the chamber is filled up with the crates. The chamber is filled up successively. Given that the sowing lasts for 1.52 days and germination for 4 days, after 4 days the crates are moved out into the propagation area. The total duration of this activity is 5.52 days. (18) Activity “R” - Tomatoes – Propagation. The process of propagation starts after the germination, when the plants are ready to be taken out of the chamber into the propagation area. It lasts for 42 days. The propagation process starts 4 days after the beginning of germination and the propagation area is successively filled out with plants. The total duration of this activity is 46 days. (19) Activity “S” - Cabbage - Sowing. The sowing begins on 21 Mar 202x+1and cabbage is sown in “speedy” peat blocks. The number of plants to be sown is 8,100,000, in 15,000 crates, occupying 5,000 m^2 of the propagation area. Time for sowing is 9.14 days. (20) Activity “T” - Cabbage - Germination. The process of germination starts right after the sowing, when the chamber is filled up with the crates. The chamber is successively filled up with crates for three days. Given that the sowing lasts for 9.14 days and germination for 2 days, after 2 days the crates are moved into the propagation area. The total duration of this activity is 10.14 days. (21) Activity “U” - Cabbage - Propagation. The process of propagation starts after the germination is finished and the plants are ready to be taken out of the chamber. It lasts for 36 days. The recess of propagation starts 2 days after the beginning of germination and the propagation area is successively filled out. The total duration of this activity is 46 days.

All methods of network planning have certain advantages and disadvantages in terms of their implementation into various projects with different technological and organizational requirements, as well as results the person wants to achieve. In this research, processes are predominant, i.e. activities duration of which cannot be fixed with certainty, primarily when it comes to the duration of seed germination and propagation of seedlings for different vegetable crops. Therefore, the researchers used the PERT method. Factors that affect duration of the activities are technological, and depend on the type of seeds, hybrids, and oscillations in temperature, light, precision during the application of crop nutrients and crop protection chemicals, etc. PERT was chosen since it took into consideration how uncertain was to estimate the amount of time certain operations in the technological and organizational plan required, due to various factors that can affect their duration. Since it is not possible to determine precisely the duration of certain activities, it is estimated by using statistical methods, and in this research by using experience estimating methods, based on the use of different hybrid seeds of vegetable crops (Ceranić, 2009).

Figure 1 shows the activities in a technological and organizational plan of seedling propagation. It shows the most probable, optimistic and pessimistic duration of all activities. If the activities were carried out successively, one after another, propagation would last for 570.90 days. Some of the activities were nevertheless carried out simultaneously, while other could start when some other activities are finished.

Having analyzed the model by using the WinQSB software, the following parameters were obtained: the sequence of activities, critical activities, duration of activities, the earliest start and finish of activities, the latest start and finish of activities, slack, standard deviation, number of critical paths, and most importantly, duration of the propagation process.

The total of 41 activities are shown and all of these are real-life activities. 21 of them reflects the work process that requires means and time (A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T and U). It was necessary to introduce 20 activities in terms of time flow, to meet the technical requirements of the software and obtain a precise estimation of duration and deadlines of the activities (a1, b1, c1, d1, e1, f1, g1, g2, h1, i1, j1, k1, l1, m1, n1, p1, q1, s1 and t1). The duration of the whole process of seedling propagation was 188.00 days, which is 382.9 days shorter than in case of carrying out activities successively, one after another. Furthermore, there is a critical path consisting of critical activities - activities whose slacks (Slack (LS-ES)) equal zero, which means there are no improvisations in terms of time of their realization, and they have to be carried out at the exact time.

Figure 1. The solution of the aforementioned problem given by the PERT method, WinQSB

02-21-2022 00:15:12	Activity Name	On Critical Path	Activity Mean Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)	Activity Time Distribution	Standard Deviation
10	e1	Yes	2	31	33	31	33	0	3-Time estimate	0.0333
11	F	no	59	33	92	129	188	96	3-Time estimate	1.6667
12	f1	Yes	35	33	68	33	68	0	3-Time estimate	0.3333
13	G	no	1.5133	68	69.5133	71.2867	72.8	3.2867	3-Time estimate	0.05
14	g1	Yes	1	68	69	68	69	0	3-Time estimate	0.0333
15	g2	no	47	69.5133	116.5133	90.8	137.8	21.2867	3-Time estimate	0.6667
16	H	no	8.5133	69	77.5133	179.4867	188	110.4867	3-Time estimate	0.5
17	h1	Yes	7	69	76	69	76	0	3-Time estimate	0.0333
18	I	Yes	63	76	139	76	139	0	3-Time estimate	0.6667
19	i1	Yes	1	139	140	139	140	0	3-Time estimate	0.0333
20	J	no	1.5133	69.5133	71.0267	186.4867	188	116.9733	3-Time estimate	0.05
21	j1	no	0.2	69.5133	69.7133	72.8	73	3.2867	3-Time estimate	0.0167
22	K	no	5.43	69.7133	75.1433	182.57	188	112.8567	3-Time estimate	0.25
23	k1	no	4	69.7133	73.7133	73	77	3.2867	3-Time estimate	0.1667
24	L	no	46	73.7133	119.7133	77	123	3.2867	3-Time estimate	0.6667
25	l1	no	1	119.7133	120.7133	123	124	3.2867	3-Time estimate	0.0333
26	M	no	2.1633	120.7133	122.8767	185.8367	188	65.1233	3-Time estimate	0.05
27	m1	no	1	120.7133	121.7133	124	125	3.2867	3-Time estimate	0.0333
28	N	no	8.23	121.7133	129.9433	179.77	188	58.0567	3-Time estimate	0.4833
29	n1	no	7	121.7133	128.7133	125	132	3.2867	3-Time estimate	0.1667
30	O	no	56	128.7133	184.7133	132	188	3.2867	3-Time estimate	0.6667
31	P	no	1.5133	116.5133	118.0267	186.4867	188	69.9733	3-Time estimate	0.05
32	p1	no	0.2	116.5133	116.7133	137.8	138	21.2867	3-Time estimate	0.0167
33	Q	no	5.43	116.7133	122.1433	182.57	188	65.8567	3-Time estimate	0.25
34	q1	no	4	116.7133	120.7133	138	142	21.2867	3-Time estimate	0.1667
35	R	no	46	120.7133	166.7133	142	188	21.2867	3-Time estimate	0.6667
36	S	no	9.1433	140	149.1433	178.8567	188	38.8567	3-Time estimate	0.05
37	s1	Yes	1	140	141	140	141	0	3-Time estimate	0.0333
38	T	no	11.1433	141	152.1433	176.8567	188	35.8567	3-Time estimate	0.05
39	t1	Yes	2	141	143	141	143	0	3-Time estimate	0.0333
40	U	Yes	45	143	188	143	188	0	3-Time estimate	1.6667
	Project	Completion	Time	=	188	days				
	Number of	Critical	Path(s)	=	1					

Source: WinQSB

At the time of making the production plan by using the “MS Project 2013” software and the network diagram, all the preconditions for using the precedence method were met. The Precedence Diagramming Method is used in project management since it is highly applicable when using computer technology and software (PMBOK Guide, 2013). The activities in network diagrams are shown in boxes, and logical relationships between them are indicated with arrows. This method is also called “AON” (Activity on Node) and it is a method that most project management software, as “MS-Project”, use to generate the network model (Slack et al., 2007). There are four types of activity relationships, “FS” (*Finish to Start*) – the previous activity must finish before the next activity starts; “FF” (*Finish to Finish*) – the previous activity must finish before the next activity can finish; “SS” (*Start to Start*) – the previous activity must start before the next activity can start; “SF” (*Start to Finish*) – the previous activity must start before the next activity finishes.

In order to plan production precisely and to adjust it to meet clients’ requirements, in terms of quantity and quality but also delivery time, it is highly important to know all the aspects of production technologies, production and machine capacities and labor availability. Knowing the aforementioned elements of the production process in detail enables the determination of the types of relationships between certain activities. There are 15 "SS"-relationships in the aforementioned example, indicating that a key thing for their setting-up is to know the technology of production and use of the same resources in terms of production. "FS" relationships, and there is three of them in the aforementioned example, are conventional by their nature, representing logical relationships in the sequence of carrying out the activities. Nevertheless, taking into consideration the software and the production plan, as well as the network diagram that is updated each time activity data are completed, it is clear that both "SS" and "FS" types of relationships can be regarded as logical relationships in the sequence. Although there are no "FF" and "SF" relationships in the aforementioned example, they should be mentioned as the relationships that are closely related to knowing production technology before other criteria.

Table 1. Descriptions of activities, their interdependence and duration in days (PDM)

No.	Activity	Vegetable crop – activity description	Depends on the following activities	Type of interdependence	Duration of activities (in days)
1	A	Lettuce - sowing (01 Nov 202X)	none	none	7.73
2	B	Lettuce - germination	A	SS+2 days	9,00
3	C	Lettuce - propagation	B	SS+2 days	32.00
4	D	Cabbage - sowing (01 Dec 202X)	none	none	3.03
5	E	Cabbage - germination	D	SS+2 days	5.00
6	F	Cabbage - propagation	E	SS+2 days	59.00
7	G	Peppers - sowing (08 Jan 202X+1)	none	none	1,52
8	H	Peppers - germination	G	SS+1.52 day	8.52
9	I	Peppers - propagation	H	SS+7 days	63.00
10	J	Tomatoes - sowing (09 Jan 202X+1)	G	SS+0.1 day	1.52
11	K	Tomatoes - germination	J	SS+0.2 day	5.52
12	L	Tomatoes - propagation	K	SS+4 days	46.00
13	M	Peppers - sowing (01 Mar 202X+1)	L	FS+1 day	2.17
14	N	Peppers - germination	M	SS+1 day	8.17
15	O	Peppers - propagation	N	SS+7 days	56.00
16	P	Tomatoes - sowing (05 Mar 202X+1)	G	FS+55 days	1.52
17	Q	Tomatoes - germination	P	SS+0.2 day	5.52
18	R	Tomatoes - propagation	Q	SS+4 days	46.00
19	S	Cabbage - sowing (21 Mar 202X+1)	I	FS+1 day	9.14
20	T	Cabbage - germination	S	SS+1 day	11.14
21	U	Cabbage - propagation	T	SS+2 days	45.00

Source: Authors' calculations

If the whole process of seedlings propagation, all activities, are regarded as one successive "FS" sequence, the whole process would last for 426.5 days. By using PDM, the authors calculated that the process could last for 189 days, namely from 1 Nov 202X to 8 May 202X+1. During the whole period, the production process would not be interrupted, only the quantity and type of crops that go through the germination chamber and propagation area would change.

It is important to note that, according to Lock (2007), PDM gives certain advantages over PERT in terms of time distribution between the activities. One of the authors has already studied the application of these techniques when generating a plan of spring operations for multiple vegetable crops (Ljiljanic et al, 2016; Ceranić et al., 2015) and confirmed those advantages. Furthermore, PDM allows additional flexibility in process modelling (Wiest, 1981). PDM is a prevailing method used nowadays. A continuous use of this method is based on its flexibility over other available techniques and an easily understandable mathematical model in the background (Hajdu, 2015).

Conclusions

The production process is carried out constantly, only crops are changed, depending on the period of a year, market demands and natural (climate) conditions that dictate when the time production starts, outdoors and indoors. Within the production process there are groups of activities that are mostly conducted simultaneously. That is sowing, germination process and propagation, of all crops. Realization of these activities requires synchronization and integration of available means and labor. Time distribution is dictated by production traits of vegetable crops.

Prior to making a plan of seedling propagation of peppers, tomatoes, cabbage and lettuce, a detailed calculation was made of all processes, production capacities and labor. It was made based on the previous recording of all operations (chronography and chronometry) and the data on production traits of all vegetable varieties and hybrids of vegetables seedlings of which were propagated. The production conditions were strictly controlled in terms of humidity and temperature, so it was highly unlikely that this factor could prolong or shorten the production process.

Two methods of network planning were used – PERT and PDM and a network diagram and a Gantt chart were created. The PERT showed that the whole production process could last for 188.0 days, and PDM that the process could last for 189.0 days. PERT took into consideration the factor of uncertainty of evaluation time needed for carrying out the operations, and PDM helped creating the output documents (a network diagram, a Gantt chart) that allowed more detailed, more transparent, and a clearer visual overview and, consequently, more practical use of the document.

Both methods gave almost identical results. Nevertheless, what can be concluded is that PERT requires more precision when making a production plan, which resulted in implementing some activities the realization of which required only the necessary time flow in order to harmonize properly the monitoring of the activities that take time and money. It was not the case when using PDM, since this problem can be overcome by predefining the type of relationships between the interdependent activities (FS, FF, SS, and SF). From the Gantt chart made by "MS Project", one can clearly see the simplicity of using PDM. Furthermore, this method also stands out as flexible in making mathematical models and modelling possibilities, enabling you to change production parameters during the whole process and learn the end result of the use of the resources.

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Conflict of interests

The authors declare no conflict of interest.

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DIGITAL AGRICULTURE – THE CASE OF THE AUTONOMOUS PROVINCE OF VOJVODINA

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ABSTRACT

Agriculture as a crucial economic sector has changed rapidly in the last few decades, more than in previous centuries, because of technological achievements that opened a niche in the international agricultural sector known as digital agriculture. The conception of digital agriculture in practice and consequences on agricultural productivity is a way to response to significant climate changes. The evaluation of the current circumstances is made through the cases of digital agricultural companies in Vojvodina which could help and enhance regional economic growth. This study has utilized a case study method to evaluate the present conditions of digital agriculture appliances in Vojvodina. The results of the research will be a case study analysis of the companies using and developing digital agriculture technologies in the agricultural sector, as well as the presentation of potentials in this niche - digital agricultural sector in the Autonomous Province of Vojvodina. The authors of the paper consider the suggested model in this sector a vehicle that could run not only the economic growth in Vojvodina and Serbia, but also the regional economic growth.

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Introduction

Agricultural production is under many challenges worldwide. Population frowing dynamics will radically change demographics towards the end of the century. Projected growth in the world's population is likely to be concentrated in Africa and South Asia and in the world's cities. According to Food and Agriculture Organisation of UN "by mid-century, two-thirds of the global population will live in urban areas. Low-income countries will see large increments in the age group of 15 to 24 years. The population will continue to grow in South Asia until mid-century and in sub-Saharan Africa until at least the end of the century. By the year 2100, Asia and Africa are expected to be home to a combined population of 9 billion, out of the projected 11 billion people who will inhabit the Earth" (Food and Agriculture Organization of the United Nations (FAO, 2017). Climate change increasingly causes stress to cultivated plants, but there is also the emergence of new diseases and pests. Some weeds and diseases have developed resistance to preparations that we have used successfully in production until recently. We have had relatively low purchase prices for the most important cereals for a long time. These are the facts that require a serious approach within the entire field production process.

Having in mind new challenges in the protection of the most important field crops, the introduction of new technologies is a precondition for achieving successful and profitable production. This primarily means effective protection of crops from weeds, diseases and pests with cost optimization, increased yield and quality. Precisely such actions give a good opportunity to convey new knowledge to our farmers, as well as possibilities of applying new solutions. In this study, we tend to analyse present circumstances, challenges and opportunities in the protection of the most important crops through the introduction of new technologies in the range of digital agriculture.

Based upon the digital agriculture applications that have already been implemented in Vojvodina, the companies that are discussed in the paper have made significant progress as far as raising consciousness of farmers and other involved parts of the agricultural sector in Vojvodina. While the quality of these applications is parallel with their quality in developed countries, the scope of use is still not on satisfactory level. Digital agriculture practices in Vojvodina are implemented on high level from the very beginning, but there are more steps to be done for acceleration, in terms of volume and scope. Like in the developed countries, EU countries and the USA, will enable the expansion of agricultural production vision in the Western Balkan region. Institutes and knowledge transfer centres of universities will be able to transform the accumulated scientific knowledge into initiatives and put the ecosystem focused on digital agriculture in practice. In this context, the development of a digital agriculture action plan and support of this strategy with related policies and implementations, to develop digital farming in the whole region, supports of government have strategic priorities.

Literature review

As it has been pointed out in literature, digital agriculture could be defined as digitization of the various aspects of the agricultural value chain. Also it could be defined as targeted information services useful for farmers to practice new technologies, in that way increasing not only productivity, but profitability, as well. In such type of agriculture, mobile phones and the Internet are important resources, as they are tools which enable farmers to make informed decisions, regarding their farming activities. This is of great importance primarily for the rural areas in developing countries. In developed countries, e.g. in the USA, digital agriculture is advanced, but it is also applicable to smallholder farmers around the world, e.g. in Africa. The agricultural sector is the basic sector for the most African countries and their economies, employing nearly 80% of African population, which are mostly small-scale farmers. In the last few years, the Internet has experienced a fast growth in Africa, and the usage of mobile phones is rapidly rising (Olaniyi, E., 2018). Agriculture is without a doubt the most important sector in this country, as far as economic development is concerned. This economic sector plays an important role for labour market, i.e. employment, presenting the basis for food production and continuation of natural cycles on the Earth. Development of countries is connected to the agricultural development. Agriculture continues to play an essential role for the emerging economies. The 3/4 of India's working population is employed in agricultural sector (Sarkar J.P., Chanagala S., 2016).

As authors of Digital Transformation and Serbia claim, "the new digital economy is the economic activity resulting from billions of online connections between people, businesses, data, devices and processes. The new digital economy has created great possibilities for individuals, enterprises and countries to improve competitiveness strategies using new technologies." (Pitić S., Savić N, Verbić S., pp. 108, 2018). The Strategy for the Development of Digital Skills in the Republic of Serbia for the period of 2020 to 2024 will determine unique and complete directions of action in the field of improving digital skills in the Republic of Serbia, having in view the results achieved so far and the desired directions of capacity development for the entire companies for the use of modern information and communication technologies, development of information society and digital economy in the Republic of Serbia. The strategy was built upon the Agenda for New Skills for Europe and the European Action Plan for sustainability (European Commission, 2016) having in mind that these documents concretize the goals set by the Strategy Europe 2020, and represent the basis for directing strategic and reform processes and development priorities for candidate countries for the European Union membership, including the Republic of Serbia. The main problems of the perceived lack of digital skills in the field of education and training are as follows: digital development skills for all citizens, development of digital skills in relation to the needs of the labour market, as well as monitoring of the further development of this area by ICT experts.

Materials and methods

The authors of the paper start with the hypothesis that the growth in the sector of digital agriculture could be a starter and vehicle for employment and economic expansion in the short term. In order to test the starting hypothesis, a case study of IT companies that are using and developing digital agriculture platforms is applied. The case study (Yin, R., K., 2003) method is used for the verification of the paper's hypothesis, as there is not enough relevant data for the analysis of this topic by other methods. After the extensive analysis of the literature and studies, we could notice that there are certain articles which cover this topic, many new strategies, action plans, case studies, practical implementations, etc. We also noticed a lack of quantitative data in this field. Understandably, as authors Laurens, K., Jakku, E., Labarthe, P. (2019) confirmed with their study "There is a lack of overview of how this field of study is developing, and what are established, emerging, and new themes and topics. An exploratory literature review shows that five thematic clusters of extant social science literature on digitalization in agriculture can be identified: 1) Adoption, uses and adaptation of digital technologies on farm; 2) Effects of digitalization on farmer's identity, farmer's skills, and farm work; 3) Power, ownership, privacy and ethics in digitalizing agricultural production systems and value chains; 4) Digitalization and agricultural knowledge and innovation systems (AKIS); and 5) Economics and management of digitalized agricultural production systems and value chains." In order to contribute to the ongoing efforts for fostering awareness of the importance, possibilities and benefits by enhancing digital agriculture, we performed the analysis of digital agricultural enterprises in Vojvodina.

The methods used, in the scope of this research and during the analysis, are the case study, the parsing and comparison method. Also, during the interpretation of given results, the descriptive method is used, as well as the empirical method. The case study method (examples of good practice in developed countries, BioSense Institute, Greensoft and Inosens) enabled us, through the experience of good practice examples analysis, to reach valuable conclusions and guidelines. New insights were based on the inductive and deductive method.

Results

The new paradigm (FAO, 2017) includes scientific knowledge of numerous agronomic procedures and measures, which enable the implementation of these principles, that is, saving input, while increasing the yield, quality and health safety of food. The basics of the new agricultural paradigm are:

• Reducing the intensity of tillage, which although until recently considered necessary, disrupts its structure and leads to loss of nutrients, moisture and reduction productivity;

• Permanent land covers for moisture conservation and nutrients;

• Periodic cultivation of legumes, which enrich the soil, on plots depleted by cereal cultivation;

• Crop rotation, according to established principles (crop rotation);

• Precise agriculture, which means timely performed agricultural work, high productivity, reduced number of operations and lower labour costs. Plants and livestock get exactly the treatment they need, which has been determined with a precision that man does not have.

With the intention to expand numerous agronomic procedures and measures anticipated by The New Paradigm of FAO, we have analysed the current situation in the companies that deal with digital agriculture in Vojvodina, we have examined current regulations, laws, and strategies in Serbia and we have compared the amount of total arable land in Serbia with land covered by digital measures, in order to determine the potential for the expansion of digital agriculture from Vojvodina to the entire available arable land in Serbia.

The area of agricultural land covers 5,734,000 hectares (0.56 ha per capita), and the arable land (0.46 ha per capita) covers about 4,867,000 hectares of that area. About 70 percent of the total territory of Serbia is the agricultural land, while 30 percent is under forests. (Serbian Government, 2020)

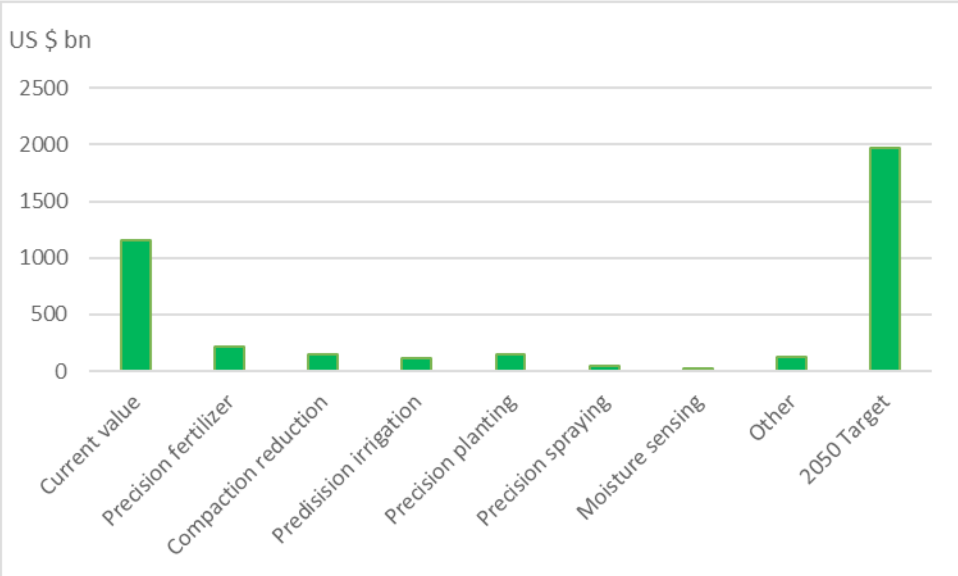
The paradox is that Serbia is the only country in the region in which the area under irrigation systems was reduced last year. According to the data of the Republic Bureau of Statistics, in 2018, only 46,823 hectares of agricultural land were irrigated, i.e. 1.5 percent of the total arable land, which is seven percent less than the year before. In recent years the share of agriculture in the realization of the GDP of Serbia was within the interval of 9 - 11 percent. However, if we look at the overall contribution of agriculture to other sectors of the economy, the food industry and producers and processors of inputs and raw materials, this share exceeds 30 percent of total GDP. (Voice, 2020).

According to The Regional Report of the World Bank Group (2018), agriculture in the Republic of Serbia is generally characterized by very low productivity, i.e. relatively low yields per hectare or per capita, as well as the lack of a process industry. It is known that yields in the Republic of Serbia are lower due to the inefficient use of modern agro-mechanic and agro-technical measures and that this is often compensated by lower labour, energy and land costs, but more dynamic growth of competitiveness requires increased productivity.

The contact with the farmers could be complicated. Over the last five years manufacturers who cultivate large areas years have been very accepting of suggestions and would like to hear and apply this to their fields, but the biggest obstacle is the lack of investing capital. It is even more difficult to explain the economic justification of implementing new technologies to producers who process smaller surfaces. Even though we have financial reports and evidence from developed countries, our farmers are faced with difficulties to implement the digital farming technology.

The report published by Goldman Sachs (2016) highlights the significant increase in expected yields based on the technological improvements being introduced by precision agriculture. This report estimates that these new technologies will allow for 70% higher yields on the existing agricultural land. This converts into a total market of $240 billion by 2050. The below figure shows how different technologies will influence the global crop value in the USA.

Figure 1. Farming technology is core to delivering a 70% increase in global crop production
Global crop value in US $ billions



Source: Precision Farming, Goldman Sachs Group Inc., pp. 17.

From this report we can see that digital technologies will have a major impact on the agricultural industry. It is clear that the US and European markets are the most attractive. This figure is another key indicator that the adoption of these solutions will only increase due to the value that they are bringing to farmers (Ivanov, I., 2018).

Table 1: Benefits of digital agriculture to various stakeholders in the agricultural sector:

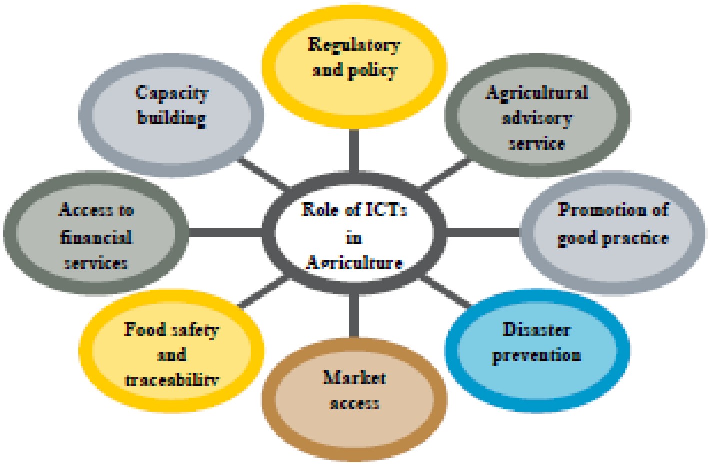
Benefits for farmers:	Creating virtual cooperatives Access to contractors Access to educational and consulting services More direct market access with fewer intermediary steps Access to agricultural services via mobile devices: Predictions of price movements of goods Track weather forecast and trends Mapping of agricultural land
Benefits for contractors:	Visibility by a large number of farmers A competitive environment Electronic contracting and reporting
Benefits for investors:	Electronic farm records (files) Agricultural Land Exchange Crop structure predictions
Benefits for educational services:	Easy communication with farmers Immediate access to all relevant information The competitive environment of other agronomists
Benefits for public administration:	Strategically important information for policy making and decision making Contribution to the system for identification of agricultural parcels Contribution to the State Geodetic Authority

Benefits for chemical sellers:	Information on the health of plants Biophysical parameters indicating the need for supplements Crop structure predictions Access to a large number of agronomists and educational services
Benefits for innovative small and medium enterprises:	Access to the technological framework for the development of value-added services BioSense accelerator

Source: Biosens (2020.) https://biosens.rs/?page_id=7745&lang=sr

As presented in Table 1, supporting the continuing model of digital solutions in Vojvodina's agriculture companies as a model of growth for regional development could only contribute to all vital factors of human society (private sector, government, university, society). In Figure 2 there is the description of what is the role of ICT in agriculture. To presume that the technology is highly adopted and will continue to be adopted by farmers, we can explore some of the benefits that come with digital agriculture technology. The main advantage that digital agriculture technology brings includes: efficiency in the use of resources like fertilizers, chemicals, fuel, water, etc., improving quantity and quality of produced agriculture products, higher yield in same amount of land.

Figure 2. Role of ICT in agriculture.



Source: FAO (2016)

The main obstacle, beside the economic power of the farmers themselves, is their view that their current way of running business is quite satisfactory, or that their technology is very complicated and therefore could not be considered profitable. The state can contribute to education, because it is in the interest of the state to apply modern technology in agriculture in order to increase production and preserve natural resources. Advisory services are the route through which information should reach farmers. To succeed in this, they must have trained counsellors. The Provincial Secretariat for Agriculture has taken a step forward in this regard and advisers in the territory of Vojvodina are familiar with the technology of data collection in electronic form, with the spatial component, etc. It is necessary to raise awareness about the protection and conservation of natural resources (land, water), as well as about saving time and energy through the use of new technologies in agriculture. It is necessary to engage both farmers and the public in the digital education.

As presented in Table 2, three major players in the field of digital agriculture of Vojvodina are the BioSense Institute, Greensoft, which is the member of TeleGroup system and InoSens.

Table 2: Three main players in the field of digital agriculture situated in Vojvodina

BioSense Institute	-Research and Development Institute for IT in biosystems was founded by BioSense Centre, which is the existing organizational unit of the Faculty of Technical Sciences, University of Novi Sad, and it has been working as a research center within the University of Novi Sad for many years -internationally recognized multidisciplinary scientific research centre; it is one of the most developed and most modern scientific research centres in Southeastern Europe and has existed for eight years. It operates on two levels - within the Faculty of Technical Sciences and at the University of Novi Sad. So far, it has successfully implemented as many as 14 FP7 projects, with a total budget of over 10 million euros in donations, i.e. non-refundable funds that were directly invested in scientific projects and salaries of scientists. So far, it has won 4 projects in the “Horizon 2020” program (Autonomous Province of Vojvodina, 2020) -By creating innovative solutions that are available to all farmers regardless of the size of their farm, the BioSense Institute has a vision to provide small farmers in the region with advanced technologies at affordable prices, which would enable them to survive in a globally competitive environment -The development of the integrated agricultural monitoring system of the BioSense Institute can offer many benefits to different stakeholders in the agricultural sector -The ultimate goal of the BioSense Institute is to link the efforts and results of various research groups into a single integrated system for agricultural monitoring. This system will provide data sets that will lead to revolutionary progress in the agricultural sector, not only in terms of increasing efficiency, reducing pollution and saving money, but also in terms of how the agricultural activity is understood and performed, making agriculture an acceptable professional choice for younger generations of farmers -The digital farm is actually a real farm, on which agricultural production is carried out. On the other hand, it is demonstration goods, an educational tool where students of agricultural schools, students of agricultural faculties, but also farmers themselves can learn a lot about the implementation of modern technologies. The digital farm was established within the ANTARES project of the BioSense Institute, funded by the European Commission and the Republic of Serbia (E-kapija, 2020).

Greensoft	-founded in 2012 -developer of software solutions specializing in the management of agricultural production processes -guided by the fact that there is no appropriate business software in the global market that would allow the agricultural sector to adequately manage complex production processes, with the aim of increasing yields and profits, and reducing overall operating costs -developed software solutions specializing in the management of agricultural production processes and all types of land, based on GIS technology. Author's Software Solution "AgroLIFE," which is patented by the Institute for the Protection of Intellectual Property of Serbia, allows customers to efficiently and optimally plan and run a complete agribusiness -currently covering 1.2 million hectares with its platform, with great ambitions on a global level and hope to cover the entire territory of the Republic of Serbia. -mostly market-oriented, but interested in all forms of cooperation, with over 3000 private household users and over 50 users among public authorities. -Since 2014, as a member of the TeleGroup system, their vision has been to place the existing group of IT products intended for agribusiness on the global market and to create new products for intelligent agriculture and water management
InoSens	-innovative company in Serbia, founded as a spin-off of the University of Novi Sad. Its mission is to accelerate the transfer of innovative ICT technologies to the agribusiness sector -engaged in the design and development of sensors, deployment of Wireless Sensor Networks and the application of advanced remote sensing techniques for optimizing economic performance and environmental sustainability in agriculture -developing platforms and applications for optimization of farming activities on the field, targeting large farming estates with emphasis on vineyards and apple orchards -the company is developing remote sensing platform for crop classification and natural hazards monitoring - *CropSupport*. Promotion of the use of blockchain technology in the agribusiness sector in the Western Balkans is just one of the many projects of the company

Source: BioSense Institute, Greensoft, Inosens, E-kapija (2020).

Agriculture is one of the areas undergoing the most dynamic changes, and today, more than ever, producers have the imperative to increase yields, grow quality products, and at the same time reduce costs.

Discussions

There are many described case studies and research models (Barkovic, D., et al, 2018, Čuković, I., 2017, Lakote, M., et al, and 2019) in digital agriculture across the region – in Croatia, Slovenia, Bosnia. The common denominators of all these successful examples are obvious benefits for agriculture as the main initiator of regional development. What is missing are quantitative data processed in form of more extensive statistical and econometric analysis, which could be used for evaluating the actual policies, strategies and action plans. It is imperative to produce safe and quality food, and digital agriculture is the right tool for that mission. The goals shown in the paper cannot be achieved in the short term, as there is a technological lag of Vojvodina's agriculture, but if we expand the benefits of digitalization of agriculture in Vojvodina, economy growth could be made.

In the recent decades in the region of Vojvodina, the growth of IoT technology is noticeable. The IoT based monitoring system for agriculture has been used to maximize the yield of crops by monitoring the environmental parameters and thus providing the necessary information to the farmer remotely. The proposed system is mainly developed for the betterment of farmers. The use of IoT over other technologies enables us to deploy it in any type of monitoring areas, making it flexible and robust. As we have described in our research and evaluation of the current circumstance through the 3 cases of digital agriculture companies in the Vojvodina Region, they have started to enhance regional economic growth. The results of our case study analysis confirmed that digital agriculture applications in Vojvodina's companies are improving education, implementation and prevalence of digital agriculture technologies in the agricultural sector, as well as capacity building in this niche – fulfilling potential of digital agriculture sector in the Autonomous Province of Vojvodina. The suggested model in this sector is a vehicle that could run not only the economic growth of Vojvodina and Serbia, but the regional one, as well.

Revolution in agricultural machines occurred a century ago. Half a century ago there was a revolution in agricultural chemistry. A decade ago, the new revolution in agricultural information technology started and it is called digital agriculture. We couldn't even assume that the basic factor of production - through agriculture - would be connected to digital technologies. We are now in the midst of a whirlwind of these developments and in a few years we will not be able to recognize the same digital agricultural landscape. According to FAO estimates, by 2050 we will need to produce 70% more food. The population is growing, therefore it is taking away land, and more food needs to be produced. Therefore, we need to find a way to increase productivity per unit area and not to disturb nature. Based on the analysis of the agricultural structure and circumstances in Vojvodina, we can conclude that digital agriculture can provide the significant regional economic growth. With The Smart Specialisation Strategy, The Strategy for Development of Digital Skills in the Republic of Serbia for the period from 2020 to 2024 and the three ongoing initiatives with a systematic approach in digitalisation of agriculture, we can expect radical changes in the agricultural policy in Autonomous Province of Vojvodina. Enhancing the technological modernisation in agriculture is a necessity for our presence and for our future.

Conclusions

According to the United Nation's Sustainable Development Goals, digital agriculture has enviable potential to increase economic contributions through expansion of market opportunities, agricultural productivity and cost efficiency. Also, there are environmental benefits through the optimized resource use and through adaptation to climate change, as well as, social and cultural benefits through increased communication and inclusivity.

The fourth industrial revolution, whith "smart" and interconnected machines and systems, also coincides with further discoveries in various areas, from determining the genome sequence to nanotechnology, and from renewable sources to quantum computing. The correlation and connection between these technologies and their interaction in the physical, digital and biological field is the key exceptional benefit of fourth industrial revolution which significantly differentiate it from the previous industrial revolutions (Lakota, M., Stajnko, D., Vindiš, P., Berk, P, 2019). As Weltzien (2016) anticipated, the interoperability and digital networking of agriculture enabled new process control systems. If we are concerned that the value added through the new technologies in digital agriculture is the extension associated with the agricultural products and that the main brunt is still on the weather risk, environmental and climate change, we can be sure that all indicators for decision making are better positioned by the usage of information and communication technology.

Likewise, four emerging thematic social science clusters, with great potential are identified: 1) Digital agriculture socio-cyber-physical-ecological systems conceptualizations; 2) Digital agriculture policy processes; 3) Digitally enabled agricultural transition pathways; and 4) Global geography of digital agriculture development. This future research agenda provides the ample scope for future inter-disciplinary and transdisciplinary science on precision farming, digital agriculture, smart farming and agriculture 4.0 (Klerkx, L., Jakku, E., Labarthe, P., 2019). Declaration of cooperation on ‘A smart and sustainable digital future for European agricultural and rural areas’ was signed by twenty five European countries, who will take a number of actions to support successful digitalisation of agricultural and rural areas in Europe. This Declaration of cooperation recognises the potential of digital technologies to help tackle important and urgent economic, social, climate and environmental challenges facing the EU’s agri-food sector and rural areas (European Commision, 2020). The advancement of digital skills is a necessary tool for the emerging the new technologies and their influence on the digital society and digital economy. Changes in architecture of business systems implies skills needed for employment, productivity, creativity and success. The Vojvodinian agricultural sector could use growing potentials of digitalisation in agriculture and maximise the availability of experts and new technologies, along with information security and safety of the network.

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Conflict of interests

The authors declare no conflict of interest.

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NEW TECHNOLOGIES AS A DRIVER OF CHANGE IN THE AGRICULTURAL SECTOR

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A B S T R A C T

Faced with a demographic boom, enormous urbanization and a lack of agricultural land, traditional agricultural production is losing pace with new needs and demands. Due to the increased demand for food, efforts are being made to develop technologies that would improve production, with the sustainable use of existing resources. Solving this challenge is possible by introducing Internet of Things technologies, satellite navigation, mobile communications and ubiquitous computing, which is called smart agriculture. The main goals of smart agriculture are to increase yields (provide information needed to analyze and make decisions that will maximize yields), efficient water use, more efficient agricultural operations (automation of daily activities, real-time monitoring, advanced analytics, daily and seasonal forecasting), cooperation with suppliers and public administration are more efficient and take place in real time). This article highlights the potential of the Internet of Things, big data and drones in agriculture, as well as the challenges of applying these technologies in relation to traditional agricultural practices.

Introduction

According to estimates and with an accuracy of 95%, the global population in 2050 will be between 9,4 and 10,1 billion (WPP, 2019). To feed so many people, food production should increase by approximately 70% by 2050 (FAO, 2017). Modern agriculture faces several challenges, the most pronounced of which are the extraordinary population

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growth, environmental degradation, lack of natural resources, reduction of arable land, climate change, and declining productivity and profitability. Because agriculture is a significant sector in every country's economy, the traditional methods used for decades to produce food today cannot meet the greatly increased needs.

The accelerated development and adoption of technologies in the 20th and at the beginning of the 21st century and the way in which they are changing our lives and the environment is not a new phenomenon. However, many advances in biology, quantum theory, electronics, computing, communications, and materials science are relatively new. Deciphering the human genome, measuring gravitational waves, producing micro-integrated circuits, developing the internet, and mass adoption of personal computers and smartphones have mostly happened in the last 10 to 30 years. Certainly, artificial intelligence, machine learning, the IoT, sensors and blockchain, are just some of the examples of new technologies (Radic, 2020; Teodosijevic Lazovic, 2020).

Technology has provided a new landscape, in which businesses that adapt are well-placed to thrive. Businesses that are slow to adapt or are inflexible to change risk compromising their own productivity, ultimately jeopardizing their business' viability. We examined key trends facing agribusiness, outlining the potential ramifications and opportunities, that will create lasting effects in the supply chain for decades to come.

The goal of applying new technology in agriculture is to increase yields, reduce harvest times, reduce costs and environmental impact. The new age implies the use of technologies, applications and solutions implemented in the concept of Industry 4.0, which radically transform the production capabilities of all industries, including agriculture (Bonneau, Copigneaux, 2017). The integration of new technologies with modern agriculture results in better production and easier supply chain management. The basic applications of digital technologies in agriculture are so-called sensor technologies, such as meteorological stations on parcels, humidity sensors and soil scanners, yield mapping, satellite and drone images, the IoT and big data analytics.

These include precision farming and robotics, which enable optimal sowing, fertilization and crop protection, precise irrigation, precise weed control and automated harvesting, and, finally, predictive and prescriptive analytics, which enable correct decisions to be made based on sensor data.

The importance and potential of digital technologies became very visible during the crisis caused by the corona virus. Procurement of raw materials, consulting or direct connection of producers and consumers have become more complicated than ever, and with digitalization they could be significantly improved in agriculture after the end of the corona virus pandemic. Solving this challenge on a global level is possible by introducing IoT, satellite navigation, mobile communication, and computing.

As in other sectors, there must be conditions in the agricultural production sector that will ensure the efficient use of digital technologies. This primarily refers to the necessary infrastructure and connectivity, accessibility, educational level of future users of these technologies and support of institutions. Although the introduction of digital technologies in rural areas allows small farmers to connect with suppliers and enter the market, great challenges have been faced. With the migration to urban areas, the number of inhabitants in rural areas is decreasing, so the progress in the field of education is limited. The biggest problem is, of course, the lack of IT infrastructure and the high costs of establishing it in remote rural communities. Finally, taking into account developing and least-developed countries, high poverty rates are a particular challenge and a kind of limitation in the implementation of digital technologies (Cowie et al., 2020; Trendov et al., 2019).

The goal of the paper is to review empirical research on the adoption of new technologies in agriculture, and to present the possibilities and limitations of IoT, big data, and Unmanned Aerial Vehicles (UAVs) in agriculture context. The research methodology includes formulating of review, research questions, selecting relevant papers for review, and extracting useful information from those papers. Finally, the conclusion and suggestions for future work follow. The main research questions were:

- What are the advantages of applying digital technologies in the agricultural sector?
- What are the limitations of using these technologies?
- What are the current challenges and future expectations?

Literature review

The importance of technology for the development of society is immeasurable because technology includes all activities that create some value as a result, regardless of whether it is a product or a service. Technology contains knowledge, expertise, as well as ways to use factors of production to create products and services for which there is economic and social demand. Therefore, any breakthrough in one area of technology has a direct consequence of their application in another area. The need to apply new technologies in agriculture is not in question.

The need for technological development in agriculture, new technologies and their adoption by farmers are key drivers of maintaining the competitiveness of agriculture in the global world. After the application of digital technologies within the agricultural sector, as part of the Industry 4.0 concept, the term “Agriculture 4.0” has recently been attributed to it, and research activities and advancements have persistently enhanced over the years.

One area of information technology that has been developing rapidly in recent times is the Internet of Things (IoT). IoT technologies allow you to connect more users, devices, services and applications to the Internet. Devices connected to other devices and applications can exchange data directly and indirectly with each other. End users access this data via the web and mobile applications, configure device configurations, and manage and maintain IoT systems. IoT is defined as a global network infrastructure that enables the connection of physical and virtual devices with interoperable communication protocols and intelligent interfaces. The infrastructure consists of three basic components: smart devices, the network infrastructure for connecting them, and systems that use data generated by smart devices. The structure of IoT can be divided into three layers: hardware, infrastructure, applications and services (Gubbi et al., 2013).

An intelligent device is an instrument or machine with the properties of a computer. Its main feature is that it can communicate with other devices in the environment and perform intelligent operations. Such a device must have power, memory, processor and communication interface. Smart devices can be powered via the electricity grid, batteries, solar panels, etc. The memory of smart devices allows storing data from sensors and performing operations for which devices are programmed. The IoT device consists of input / output interfaces for sensors and actuators, an interface for internet connection, an interface for storage and memory and an audio and video interface. IoT devices include: sensors (for monitoring the status and notification of changes in the environment in which they are located), actuators (which based on detected changes in the environment through management actions perform physical activities), modules (which allow receiving commands in a particular environment), microcontrollers with built-in memory, clock and hardware for connecting to external devices), microcomputers (which have a microprocessor, memory and input-output devices on one chip).

Technologies used for the development of the Internet of intelligent devices are: network technologies and protocols, sensor networks, mobile technologies, cloud computing and big data. Mobile technologies that have contributed to the development and application of the Internet of Intelligent Devices are mobile telephony and mobile Internet networks, Bluetooth, RFID, WiMAX, Global Positioning System (GPS), Near Field Communication (NFC), ZigBee and others.

With the development of mobile business technologies, IoT and social media, the amount of data stored in the information systems of organizations (companies, companies, firms) is increasing. Requirements for the development of advanced e-business applications, which are characterized by reliability, distribution and scalability, cannot be realized using traditional databases. That is why new approaches are being developed for storage, fast search and analysis of large amounts of data in real time, based on big data technologies. The need for big data technologies is often explained by the use of three "V" models, according to which the main characteristics of big data are: data volume (Volume), data diversity (Variety) and speed (Velocity).

In the professional literature in the last few years, numerous authors have published papers related to IoT, intelligent devices and the concrete application of IoT in agriculture. These papers provide an overview of the concepts, infrastructure and technologies used to develop smart environment management applications, present solutions based on data collection from sensors on soil, temperature, humidity, pH, nutrients, pests, and the possibility of establishing a link between crop, weather and equipment data for efficient irrigation, reproduction and optimal livestock nutrition (e.g. Yadav et al., 2015; Forkan et al., 2015; Ribarics, 2016; Stubb, 2016; Nandyala & Kim, 2016; Ingale & Jadhav, 2016; Nalini & Suvithavani, 2017; Kamath et al., 2019; Khanna & Kaur, 2019; Rao et al., 2019; Shafi et al., 2019; Zikria et al., 2019).

Other authors point to big data analysis techniques and their application and suitability in different areas of agriculture (e.g. Hilbert, 2016; Rajeswari et al., 2017; Al-Kathani & Karim, 2018; Wolfert et al., 2018; Kumar & Menakadevi, 2018; Asghari et al., 2019; Sarker et al. , 2019; Tseng et al., 2019; Li et al., 2015; Li et al., 2019; Liu et al., 2019; Farooq et al., 2019). A special segment in the field of sensors is the establishment and integration of wireless sensor network (WSN - Wireless Sensor Network), which dealt with Anushree & Krishna (2018), Toth et al. (2019) and Rasooli et al. (2020) etc. Of course, a large number of generated and processed data requires their storage and uninterrupted access, which is coupled with the security aspect and the possibility of misuse or theft of such data. This segment of information technology has long been the focus of many experts and researchers, who recommend different methods, techniques and solutions (e.g. Stergiou et al., 2018; Hussein et al., 2020; Shang et al., 2020; Zhang et al., 2021).

Internet of Things in agriculture

The advent of new and better sensors and IoT has led to significant changes, such as automation of management, surveillance of protected areas and facilitated cultivation. IoT enables remote management, achieving greater efficiency, accuracy and reducing costs, saving time, especially if agricultural land is far away. IoT is a technological revolution, and it represents the future of computing and communications. Its development depends on technical innovations in many areas, from wireless to nanotechnology. Li et al. (2105, 2019) state that the basic concept of IoT is to sense the physical world by connecting physical objects with each other, which is based on different identification and tracking technologies that allow remote monitoring of these physical objects without the need to be in line-of-sight (Xu et al. 2014). As more and more physical objects are equipped with remote sensing and controlling devices, it is possible to continuously monitor the status of a specific physical object or its environment (Madakam et al., 2015).

Dramatic climate change, especially rapid depopulation, air, water and land pollution, increasing urbanization and shrinking agricultural land, and unprecedented demographic shocks have contributed to the technological transformation of the agri-food sector in recent decades. This refers not only to the automation and application of machines with new possibilities, but also to the greater use of digital technologies, especially IoT. In this way, farmers can gain better control over agricultural land, take corrective action and achieve desired yields. According to marketing estimates, the use of IoT in agriculture is expected to reach 20.9 billion dollars by 2024 (Chui et al., 2021). This is mostly influenced by increased demand, wider acceptance of IoT and related technologies by farmers, as well as the desire to increase the efficiency of agriculture.

Smart agriculture gathers data from the field frequently and accurately, combined with external sources (e.g., weather information, environment conditions, etc.) and administrative documents from the food chain (invoices, laboratory results, etc.). The combined collected data is analysed and interpreted, and insights are generated to support the farmers to make better decisions. These decisions can then be applied by using robotics and advanced machinery, and farmers can monitor in real-time the processes and get feedback. Technologies used include sensors, communication networks, edge computing, platforms, unmanned aerial systems, artificial intelligence and IoT as the pivotal technology for the future. Table 1 shows some of the benefits of using IoT in the agri-food sector.

Table 1. Benefits of IoT in the agri-food sector

1.	Collect data using sensors and IoT devices to track agri-food processes, equipment efficiency, fertilisers needed, and ensure uniform quality of the food.
2.	Sustainable cost management and waste optimisation using efficient control over production by identifying anomalies in crop growth or livestock health, to mitigate risks.
3.	Improving the functioning of the food chain by making farm data available to other actors and trigger consumers to buy more sustainable food.
4.	Process automation during the production cycle using IoT, digital technologies and platforms (e.g., fertilization, irrigation, pest control).
5.	Effective control of production processes to maintain high quality and volume of products.
6.	Accelerate the transition to sustainable fair food systems with a neutral or positive environmental impact, and ensure food security, nutrition, public health, preserve affordability of food while generating fairer economic returns, and promoting fair trade.

Source: Project “Internet of Food and Farm 2020”, EU, 2021.

The benefits of ensuring the successful development, deployment, and use of IoT solutions in the agricultural sector are quite apparent. It makes sense from an economic point-of-view (greater growth within the industry, increased productivity, reducing long-term costs, and costly waste). It is also very clear from an environmental perspective (reduce climate emissions, less food waste, less herbicide, and pesticide use [through greater optimisation], and improved yields, and a reduction of plant and animal disease through early detection). IoT solutions should be promoted and ensured through effective policy, supportive regulation, and incentives.

Technological limitations (Table 2) were a major inhibitor for adopting and implementing IoT solutions. These limitations were wide-ranging, and require a concerted effort between policymakers and technology providers to overcome these difficulties. Examples of use IoT in EU countries have identified many technological and regulatory differences between countries, such as bandwidth, internet access and IoT solutions. The lack of rural connectivity, poor or costly internet access, or interference with connectivity, proved to be one of the greatest challenges. Rural areas, where most of the agriculture activity is concentrated, have been traditionally underserved in terms of connectivity services. This represents a serious bottleneck for the development of digital agriculture and the uptake of its benefits (Ryan et al., 2021).

Table 2. Technological limitations IoT

1.	Transnational and national policymakers need to find greater convergence on regulation to ensure easy, effective, and mutually beneficial transitions between borders, allowing easier adoption of new agricultural IoT technologies.
2.	There needs to be clear policy to support technological innovation and adoption through economic incentives, advice, integration, and education.
3.	Implement sufficient internet connections in rural areas, ensuring fast, widespread, and reasonably priced availability. Ensure that rural areas have sufficient mains/electricity for IoT connectivity, promote an awareness of this availability, and education of how the sector can benefit from cloud-based services and online business channels.
4.	Make specific policy efforts for fair access to, and education of, technology to avoid the "digital divide" and information asymmetries. The digital divide is caused when there are those who benefit from, have access to, and can use digital technologies, while others cannot.
5.	Technology standards and the use of performance standards need to be set, along with policy decisions including holistic consideration of benefits, costs, effects of digital technologies, climate, re-use, and recycling. The technology itself must be robust and reliable, achieved through independent testing facilities to ensure they are effective.

Source: Project "Internet of Food and Farm 2020", EU, 2021.

Efficient use of IoT and digital technologies in agriculture depends on enabling technologies, connectivity infrastructure, edge computing processing and data collection. However, among all the above parameters, in the agri-food sector, the most important is the connectivity. Connectivity requires low-cost IoT networks that are easy to set up, support multiple devices, and provide superior real-time data performance. Only with the fulfillment of these requirements can it be expected that the advantages of advanced IoT implementation will be used in the best way.

Agriculture is expected to be one of the sectors that will be extremely affected by progress in the IoT domain (Tzounis et al., 2017). The main advantages of using IoT in agriculture are higher crop yields and lower costs. Gralla (2018) states that yields on the average farm using IoT increase by 1.75%, the cost of energy used decreases from 17 to 32 dollars per hectare, and the use of water for irrigation decreases by 8%.

Potentials and problems of using drones in agriculture

Unmanned aerial vehicles (UAV) or Unmanned Aerial Systems (UAS) are aircraft of various shapes and sizes, which can be remotely controlled or can fly autonomously. Drones are made of lightweight composite materials to reduce weight and increase the ability to change position. Due to the use of composite materials that have high strength, they can fly at extremely high altitudes. In principle, they can be equipped with a wide range of navigation systems or recording devices (RGB and infrared cameras, GPS). In addition to low weight, the advantages of using drones are that they are easy to transport, they can take high-resolution images, change the flight altitude depending on the needs of data collection, they can move on terrains that are not accessible to off-road vehicles. In addition to the above, the most important feature is the availability of data in a short time interval (Simelli & Tsagaris, 2015).

The UAVs are characterized by small dimensions, portability, as well as the possibility of quick and easy installation in the field. In agriculture, UAVs show unlimited potential and they are used to processing of photographs and obtain a significant amount of information on the condition of crops on agricultural land. They are used for chemical protection, sowing and fertilization. The UAVs can also be used to monitor the condition of crops and mapping production areas, classification of plants on production areas, monitoring the occurrence of diseases and pests, detection of areas where stress occurred in plants due to excessive water or other factors, detection of areas where perform watering or drainage, assessment of plant biomass, as well as monitoring of weeds present on production areas (Zhang & Kovacs, 2012).

It can be concluded that there is a wide range of activities in agriculture that can be implemented using UAVs, which include soil analysis for field planning, crop monitoring, crop spraying, irrigation, crop health assessment, crop surveillance, controlling weed, insect, pest and diseases, tree / crop biomass estimation, and scaring birds (Kim et al., 2019; Pathak et al., 2020).

With the help of cameras with different characteristics installed on unmanned aerial vehicles, it is possible to generate 2D and 3D high-resolution soil maps, based on which useful information on soil properties, crop condition, moisture content, soil erosion, stressed surfaces, etc. is obtained. The use of UAVS can reduce the use of pesticides and maximize efficiency by decontamination on a large scale (up to 50 ha per day), which requires only 10 minutes of work on 0.5 ha of surface. Thus, research in the field of unmanned aerial vehicles aims to reduce the need for physical engagement of farmers (Luck et al., 2010). For example, the Chinese company DJI, with a large share in the market of UAVs, launched the MG-1 model for spraying pesticides. The MG-1 has eight rotors, a payload of 10 kg and can spray up to 4 ha per hour, and automatically adjusts the required (lowest) amount of pesticides to flight speed (Kim et al., 2019).

For optimal production, crop monitoring is necessary, which in the case of large farms requires significant time and work. Therefore, it is proposed to monitor crops through unmanned aerial vehicles, which significantly reduce the working time. The UAVs, equipped with multispectral cameras and thermal sensors, can also be used to control irrigation. In the United States, pest infestations and infections cause damage of about 33 billion dollars annually, so early warning and diagnosis is necessary because the damage is spreading rapidly (Kim et al., 2019). Nebiker et al. (2016) conducted research on potato fields to infect and showed that high-resolution RGB cameras and multispectral sensors mounted on UAV accurately and quickly detect pathogens.

For example, in Xinjiang, the most important region for cotton production in China, cotton production takes place on areas of over 2,5 million hectares. Before the cotton is harvested in October, defoliants must be sprayed so that the harvested cotton does not contain impurities from the leaves. For this activity, local producers, apparently, use tractors, which can damage the land and 5-8% of the obtained amount of cotton. Lately, however, more and more farmers are turning to UAVs to do these jobs, because flying over areas with cotton UAVs does not cause additional damage. It is estimated that one UAV does the job as 60 farmers in one hour, which is a significant saving of time and labor costs. Since productivity measures the efficiency with which farmers use inputs to produce outputs, it is obvious that the use of UAVs increases productivity. Also, during 2019, about 4500 UAVs performed tasks on 65% of the cotton fields in Xinjiang, which increased the total cotton production in the region by 400.000 tons and resulted in an increase in revenue of more than 430 million dollars. Across China, there are over 50.000 agricultural UAVs in operation, which have sprayed with fertilizer and pesticides on an area of 30-33 million hectares of crops (Wang et al., 2019). The constant adoption of new technologies and practices enables farmers to increase the quantity and quality of agricultural products, use inputs and reduce production costs. Xia et al. (2017) cites the example of farmers in Australia who have reduced the use of inputs (including land, working capital) by approximately one percent per year in the last four decades.

The advantages of using UAVs are expressed in several ways. For example, the flight of UAVs is controlled from a distance by trained pilots, which eliminates direct contact of farmers with toxic substances. Secondly, on large areas with agricultural crops, farmers would have to work longer and get more tired, which reduces their efficiency. The UAVs do this in a shorter time, eliminating other delays in the field, because they can spray 20-40 ha per day, depending on the capacity of the UAV (which is up to 30 times larger than traditional sprayers with a backpack). Automation affects even spraying which reduces spillage and saves up to 30% of pesticides. The UAVs use ultra-low volume spraying technology, which saves 90% of water compared to traditional spraying methods. Since the work of farmers in traditional spraying is longer and requires intensive use of labor, the price of conventional spraying is affected by the number of farmers and the area on which they are engaged. The use of drones in this operation provides a lower cost of spraying by as much as 97%. The main characteristics of UAVs used in agriculture are ease of use, long projected service life, easy maintenance, availability and replacement of spare parts that are not expensive (Pathak et al., 2020).

Since UAVs are used in agriculture in only a few countries in the world (USA, Japan, China, Spain, Australia, Brazil, India, South Africa), examples of specific use are related to both technological and regulatory constraints. Technological constraints relate to the characteristics and specifications of UAVs (mass, materials, fixed wings or multirotors, application of different types of sensors, cameras and other equipment). Regulatory constraints apply to the legal framework defined by national aviation authorities (classification of UAVs into categories according to mass, altitude and speed, and range, obtaining a permit to fly, examinations for operators, etc.).

In addition to specific advantages, UAVs for application in agriculture also have certain limitations. The flight duration of UAVs, due to the higher carrying capacity (sensors, camera, accompanying equipment), ranges from 20-60 minutes, which is reflected in the lower coverage of the land surface in one pass. On the other hand, the price of UAVs that have the option of a longer flight is progressively increasing. The UAVs that are used in agriculture to record the land and the condition of agricultural crops are, most often, with fixed wings and their market price is around 25,000 dollars. The price of UAVs, of course, is influenced by the characteristics of sensors, cameras and accompanying equipment. The choice of UAV is similar to the choice of other machines, devices or tools used in agriculture. The farmer decides on a specific UAV based on his own needs (land area, type of agricultural crop, available finances and willingness to invest) and offered UAV specifications, their availability, maintenance costs and spare parts and prices.

A big problem facing farmers is online coverage, which is mostly unavailable on arable farms. In such a situation, farmers who intend to use UAVs must invest certain financial resources in the connectivity infrastructure and procure UAVs that have the ability to store data in an appropriate format.

The problem that is already present is the availability of appropriate software for receiving, storing and processing data (information). Software is an integral part of the application of UAV in agriculture, because a large number of individuals and companies are engaged in creating programs of specific capabilities. Sometimes, in addition to online access, it is necessary for the farmer to receive real-time data on the condition of land and crops, all with the aim of applying preventive and corrective measures to prevent damage. Sensors, cameras and software are market goods, the price of which is influenced by many factors. However, the farmer must be sure that the data obtained from the UAVs are accurate and that they reflect the real situation on the ground (Ampatzidis et al., 2020). The reasonable assumption is that the average farmer does not have specialized knowledge and skills for processing the collected data, so he must train or hire qualified staff for such activities.

As in other areas of computing, in the phases of data collection and processing, there is the problem of information security, illegal downloading or violation of privacy (Gupta et al., 2020; Pathak et al., 2020).

The biggest problem in the application of UAVs in agriculture is related to weather conditions. In conditions of rain or fog, as well as strong wind, cameras and built-in sensors on UAVs cannot provide images of the required and sufficient resolution, and obtaining reliable data. This requires waiting for the weather to improve, repeating the flight, and re-collecting (and later processing) field data (Simelli & Tsagaris, 2015).

Conclusions

The era of new technologies and intensive development of new models and methods of production and work has largely affected all types of industrial production. We are witnessing the fourth industrial revolution and the great breakthrough of computers, sensors and smart devices in everyday life. We are also witnessing an unprecedented demographic boom, industrialization and urbanization, dramatic climate change and its consequences. With the growing population, the requirements for providing food in terms of quantity and quality become even more urgent. The only solution to such challenges is to grow crops in a smart and precise way. The industrial development of the new age also affects the agricultural sector and enables a new evolution in the digitalized industry. In that sense, new information and communication technologies can make agricultural production more efficient. This includes the development of new technologies and solutions in the field of micro- and nanoelectronics, signal processing, artificial intelligence, IoT, big data, robotics, satellite crop monitoring. By applying advanced methods of machine learning and artificial intelligence, it is possible to analyze large amounts of data and extract new knowledge about agricultural production and crop development. This knowledge, further, is used to answer practical questions, crucial for agricultural production. In accordance with the concepts of precision agriculture, it is possible to give recommendations for fertilization, irrigation and application of pesticides, which ensures proper plant treatment, risk reduction, increased yields and, above all, resource savings (seeds, fertilizers and pesticides).

Agriculture, without a doubt, is the oldest form of business, and the advancement of technique and technology has a huge role in its development and improvement (Luković et al., 2021). The main benefits that digital technology provides to agriculture are sustainability, knowledge and efficiency. When we talk about sustainability, we mean not only productive, but also environmental and social. Knowledge means more awareness of the dynamics of internal processes in production itself, supply chains and competition. Efficiency means reduced costs, shorter operating and production times, better management control and higher productivity.

Digitization of agriculture means the evolution of precision agriculture achieved by collecting, integrating and analyzing data from the field via sensors. In fact, digital agriculture is a set of tools, machines and strategies that enable farms to synergistically use interconnected advanced technologies in order to make production more efficient and sustainable. Digitization of agriculture is the only way to increase the competitiveness of agricultural production in a short time, because most other solutions to increase productivity work only after a long period of time. New technologies favor the optimization of resource use, and the world of agriculture needs intelligent equipment that allows everything to be more efficient in terms of sustainability.

Digitization of agriculture is a process that depends not only on those who create these innovations, but also on the users of these innovations, i.e. from the farmers themselves. Prejudices and mistrust towards the new, as well as the lack of desire for education related to the digitalization of agriculture must be overcome, and that is the basic precondition for facing one of the most difficult challenges of our time.

The proposal for future work refers to the analysis of the potential for modern digital technologies to be applied in agriculture in Serbia and to emphasize the need for wider involvement of scientific institutions in solving problems related to IoT infrastructure, connectivity, data collection by sensors or UAVs, etc.

Conflict of interests

The authors declare no conflict of interest

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COMPARATIVE ANALYSE OF FOODSTUFF GEOGRAPHICAL INDICATIONS IN THE WESTERN BALKANS

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ABSTRACT

The aim of this paper is to determine the current situation in the field of geographical indications schemes (GI), obstacles for futures development and to provide recommendations for GIs development in Serbia, Bosnia and Herzegovina and Montenegro. GIs quality schemes provide confirmation to consumers that foodstuff is a traditional product produced in a certain area and with certain attributes. Although the Western Balkan countries are reach in well-known traditional products and have excellent ago-ecological conditions for GIs production, this quality schemes are not developed. In this paper are applied comparative methodology, literature review and field research. Results are showing that path to improvement GIs is in the further legal framework harmonization with EU legal framework, providing flexibility for registration of the GIs foodstuff processing capacities, support to the producer's organization, shifting of the national GIs recognition to the EU, systematic support to the GIs etc.

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Introduction

Consumers demand for traditional food has increasing trend in recent years. Instead of mas produced food consumers are demanding high quality foodstuff linked to the place of origin.

GIs are defined by the most authors as certification schemes which designate foodstuff with distinctive characteristics, reputation and geographical origin (Marie-Vivien, Biénabe, 2017; Albuquerque et al., 2018; Härtel, Zhong L. 2018).

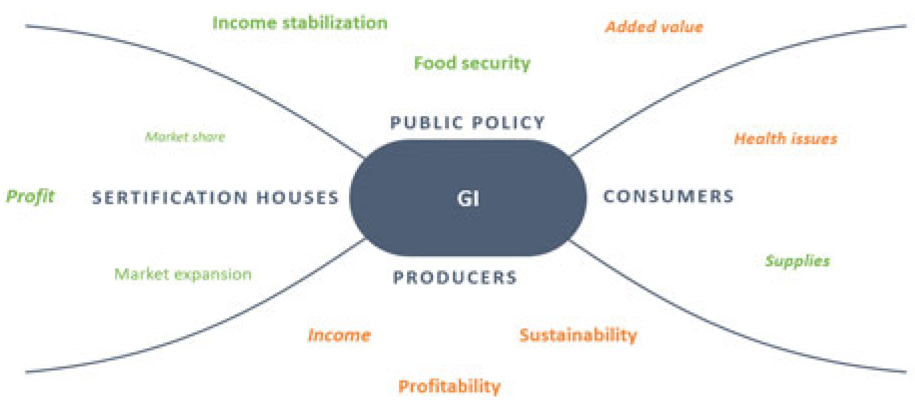
In the era of globalisation GIs emerged as tool for certification of foodstuff with special quality and place of production (Belmin et al., 2018; Grujic-Vuckovski, Kovacevic, 2020).

Main motive for this research lies in GIs importance for underdeveloped rural are. A relevant number of studies indicate significant GIs role in the rural area developments (Barjolle, 2010; Popović et al. 2018; Arfini et al. 2019; Paraušić, Roljević-Nikolić, 2020). GIs represent opportunity for small and economically weak rural households to produce added value certified foodstuff and to improve economic position. Standardization and certification of foodstuff is contributing to development of the food supply chains (Schmitt et al., 2017; Popović, Paraušić, 2016; Bérard, Marchenay, 2006).

GIs foodstuff implementation in Western Balkan legging significantly behind EU (Janković et al., 2018). According to Barjolle et al. 2010 one reason is low consumption of GIs products in Western Balkans countries due to the barriers such as high price and uncertainty with respect to the true GIs product characteristics. Founding significant importance of GIs Fabris & Pejović 2012 recommended new policy in Montenegro such as orientation on traditional production as a tool for improving farmers profitability.

Importance of GIs for stakeholders is presented at the scheme 1.

Figure 1. Importance of GIs for different stakeholders



Source: Authors'

Due to the fact that all Western Balkans countries are in European Union (EU) approximation process, EU' common acquis in the area of the GIS is analysed. Traditional foodstuff are important part of European culture and heritage (Milosević et al, 2012; Giraud et al., 2013).

In the EU three main foodstuff quality schemes are established: Protected Designation of Origin (PDO), Protected Geographical Indication (PGI) and Traditional Speciality Guaranteed (TSG).

Protected Designations of Origin (PDO) are names used to designate a product with special characteristics, which are also originating from a certain territory. For PDO the raw material production as well as processing should be produced in the designated geographical area (SWG, 2020).

PGI are label referring to foodstuff processed under certain production specification with distinct characteristic, but differenced from PDO as raw material is not mandated to be produced in designated territory (SWG, 2020).

TSG label refers to the traditional receipt product (EU Commission, 2021)

Other EU' quality schemes include: Mountain product and product from my farm. Mountain product referred to the high-quality product produced in mountain regions with difficult natural conditions, while Mark from my farm referee to the high-quality products produced locally for local consumption (EU Commission, 2021).

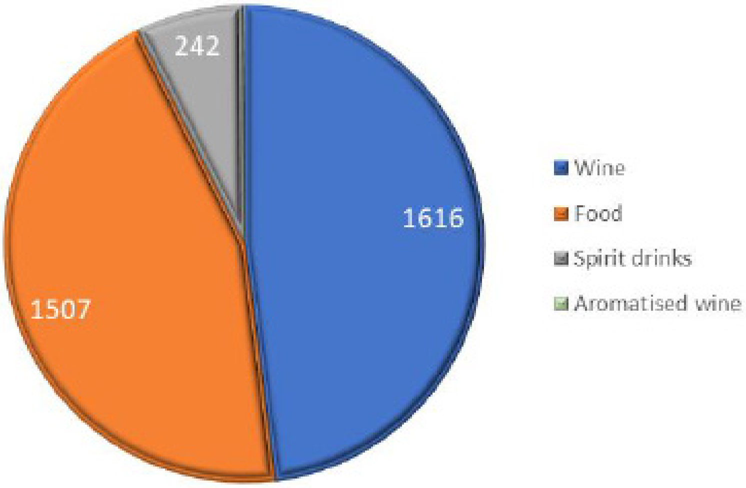
GIs foodstuff regulation in EU is based on the type of products: agricultural and foodstuffs, wines and spirits.

EU' GIs legal framework including:

- Regulation (EU) No 1151/2012 on the quality schemes for agricultural products and foodstuffs;
- Regulation (EC) No 1308/2013 on the protection of geographical indications for wine;
- Regulation (EC) No 251/2014 on the protection of geographical indications for aromatised wine;
- Regulation (EC) No 787/2019 on the protection of geographical indications for spirit drinks.

There are significant number of registered GIs products within EU (Figure 2). In total, on the 18th January 2021 there was 3753 designated products.

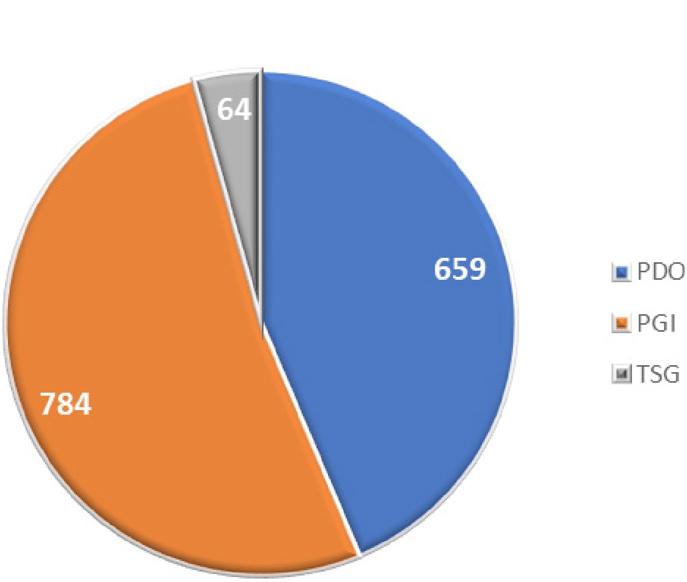
Figure 2. Products enrolled in the EU' Geographical indications register on the January 18th 2020



Source: DOOR database

Structure of the EU' recognized foodstuff is presented at the Figure 3.

Figure 3. Foodstuff products enrolled in the EU' Geographical indications register by the GIs type on the January 15TH 2020



Source: DOOR database

GIs in selected countries of the Western Balkans

All three selected Western Balkans countries – Serbia, BIH and Montenegro have established GIs certification schemes.

Western Balkan countries have a long-standing tradition and numerous high quality famous traditional products. The promotion of traditional foodstuff is promising vehicle for increasing regional agricultural sector competitiveness (Giraud et. al,2013; SWG, 2020).

As the structure of the agricultural sector has a great influence on the GIs, the basic indicators of agricultural production in all three countries are analysed.

Agriculture is important sector in Serbian economy, with its share in 2019 in Gross Value Added (GVA) of 11.7% and employing 19.1% of total workforce. Agricultural sector has constant positive foreign trade balance (MAFWM, 2020). Farm size in Serbia is small in average 5.4 ha (SORS, 2013). As other Western Balkan countries Serbia is reach in traditional products which can be driving force for improving livelihood in rural areas (Stojković et al., 2011).

Agriculture, forestry and fishery is one of the most important sectors in BIH accounting of 8% of national GDP with usage of 1.781.000 ha of utilized agricultural land. This sector employing 18% of workforce, with. BIH has limited conditions for agricultural production as 66% of the territory is considered mountainous or hilly, with small farms' land parcels (SWG, 2020). As all other Western Balkan countries BIH is reach in traditional food produced at the farms. Samardzić et al. 2013 found that BIH has significant number of GIs products and potential social and economic benefits of the GIs foodstuff production. Importance of GIs for rural development in BIH is researched and proved on Visocka ham (Ganić et al., 2019).

Agriculture contribute with 10% of the Montenegro' GDP, employing around 6% of the work force. Small farms are prevailing, with average farm size of 4.4 ha (SWG, 2020). Even 96.1% of used agricultural land are meadows and pastures (MONSTAT, 2012). There is significant number of perspective GIs products in Montenegro, dominated with small farms producing and processing large number of traditional products at the farms. FAO-EBRD, 2018 in Montenegro found 22 products with high potential for being registered as GIs. Sarić et al. 2007 found significant marketing potential for GIs milk products and recommended Pljevaljski, Njeguški and Lisnati cheese and Skorup as a most promising candidate for GIs protection.

The GIs is important for agricultural development in the selected countries, largely due to the small farm sizes and fragmented land parcels. For small farms, the path to improved competitiveness cannot be sought through high yields of standard quality foodstuff that require large areas and significant investments. The way to improve the competitiveness of the Western Balkans agricultural sectors has to be found throughout production of the high quality - added value products such as GIs (SWG, 2020). Cesaro et al. 2017 and Huysmans, Swinnen 2019, indeed found evidence in the EU that in lover productivity areas are with more GIs designated.

Despite the excellent production conditions and numerous traditional products, there is none of the GIs products from this region designated in EU (Kovačević et al., 2021)

Although there is a possibility of registering GIs products from non-EU countries, no product from the countries of Western Balkan is registered in the EU. According to analyses in this paper, registration of products in the EU would have a significant importance for regional producers due to:

- The "visibility of the GIs product" would be increased, as numerous national labels would be replaced by EU labels (Figure 1), which are unique and recognizable nationally and throughout the EU;
- The costs of product registration, as well as certification and recertification for producers would not change in relation to the costs in national GIs schemes, while the effect would be significantly increased;
- Registration in the EU after national registration would be an excellent check and significant experience for national institutions responsible for geographical indications schemes;
- Product protection at the EU level provides full worldwide product protection (Hazel, 2017).

This research contributes to the literature as a first survey on testing a legal framework and level of business environment development related to of GI protection in selected Western Balkan countries. Based on the comparative analyse gaps in implementation of GIs are recognized and recommendation for GIs schemes development are derived.

Materials and methods

Extensive literate review is conducted. Interviews with the relevant experts and stakeholders in the GIs system was performed. Method of comparative analyses was implemented.

EU Commission DOOR Database is used as a source of information on designated GIs in EU. National statistical offices and national ministries of agriculture data were used.

The paper presents two research hypotheses:

Hypothesis 1: All analysed Western Balkans countries have a harmonized legal framework governing geographical indications of quality with the EU.

Hypothesis 2: All analysed Western Balkans countries have established preconditions in terms of the general business environment for the development of a system of geographical indications. Under the general preconditions are considered: flexible conditions for registration of small traditional processing capacities, system of producer organizations, visibility (recognizability by consumers of geographical indications) and systematic long-term support measures to the GIs.

Results

Western Balkans countries are all with GIs schemes implemented.

Similar backgrounds and challenges in GIs in Former Yugoslavia's countries, making comparative analyses in foodstuff quality schemes valuable as a lesson learned tool for futures GIs development.

Hereunder, all important factors for the functioning of foodstuff GIs schemes in Serbia, BIH and Montenegro are analysed.

Table 1. Comparation analyse between Serbia, BIH and Montenegro GIs legal and institutional framework

Element	Serbia	BIH	Montenegro
Competent authority	Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia (MAFWM) and Intellectual Property Office of the Republic of Serbia (IPO)	Food safety agency BIH	Ministry of Agriculture and Rural Development of the Republic of Montenegro
Legal framework	Law on Indications of Geographical Origin (O.G 18/2010)	The Rulebook on quality systems for food products (Official Gazette of BiH, no. 90/18)	Law on quality schemes of agricultural and foodstuffs (OG 01-347/2)
Registration and controlling procedures	- MAFWM as supervising authority - Accredited certification bodies	- Food Safety Agency as supervising authority - Accredited certification bodies	- Ministry of Agriculture and Rural Development of the Republic of Montenegro - Accredited certification bodies
GIs in place	- PDO - PGI	- PDO - PGI - TSG	- PDO - PGI - TSG - Higher quality mark - Mark mountain product - The mark from my farm.
No of GIs products registered	46	4	7
Level of harmonization with EU*	Fully harmonized	Partially harmonized	Fully harmonized
Producer organisations and producers' groups	Legal regulation not in place	Legal regulation not in place	Legal regulation not in place

Element	Serbia	BIH	Montenegro
Flexibility for the GIs processing capacities	In place	No	In place
GIs products labelling	Self-adhesive labels	Printed on the product package	Printed on the product package
Visibility of the GIs products specifications	Poor	Well	Well

Source: Authors' survey based on the SWG, 2020

Discussions

Hereunder each GIs important development preconditions are analysed in more details, followed with recommendations.

Competent authority Serbia has two institutions involved in managing GIs scheme. IPO is receiving application and transferring to the MAFWM for opinion. It is unique procedure not in accordance with EU rules. Montenegro and BIH have single institutions in charge of GIs in accordance with EU requirements. Recommendation is for Serbia to change licensing procedure and rely on MAFWM as a sole institution in charge.

Legal framework in all three countries is regulated by the separate legal framework governing GIs.

Registration and controlling procedures are in BIH and Montenegro in compliance with EU requirements, only group of producers involved in the product production are eligible to submit GIs registration application. In Serbia any entity may apply for GIs registration (chamber of commerce, local municipalities, cooperatives, etc.). Serbian procedure is not aligned with EU where only producers of the potential GIs products may apply throughout producers' organizations. Recommendation for Serbia is to accept BIH and Montenegro practice.

GIs in place analyse shows difference among countries. While Serbia has regulated two quality marks – PDO and PGI, BIH has three - PDO, PGI and TSG, while Montenegro has applied besides PDO, PGI and TSG, optional quality marks - Higher quality mark, Mark Mountain product and The mark from my farm. It could be recommended for Serbia to include mandatory TSG mark and for Serbia and BIH to consider application of optional quality marks as Montenegro (Kovačević et al., 2021).

Number of GIs products registered, Montenegro has seven GIs products registered, two PGI and five PDO. BIH has in total four GI products, one PDO and three PGI. Forty-six GI products are registered in Serbia of which PDO - 36, PGI -10. There is evidently small number of GIs users in Serbia, only eleven of registered products are with registered users. This is a consequence of the practice to registered GIs throughout donators support by the entities not involved in the production.

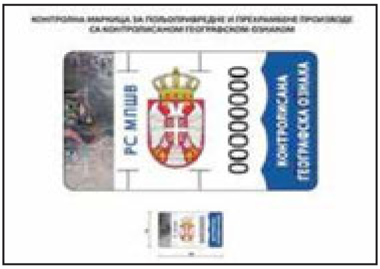
Level of harmonization with EU, Montenegro is positive example of a country which legal framework is fully harmonized with Regulation No 1151/2012. This funding corresponds with Mirecki, 2012 who found full Montenegro compliance with EU acquis. BIH has three minor subjects not aligned with Regulation No 1151/2012: 1) agricultural products are not included in quality standards; 2) non-mandatory quality marks are not included in the legal framework; 3) GIs product name has to be registered in the Latin alphabet. This founding corresponding with Samardzić et al. 2013 who found need for BIHs additional legal harmonization with EU and highlighted additional confusion caused by the GIs protection under another scheme (Lisbon agreement) and EU. Serbian legal framework is not aligned with Regulation No 1151/2012. Main incompliances are: (1) Application for GIs designation can be submitted with entities not involved in the production; (2) Two institutions are involved in the GIs registration instead of the sole MAFWM authority; (3) The format and the content of the application is not in accordance with Regulation No 1151/2012; (4) product specification is not in compliance with the Regulation No 1151/2012; (5) Summary document on product is not defined; (6) Objections procedure at the product registration is missing; (7) TSG and optional quality marks are absent. Recommendations are for Serbia and BIH to follow Montenegro example and harmonize legal framework with Regulation No 1151/2012.

Producer organisations (PO) and Producers groups (PG) are essential for GIs. According to the Regulation No 1151/2012 more than 50% of potential GIS product producers have to be involved in producer's organisation in order to apply for EU recognition. PO and PG are defined by the Regulation (EU) No 1151/2012. All three countries are obliged to adopt this regulation and to establish PO and PG. It is recommended to adopt CMO regulation in all three countries and to support PO and PG.

Flexibility for the registration of small foodstuff traditional processing capacities. GIs foodstuff is usually processing at the farm or at the small processing capacities. For the successful functioning of GIs schemes, it is crucial to enable registration of the processing capacities according to the flexible conditions. Sarić et al., 2007. found in Montenegro poor hygiene in traditional milk production and processing (processing is mainly from raw milk) as obstacle for development of the GIs foodstuff market. Same results and importance of the hygiene roles derogation for traditional products is found on the example of Hercegovina ham production (Brenjo et al., 2011). The main reasons for the need for flexible conditions in the registration and processing capacities are: (1) products are most often processed according to the traditional methods, so usually cannot be registered according to the standard hygienic requirements; (2) as a rule, those are small processing capacities that cannot bear the high costs of production and processing according to the standard requirements for processing capacities; (3) most often processing capacities are in the remote area lacking basic infrastructure for high hygiene standards. Certain deregulations for small traditional processing facilities are allowed by the EU (SWG, 2020). Serbia is the only one of the three analysed countries that has introduced derogation on plant products for small processing capacities. Montenegro has in place derogation for registration of small processing capacities for animal products, while BIH has no flexible regulation for small processors in place. Serbia enrolled Rulebook on production and trade of small quantities of food of plant origin, area to implement said derogation, as well as exclusion, adjustment or deviation from food hygiene requirements ("Official Gazette of RS", No. 13/20 of 14 February 2020). It enabled small farms to register processing under simplified procedure. The obstacle is found in the Central Register of Facilities kept in the MAFWM, not allowing farmers as a natural person to be enrolled in the Registry. The inability to regulate administrative processing permits is a particularly major obstacle for GIs processors who, if they do not have registered processing capacity, cannot certify GIs processed products. Of interest is Montenegro experience allowing small animal product processors to register processing capacities under flexible conditions. Montenegro found solution to support small processing dairies. Framers enrolled in Traditional dairy processors registry are receiving subsidies per litre of milk. For BIH and Montenegro it is recommended to enrol regulation on flexible conditions for traditional foodstuff plant processors. For Serbia and BIH it is recommended to follow Montenegro experience and introduce subsidies per litre of milk for farmers enrolled in the traditional foodstuff milk processors registry[5].

GIs products labelling is differing in Serbia compared to BIH and Montenegro. Serbia has unique labelling with self-adhesive mark printed by the National Bank of Serbia (Figure 4).

Figure 4. Self-adhesive PGI label – R. Serbia



Source: Official Gazette of RS, no. 92/12 and 19/13

BIH and Montenegro have printed GIs labels at the products package. The solution with a self-adhesive label in Serbia did not prove to be optimal. First, the price of the stamp increases the production costs for GIs product. Second it is not convenient to put a stamp on some type of package. Recommendation can be given for Serbia to follow BIH and Montenegro practice and to shift to the printed GIs labels.

According to Alibabić et al., 2012 labelling of foodstuff in BIH are in line with the basic legal requirements in most cases. This research examined by of 208 consumers

5 Currently Serbia has subsidies per litter of milk only available for producers who selling milk to the dairies. By this model traditional producers processing milk by their own are destimulated and lived with no subsidies.

towards the information available at the GIs products label. Study found that label is often not visible or understandable. Consumers in 43% review the label, and 62% of consumers pay attention mainly to the shelf life, while16% pay attention to the nutritional information and 27% on the health-related issues. Similar results are found by Milošević et al., 2012 using questionnaire for 3085 respondents where main factors sensory apple, sensory appeal, purchase price and health issues.

Visibility of the GI' products specifications are the milestone for GIs development, as it provides consumers with an insight into production practices, characteristics and specifics of GIs products. Survey included 4,828 respondents increase in consumer awareness related to GIs products is recognized as a priority activity within the EU (Verbeke et al., 2012). The EU Commission publishes the GIs Product Specifications at the DOOR website. BIH is announcing GIs products specifications at the Food Safety Agency web page, while Montenegro has a clear and visible announcement at the web-site of the Ministry of Agriculture and Rural Development of the Republic of Montenegro. Serbia has poorest GIs product specification visibility. All GIs products specifications are hard to find published at the IPO web-site. Main goal in visibility increasement of the Western Balkans countries should be directed to the EU' GIs products designation. EU regulation is allowing third countries to gain EU GIs products recognition[6]. With EU' designation, products packaging is marked with EU GIs which makes it more appealing and recognizable to the customers. Western Balkans foodstuff are famous worldwide and vaster emigration in the EU from the Region widen export the market for regional GIs products. Procedure for EU GIs approval is that firstly products have to be registered nationally and then national authority is forwarding application to the EU Commission. This finding is in line with the results of the SWG, 2020.

The Hypothesis 1 "All selected Western Balkan countries have a harmonized legal framework governing geographical indications of quality with the EU" is partially confirmed, as only Montenegro has a fully harmonized legal and institutional framework with the EU, while BIH' legal and institutional framework is highly aligned with the EU. Serbia has inconsistent legal framework with the EU.

The Hypothesis 2: „All selected Western Balkans countries of have established preconditions in terms of the general business environment for the development of a system of geographical indications". The Hypothesis 2 has not been confirmed because of the lack of the flexibility in registration of traditional processing capacities, not established PO and PG and lack of long-term systemic support.

Conclusions

GIs is promising quality scheme for Western Balkans agricultural sectors. Small and economical week farms' path to gaining competitiveness is in the production of added value products such as GIs. Despite the excellent production conditions, rich tradition

6 GIs products recognition is firstly requiring national legal settings to be harmonized with EU Acquis.

in traditional products there is none of the GIs products recognized in EU and GIs has no significant role in the foodstuff production in the Western Balkans countries.

Given that all three countries have a similar background and had different approaches in creating GIs systems, it is of great importance to analyse the results achieved in order to extract lessons learned and give recommendations for improving the GIs system. The following elements that crucially affect foodstuff GIs were analysed.

Competent authority should be one institution as in Montenegro and BIH, while Serbia needs to shift authority to MAFWM as a sole managing institution.

Registration and controlling procedures are in BIH and Montenegro in compliance with EU requirements, only producer's organization involved in the product production are eligible to submit application. Montenegro is positive example having legal framework fully harmonizes with Regulation No 1151/2012. BIH has three subjects not aligned with Regulation No 1151/2012, while Serbia has most inconsistencies.

Serbia has only two GIs marks PDO and PGI while BIH has all three and Montenegro has full range of the GIs marks.

BIH is in the initial stage of the registration of the GIs products. Serbia has largest number of the products, but very small number of GIs authorised users.

Producer organisations (PO) and Producers groups (PG) are essential for GIs. None of the three countries has enacted CMO regulation as a base for PO and PG establishment.

Processing of GIs takes place on the farms themselves and in small processing capacities according to traditional methods, which usually cannot be approved according to standard hygiene procedures. None of the three countries has found a satisfactory solution for registering small processing facilities. The best results and an example to the other countries can be Montenegro, which has introduced subsidies per litre of milk for processors entered in the register of small milk processors.

Referring to GIs products labelling, BIH and Montenegro have printed labels at the GIS products packaging's while Serbia has unique system of self-adhesive labels printed in National Bank proved to be inefficient in practice.

BIH and Montenegro have good visibility of the GIs producer specifications, while Serbia has to improve visibility.

Ultimate goal should be to register GIs products within the EU. In order to achieve this, first condition is to have full national legal and institutional compliance with EU. Only Montenegro has fully harmonized GIs with EU Acquis.

Scientific research of GIs as important rural development tool has to be intensified using lessons learned within the Western Balkan in order to implement most suitable GIs system.

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Conflict of interests

The authors declare no conflict of interest.

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IMPROVING THE MARKETING POTENTIAL OF RURAL AREA THROUGH THE CULTIVATION OF THE INDUSTRIAL HEMP

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ABSTRACT

In presently, industrial hemp (Cannabis sativa L.) represents a controversial plant that is not researched enough. The aim of the study presented in this paper is to show that marketing of the rural areas can be done through the cultivation of industrial hemp. Hemp has a huge marketing potential which can be a tool of rural development in Serbia. Concrete results are given from the point of the view of three groups: people who reside in cities, owners of healthy food markets and producers. The author presented survey research which shows that the majority of people are not well educated about the difference between marijuana and industrial hemp. There is a common opinion that the production of industrial hemp itself is an advertisement of a rural area. The contribution and significance of herein presented results lies in the marketing of underdeveloped rural areas, redevelopment of cultivation of sidelined agricultural crops in order to strengthen the rural area.

Introduction

Imperative for the research hides in the negative demographic situation in rural areas in Serbia and high international market potential of industrial hemp (IH). As an agricultural crop that can be used in several important industries, this plant potentially could bring

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back people to rural areas. Many villages in the rural areas are abandoned and the rest of the population live into their old age. Serbia has 1034 settlements that have less than 100 people living there, which is very worrisome. Over a nine year span, the population of East and South Serbia has reduced by 19%. The number of the inhabitants in the region of Vojvodina, one of the most developed regions in Serbia, has decreased by 115 thousand in the period of two population censuses. Negative natural growth is present in 82.5% of the settlements (Novakov, Janković, 2019). Research continues to show evidence of a downward trend.

The population of the rural areas should come back to thoroughly tested economic methods and natural values. Arable production and healthy life are both quite sought-after in the modern age.

At the very beginning of 21st century, *Cannabis sativa* has been rediscovered as a high-value crop that can be used for numerous products in almost all industries. Hemp has been used for more than 10000 years in all parts of the world. Within the last century it has been used in many industries such as textile, pharmacy, food industry, car as well as civil engineering (Henry Ford presented "hemp car" in 1941) (Panzer, Stoiser, 2014).

Scientists were very divided over the classification of IH. The nature of this plant is very fascinating and depends on both morphological characteristics and geographical origin. Its controversial background comes from phenology and quantitative traits due to the influence of the environment, more specifically climatic conditions. Firstly, taxonomic units' division and the number of species within the genus *Cannabis* were focused on morphological performance and geographical provenance. With the development of technology in chemistry, the approach to classification has changed to molecular levels and biotechnology. The main reason for disagreements over the classification is the crossing of wild hemp species and the variability of their characteristics in quantitative terms (Koren et al., 2020).

Around 25,000 products can be made from IH. Every part of the plant is useful. From the seed one can obtain cold pressed oil which can be used for cooking various food and salads. Seed oilcake is rich in proteins and also good as powder. Fiber can be used for textile, paper, car industry, carpeting, composites, furnishings, and more. IH can also be used for body care such as soaps, bath gels, cosmetics, and lotions, pharmacy, nutritional supplements and can even been used in the aviation sector as a fiberglass alternative. Hemp mixed with lime is a very good building material. A wide range of IH's usage can be concluded with the application as a cover crop and potential biodiesel feedstock (Johnson, 2018).

Taking the significance and benefits of the IH, there is a main question why this plant is still not used as a economic tool for the development of the rural areas? The aim of the study presented in this paper is to show that marketing of the rural areas can be done through the manufacture of industrial hemp. The significance and contribution of this paper is reflected in a concrete example of the marketing of underdeveloped rural areas, redevelopment of cultivation of sidelined agricultural crops in order to strengthen the rural area economically and statistical support of the above through the processed information of the Ministry of Agriculture, which is published summary for the first time in the 21st century.

Industrial hemp

According to the increased interest for industrial hemp in the previous 10 years in Europe, this trend also came to Serbia. Hectares of agricultural land under the IHis enlarged, new companies are open and many investors are coming from abroad. In Serbia, IH is a forgotten plant that was grown on more than 50000 hectares, mainly on the north of the country in the region of Vojvodina. The Ministry of Agriculture of Serbia shows that the last 10 years IH came back to our fields started from only a few hectares and spread to 922 hectares throughout Serbia in 2019 (*Table 1.*). There is no doubt that growth would have been recorded also in 2020 if there had not been the Covid19 virus pandemic and lockdown. Due to the pandemic, many farmers did not submit permit documentation until the 1st of May 2020 (lockdown in Serbia was from 15th of March till 6th of May 2020). Instead of growth, the hectares reduced to 630 in agricultural season 2020.

Table 1. Areas under industrial hemp in the period from 2016 to 2020 in the Republic of Serbia

Year	2016	2017	2018	2019	2020
Total area of industrial hemp in Serbia in hectares	172.72	281.52	307.81	922.92	630.15
North region - Vojvodina	145.68	275.04	289.33	822.04	408.69
The rest of the Serbia	27.04	6.48	18.48	100.89	221.46

Source: Ministry of Agriculture, Trade, Plant protection directorate, 2020

Depending on the purpose of IH, it is divided into the following groups: oilseed hemp, fiber hemp, hemp products for pharmaceutical markets, and hemp products for recreational markets known as marijuana. Fiber and oilseed/grain hemp are collectively known as industrial hemp (Jelizkov et al., 2019).

Hemp belongs to the *Cannabinaceaei* plant family order *Cannabis* which originates from Central Asia. It is one of the very first plants in the world which humans started to use for other necessaries except for clothes and food. According to previous researchers, this genus consists of only one species with several varieties:

- *Cannabis sativa var. vulgaris* (industrial hemp),
- *Cannabis sativa var. indica Lam.* (marijuana),
- *Cannabis sativa var. indica Lam.*subvar. gigenta (giant hemp) i
- *Cannabis sativa var. ruderalis Janisch* (wild hemp) (Butorac, 2009).

If we consider the purpose of the plant, psychoactive/medical cannabis is distinguished with the THC content higher than 0.3% and IH sorts with THC (delta-9 tetrahydrocannabinol) content lower than 0.3%. Content of psychoactive substance is the most common reason for controversy and marking this plant as a taboo topic.

IH and marijuana are from the same species of the plant but from different varieties. Two plants are genetically unlike, having different cultivation, use and chemical makeup. IH is defined as “the plant *Cannabis sativa* L. and any part of such plant, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3% on a dry weight basis” while marijuana falls under the U.S. drug law with high percentage of psychoactive substance THC (Johnson, 2018).

Only 5 species of IH are allowed in Serbia to be grown until now: Novosadska konoplja, Helena, Marina, Fedora 17, and Monoica (register of recognized varieties, 2021). Three of them are domestic Serbian species. There is no official data about the quantity of produced IH in Serbia in the last century. Therefore, the author of this paper contacted Ministry of Agriculture of Serbia and collected all official permits for production from 2016 to 2020. In the table below are unique information about the areas under IH in Serbia:

Table 2. Land area in hectares under different varieties of industrial hemp

	Hectares by the year of cultivation				
Name of the varieties	2016	2017	2018	2019	2020
Helena	25.14	90.38	151.95	726.06	219.79
Marina	0.00	0.00	0.00	0.44	5.06
Novosadskakonoplja	0.00	0.00	0.00	0.00	0.00
Fedora 17	94.80	188.79	113.63	193.67	402.86
Monoica	0.00	0.00	39.00	0.00	0.00
Sorts under the code	3.16	2.34	3.22	2.74	2.42

Source: Ministry of Agriculture, Plant protection directorate, 2020

According to *Table 2*. IH varieties, Helena and Fedora 17 are the most common varieties in Serbia. The usage of these two types are quite similar throughout Serbia and surrounding countries. Sowing depends on whether we want to get: fiber, a seed, or a flower (Burczyk et al., 2009). For anyone interested in producing hemp, it is important to understand that every single part of IH contains THC at a very low level (under 0.3%). Seeds, however, do not contain THC, the psychoactive substance. Essential oil extracted from IH also does not contain THC (United Nations, 2013).

Branding of rural area

Considering that in Serbia most of the agricultural fields are in rural areas, the majority of the conversation topics are agricultural. Cultivation brand can be a great opportunity for marketing of the rural area. The process of globalization has brought to rural areas social, economic and environmental troubles and a struggle with competition. During globalization as inevitable force residents are leaving rural areas which reshape the look of the region and habits of the rest of the population. This strong influence dramatically modifies these mentioned areas. Inhabitants are leaving searching and for a better life. Rural areas require a marketing strategy to develop products, bring in customers and, possibly, to attract tourists. When we are talking about place branding it is certainly based on the interaction between several stakeholders who are coming from different sides. One group of stakeholders are farmers and users of their products like consumers, retailers and processors. The second group is organizations and, very important stakeholder, governmental institutions. Public policies affects the environment in which companies and farms are working. There is no doubt that place branding can reshape economic and social structure of the rural area and it can be an instrument of strategic space planning for development (Donner et al., 2016).

Internal and external communications are needed to create a brand. Manufacturers are the ones who maintain the necessary consistency in communication. Companies, in our case producers, associations and consumers must have communication, which represents “branding triangle” (Bulatovic et al., 2016). Many rural areas are working on the concept of place branding, competition is quite high. Every place has its own branded product but it is very common to have the same or similar offer of infrastructure, program, landscapes, or agricultural food. They have to compete internationally and often in the global market. It is not easy to stand out and be more competitive than others. This is the chance for place branding to show full potential and the time when place branding became substantial. Definition of the place branding is the marketing of the place, region, city, or area, a promotional strategy which leads to increasing of the attractiveness of the place for spending vacation, for working and living. A regional brand can solve economic problems and give perspective to residents of the region including better quality of all contents of the region and branding of all regional segments as nature, heritage, domestic food and more. The identity of the region represents the brand of the region that creates value, promotes the region, and as a trademark encourages the development. It is the right way to productive, strong, sustainable, and developed rural area (Messely et al., 2010).

One of the examples of place branding is West Cork, in Ireland. This Southern Irish rural area is mainly composed of grass fields and is surrounded by the sea. Many people from other regions came here to work and live due to the aspiration to improve the quality of life. Despite a lack of an ideal geographical position, which is seen as disadvantage of the region, people who choose West Cork for their home are satisfied with original West Cork agricultural products, food, and collaboration between inhabitants. This luckily turns a disadvantage into an advantage. The greatest motives for West Cork have been cited as being the pride of the people of this region and their passion and love for their region. Local cooperatives uses the specific images that identify the region as the main tool of the rural development strategy of West Cork. Supported by European Union funds since 1995, through many different marketing staffs as flyers, brochures etc., Cooperative raises the inhabitants’ awareness of the exclusive qualities of the region (Messely et al., 2010).

Brand as a trademark of rural region can bring a lot of tourists. The influx of tourists opens up new entrepreneurial ideas, increases the quality of life and generates income. According to Dašić et al.(2020), rural tourism can solve economic and demographic problems and revitalize rural areas in Serbia. Countries around the world make different projects to attract investors, to bring tourists, to develop international partnership, to stimulate export, to create better and more attractive brands as a tool of marketing in an international environment. The same authors note that agritourism is special shape of rural tourism which allows guests to be part of everyday agricultural activities. They further quote Lin et al. (2011) who wrote about potential only in the villages where guests can follow full circle of making food starting from the field and finishing with setting a meal on the table. Service users are not asking for the price for the possibility to eat healthy food directly from nature and to experience a healthy life style. Authors underline that it will be very welcome to brand and inform through media the individuality of every single rural place just like Guča and Mokra Gora in Serbia (Dašić et al., 2020).

There are many rural areas financed to finish their projects successfully. Lot of places upgrade and adjust marketing to find buyers for their products. Marketing of the rural places is actually combination of political and public instruments (Donner et al., 2015). But what if rural area project is not financed by the government or some of international funds? Then one of the approaches is to be "self- branded" with product which attract attention of media, science, economic circles, consumers and curious people. IH is the answer. Just like it was in region Bačka, Municipality Odžaci and Bač in Serbia. Starting from the 18th century, together with the coming of baron Kotman in the city of Odžaci, hemp became main agricultural crop and medium which changed the picture of the region. Producing of the IH made significant economic progress of the region resulting of the first annual hemp trade in 1779. The number of factories and employees in this reproducing and processing was increased. Odžaci and hemp trade in this city were mentioned in European newspapers. Foreign factories were buying products from this region. The city was promoted to market town. New jobs like weavers, spinners and breakers start to appear, investors from abroad are coming to build new factories. Odžaci and surrounding rural areas were very well known for growing hemp. IH made economic progress of this places from 18th to second part of 20th century (Stojanovic, 2016).

Materials and methods

Research included three main groups of stakeholders in IH production. In order to improve marketing potential of rural areas in Serbia through the cultivation of IH it is necessary to determine requirements of the market. Three major groups of participants were examined through the questionnaire: 10 farmers, 10 owners of selling markets (health-food markets) and 151 consumers (end-users of the hemp and hemp products). These groups have been selected because they are major constituents in the chain of harvesting and distribution, and are the main reason for Governmental department's existence. A Google questionnaire was sent to the members of the above-mentioned groups. The questionnaire was conducted during March 2021. Results are presented through tables.

Results and discussion

The first group of 151 randomly choosen participants in the survey of this research are by large majority interested in buying, consume and even to sow IH. Ratio between woman and man is almost equal (*Table 3.*). Huge differences between the ages of the participants is one of the positive features of the study (*Table 3.*).

Table 3. Ages and gender ratio of participants

Age	Number of participants	Percent %
Under 18	7	4,6
18-30	69	45,7
30-40	58	38,4
40-50	9	6,0
50+	8	5,3
Gender ratio	**Women**	**Men**
	81 (53.6%)	70 (46.4%)

Source: Author's research

A huge percent of the participants don't know the difference between marihuana and IH (*Table4. Q1*). According to the results it is obvious that many people identified these two varietes of cannabis as equal. For those two third of respodents talking about IH is the conversation about something illegal. Their first thought is secret, the illegal market of weed. A simple solution lies in educating them about IH, demonstrating the physical differences between the two brands, as well as mandatory random check-ups (Mašić, 2018).

This can be turned to benefit and enable good marketing of rural areas which can be presented and use IH production as a marketing tool. An additional fact is that most of the respondents consider this plant as healthy medicinal plant (*Table4. Q2*) and they are informed about CBD oil as a potential cure for several the most terrible diseases (*Table 4. Q3*). They would like to buy it easier in special IH stores or in the existing healthy food stores (*Table 4. Q4 and Q7*). This is in correlation with the absolute majority of the healthy food store owners' answers who would like to order IH CBD oil for their stores.

Results send clear message to authorities and entrepreneus that it is a good idea to open new markets and enable easier access to products made of IH. The solution is to educate poople through media marketing. Huge percent of people are not against IH advertisement and IH leaves, who look alike cannabis indica leaves, at the products packaging (*Table 4. Q5 and Q6*). Yielding of the mentioned plant should be an advertisement of rural areas (*Table 4. Q14*).

Investments are not enough to increase attractiveness of agricultural business in the rural areas. The rural way of life is like a social paradigm, which is developed under an influence of a whole set of non-economic factors: social, cultural, historical, ethnic, etc. (Erokhin, 2014).

Table 4. Consumer's questionnaire results

Question	YES	NO
Q1 Do you know the difference between cannabis indica and cannabis sativa (industrial hemp)?	58 (38.4%)	93 (61.6%)
Q2 Do you consider industrial hemp as medicinal herb?	118 (78.1%)	33 (21.9%)
Q3 Have you ever heard about CBD oil made from industrial hemp which, according to the expertise of the World Health Organization from 2017 (agenda item 5.2. in Geneva 6-10.November 2017), could help in the treatment of Parkinson's and Alzheimer's disease, cancer, multiple sclerosis, diabetes, inflammatory deseases, reises immunity etc.	101 (66.9%)	50 (33.1%)
Q4 Would you like to have easier ways to acquire CBD oil and their products made of industrial hemp?	128 (84.8%)	23 (15.2%)
Q5 Are you against hemp being advertised on TV, radio, social media or in newspapers?	19 (12.6%)	132 (87.4%)
Q6 Would you mind if industrial hemp leaf is being presented on the industrial hemp products?	20 (13.2%)	131 (86.8%)
Q7 Do you think that citizens of the Republic of Serbia need specialized stores of industrial hemp products?	103 (68.2%)	48 (31.8%)
Q8 Do you think that farmers should receive subsidies from the country in order to encourage the production of industrial hemp?	129 (85.4%)	22 (14.6%)
Q9 Do you think that the Ministry of Agriculture should be actively involved in advertising and encouraging citizens to produce industrial hemp?	118 (78.1%)	33 (21.9%)
Q10 Do you think that the Republic of Serbia is recording an economic loss as well as farmers and industry because the law does not recognize production of industrial hemp?	113 (74.8%)	38 (25.2%)
Q11 Do you think that the authorities in Republic of Serbia should organize educational television and radio shows about industrial hemp?	128 (84.8%)	23 (15.2%)
Q12 Would you produce industrial hemp?	78 (51.7%)	73 (48.3%)
Q13 Would you be willing to move to a rural area, produce industrial hemp, and live from that production?	78 (52.7%)	73 (48.3%)
Q14 Do you think that the production of industrial hemp in rural areas itself is an advertisement of a rural area?	118 (78.1%)	33 (21.9%)
Q15 Did you know that cold pressed hemp seed oil contains omega-3 and omega-6 acids in the best ratio for human health (2:1 - 3:1)?	41 (27.2%)	110 (72.8%)

Source: Author's research

The advertisement should be followed by the support of the authorities, together with new laws and subsidies from the Ministry of Agriculture in order to follow the growing interest of farmers and processors in IH (*Table 4. Q8, Q9, Q10 and Q11*). On that way, the economy of families living in the countryside and the development of rural areas would be stimulated.

More than half respondents are interested in producing IH and moving to a rural area doing hemp manufacturing for a living (*Table 4. Q12. and Q13*). IH is an unused marketing tool that can make greater picture of rural areas retrieving population and bringing daily visitors, buyers and tourists. As much as 90% of the territory and 54% of the population are rural areas in Europe, while 52% of the territory and 23% of the EU population are predominantly rural areas (Zheliazkov et al., 2015).

Svetlana Ćirković interviewed inhabitants of the Eastern Serbia in 2019. The study shows their opinion about IH and made a parallel of past and present time. Eastern Serbia villages, around mountain Stara Planina are almost empty, deserted, without people or with only a few families left (e.g., villages Tatrašnica and Grabovica 3, Popratna 5, Staro Korito 23 residents). This is reality of most of the villages in this region. Larger villages have just over 300 inhabitants (Gornje Zuniče 420, Donje Zuniče 374, Debelica 333 residents). Inhabitants in these villages talked about hemp with nostalgia, they are connecting IH with happy times of their life when they made their own clothes out of the hemp. They used to sow, picked, dried, eaten seeds and made various garments from hemp fiber, and today they are listening on television that hemp is a drug. The author concludes that stigmatization of the hemp occurred in parallel with transformation of rural communities in this region through industrialization, migration to the cities and other properties of present time (Ćirković, 2019).

In Serbia, plots are being enlarged by residents selling rural land to the large companies and moving to cities. The Ministry of Village Care announces the donation of state rural land and houses in rural areas to young people and people who would like to return to rural areas (B92, 2021). Call for return of the population in rural areas we hear in other countries as well. Villages in Uttarakhand state in India are abandoned. People are leaving this region which could be saved with the cultivation of IH. Laws that allow sowing hemp would encourage farmers to return to their homeland and to earn enough for living through their work. Such a situation should also make a positive impact on the larger cities by lowered some burden to which the farmers had to migrate (Joshi, 2019).

Innovation can be a crucial step to make a brand of the agricultural product which leads to increasing competitiveness of rural place and which can make a final success. Innovation can also be some traditional, already existing product implemented into a service seen as new from the point of view of the group or the person who is the target group. Target groups are not only tourists or business related to tourism, but also investors, buyers, retail chain, competitors, factories, employees and processing companies. If the brand is one product, one idea or one innovation this place is thematic village subordinated to one, leading idea. The theme of thematic village, in most of the cases, is determined by some of the characteristics of the village, some cultural heritage, interesting of inhabitants or idea which is, or could become known (Sin et al., 2020). The theme discussed in this study is exactly one idea, one agricultural product, a plant which may become characteristic of rural area. IH can attracted public opinion in rural place and start development.

The above research shows that the potential of IH should be used as a means of marketing rural areas. People in Serbia, participants in this research, stated that marketing greatly affects their opinion and that advertising is crucial in changing opinions and educating people of something new, in this case IH (*Table 5. Q2*).

Table 5. Buyers' responses

Question	1	2	3	4	5
Q1 Rate your knowledge about industrial hemp. 1 (do not know anything) to 5 (excellent knowledge)	32 (21.3%)	47 (31.3%)	39 (26%)	21 (14%)	11 (7,3%)
Q2 How much marketing affects the change of awareness and education of citizens? 1 (does not affect) to 5 (huge affect)	2 (13%)	4 (2.6%)	19 (12.6%)	34 (22.5%)	92 (60.9%)

Source: Author's research

People in Serbia are not enough educated about IH (*Table 5. Q1*). Research results shows that even a questionnaire with the topic "industrial hemp" could be the way of marketing rural area and education tool. They can learn something through a questionnaire (*Table 6.)*.

Table 6. Marketing through the survey

Did you learn something from this questionnaire?				
1 - nothing	2	3	4	5 - a lot
4 (2.7%)	8 (5.3%)	26 (17.3%)	45 (30%)	67 (44.7%)

Source: Author's research

Sellers are very important grummet in the IH production chain. Health food markets are stores with hemp goods. A minority of respondents are shopping in open markets and via catalogs and phones. These results say that people are still shopping the traditional way in the stores, but online shopping is also popular (*Table 7.*).

Table 7. Prefered way of shopping

	Online	Open markets	Stores, pharmacy, health food stores	To get flyer and order by phone
Which way of shopping do you prefer?	25 (16.6%)	5 (3.3%)	117 (77.5%)	4 (2.6%)

Source: Author's research

As the most popular place for getting goods author interviewed owners of 10 health-food stores in 4 cities in Serbia: Novi Sad, Beograd, Subotica and Niš. All of them answered that they have or used to have hemp products such as tea, protein, seed, hulled seed and other. Owners of the health-food stores supported opening of the IH market, as well as IH marketing on the TV, subsidies, and even 40% of them would like to produce this plant (*Table 8.*).

Table 8. Responses of health food stores owners

Questions	Yes	No
Q1 Do you consider industrial hemp as healthy medicinal plant?	10 (100%)	0 (0%)
Q2 Would you mind industrial hemp being advertised on television, radio, social media, in newspapers?	0 (0%)	10 (100%)
Q3 Would you mind that industrial hemp leaf is being presented on the industrial hemp products?	0 (0%)	10 (100%)
Q4 Do you think that it is necessary to expand the production offer of industrial hemp in health food stores in the Republic of Serbia in order to increase the production and turnover in "healthy foods"?	10 (100%)	0 (0%)
Q5 Do you think that farmers should receive subsidies from the state in order to encourage the production of industrial hemp?	9 (90%)	1 (10%)
Q6 Do you think that the Ministry of Agriculture should be actively involved in advertising and encouraging citizens to produce industrial hemp?	9 (90%)	1 (10%)
Q7 Do you think that the state should organize educational television and radio shows about industrial hemp?	9 (90%)	1 (10%)
Q8 Would you produce industrial hemp?	4 (40%)	6 (60%)
Q9 Would you order CBD oil for your health food store?	9 (90%)	1 (10%)

Source: Author's research

Average mark of 4.8 for the question, on a scale from 1 (does not affect) to 5 (huge affect), assess how much marketing does influence on the change of consciousness and education of citizens, shows that owner of health-food stores are sure about huge impact of marketing *(Table 9.*).

Table 9. Responses of health food stores owners

Question	1	2	3	4	5
Q1 How much marketing does influence on the change of consciousness and education of citizens? from 1 (do not have influence) to 5 (many influence)	0 (0%)	0 (0%)	0 (0%)	2 (20%)	8 (80%)
Q2 Rate on a scale from 1 (not at all) to 5 (extremely sought after) how much do you think industrial hemp products are in demand? (and if you don't keep the products listed, answer how many customers are looking for these products)	0 (0%)	1 (10%)	4 (40%)	3 (30%)	2 (20%)
Q3 I have learned something from this questionnaire (score on a scale from 1 (nothing) to 5 (a lot))	0 (0%)	1 (10%)	2 (20%)	2 (20%)	5 (50%)

Source: Author's research

Producers are the third group of respondents. In total 10 producers have participated in the questionnaire. All of them produce flower, seed, and stems for sale. This is understandable because IH is insufficiently defined by law and is a taboo topic so, they don't process hemp and make products from the plant. A high majority of them would like to pay some kind of present advertisement and the same high percentage would like to give interview to TV, radio or newspapers (*Table 10. Q11 and Q12*). If we compare with previously discussed group - customers, we have an even higher percentage of those who would live in a rural area and produce IH (*Table 10. Q1*).

Table 10. Producers of industrial hemp questionnaire responses

Question	Yes	No
Q1 Given that our fields are in rural area if the state provides open market, longer variety list and conditions for work and development of agriculture and processing of IH, would you be willing to move with your family in rural area?	7 (70%)	3 (30%)
Q2 Do you advertise your industrial hemp and industrial hemp products?	3 (30%)	7 (70%)
Q3 Do you exhibit at trade fairs?	0 (10%)	10 (100%)
Q4 As a visitor, do you go to industrial hemp and agricultural fairs in Europe?	3 (30%)	7 (70%)
Q5 Would you like to organize an industrial hemp fair in Serbia?	10 (100%)	0 (0%)
Q6 Would you like from the Ministry of Agriculture or the Serbian Chamber of Commerce to allow you to appear at fairs in Europe, as this is case with the producers in Croatia?	10 (100%)	0 (0%)
Q7 Do you think that successful and quality production and processing of hemp itself could be a rural area marketing?	9 (90%)	1 (10%)
Q8 Would you support the construction of a purchase center and a center for processing industrial hemp in a rural area of the Republic of Serbia?	10 (100%)	0 (0%)
Q9 Would an association of industrial hemp producers yield stronger and more competitive production in rural areas?	10 (100%)	0 (0%)
Q10 Would you like to have a database of IH producers and purchasers available to everyone?	10 (100%)	0 (0%)
Q11 Would you like to advertise your IH production in the social media?	9 (90%)	1 (10%)
Q12 Would you like to give an interview about the production of industrial hemp for newspapers or radio?	9 (90%)	1 (10%)
Q13 Would you like the production of CBD oil, cold-pressed oil, consumer food for people from IH seeds, etc. to be defined by law in Serbia, and for everyone to be able to produce and be competitive on the market of Serbia and Europe?	10 (100%)	0 (0%)
Q14 Do you think CBD oil is healthy and it can be used as a cure?	10 (100%)	0 (0%)
Q15 In your IH, according to the law of Serbia, it must not contain more than 0.3% THC (tetrahydrocannabidiol), and in human food from IH it must not contain more than 0%, but it is not defined how much it is zero, whether is up to 0.9% or to the fourth decimal place (0.0001%) or something third. Do you think that this law is meaningless, considering that the technology has advanced and that it needs to be corrected and precisely defined?	10 (100%)	0 (0%)
Q16 Did you learn something from this questionnaire?	7 (70%)	3 (30%)

Source: Author’s research

A very high percentage of producers are interested in visiting and exhibiting at trade fairs but also to have backing in Ministry of Agriculture as it is in the Republic of Croatia (Croatian Chamber, 2019)(*Table 10. Q from 2 to 6*). The same Ministry should submit a database with IH statistics for the current year. All producers would like to be informed by post or by mail about the data on how many hectares of IH has been sown in the current year, how many seeds have been consumed and which varieties, how much biomass has been produced, etc. (*Table 10. Q10*). Opinion 100% of them is also that CBD oil is healthy and Serbia needs new laws which will define the allowable percentage of THC in food derived from IH (*Table 10. Q14 and Q15*). The suggested level could be 0.3%.

Producers agree with customers that new laws and defining hemp food products are necessary to enable production (*Table 10. Q13*). Huge help for them could be representative association and IH redemption place as some kind of safe house and secure placement of the products (*Table 10. Q8 and Q9*). Most of producers are convinced that producing of industrial hemp is the marketing for itself (*Table 10. Q7*).

Conclusions

According to the results, the majority of all three groups of respondents agree that the working with IH itself is an advertisement for the rural area. It is obvious that they would live, together with their families, in rural areas and engage in cultivation if the Republic of Serbia allow for the development, production and processing of IH. The buyers are not well educated about the difference between IH and Indian hemp (marijuana) and they identify these two plants which confirms its controversy. The same group confirms that IH would advertise a rural area. Such advertising would lead to tourist, business and other visits to the rural area, as a result of which there would undoubtedly be an influx of money, and thus the development of the rural area. Therefore, this study may be used as a first step in education of the wider public about the benefits of the IH production. On the other hand, limitation of this study may be the limited number of participants in the questionnaire, which is influenced by controversy of this subject in the Republic of Serbia. Further studies could follow whether the areas under IH have a tendency to fall or increase and how the awareness of the production and processing of IH in these three groups is changing.

Conflict of interests

The authors declare no conflict of interest.

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BIOMASS AS A RENEWABLE ENERGY SOURCE

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ABSTRACT

The use of RESs reduces the emission of gases and hazardous materials into the atmosphere, which has an impact on the improvement of the quality of the environment. The use of biomass, especially that from municipal waste and agriculture, reduces the need for importing energy sources. Energy production from RES is a fast-growing economy branch employing a significant workforce.

Of 5.6 Mtoe of the total annual usable technical potential of the RES in Serbia, 1.96 Mtoe (i.e. 35%) is used up, whereas only 1.1 Mtoe (i.e. 32%) is used up of 3.4 Mtoe of the total biomass.

The paper is aimed at indicating the significance of the production of renewable energy from biomass, the available quantities, the structure and the advantages of using it in the future development of the energy sector.

Some states, Serbia included, have prescribed stimuli to green energy kW delivered to power distribution enterprises.

Introduction

Energy is the basis for every activity undertaken by man. Economic development increases the need for and consumption of energy. The current structure of the primary energy sources at a global level can't satisfy the accelerated trend of increasing energy consumption. The world is faced with a severe crisis in its further economic development. The disturbances we are witnesses of are a consequence of the reduction in natural resource stocks, first of all in fossil fuel reserves (coal, oil, natural gas). It is exactly due to this fact that an effort should be made towards finding alternative renewable energy sources as a replacement for oil and its derivatives.

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Serbia has a high energy consumption growth rate, whereas it is much poorer in the primary energy reserves concerning to the world average. The previously mentioned indicates the need for the rational use of the existing energy reserves and for searching for RESs: solar energy, wind energy, geothermal energy, hydro-energy, biomass, tide and sea and ocean wave energy, and so on. The available nonrenewable energy source reserves that would meet Serbia's needs for energy are modest, but there are big RES energy potentials, first of all in biomass. Agriculture is a major energy consumer and simultaneously it can become an energy producer as well. Today, the amount of the biomass used as an energy source is negligible concerning to the amount of the biomass produced in agriculture. In world developed countries, biomass as an RES plays a particularly important role, great attention being paid to the environment protection, since combustion does not lead to an increased emission of CO_2 in the atmosphere (Jordanović-Vasić, 2009).

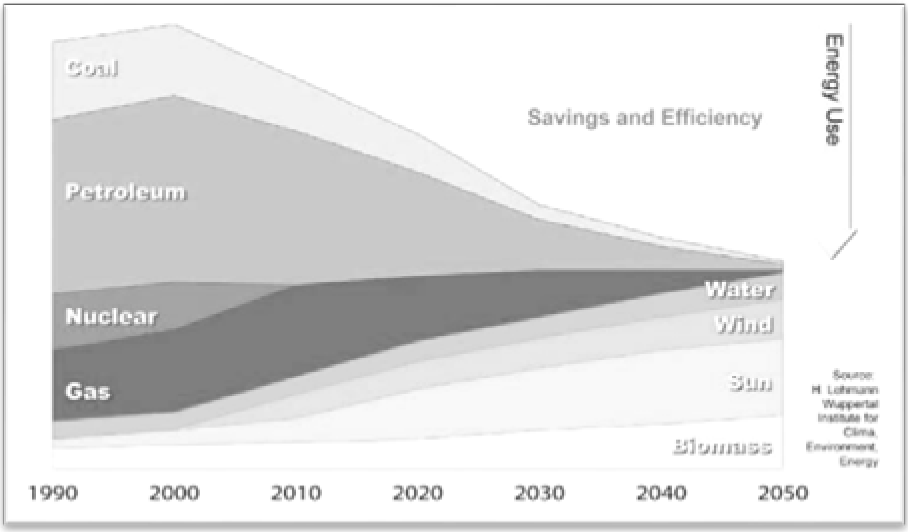
In the paper, the significance of the production of primary energy from biomass as a renewable energy source is pointed out, with a special reference to the available amounts, the structure, significance to the economy, the safety of energy production and the low energy efficiency of energy consumption in Serbia. The significance of renewable energy sources in the future development of Serbia's energy sector is highlighted. The new institutional ambience that would enable the stimulation of the development of energy production from renewable sources aimed at reducing gas emission with the greenhouse gas effect (GHG) is also suggested.

The Biomass Potential for Energy Production

A question is raised regarding the amounts of energy in RESs. It is estimated that mankind needs about 10^{14} kWh of energy per annum. About 15000 times more energy reaches the Earth from the Sun every day than man's overall needs are. Only 2% of solar energy is transformed into the energy of the wind, which is also 300 times more than the overall energy consumption. The energy of waves, tidal energy, is about 70 times greater than the overall energy consumption of mankind. The biomass potential is about 15 times greater than its present use in energy production. The present use of hydro-energy may only ensure one-half of the need for energy (NPEE, 2004).

The fact that there have been changes in the world energy market, that many nonrenewable energy sources have already reached the very verge of exhaustion, and that energy management is one of the major environmental polluters as well must be acknowledged as such (Kokeza, 2020). Renewable energy sources impose themselves as an alternative to nonrenewable energy sources, whose excessive use led to the drastic pollution of the environment at the end of the 20th century. The condition of available resources in the future will exert an influence on the structure of energy consumption worldwide (Figure 1).

Figure 1. Changes in the structure of energy consumption in the world in the period from 1990 to 2050



Source: Wuppertal Institute for Climate, Environment and Energy (https://wupperinst.org/en/)

Biomass is a renewable and biodegradable material of an organic (plant or animal) origin. Its possibilities are big, but they have insufficiently been utilized in the field of the production of thermal and electrical energy from biomass. First of all, we think of briquette and pellet production. The greater use of briquettes and pellets in energy production, especially in households, will depend on the parity between these products and other energy sources, especially electrical energy, and on the prescribed standards for their production and distribution as well.

For the convenience of an easier study of the same, biomass has been classified into woody biomass, non-woody biomass, animal origin biomass, industrial and municipal waste.

Woody biomass originates from forestry, fruit growing and viticulture, waste wood and residuals of the wood processing industry (sawdust, wood slabs, etc.). Besides, biomass production may also originate from fast-growing trees (the willow tree, the poplar tree, the ash tree, the sequoia tree, etc.).

Secondary and tertiary agricultural byproducts are made by collecting agricultural products in plant fruit or viticulture production (cereal straw, corn stover and stalks).

Residuals of agricultural-processing industries (skins, shells, corncob, etc.).

Non-woody grown biomass (fast-growing algae and grasses).

Animal wastes and remains, and

Municipal and industrial waste (Janjić et al., 2010).

In order to stimulate energy production from renewable sources, states have prescribed incentives for each kW of renewable energy delivered to electrical power distribution enterprises. So has Serbia. According to the Energy Sector Law (ZE, 2108), an energy entity may acquire the status of a producer of electrical energy from renewable sources for that particular electrical power plant, if:

1. it uses RESs in the electrical energy production process;
2. it was built to be used and is suitable for being used in compliance with the law regulating the construction of buildings;
3. it has ensured the special measuring separated from the measuring performed in other technological processes that serves to measure the received and delivered electrical energy, or thermal energy into the system;
4. it has a license to perform the activity in compliance with this Law; and if
5. it also meets the other conditions in compliance with the deed from Article 74 of this Law.

No entity may acquire the privileged producer status if it produces electrical energy from a reversible hydropower plant. The stimulating measures for electrical energy privileged producers encompass the following:

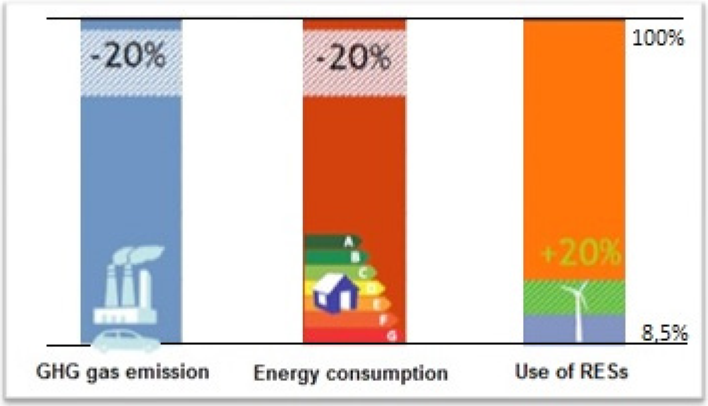
1. an obligation upon the entity to purchase all the amounts of the energy produced from renewable sources from the privileged producer;
2. the prices at which that energy is purchased;
3. the period of the validity of the obligation to purchase electrical energy;
4. assuming balance responsibility;
5. and the other incentive measures prescribed by the deed based on this Law and the other laws and regulations, too, by which taxes, customs duties and other duties, the environment protection and energy efficiency (ZE, 2018).

Projections of the production of energy from renewable sources are based on the forecasts for the economic development of the country, the energy market development dynamism and the like, due to which fact deviations of real data from projected data may also be expected to appear. Therefore, there is the need for the permanent adjustment of the energy production projection in compliance with Serbia’s needs in the energy management sector. Article 52 of the Law on Energy Management envisages that the ministry relevant for the energy management field shall monitor the implementation of the National Action Plan and that the Government shall submit an annual report. Also, Article 15 of the Energy Community Ministerial Council imposes the obligation to have it constantly updated because of the preparation and submission of appropriate reports to the Energy Community Secretariat on the progress made in the implementation of the National Action Plan until the Year 2020 (SNSRES, 2013).

There is an assumption that energy supply will be both economically and ecologically completely sustainable in the future. The use of renewable sources and forming a closed circle of energy production and use, as well as using waste energy, is becoming the most important item of all future development and energy supply strategies.

The Club of Rome's report entitled "Beyond the Age of Waste" indicates the problem of the production of sufficient amounts of the energy that would be economically cost-effective as well. They are still warning that national economies should be managing energy balance, not only the monetary dimension, since money is only relative and ephemeral, whereas on the other hand, energy is necessary and eternal (Jovanović, 2018).

Figure 2. The EU Energy Policy until the 2020



Source: Authors' modification (http://banisaenergy.com/en/novosti-otrasli/20-20-20-eu-program-renewable-energy-and-emission-reduction)

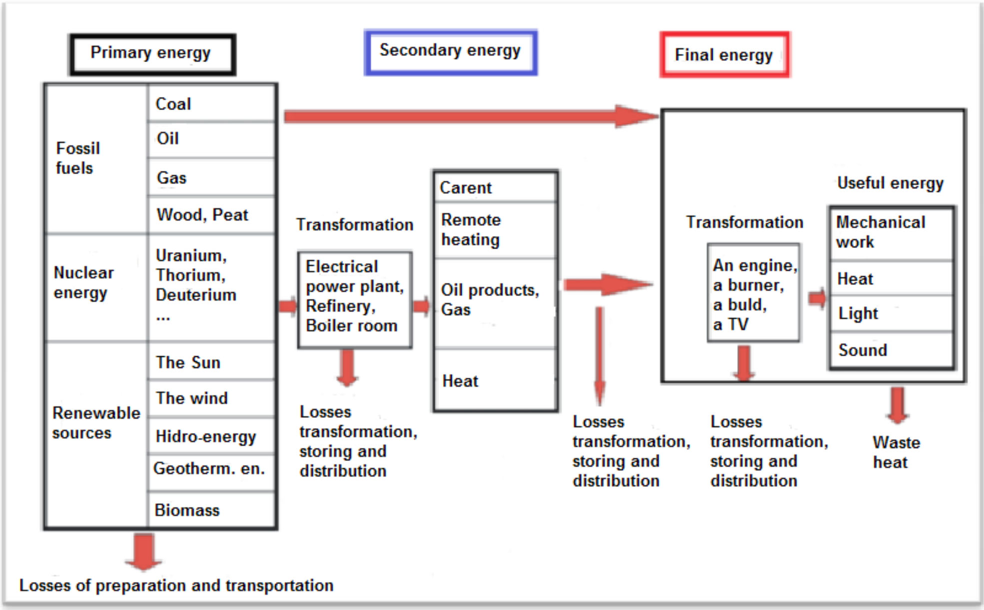
In compliance with Directive 2009/28/EC, the mandatory goals have been set for all the EU member states so as to ensure that, in the year 2020, RESs have a 20% share in the gross final energy consumption (GFEC) at the EU level. The mandatory national goals of the EU member states are defined in the section of Annex I and are consistent with the goal that the RES share in the GFEC should be at least 20%. Each member state is also obliged to ensure at least 10% share of energy from RESs in the GFEC in traffic by the year 2020 (***, Energy, 2020)

Bearing in mind Directive 2009/28/EC, as a country in the EU association process, Serbia has the obligation to ensure that 20% of primary energy production should be from RESs by the year 2020. The total RESs available in Serbia with a technically usable potential is 5.6 Mtoe (million tons of the oil equivalent[3]) per annum. The biomass potential is 3.4 Mtoe (of which as much as 1.1 Mtoe is already being used today). The biomass potential still unused is 2.3 Mtoe. The hydro-energy potentials are 1.7 Mtoe (0.9 Mtoe is already being used). The geothermal energy potentials are estimated at

3 1 toe = 7.33 barrels of the oil equivalent

0.2 Mtoe, the energy of the wind 0.1 Mtoe, solar energy 0.2 Mtoe and biodegradable waste energy 0.04 Mtoe. Of the total available RES technical potential, Serbia uses 35% (NSOIE, 2013). A greater use of RESs may significantly reduce the use of fossil fuels and reach the goal related to the RES share in the total final energy consumption.

Figure 3. Energy production classification



Source: (Banjac, 2012)

Bearing in mind Directive 2009/28/EC, as a country in the EU association process, Serbia has the obligation to ensure that 20% of primary energy production should be from RESs by the year 2020. The total RESs available in Serbia with a technically usable potential is 5.6 Mtoe (million tons of the oil equivalent[4]) per annum. The biomass potential is 3.4 Mtoe (of which as much as 1.1 Mtoe is already being used today). The biomass potential still unused is 2.3 Mtoe. The hydro-energy potentials are 1.7 Mtoe (0.9 Mtoe is already being used). The geothermal energy potentials are estimated at 0.2 Mtoe, the energy of the wind 0.1 Mtoe, solar energy 0.2 Mtoe and biodegradable waste energy 0.04 Mtoe. Of the total available RES technical potential, Serbia uses 35% (NSOIE, 2013). A greater use of RESs may significantly reduce the use of fossil fuels and reach the goal related to the RES share in the total final energy consumption.

Legal Regulations on Renewable Energy Sources

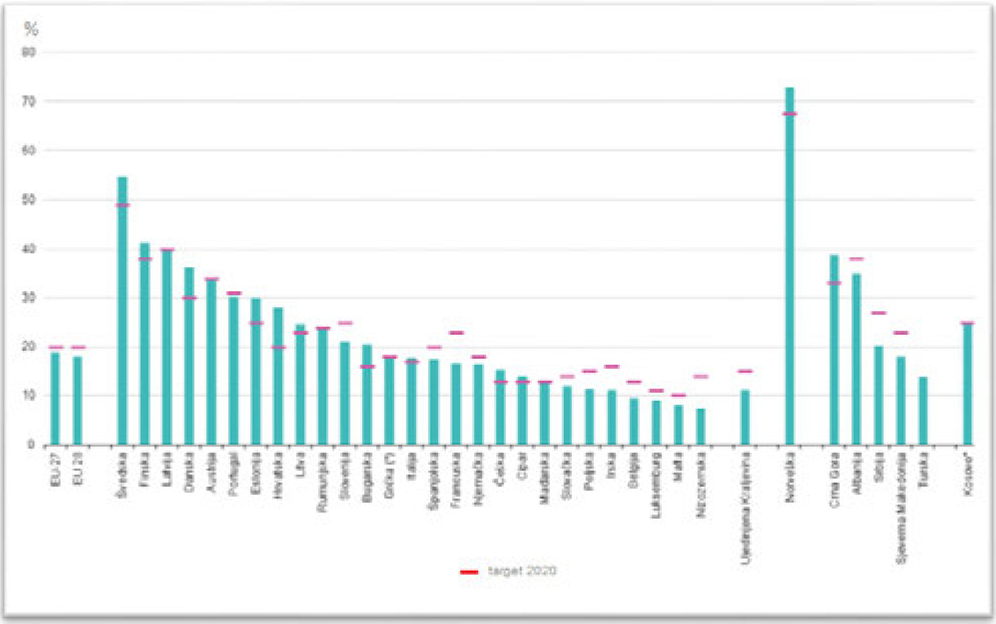
EU Directives on renewable energy sources. In 2001, the EU adopted the Directive on Renewable Sources (2001/77/EC), which is the obligation for the legislations of the EU member states in the sense of increasing the share of renewable sources in electrical

4 1toe = 7.33 barrels of the oil equivalent

energy production. The average share of renewable sources in the total production of electrical energy in 1997 was 13.9%. In 2010, that share had to be 22.1%. According to the Directive, that percentage also included big Hydropower Plants (HPs) although it was about a conventional energy source.

The new EU directive (2009/28/EC) on the RES use promotion is aimed at achieving a 20% share of RESs in overall energy consumption and a 10% share of biofuels in total EU transportation by 2020. Yet another request also refers to the adjustment of the national goals of all the EU member states. The year 2007 is taken as the reference year. The main goal of the Directive 2009/28/EC is the so-called 3 x 20 by 2020 (20% less CO_2 emission; 20% of renewable energy sources, and 20% greater energy efficiency). Namely, in September 2008, the European Parliament adopted a package of regulations on climate changes, whose aim was to ensure a 20% reduction in the greenhouse effect gas emission, a 20% improvement of energy efficiency and a 20% share of renewable energy in total energy consumption in the EU by 2020, as perceived in relation to 1990 (Petrović, 2018).

Figure 4. The share of renewable energy sources in total energy consumption in the EU member states in 2018 and the goals for the year 2020 as defined by Directive 2009/28/EC



Source: https://ec.europa.eu/eurostat

The EU policy and legislation in the RES field. The EU policy is formed through the standards and rules known as the EU Directives. The Directives are common for all nations, but they do respect national specificities, so they determine the minimum requirements. For the first time in 1983, the EEC adopted a common regulation (Council Directive 83/189/EEC), which prescribed the standards for the equipment for using RESs. The recommendation for an increase in the RES share in total energy production and consumption was adopted by the EEC in 1988. By the adoption of the Directive (EC 96/92), the EU started a serious reform of the electrical-energy system in 1997. The gas system reform began in 1998 by the Directive (EC98/30). These directives lead towards the liberalization of the internal electrical energy market and the energy sector as a whole.

At the end of 1996, the European Commission adopted the Green Paper that defines the priority measures needed to be undertaken by the EU and its member states as the first step towards a joint strategy for the production of energy from renewable sources. A special emphasis was placed on the importance of RESs in the reduction of the emission of the greenhouse effect gases and an increase in energy self-sufficiency, as well as the opening of new jobs, especially in rural areas, in the fields of the production of energy from renewable sources. As a result of an extensive debate on RESs, a document (the so-called White Book on Renewable Sources) was adopted. Based on the current condition of the environment and the energy sector, the Book proposed a national energy activities program.

The research study revealed that the goals set in Directive EC 96/92 in its relevant parts had not been achieved, so in 2003, the EU adopted another Directive 2003/59/EC[5] on the electrical energy market, wishing to liberalize the energy source market, which is expected to be completely satisfied by the introduction of a uniform financial market in the EU (Milenković, 2017)

As early as in 2017, as many as nine EU countries (Sweden, Finland, Italy, the Czech Republic, Estonia, Latvia, Romania, Bulgaria and Croatia) achieved the goal of 20% of energy originating from renewable sources. Austria, France and the Netherlands are quite close to achieving the goal. In the last few years, 24 of the 28 EU member states have been accelerating the transfer-to-renewable-energy-sources procedure (http://www.rts.rs, 2021). Since 2008 to date, the EU has doubled the amount of the energy produced from RESs. Once the prior goal has been achieved by 2020 (20% of the production of energy from renewable sources), the EU will start realizing a new goal – 27% of the production of energy from renewable sources. In some countries, such as Romania and Croatia, there has been an investment boom in the RES sector.

An increase in the production of energy from renewable sources leads to the opening of new jobs in this fast-growing branch. The number of employees in the production of energy from renewable sources in the world increase from 5.0 million in 2012 to 9.8 million in 2016[6], the leaders in this increase being China, India, Brazil, Japan, the USA and Germany. Only in the RES field in China, 3.5 million workers are employed. Worthy of mention is also an increase in the number of the employed in Malaysia and Thailand. Asia employs over 60% of the total population employed in the production

5 The directive started being applied in July 2004, until when the EU member states had a deadline to bring their legal regulations into compliance with the provisions of the Directive.

6 International Renewable Energy Agency (IRENA)

of energy from renewable sources. According to estimations, more than 25 million workers will have been employed in the sector of the production of energy from RES by the year 2030, and this sector will have been acknowledged as one of the main sectors generating economic growth. There are 85,000 workers engaged in the research and development program in Germany (Vorlop, 2005).

The EU founds its new Energy Policy Strategy on the diversification of energy sources, especially renewable ones, and the application of new contemporary energy production technologies. In this manner, the EU will achieve greater energy independence.

The data pertaining to Serbia are all but encouraging. Only 25% of Serbia's needs for energy are satisfied by the production of energy from own sources. A low percentage of self-sufficiency in energy production like this will turn Serbia into a country whose further economic development will be conditioned by the possibility of ensuring energy sources on the world market. There is increasingly less time for that, given the fact that the estimated coal reserves will be exhausted in about 50 years, and those of oil and gas in only 20 years from now.

Biomass as an Energy Source

Ever since fire was discovered, biomass has been the main energy source for mankind. Biomass is specific because of the "storing" of CO_2 and solar energy during its creation. The use of biomass for a biofuel, bioenergy, chemical and other products does not increase the concentration of CO_2 in the atmosphere. By the transformation of biomass into energy (electrical/thermal, a fuel for engines or raw materials for the chemical industry), CO_2 is released, but in a considerably smaller amount in relation to the combustion of other energy sources. Differently from the fossil fuels that are a product of the effect the Sun makes on plants, then their transformation into energy sources several thousand years later, biomass as an energy source is most frequently used immediately after its creation. The EU has been imposing an additional stimulus for using biomass as an RES to a greater extent due to its increasingly stricter regulations on the environment protection. The combustion of agricultural and forest remains, as well as solid waste for energy production, is twice as beneficial since it represents an efficient use of waste products, simultaneously also solving the waste disposal issue.

Because of its characteristics during combustion, the production and use of biomass protects the environment, stimulates the growth of the economy and ensures additional energy safety. The biomass potential for bioenergy is quite a big one and very widespread throughout the world. Today, biomass is the main source of the world energy resources, ensuring 13% of total energy. In developing countries, 35% of energy is generated from biomass. The European countries such as Austria, Sweden and Finland are already producing around 20% of commercial energy from biomass today. It is estimated that approximately 38% of the world's needs for fuels and 17% of its needs for electrical energy might be satisfied from biomass by 2050. (Janjić et al., 2010)

Differently from the energy of the Sun and the energy of the wind, whose production significantly depends on the weather factors, biomass can be used to produce energy throughout the year. If energy produced from biomass is cogenerationally[7] used to produce electrical and thermal energy, then the heat effect ranges from 70% to 80%. In case biomass is only used to produce electrical energy, that effect ranges from 10% to 25%.

Using biomass as an energy source is of a general interest due to the following advantages:

1. biomass is a renewable, sustainable and relatively ecologically clean energy source;
2. biomass can be used to generate from it a larger number of the materials of a new structure of different physical and chemical features (Bozell, 1999);
3. an increased use of biomass will prolong the lifecycle of reduced crude oil reserves;
4. the fuels obtained from biomass are with an insignificant concentration of sulfur, and because of that they do not contribute to the emission of the sulfur-dioxide that causes acid rains;
5. by biomass combustion, smaller amounts of ash are produced than in the case of coal, and ash products may be used as additives for farm soils, etc.
6. the combustion of agricultural and forest remains, as well as municipal solid waste (MSW), for energy production is an efficient use of waste products which reduces the significant issue of waste disposal, especially in municipal areas;
7. biomass is a domestic resource which is not subject to price changes in the world, or imported fuel supply uncertainties;
8. biomass offers a clean and renewable energy source so as to enable the improvement of the conditions of our environment, economy, energy management and market, too; and
9. the use of biomass may be a way to prevent a greater share of carbon-dioxide in the atmosphere, since it does not increase the atmospheric level of carbon-dioxide (White and Plasket, 1981).

Because of the mentioned specificities, biomass imposes itself as an alternative RES today, especially in the conditions of deficient solid, liquid and gas fuels, and unused land areas on which biomass could be produced for the needs of energy production.

At the beginning of 2021, it was for the first time that the EU produced more electrical energy from RESs than separately from coal and nuclear power plants. When the EU member states are looked at individually, there are big differences. In one group of them, the number of green kW grew, whereas in the other group no step forward was made. Irrespective of the modest results obtained so far, the EU does not give up on the plan to stop using coal in electrical energy production in the next ten years. The same is also required from Serbia and the other Balkan countries. In the past five years, the EU

7 Cogeneration is the procedure of the simultaneous production of thermal and electrical energy (combined heat and power, or CHP). In this procedure, the thermal energy created by producing electrical energy in thermal power plants is used to remotely heat buildings and settlements.

has halved coal consumption, and in 2020, it made a “green” turn. In 2020, the largest number of the new capacities built from RESs were built for the purpose of producing electrical energy from the wind, then from solar energy, whereas the construction of hydropower plants and biomass-operated plants was stagnating. The EU generated 19% of electrical energy from the energy of the wind and solar energy in 2020. Yet about 20% of electrical energy in the EU is generated from hydropower plants and biomass. So, the EU generates 38% of electrical energy production from RESs, 37% from fossil fuels (coal, oil and gas), and the rest of it from nuclear energy (https://euractiv.rs, 2021). Research studies show that the leaders in the production of electrical energy from RESs are Denmark, Ireland, the Netherlands, Spain and Germany. A total of the seven EU member countries, however, have not made any progress in the production of energy from RESs so far. The EU Eastern European countries that have obliged themselves to adhere to the EU ecological plan envisaging that, by 2050, Europe will be the first energy-neutral continent in the world are being faced with the same problem as well. It will be all but easy for Poland and Czechoslovakia, as well as the other countries whose electrical energy production is dominantly based on coal-operated thermal power plants, to achieve that goal. The Balkan countries whose electrical energy supply depends on the performance of coal-operated thermal power plants will also have to do the same work. Serbia generates 70% of electrical energy from thermal power plants by lignite combustion.

Decision-makers are now expected to make the best possible concept, bearing also in mind the goals taken over on the occasion of joining the Energy Community, as well as the goals that we should set on our own as a country, bearing in mind the present level of the environment pollution. A gradual increase in the share of green kilowatts in electrical energy production will make better the adoption of the Law on Renewable Energy Sources, which itself envisages that at least 50% of produced electrical energy and thermal energy will originate from RESs by 2050.

The largest share in the production of energy from RESs in Serbia is realized via hydro-energy, i.e. through hydro-power plants, from which about 10,200 GWh per annum are generated using quite outdated pieces of equipment, with an estimation that the upgrading of the capacities from those sources at the annual level could enable the generation of around 14,200 GWh. Even in such an uncertain situation, only 20% to 25% of total real RES potentials is used in Serbia. With the present technological-technical development and investment possibilities, around 80% of unutilized potentials are found in biomass exploitation (woody biomass and biomass from agricultural production), whereas 20% accounts for the micro-hydro-plant and geothermal source potentials (Janić et al., 2010).

Energy sources consumption in Serbia is at the level of 15 million tons of the oil equivalent (Mtoe), of which 7.4 Mtoe accounts for net consumption, and 3 Mtoe accounts for electrical energy consumption. Of the total consumption, 7.9 Mtoe (i.e. 52%) is from coal, 4 Mtoe (i.e. 27%) is from liquid fuel, 2.1 Mtoe (14%) is natural gas, and 1 Mtoe (i.e. 7%) is hydro-energy. Of the total consumption, only 7% originates from renewable sources, which are related to big hydro-power plants (Dakić and Kragić, 2008). On the other hand, Serbia is estimated to have 3.2 Mtoe in RESs, which are used in an insignificant amount. As far as the RES potential is concerned, 2.6 Mtoe accounts for biomass, 0.15 Mtoe accounts for small-sized hydro-power plants, 0.18 Mtoe accounts for geothermal energy, and 0.1 Mtoe accounts for solar energy, whereas the rest accounts for the energy of the wind[8] (SEEA).

This analysis allows us to see that biomass is Serbia's basic potential in RESs. Of the estimated amount of biomass, 60% accounts for the biomass of an agricultural origin, whereas 40% accounts for forest biomass. Forest biomass combustion plants have been developed to a high level, whereas plants for using agricultural biomass are still being developed. (Dakić and Kragić, 2008).

Conclusions

In the conditions of deficient and limited available amounts of solid, liquid and gas nonrenewable energy sources, as well as the unutilized land areas on which it could be produced, biomass imposes itself as an alternative RES due to its production specificities. Apart from the reduced emission of CO_2 and the environment protection during combustion, the use of biomass through an additional engagement of the workforce stimulates the growth of the economy and ensures a country's greater energy safety.

The production of energy by combusting municipal waste generates double effects. On the one hand, the amount of waste is reduced and disposed of to landfills, thus polluting the environment less, whereas on the other, foreign-exchange funds necessary for importing energy.

Today, 13% of total energy is generated from biomass. Developed countries, such as Austria, Sweden and Finland, produce around 20% of energy from biomass. It is estimated that, by the year 2050, approximately 38% of the world's needs for fuel and 17% of the world's needs for electrical energy will be satisfied from biomass. Transition towards the production of electrical energy from RESs must, first of all, rest on the decisiveness of the state to subsidize the producers of this energy. That decisiveness is also stimulated by the financial institutions that will not support the construction of coal-run energy capacities.

Due to increasingly stricter regulations on the environment protections, the EU has introduced additional stimuli for each kWh of delivered energy produced from RESs. Serbia also applies similar regulations in the field of the production of energy from RESs. Regulations will positively influence the construction of new capacities for the production of energy from RESs.

Given the potentials of the biomass available in Serbia, it is necessary that own technologies for its use should be developed. A greater use of biomass might satisfy 25% of Serbia's needs for energy. In order to make a more significant progress in increasing the use of biomass as an RES, it is necessary that the country should have a well-devised and well-coordinated energy policy.

8 Serbian Energy Efficiency Agency (SEEA).

By building plants for the combined production (cogeneration) of thermal and electrical energy in the future, the issue of heating and a greater production of electrical energy would be solved. Simultaneously, the use of electrical energy for heating would be reduced, and the total energy efficiency of the country would be increased.

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Conflict of interests

The authors declare no conflict of interest.

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SERBIAN WINE PRODUCERS' PERFORMANCE EVALUATION: A NETNOGRAPHIC BASELINE STUDY OF WINE INDUSTRY IN SERBIA

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ABSTRACT

The paper presents the wine production performance in the Republic of Serbia. The research adopts quantitative and qualitative methods, using a relatively novel method, netnography, which involves the observation and analysis of specific social groups or occurrences in the digital world using search engines as the primary source of data gathering. Key factors identified in the study are land, labor, capital and factors supply and demand. Goal of this research is, through the analysis of before mentioned factors, to evaluate wine production of Serbian wine producers. The paper also examines current conditions and possibilities of grape growing and wine making in the Republic of Serbia

Introduction

In the Republic of Serbia there are three main vine-growing regions: Central Serbia, Vojvodina and Kosovo and Metohija. By dividing these main vine-growing regions into smaller areas, Serbia has on its territory 22 vine-growing areas with 77 sub-areas. Vine-growing regions are at a maximum of 800 m above sea-level. These areas are:

1. *Central Serbia*: Pocerina-Valjevo, Negotin, Knjaževac, Mlava, Toplica, Niš, Nišava, Leskovac, Vranje, Čačak-Kraljevo, three Moravas, Belgrade and Šumadija;
2. *Vojvodina*: Srem, Subotica, Telečka, Potisje, Banat, South Banat, Bačka;
3. *Kosovo and Metohija*: North Metohija and South Metohija.

Serbia also has one of the most complex regional divisions in the world. Today's regionalization is legally regulated, but it is too ineffective and complex for marketing purposes and communication (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia).

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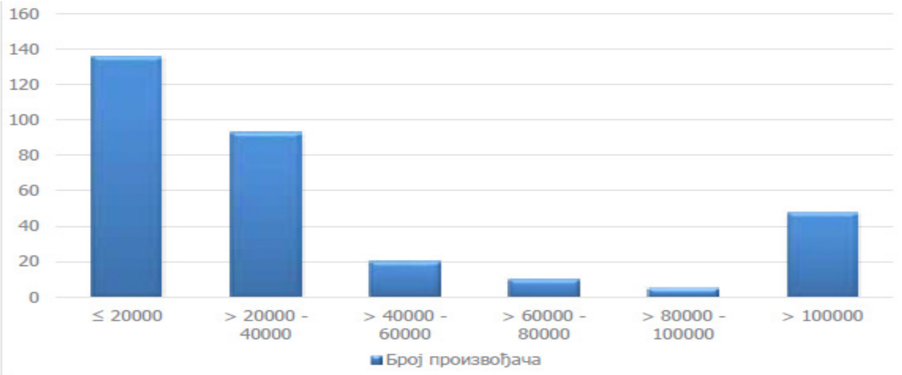
According to the Ministry of Agriculture, Forestry and Water Management, for the year 2019, in the Wine registry are registered 369 wineries. Most of these wineries, 225, are located in Central Serbia, with 139 in Vojvodina and five wineries in Kosovo and Metohija. When it comes to municipalities, most wineries are located in the municipality of Aleksandrovac (55), then Negotin (22) and more than 10 wineries are located in municipalities of Vršac, Novi Sad, Irig, Sremski Karlovci and Indjija (Jakšić et al, 2019).

The majority of wineries (136) registered in the Wine registry are small wineries, whose yearly production capacity does not exceed 20,000 l (Figure 1). After those there are 93 wineries whose yearly production capacity is between 20,000 and 40,000 l. The number of wineries that can produce more than 100,000 l of wine per year is 48 (Statistical Office of the Republic of Serbia, Wine registry, 2019).

Figure 1. Number of wine makers registered in the Wine registry according to their maximum possible production in a year, 2019.



Source: Centre for Viticulture and Oenology chart by Ministry of Agriculture, Forestry and Water Management, Wine registry, 2019

The purpose of this paper is to evaluate the overall performance of Serbian wine producers by using an innovative method, netnography. It also aims to present the current state of Serbian wine producers and vine growers. Similar research has been conducted for the Uruguayan wine industry (Camillo, Kim, 2021), where the competitive position of the emerging Uruguayan wine industry and its potential to become a player in the global wine trade was analyzed using netnography. This paper intends to follow up that research by using the same critical factors. Similar researches for different countries have not been conducted.

Materials and methods

The research applies quantitative methods, where domestic and foreign literature was used. It also applies a qualitative method, netnography, with one part of the collected data is presented through tables and charts. The study adopts a holistic research design, using desk research as a method to collect and describe gathered data.

Netnography was developed by marketing professor Robert Kozinets in 1995. The term is a portmanteau which combines “network” with “ethnography”[3]. Netnography represents a qualitative method to gather data using online search engines. It applies non-invasive techniques of observation, focusing primarily on the context of online textual communication (Kozinets, 2002).

When compared to surveys, focus groups or interviews, netnography can be less obtrusive. This methodology, although popular with marketing scholars, is beginning to be used more by wine research scholars as well (Camillo, Kim, 2021). It is designed to gather data from online platforms, including social media, websites and blogs, by searching for specific keywords or hashtags and by eye-scanning individual websites and webpage content (Kozinets, 2014).

Data was collected during May to July 2021 from aggregate sources. As for the data collection, desk research was conducted to analyze the data. Online data were searched using keywords and statistical data were gathered from official government websites, such as from Statistical Office of the Republic of Serbia and Ministry of Agriculture, Forestry and Water Management. Wine registry was examined, as well as statistical yearbooks for 2019. and 2020 which were published by Statistical Office of the Republic of Serbia.

Critical factors identified in the study of Serbian wine producers are *land, labor, capital and supply and demand*, similarly as with the prior Uruguayan wine industry assessment.

Results and Discussion

As previously stated, a performance evaluation will be conducted through analysis of four critical factors necessary for wine production, which are *land, labor, capital and factors supply and demand.*

The factor “land”

According to the Statistical Office of the Republic of Serbia, there are 5,178,692 ha of available agricultural land. Table 1 presents total available land (in ha), used and unused agricultural land, the total arable land with gardens and total area covered in orchards.

Table 1. Total, used and unused agricultural land with total arable land, gardens and orchards (in ha)

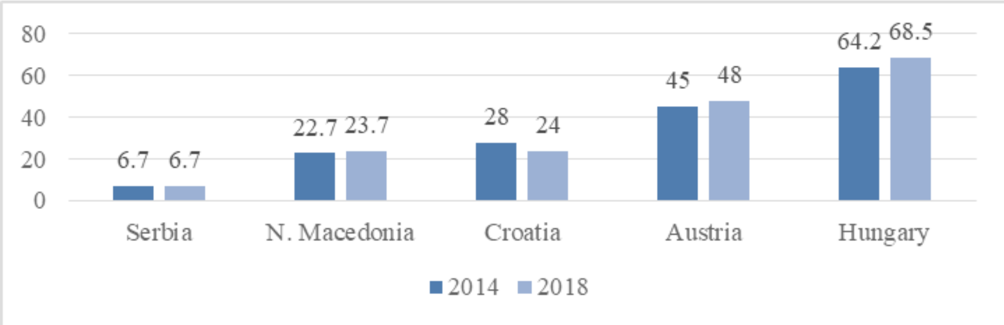
Available agricultural land	5,178,692
Used agricultural land	3,475,894
Unused agricultural land	289,953
Arable land and gardens	2,571,580
Orchards	182,923

Source: Authors illustration by date of Statistical Office of the Republic of Serbia, 2018

3 Ethnography (from Greek “ethnos”- folk, people and “grapho”- to write) is a branch of anthropology and the systematic study which observes and describes behaviors of certain cultures, nations or social groups.

Serbia has in total 22,150 ha of vineyards, out of which only 30%, or 6,700 ha are registered for wine production. The majority of land is used for cultivating grapes that are freshly consumed, while the rest is categorized as "other" (non-arable land or black market). This means Serbia has the smallest area which is covered in vineyards, comparing to other countries from the region with no growth between 2014 and 2018, as shown in Figure 2 (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia).

Figure 2. Vineyard areas in Serbia and surrounding countries (in 000ha) in 2014 and 2018



Source: Authors illustration by date of Statistical Office of the Republic of Serbia, OIV, 2019

Total grape production, for the 2018-2020 period, as well as average yield (t/ha), can be seen in Table 2.

Table 2. Total production and average yield of grapes produced in Serbia for 2018-2020

Period	Total production (t)	Average yield (t/ha)
2018	149,474	7.4
2019	163,516	8
2020	160,307	8.1

Source: Authors illustration by date of Statistical Office of the Republic of Serbia, 2021

According to data from 2018, there are a total of 60,228 farms that own a vineyard and grow vines for wine production (Statistical Office of the Republic of Serbia, 2018). Table 2 presents the distribution of farms according to the type of grapes produced.

Table 3. Overview of the total number of farms and their specified grape production

Total number of farms	60,228
Grapes for wine production with geographical origin	3,780
Grapes for red/rose wine production	32,622
Grapes for white wine production	12,018

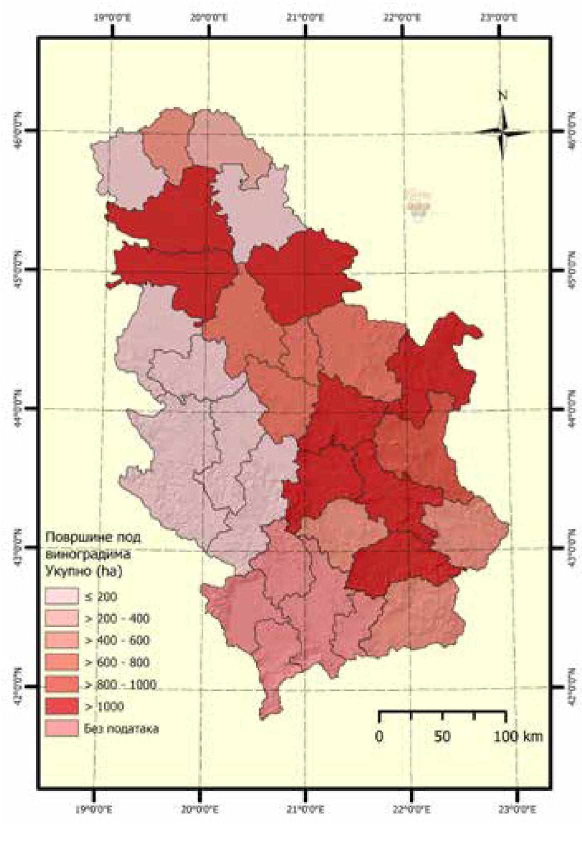
Source: Authors illustration by date of Statistical Office of the Republic of Serbia, 2018

As stated, Serbia has three vine-growing regions, in which there are 22 vine-growing areas with 77 sub-areas. Alongside Hungary (which also has 22 vine-growing areas), Serbia has the most complex regional division. Other countries have less areas, like Italy

(20), Portugal (13), France (11), Spain (7), Croatia (4) and Austria (4). The majority of these areas (72%) are smaller than 150 ha and the average size of a vine-growing area is 10 to 13 times smaller comparing to Hungarian ones (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia).

Regarding the distribution of vineyards, most vineyard areas (more than 1,000 ha) are located in South Bačka, Srem, Bor, Pomoravlje, Rasina, Nišava and Jablanica county (Statistical Office of the Republic of Serbia, 2012). There is no available data for Kosovo and Metohija region. Figure 3 presents the distribution of vineyards in Serbia.

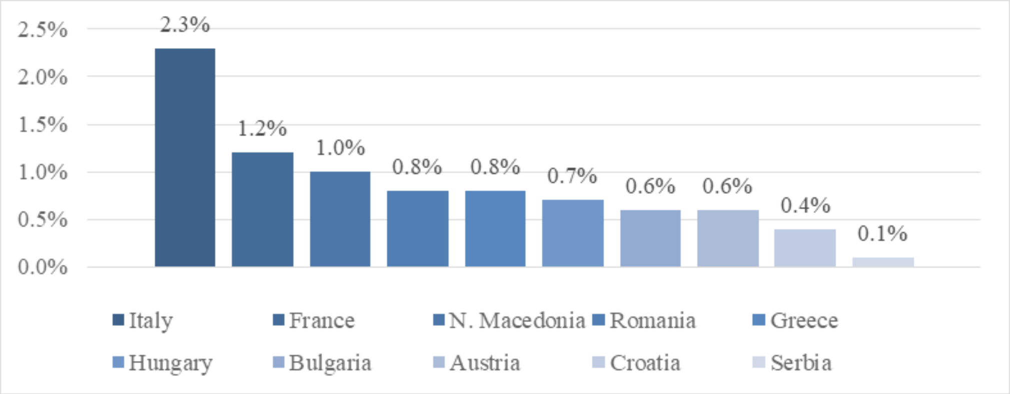
Figure 3. Distribution of vineyards in Serbia, 2012



Source: Centre for Viticulture and Oenology map by date of Statistical Office of the Republic of Serbia, Agricultural census, 2019

Serbia has one of the smallest vineyard coverages in Europe. Its vineyards cover around 0.1% of territory. The following chart (Figure 4) presents the relation between total area of selected countries and their coverage with vineyards.

Figure 4. Coverage with vineyards comparing to the total area of selected countries, 2017

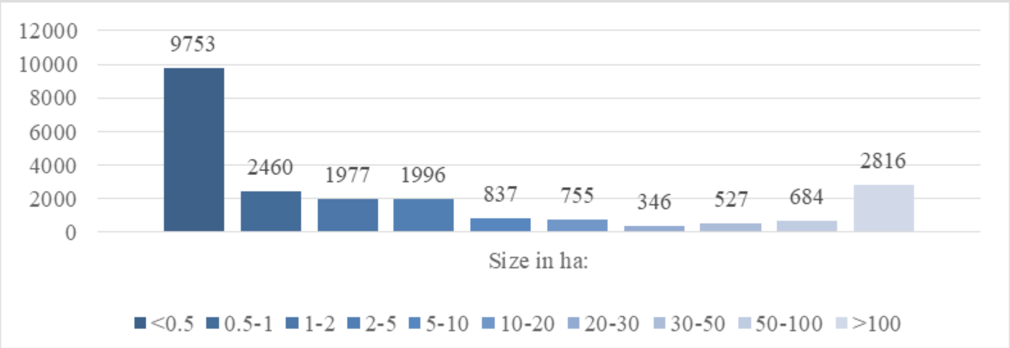


Source: Authors illustration by date of OIV, 2019

In order for Serbia to reach the level of vineyard coverage of the selected countries, it would need to plant at least 44,000 ha to reach Austria, 58,000 ha to reach Hungary and 198,000 ha to reach Italy's coverage (Development program from 2021.-2031. for winemaking and viticulture in the Republic of Serbia).

As shown in Figure 5, the majority of vineyards in Serbia are smaller than 0.5 ha (44%). Out of total vineyards, 77% are smaller than 10 ha (Agricultural census 2012, Statistical Office of the Republic of Serbia, 2019).

Figure 5. Number of vineyards categorized by size



Source: Authors illustration by date of Statistical office of the Republic of Serbia, 2019

Given this, 99% of farms is cultivating less than 2 ha of vineyards. The average size of vineyard that one farm is cultivating is 0.28 ha (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia). Table 4 shows the number of farms categorized by the size of vineyards they cultivate.

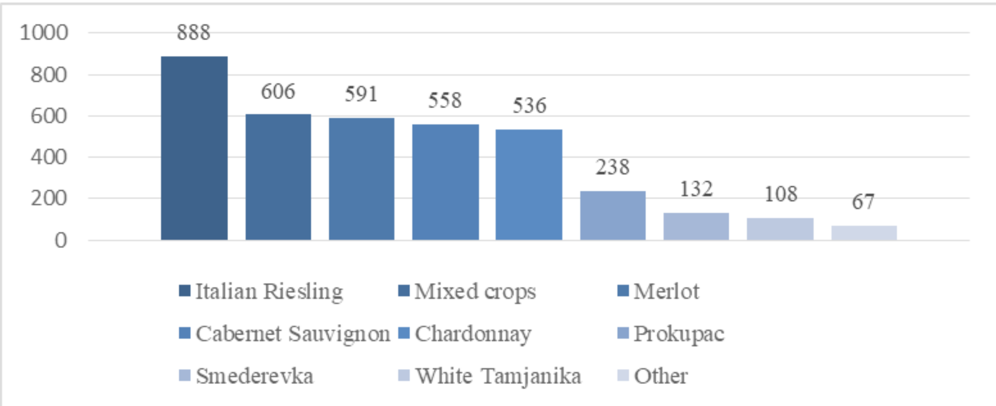
Table 4. Number of farms by vineyard size

Size (in ha)	<0.5	0.5-1	1-2	2-5	5-10	10-20	20-30	30-50	50-100	>100
Number of farms	73,840	3,960	1,590	716	131	60	14	14	10	6

Source: Authors illustration by date of Statistical Office for the Republic of Serbia

Regarding grape varieties that are cultivated in Serbia, according to data from 2014, majority of cultivated grapes are of international origin (Cabernet Sauvignon, Merlot, Chardonnay) and the most common grape variety that can be found in Serbian vineyards is Italian Riesling (13,29% of vineyards). The main reason for this higher percentage is because Italian Riesling is cultivated mainly in agro-industrial complexes, such as the Vršac vineyards. After Italian Riesling are mixed grape varieties (9,07%). Autochthonous and local grape varieties account for about 8,1% (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia). Figure 6 depicts most common grape varieties in Serbian vineyards.

Figure 6. Overview of most common grape varieties found in Serbian vineyards

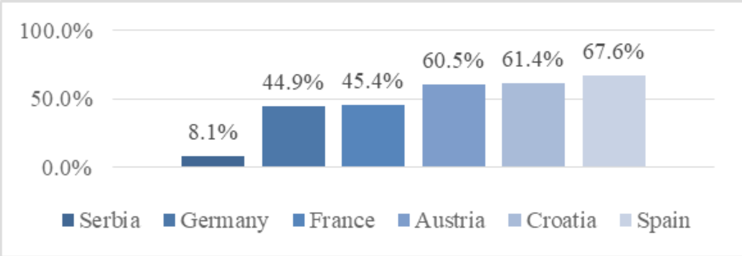


Source: Authors illustration by date of Statistical Office of the Republic of Serbia, 2019

During the recent years, an emerging trend of cultivating high quality vines was recorded. The main reasons for this trend are that a law regulating vine seedlings was passed, introduction and registration of new grape varieties were eased and subsidies were introduced by the Ministry of Agriculture, Forestry and Water Management. The development of small and micro wineries also had a positive influence on this growth. The production of wines with geographical origin from 2014-2016 was 5,100,000 l, or 13.6% of total wine production (Vlahović, 2017).

In case of autochthonous and local grapes, as presented, they are least cultivated varieties in Serbian vineyards. Serbian domestic grapes are: Prokupac, Smederevka, Tamjanika (red and white variety), Bagrina, Morava, Petka, Petra, Probus, Sila etc. Comparing to chosen countries (Germany, France, Austria, Croatia, Spain), Serbia has the smallest percentage of vineyards covered with domestic grape varieties (Figure 7).

Figure 7. Area covered with autochthonous grapes



Source: Authors illustration by date of Statistical Office of the Republic of Serbia, austrianwine.com, germanwines.com, total-croatia-wine.com, OIV, Horwath HTL, 2019

Cultivating grapes for organic wine production in Serbia is at its beginning, comparing to other countries (Italy, Austria, France). Organic vineyards in Serbia cover the area of 0.7% out of all registered vineyards (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia).

The factor "labor"

According to Wine registry data, there are 1,629 part-time and full-time registered workers[4]. Out of the total number of workers, 1,364 are full-time employed and 265 are part-time employed in wineries. The following chart (Figure 8) presents how many workers are employed by wineries. Most wineries in Serbia hire up to five workers and the least wineries employ between 11 to 15 workers.

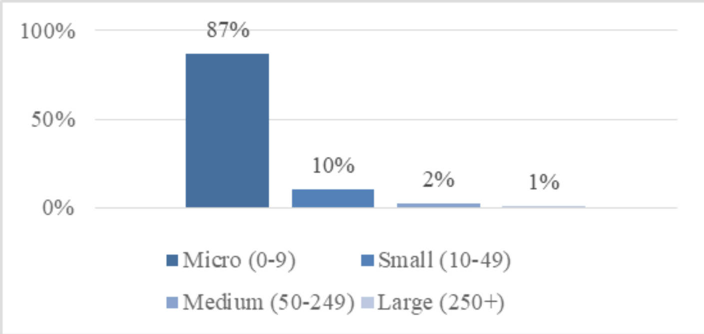
Figure 8. Wineries categorized by their number of employed workers

Source: Authors illustration by date of Ministry of Agriculture, Forestry and Water Management, Wine registry, 2019

According to European Commission criteria, which is based on the Commission's 2003 standards, Serbia has a dominant number of micro wineries (87%) by the number of full-time employed workers (0-9 workers) (Figure 9).

4 Note: data collected was on 14 March 2019. At the time, Wine registry had 330 wine producers registered.

Figure 9. Size of wineries according to their number of full-time employed workers



Source: Authors illustration by date of the questionnaire completed by wine makers (n=97), Statistical Office of the Republic of Serbia, 2018

There is a disproportionate number of vine growers compared to wine makers in Serbia. Vine growers outnumber wine makers 12.5:1. From 2014 to 2018 the number of wine makers has increased by 10% and the number of vine growers has increased by 42%. There are several main reasons for this. One is that wine makers are demotivated to register due to unfavorable legislation which regulates the production and distribution of wine. The second reason is a lack of appropriate know-how, along with risks that disincentives entering the wine business (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia).

Serbia intends to implement a digital reform of agricultural employment. The main goals of this reform are eradicating the gray economy, easing financial and administrative procedures for employers, regulating informal employment and the protection of rights for seasonal workers. The reform intends to:

1. Cut time needed for registering a worker;
2. Reduce monthly costs for employers regarding taxes and fees;
3. Decrease average yearly expenses for hiring seasonal workers;
4. Increase the number of registered seasonal workers with the right for social insurance;
5. Create a registry of seasonal workers.

There are multiple benefits from this digital reform. For the state it means an increase in formal employment and an increase in income from taxes and fees. For the employers this means less time needed to register workers, as well as lesser monthly expenditures per worker. And finally, this reform gives workers a right to social insurance, pension and insurance from work related injuries. Workers can apply for unemployment benefits if they are unemployed and their years of service will be accepted (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia).

The factor “capital”

Capital is one of the three economic factors (other two being land and labor) believed to be the pillars of any economy. To a certain extent, capital is a crucial factor in the wine industry as well.

If an entrepreneur decides to plant and cultivate a vineyard in Serbia, given average input prices, excluding the expenses for land clearing, resting the soil or insurance costs, the average cost would be 14,692 €/ha. The cost of yearly maintenance during yielding would be 2,827,6 €/ha. A general economic assessment indicates that one farm can have use of vine growing and wine making if it owns at least 5 ha of vineyards. Given that, total costs for planting and maintaining 5 ha of a young vineyard until yielding are 73,460 €. Yearly costs of maintenance and insurance are 14,138 € (Jakšič, 2019).

Appropriate wine processing rooms and equipment is needed for wine production. If appropriate processing rooms, such as a wine cellar, is already owned, the next biggest investment would be in equipment, which requires additional 5,000 €. Equipment in wine production are wine mulches, stainless steel tanks, bottling machines etc. There are also expenses regarding bottles, corks, labels, yeasts and other enological equipment which amount to 2.5 € per bottle. It is estimated that, for 1 ha of vineyard and for wine production, around 30,000 to 35,000 € is needed[5].

The factors “supply and demand”

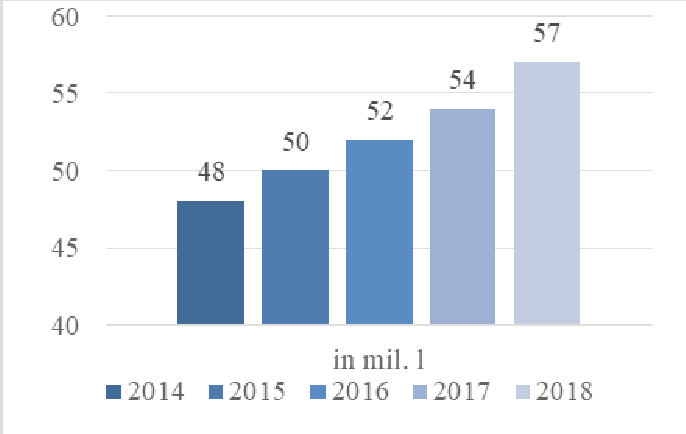
There are no special limitations or licensing systems regarding wine trade in Serbia. Wine trade is operated by a business entity or entrepreneurs registered in Serbian Business Registers Agency. Wine can be sold to the end customer only in original packaging, but wine producers can sell their wine, without geographical origin, to customers in wineries or at wine events. The bulk wine trade is limited to wine makers registered in the Wine registry (Jakšić, 2019). Most of the wine is sold in a glass bottle (75%), then in a plastic (PET) container (15%) and finally in a cardboard packaging (10%)[6].

For the period from 2014 to 2018, wine sales were on the rise. Income from wine sales rose approximately 9% as well as consumption on average 4% (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia). Figures 10 and 11 present wine trade in Serbia in sold quantities and acquired profits.

5 Source: www.vino.rs/podrum/q-and-a/item/2165-koliko-novca-treba-za-proizvodnju-vina.html

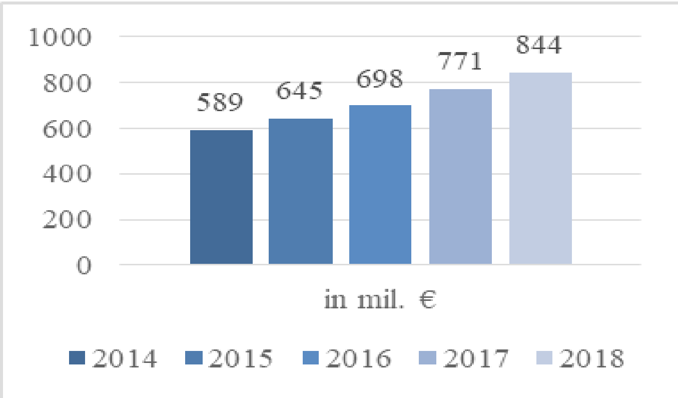
6 Source: www.agroklub.rs/vinogradarstvo/uvozimo-tri-puta-vise-vina-nego-sto-izvozimo/40271/

Figure 10. Sold quantities of wine in Serbia, 2014-2018



Source: Authors illustration by date of Euromonitor International, 2019

Figure 11. Profit from wine sales in Serbia, 2014-2018



Source: Authors illustration by date of Euromonitor International, 2019

Retail is the most dominant wine distribution channel (69%). Although, when it comes to revenue, most of revenue is made through HoReCa[7] distribution channel (57%), (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia).

Most of the wine customers in Serbia are willing to pay 350-500 RSD for a bottle of wine (32%). After that, 26% of customers from 200-350 RSD, 17% from 500-750 RSD and only 5% are willing to pay over 900 RSD. The cheapest wine, under 200 RSD is bought by 11% of customers[8].

Serbia has great potential for exporting wine, given its many bilateral and multilateral agreements. The most significant agreements are CEFTA (agreement made with

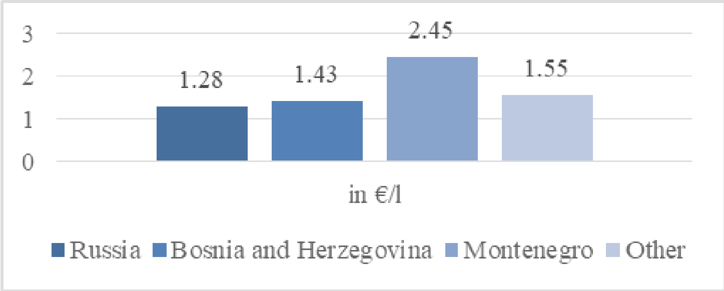
7 Syllabic abbreviation of the words Hotel/Restaurant/Café.

8 Source: www.agroklub.rs/vinogradarstvo/uvozimo-tri-puta-vise-vina-nego-sto-izvozimo/40271/

countries from South-eastern Europe), with the EU, Russian Federation. Serbian wine exports to CEFTA countries in 2016 was approximately 13,700,000 l, which is 6% out of all CEFTA countries wine exports (Vlahović, 2019).

Serbia's largest wine export market between 2015 and 2018 was the Russian Federation (on average 44,360 hl of wine per year, with an average value of 4,800,800 €). Bosnia and Herzegovina (on average 35,633 hl per year, with an average value of 4,228,870 €) and Montenegro (on average 15,985 hl per year, with an average value of 2,823,777 €) were also notable destinations for Serbian wine (Statistical Office of the Republic of Serbia, 2019). Average export prices (in €/l) of Serbian wines on beforementioned markets are presented on the following chart (Figure 12).

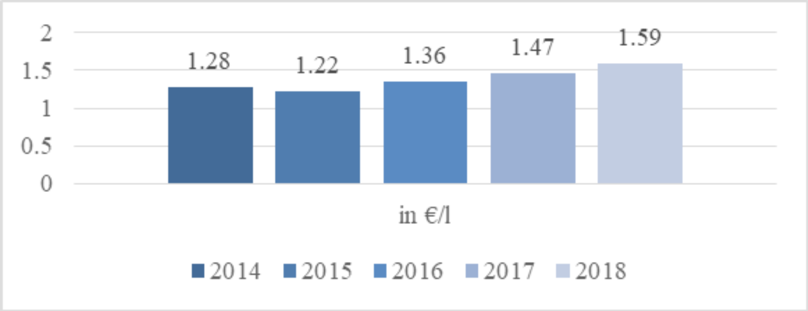
Figure 12. Average export price for Serbian wines on various markets, 2018



Source: Authors illustration by date of UN Comtrade database, 2018

The average price of Serbian exports rose 5,5% from 2014 to 2018. The following chart (Figure 13) clearly indicates such trend (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia).

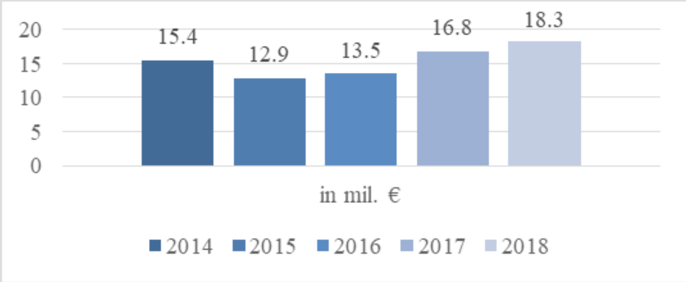
Figure 13. Average export price of Serbian wines, from 2014 to 2018.



Source: Authors illustration by date of UN Comtrade database

The biggest revenue from wine exports was made in 2018, when it was 18,3 million € (Figure 14). The value of Serbian exports from 2014 to 2018 grew on average 4,4% (Development program for 2021-2031 for winemaking and viticulture in the Republic of Serbia).

Figure 14. Value of Serbian wine exports, 2014-2018



Source: Authors illustration by date of UN Comtrade database, Statistical Office of the Republic of Serbia, OIV, 2019

Conclusions

As stated, performance evaluation of Serbian wine producers was evaluated using a relative novel method, netnography, which gathers data and observes occurrences in a digital sphere. Netnography is a qualitative method, which was used to search relevant sources during research. Conclusions will be presented individually for each before mentioned factor.

The factor "land"

The total agricultural land in Serbia is 5,178,692 ha, out of which 22,150 ha are covered with vineyards. Out of the total vineyard area, 6,700 ha are registered for wine production. International grapes can be mostly found in Serbian vineyards with a small percentage of autochthonous grape varieties. The average yield from 2018 to 2020 was 7.8 t/ha and the majority of wine produced is red and rose. Land coverage with vineyards in Serbia is among the smallest in Europe, which results in small individual vineyards, where the average farm cultivates 0.28 ha of vineyard. There is also a small percentage of vineyards registered for organic wine production.

The factor "labor"

As measured by number of workers employed, small and micro wineries are the dominant types of wineries in the Republic of Serbia. The majority of wineries employ a maximum of 10 full-time workers. There is also a notable imbalance between the total number of vine growers and wine makers, which shows that wine makers are not motivated to register their business. Steps to ease regulations and provide a better transfer of know-how, which has been identified as main reasons for this small number of wine makers, should motivate them to register.

The factor "capital"

When looking at costs for planting a vineyard and producing wine, it can be concluded that high expenses make this business one of the most expensive agricultural branches. The costs consist of costs for planting a vineyard, servicing, equipment and other materials. If small wineries are to be profitable, and also competitive on the ever-growing market, various subsidies from the state are needed.

The factors "supply and demand"

Wine consumption in Serbia has increased over the years, and with that, wine makers income has increased as well. Given the bilateral and multilateral agreements the Republic of Serbia has, there is an increase of Serbian wine exports. Most notable trading partners are the Russian Federation, countries that signed the CEFTA agreement and the European Union. The biggest quantities of wine, for the 2014-2018 period, have been exported to the Russian federation, Bosnia and Herzegovina and Montenegro. Because of low exporting prices, it can be concluded that Serbian exports are based on low priced wines. The average export price of Serbian wines has increased, though, as has overall value of Serbian wine exports. This trend is expected to continue for the foreseeable future.

This research has some limitations. Given that it is conducted using netnography, the reliability of aggregate data depends on the sources where that data was obtained on the internet. However, most of the data were collected from the Statistical Office of the Republic of Serbia and Ministry of Agriculture, Forestry and Water Management. Further avenues of research could include detailed interviews or surveys to corroborate the results presented here. It can also be conducted by introducing additional factors other than the assessed five factors.

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Conflict of interests

The authors declare no conflict of interest.

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COMPETITIVENESS OF AGRI-FOOD EXPORTS OF THE REPUBLIC OF SERBIA IN THE COVID-19 CONDITIONS

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ABSTRACT

The research aims to determine the intensity and direction of the impact of the global health and economic crisis from 2020 on the export competitiveness of the agri-food sector of the Republic of Serbia. Empirical study shows that there was an increase in the importance of exports of agri-food products in the crisis year 2020 according to all analysed indicators (net exports index, index of contribution to trade balance, relative coverage of imports by exports, unit values of exports). This confirms the hypothesis that this sector has exceptional resilience to crisis events. Moreover, net exports of these products increased significantly in 2020 compared to 2019 as a pre-crisis year. Therefore, the agri-food sector of the Republic of Serbia plays an important role in periods of such a crisis caused by non-economic factors, because it can compensate for the decline in exports and gross value added of other sectors.

Introduction

The global health and economic crisis caused by the COVID-19 has affected almost all sectors of the economy. The crisis of a non-economic nature quickly spread to the economic sphere (Cvijanović & Pantić, 2021). Economic disruptions were inevitable due to government efforts to curb the spread of the virus to protect the population health (Kerr, 2021). Travel restrictions caused difficult movement of goods, an increase in stocks in companies' warehouses due to problems in supply chains, but also a lack of manpower (Kalogiannidis & Melfou, 2020). On the other hand, farmers engaged in

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the production of fresh fruits, vegetables and dairy products, at first suffered heavy losses due to logistical and transport difficulties (Štreimikienė et al., 2021). All this has affected the reduction of exports and production due to the difficult import of inputs needed for food production (seeds, pesticides, agricultural machinery). Labour shortages and declining imports in import-oriented countries have resulted in a significant decline in the agricultural sector, as a typical labour-intensive sector. Due to the need to enhance immunity, there has been a change in the demand. In addition, larger purchases and the creation of stocks are noticeable, which has led to an increase in the demand for agri-food products.

At the macro level, the restriction of socio-economic activities has led to a deterioration in national accounts, as many sectors have collapsed. The negative impact is especially noted on the tourism, air transport and foreign trade sectors (Rueda Cantuche, 2021). As the link between exports and economic growth is two-way (Syamni, 2021), countries with a high share of tourism, as well as some industrialized countries, have faced negative growth rates. On the other hand, the Republic of Serbia in 2020 achieved a decline in gross domestic product of only 1.1%, which is one of the better results given the European countries (Savić et al., 2021). This is the result of a well-conducted macroeconomic policy, timely and effective measures to overcome the consequences of the crisis, but also above-average results in certain sectors of the economy. The ICT industry stands out in particular, as well as the agri-food sector, as part of the real sector of the Serbian economy.

The agri-food sector of the Republic of Serbia has a high share in total exports, employment and gross value added. Since it is a traditional export-oriented sector (with significant net exports), it can meet all the needs of the population and place a certain “surplus” abroad. Therefore, improving the balance of payments is one of the most important roles of this sector. As the agri-food sector is considered one of the most unpredictable sectors (Jámbor, Czine & Balogh, 2020), it is essential to investigate the effects of the COVID-19 pandemic on food prices, demand, supply, but also the macroeconomic consequences on exports, imports, and the competitiveness of the same.

In the period before the crisis, the Republic of Serbia achieved good results when it comes to the competitiveness of agriculture and the food industry. In times of crisis, the challenge is to achieve food security of the population and to realize adequate foreign exchange inflows based on exports. The objective of this paper is to review and compare the importance and competitiveness of exports before and during a pandemic. For that purpose, the index of net exports, the index of contributions to the trade balance, as well as the relative coverage of imports by exports were used. An additional goal is to analyse the movement of unit values of exports of this sector in regular circumstances (2019) and in the midst of the crisis caused by the COVID-19 at the end of 2020, in order to explore the effects from the point of view of price competitiveness factors. The chances of Serbian agriculture in the period of the current pandemic are summarized in the Conclusion, as the last part of the paper.

Materials and methods

The agri-food sector includes the following divisions classified according to the methodology of the Statistical Office of the Republic of Serbia (2019) and according to the SITC (revision 4), marked with two-digit numbers: 00 - Live animals other than animals of division 03; 01 - Meat and meat preparations; 02 - Dairy products and birds eggs; 03 - Fish (not marine mammals), crustaceans, molluscs and aquatic invertebrates; preparations thereof; 04 - Cereals and cereal preparations; 05 - Vegetables and fruit; 06 - Sugar, sugar preparations and honey; 07 - Coffee, tea, cocoa, spices, and manufactures thereof; 08 - Feeding stuff for animals (not including unmilled cereals); 09 - Miscellaneous edible products and preparations; 11 - Beverages; 12 - Tobacco and tobacco manufactures; 21 - Hides, skins and furskins, raw; 22 - Oil-seeds and oleaginous fruits; 29 - Crude animal and vegetable materials, not elsewhere specified; 41 - Animal oils and fats; 42 - Fixed vegetable fats and oils, crude, refined or fractionated; 43 - Animal or vegetable fats and oils, processed; waxes of animal or vegetable origin.

The research within this study covers a fourteen-year period, more precisely from 2007 to 2020. The main source of empirical data is the database of the Statistical Office of the Republic of Serbia. The study will try to answer the research question: did the importance and competitiveness of agri-food exports of Serbia decrease in the period of COVID-19?

Indicators of the importance of agri-food exports for total foreign trade may be different. The value of exports, the value of net exports, as well as the share of exports of the agri-food sector in total exports of the economy and world exports, can be the starting measures in the analysis and assessment of competitiveness. The main indicators of the importance of total and sectoral exports present in the literature and which will be applied in the forthcoming analysis are:

(i) net export index (NEI),

(ii) index of the contribution of the external trade of a sector to the trade balance of goods (or shorter, contribution to the trade balance of goods) (CTB) and

(iii) relative coverage (RC) of imports by exports.

These are relative indicators that more comprehensively reflect the competitiveness of exports and are used when it comes to analysing the role of partial segments of the economy.

The first in a series of measures of export competitiveness that will be calculated and monitored is the NEI. This is a typical indicator that is used in the analysis of the external competitiveness of the entire economy or its parts. The term relative foreign trade balance or net trade index is also used in the literature (Marković, Krstić & Rađenović, 2019), and shows the revealed comparative advantages (RCA index) (Marjanović & Marjanović, 2019). Unlike a simple indicator of import-export coverage, this one includes the entire external trade exchange of the analysed sector. The index is calculated simply, as the quotient of the difference and the sum of the values of exports and imports of a certain group of products, in this case the agri-food sector, using the following formula (Bozduman & Erkan, 2019; Marković, 2019; Božić, Nikolić & Božić, 2021):

$$NEI = \frac{x_{ij} - m_{ij}}{x_{ij} + m_{ij}} \quad (1)$$

where:

NEI – index of net exports of the agri-food sector,

x_{ij} – value of exports of the agri-food sector *i* of the country *j*,

m_{ij} – value of imports of the agri-food sector *i* of the country *j*.

The logic of this indicator is such that its growth indicates that there has been an increase in net exports of the sector compared to the sum of sectoral exports and imports. To enhance the competitiveness of exports, it is necessary that (in addition to the absolute growth of net exports) the value of exports grows in a higher percentage than the increase in imports of the agri-food sector.

In contrast to the presented index, the CTB index measures the importance of the sector's exports in relation to the total external trade balance of the economy. The index is obtained by the following formula: (Melišek, 2012; Jovović & Jovović, 2018; Marković, 2019; Marković & Marjanović, 2021):

$$CTB = \left(\frac{x_{ij} - m_{ij}}{X_j + M_j} - \frac{X_j - M_j}{X_j + M_j} * \frac{x_j + m_j}{X_j + M_j}\right) * 100 \quad (2)$$

where:

CTB – index of contribution of the agri-food sector to the (external) trade balance of goods,

xij – value of exports of the agri-food sector *i* of the country *j*,

mij – value of imports of the agri-food sector *i* of the country *j*.

Xj – value of goods exports of all sectors *i* of the country *j*,

Mj – value of goods imports of all sectors *i* of the country *j*.

A higher value of this index implies a greater importance of the sector in the external trade balance of goods (Marković & Marjanović, 2021).

The next indicator, as well as the previous one, measures the internal competitiveness of agri-food exports. In fact, it is the RC of imports by exports of the agri-food sector in relation to the entire economy. The coefficient of RC of imports by exports is calculated as follows (Kersan-Škabić, 1999; Milanović, Stevanović & Vićentijević, 2013; Marković & Marjanović, 2021):

$$RCij = \frac{\frac{x_{ij}^t}{m_{ij}^t}}{\frac{\sum_{i=1}^n x_{ij}^t}{\sum_{i=1}^n m_{ij}^t}} \quad (3)$$

where:

RCij - coefficient of relative coverage of imports by exports of the agri-food sector,

xij – exports of agri-food sector i of the country *j*,

mij – imports of agri-food sector *i* of the country *j*,

$\sum_{i=1}^{n} xij^{t}$ – total exports of all sectors *i* of the country *j*,

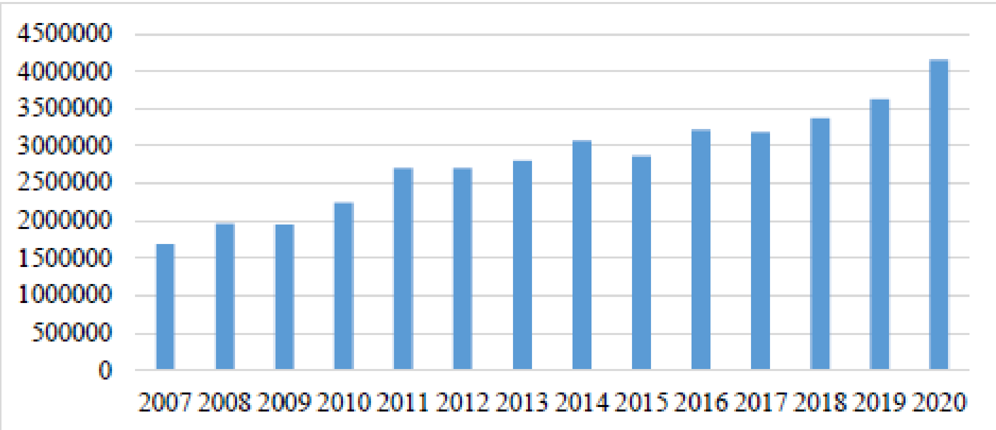
$\sum_{i=1}^{n} mij^{t}$ – total imports of all sectors *i* of the country *j*.

The higher importance of agri-food exports in the total economy will be in the case that exports increase or imports of this sector fall, and will further increase if the deficit of the total external trade balance of goods deepens.

Results and Discussions

At the very beginning of the analysis, it is interesting to see whether there was an increase or decrease in exports of the agri-food sector of the Republic of Serbia in 2020. The results show that in the period of the pandemic, an enormous growth of exports of the agri-food sector of as much as 14.4% was recorded, so that the value of exports at the end of 2020 exceeded USD 4 billion (Figure 1). Starting in 2012, this is the highest annual growth rate of the value of exports of this sector. Also, for comparison, the average growth of the agri-food exports was about 7% in the analysed period.

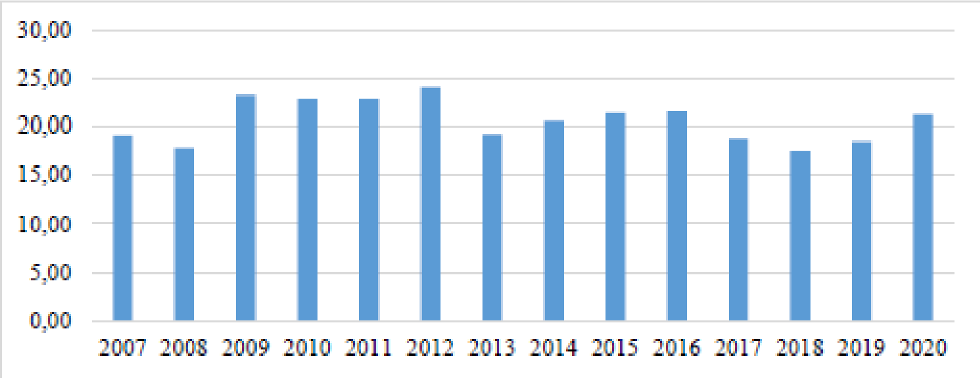
Figure 1. Evolution of the value of exports of the Serbian agri-food sector (thousands of USD)



Source: Authors' presentation according to the data of the Statistical Office of the Republic of Serbia, 2021.

As absolute values in economic research often have less analytical significance, the share of agri-food sector in the total exports of the Republic of Serbia for the same period was also considered. The data in Figure 2 show that this share increased in the crisis year 2020, and again amounted to over 20% (after several years of stagnation). The importance of agri-food exports in the Serbian economy has obviously increased during the pandemic, unlike the economic crisis of 2008, which had a negative impact on its exports.

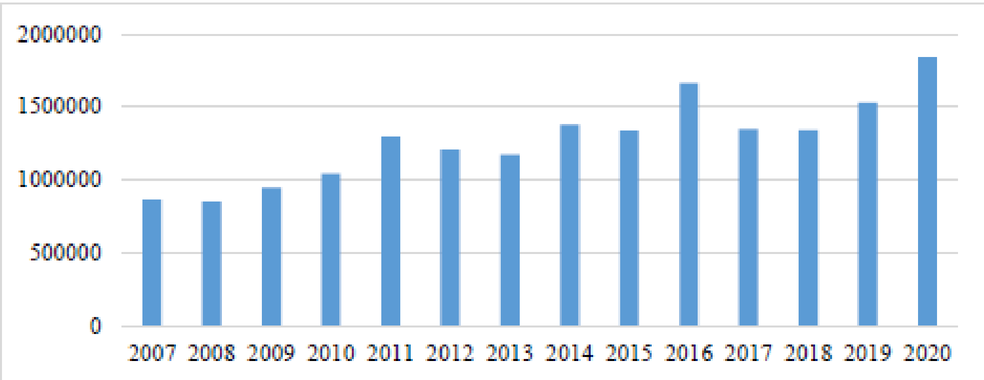
Figure 2. Share of the agri-food exports in the total exports of the Republic of Serbia (%)



Source: Authors' calculation according to the data of the Statistical Office of the Republic of Serbia, 2021.

On the way to relative indicators of importance and competitiveness of exports, it remains to see the value of net exports of the analysed sector. Net exports of the agri-food sector were at their peak in the year of the COVID-19 pandemic, amounting to over USD 1.84 billion at the end of 2020 (Figure 3).

Figure 3. Value of net exports of the Serbian agri-food sector (in thousands of USD)

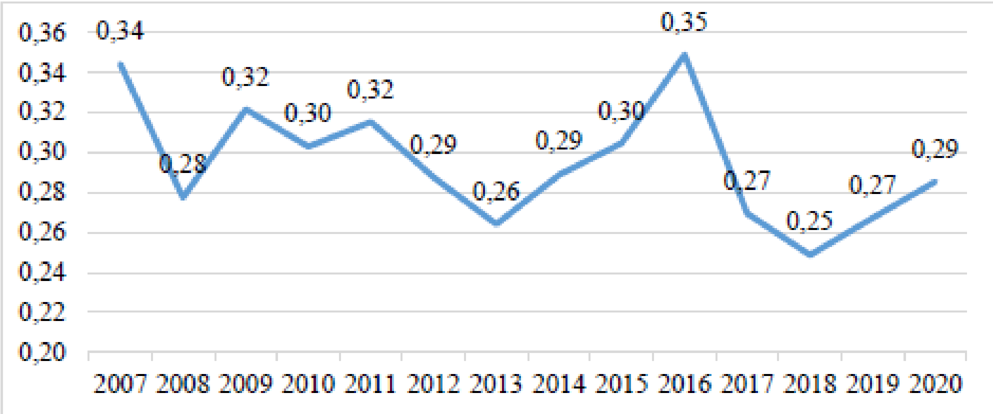


Source: Authors' calculation according to the data of the Statistical Office of the Republic of Serbia, 2021.

Compared to 2019, net exports of this sector increased by over 20%. So, in addition to the increase in exports, there has been a significant growth in net exports, which shows that the agri-food sector of the Republic of Serbia belongs to the leading export-oriented activities even in times of crisis of this type.

Figure 4 aims to present the first indicator of the importance of exports described in the research methodology. The results show that the NEI of the agri-food sector of the Republic of Serbia also increased in 2020, which is logical given the movement of the previously analysed absolute indicators. Regardless of the growth of imports, the growth of exports was high and enabled the growth of the NEI value, in contrast to the purely economic crisis from 2008, when there was a sharp decline in this indicator.

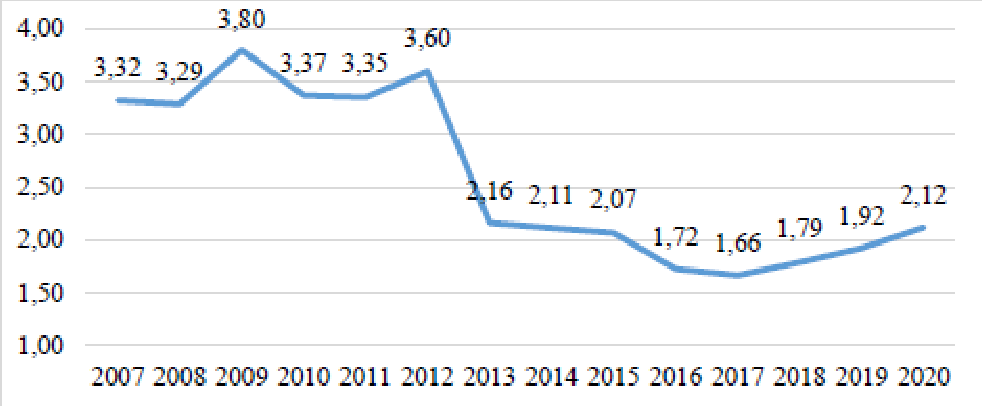
Figure 4. NEI of the agri-food sector of the Republic of Serbia



Source: Authors' calculation according to the data of the Statistical Office of the Republic of Serbia, 2021.

The following two Figures describe the importance of the agri-food sector in total external trade in goods. The movement of the CTB index values is the subject of Figure 5. Since 2013, there has been a significant decline in the value of this index. This is because the total external trade in goods of the Republic of Serbia grew much faster, so that the relative importance of net exports of agriculture and the food industry in that sense has decreased. In fact, the relative importance of external trade in agri-food products decreased in relation to other sectors in the trade balance (until 2017) due to the relative reduction of the share of exports in relation to the entire external trade of the Republic of Serbia. However, in addition to that, in 2020, the CTB index of agri-food exports to the trade balance increased, thanks to the good export results of the respective sector in a pandemic.

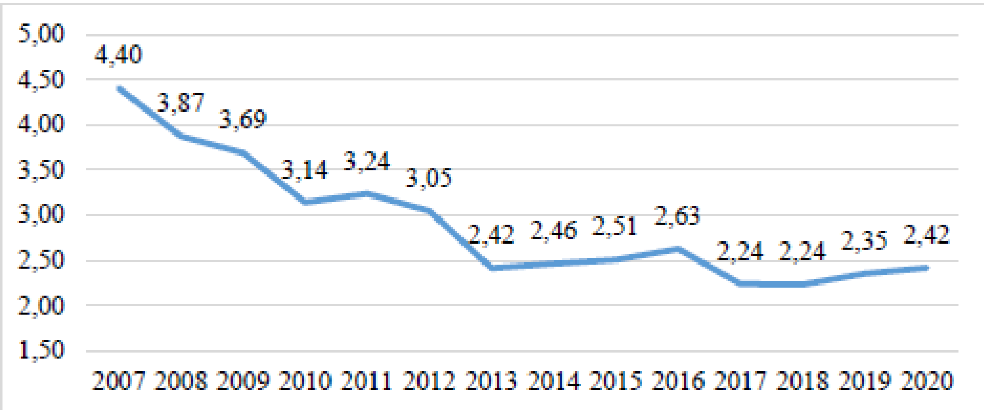
Figure 5. CTB index of the agri-food sector of the Republic of Serbia



Source: Authors' calculation according to the data of the Statistical Office of the Republic of Serbia, 2021.

The coefficient of RC of imports by exports of the agri-food sector from 2013 shows a declining importance of this sector in the overall economy (until the outbreak of the pandemic). This is a normal consequence of the structural transformation of a developing country in which industrial high-tech products get a larger share in external trade. More precisely, there was a stronger reduction in the deficit of the overall balance in relation to the coverage of imports by exports of the agri-food sector. However, in 2020, this coefficient will also enhance due to significantly weaker achieved results of other sectors of the Serbian economy and an increase in the external trade suficit of agriculture and the food industry. The rest of the trends can be seen by a detailed review of Figure 6.

Figure 6. Coefficient of RC of imports by exports of the Serbian agri-food sector



Source: Authors' calculation according to the data of the Statistical Office of the Republic of Serbia, 2021.

Based on all analysed indicators, the growth of the importance of Serbian exports of agri-food products during the pandemic period is evident. However, it is important to determine whether this is the result of increased export quantity, or whether rising food prices played a decisive role.

The fact is that food prices are very unstable, significantly sensitive to shocks and have an unpredictable trajectory during the crisis. The COVID-19 pandemic conditioned the rise in prices because it reduced the supply of food and at the same time raised the demand. Due to the panic on the market, there was an excessive purchase of food products, while the weaker supply was due to the lack of workers who were engaged in harvesting crops, as well as the transport of goods (Daglis, Konstantakis & Michaelides, 2020). Therefore, these effects are examined in Table 1 and Table 2. In doing so, all 4 parts of agri-food exports were analysed separately: Food and live animals, Beverages and tobacco, Crude materials and Animal and vegetable oils, fats and waxes.

The Tables 1 and 2 show the unit values of exports and imports of the analysed sector in 2019 and 2020. They are obtained by simple calculation; the value of exports/imports is put in relation to the amount of exports/imports. Based on the calculated data, an increase in unit prices was observed in two sectors, and it was most pronounced in the sector with the highest added and market value - Beverages and tobacco. In this sub-sector, the unit values of imports are higher by over 30% in 2020. Therefore, despite the decline in export volumes, there was an increase in the total value of exports of these products. The authors believe that this is a consequence of higher demand for these products on a global level during this type of crisis events, which has raised prices on the world market. The situation was similar in the sector that includes Animal and vegetable oils and fats.

Table 1. Unit values of exports and imports of sectors belonging to agri-food products in 2019 (in thousands of USD per ton)

Sector	Total, USD thousand	Quantity, tonnes	Unit export values
Food and live animals	2583896,2	5545367,7	0,47
Beverages and tobacco	582500,4	599280,5	0,97
Part of the Sector Crude materials*	235978	425084,6	0,55
Animal and vegetable oils, fats and waxes	222231,1	299605,5	0,74

Source: Authors' calculation according to the data of the Statistical Office of the Republic of Serbia, 2021.

Note: (*) only divisions 21, 22 and 29 of the Crude materials sector belong to the agri-food products

Table 2. Unit values of exports and imports of sectors belonging to agri-food products in 2020 (in thousands of USD per ton)

Sector	Total, USD thousand	Quantity, tonnes	Unit export values
Food and live animals	2945956,0	6179824,5	0,48
Beverages and tobacco	689752,8	539953,4	1,28
Part of the Sector Crude materials	291553,1	522159,9	0,56
Animal and vegetable oils, fats and waxes	222092,3	259009,4	0,86

Source: Authors' calculation according to the data of the Statistical Office of the Republic of Serbia, 2021.

As there has been an increase in unit values of exports of beverages, tobacco and animal and vegetable fats, agricultural policymakers should keep this in mind when deciding on stimulative measures, because these parts of agri-food exports can radically improve the structure and value of exports during the crisis. As these are also products with the highest added value, special attention in further strategies of agricultural development must be directed towards them. It is imperative to get the maximum results in crisis periods in order to compensate for the bad economic results in other sectors of the Serbian economy, which obviously did not show resistance to the crisis caused by the non-economic cause.

In periods of crisis, there is a noticeable increase in the price of basic agricultural products, which can be useful for the future improvement in the value of exports and the reduction of the chronic deficit of the balance of payments of the Republic of Serbia. In addition, it turned out that in these conditions, thanks to agriculture and the ICT sector, there was a smaller decline in economic growth compared to the European average. This is because the demand for food (basic foodstuffs) is, by definition, quite inelastic (Elleby et al., 2020).

Conclusions

The aim of the paper was to investigate the consequences of the COVID-19 pandemic on the export and competitiveness of the Republic of Serbia's agri-food sector and at the same time prove the benefits and possibilities of this sector for the Serbian economy in the current crisis period. Specific indicators of external (index of net exports and unit value of exports) and internal competitiveness of exports (index of contribution to the trade balance and relative coverage of imports by exports) were used to assess the place and importance of agri-food exports in total foreign trade in goods.

The fact is that the agri-food sector has significantly improved its macroeconomic accounts. Exports increased, the value of net exports increased drastically, as did the share in total exports of the Republic of Serbia. In addition, progress has been made when it comes to growing the net export index and improving the competitiveness of this sector in foreign markets.

The research covered a longer period of time, in order to compare the effects of the present crisis due to the coronavirus pandemic with the impact of the global and financial crisis from 2008. In contrast to that crisis of a purely economic character, completely different movements of almost all applied indicators were determined. Undoubtedly, structural transformations in the economy reduce the relative importance of agriculture and the food industry in the Serbian economy (Marković, Milanović & Marjanović, 2019). However, the COVID-19 pandemic has raised again the question of the importance of this sector, both from the point of view of ensuring national food security and internal competitiveness. Serbian agriculture and the food industry have obviously withstood the crisis, recorded an increase in competitiveness in the foreign market. Their impact was reflected in a reduction in the trade and balance of payments deficit, as well as a substantial increase in exports.

Almost all values of the indices applied in the research show that the pandemic has increased the relative importance of the agri-food sector in the total external trade in goods. Despite the decline in the importance of this sector since 2012 in the overall economy as a result of structural changes in the growing economy, it is necessary to note that the agri-food sector since 2019 is growing again in total trade. On the one hand, the poor structure of exports is an unfavorable situation for the economy. However, in this situation, the crisis did not affect the agricultural sector, so that was the reason for the reduced impact of the pandemic negative trends on the economy.

The crisis period could be a chance for Serbian agriculture, as many countries have restricted exports to ensure national food security. Negative trends and declining economic activities were compensated by the good results in the agri-food sector. The challenge was to meet the rapidly increasing consumption from countries which are in possession of sufficient quantities of food supplies ready to export to foreign markets.

The authors recommend that economic policy makers must continuously improve the structure of production and exports of the agri-food sector, not only because of its significant role in times of crisis, but also because of the strengthening of the Republic of Serbia's economy in regular circumstances. However, livestock production will face a special challenge, given the time it takes to replenish food stocks, as well as the uncertain future business decisions of farmers (Beckman & Countryman, 2021).

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Conflict of interests

The authors declare no conflict of interest.

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RURAL TOURISM OF EASTERN SERBIA – HUMAN RESOURCES MANAGEMENT AND MOTIVATION

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A R T I C L E I N F O

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A B S T R A C T

Depending on the existence and dominance of a resource in a certain rural area, different forms of rural tourism can be developed. Human resources are the most important factor in all forms of tourism business, including rural tourism. The subject of this paper is a survey of employee satisfaction in rural tourism, in Eastern Serbia - in the villages of the Timok region. The authors aimed to highlight the most important motivating factors of employees in smaller rural households. The technique of survey questionnaires was applied, while the obtained data were processed by the appropriate statistical method. The paper represents a modest contribution to the research of human resources motivation in the field of rural tourism, but the results obtained by the research can be recommendations to the general managers of rural households, in which way to best motivate their employees.

Introduction

Human resource management is considered a new theoretical and scientific discipline, which deals with the study and critical review of all important aspects of human management. Man is less and less treated as an object of management, and more and more as a subject of leadership (Milić, 2011). Rural tourism is tourism that takes place in a rural area. At the same time, the rural area, in addition to the village as a settlement, includes the rural area - atar, as well as uninhabited areas and wilderness areas (Đenadić et al., 2016). The authors studied the directions of rural tourism in the

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region of Eastern Serbia in their previous research on the development directions of the Timok region (Ilić et al., 2020a). The ability to know and recognize people, ie employees, can be practiced through continuous education, through life experience, or it can be spontaneous or naturally innate (Ilić, Đukić, 2021). Tourism is becoming the main economic power in the new century. Due to its specific business, which includes travel and stays of people outside the place of residence, or due to the specific services it offers, organized tourism can significantly participate in increasing the total income of the economy and contribute to its development (Vojnović et al., 2012). Employees need the organizational ability of transformational leadership, ie understanding of their needs by managers (Ilić et al., 2020b). The future requires the unification of functions and the flow of information in all activities, especially in the tourism industry. New management models emphasize management that combines orientation, goal setting, decision making, and the application of various forms of leadership (Ilić, Simeonović, 2018). By conducting a survey of employee motivation factors in the rural tourism sector, the authors wanted to present the main motivations of employees, as an opinion about the relationship they have with their superior/boss or household manager.

Literature review

Creating a simple picture of tourism is not easy at all because there are too many factors "playing the role", inother words it is a multidimensional phenomenon. Based on the fact that people, as tourists, are the basic objects and drivers of tourism development, this fact must be considering in defining terms of tourism (Marković, S., Marković, Z., 1970). Tourism, as a socio-economic phenomenon, represents the movement of people to meet tourist needs (Perić et al., 2020). It is a phenomenon that is present in all countries but manifests itself differently in scope and effects. Tourist satisfaction means meeting all his/her expectations. The modern tourism business has led, as in other service and production activities, to the emergence of a spoiled consumer (Zečević-Stanojević et al., 2021). The modern tourist is spoiled for the reason that tourist facilities are offered to him from all sides. As the offers are numerous, so are the contents (Vehapi, Mitić, 2021). What is important, when interacting with consumers and producers or service providers, is the possibility of such an offer that would exceed the expectations of tourists (Prodanović et al., 2021). Achieving this goal in modern tourism is not easy. But to delight, the tourist, as a consumer is not impossible. A tourism organization consists of many resources, but human resources make up its soft and sophisticated, most important component. Modern human resource management in organizations is not an easy task. In the past, a couple of decades ago, it was enough for a manager to be in a position to issue orders, which had to be carried out by employees without discussion (Vojnović et al., 2012). However, with the development of overall social relations, the approach to human resource management has also developed (Ilic, Nikolic, 2019). The modern market is characterized by turbulent changes, while globalization has accelerated them even more (Dukić Mijatović et al., 2021).

As organizations had to adapt to business conditions, so did their leaders have to change management styles. Human resources, their knowledge, skills, abilities, and competencies are key factors in the business of tourism companies. Numerous entities have recognized the importance of investing in human resources because they have proven to be extremely important capital (Cook, 2011). Human resources can also be defined as the total amount of knowledge and skills available to employees as a result of knowledge acquired through formal education and knowledge acquired through practical work and experience (Sánchez Cañizares, López-Guzmán Guzmán, 2010). Investing in human resources has its equivalent in better business, better services, and the expected increased satisfaction of users of services and tourism products.

According to Werther, and Davis, the following sentence can be highlighted: “Equipment makes things possible, and people are the ones who make things happen.” (Werther, Davis, 1996). Human resources enable and determine the success of every company, especially the tourist one. Among the employees are the people who come from different backgrounds, different attitudes, views on life, ways of solving problems, bringing with them some family inconsistencies. However at work, they must function as a well-tuned and rehearsed orchestra. The most important thing is that they all have to adapt to the cultural pattern that prevails in the company because that is the only way for optimal business result (Stojanovic et al., 2017). All the skills and potential of the employees must be expressed, especially in the tourism business. They must respect the philosophy and culture of the organization, but also of their clients, and function in harmony to achieve a synergy effect and provide an image of quality and business excellence. Of course, employee satisfaction must be ensured by taking care of the even distribution of work, fair remuneration, and taking care of health and working conditions - by creating and encouraging a sense of community and loyalty to the company. According to Blažević, as education is one of the most important forms of human capital, investing in it results in much better and greater effects than investing in equipment (Blažević, 2007). However, such capital shows its value only when it is implemented, applied, and turned into something tangible and valuable for the offer of tourist products. When such an offer gets its valorization through consumers and gets a financial equivalent, only then are human resources the capital of the company (Ilic et al., 2019). Otherwise, it is only intellectual potential that is untapped. “Human resource management (especially in rural tourism) is a process of attracting, engaging, training, motivating, retaining and rewarding employees, to create a safe and fair environment for employees on the one hand, and on the other hand to achieve strategic goals of the organization.” (Djordjević-Boljanović, 2018). Human resource management is successful if the basic task is done, which means increasing labor productivity under the company’s strategy and in an ethically and socially responsible way. It is necessary to harmonize individual, organizational and social goals. What is the importance of motivating human resources, ie employees for the tourism industry? Motivation is one of the most important topics in management, in general. The concept of motivation is associated with several elements: needs, desires, intentions, and aspirations. All the above terms are the drivers of the activity.

Motivation can therefore be defined as: "the process of initiating, directing and maintaining human behavior towards a certain goal" (Šarović, 2009). This way managers can achieve better business performance. Achieving the performance of employees and managers can be presented as a combination of three key factors: the ability of employees to achieve performance, the chances of employees to achieve performance and the will or motivation of employees to achieve performance (Bratić et al., 2021). The ability of employees to achieve better business effects is possible through their education and training. The organizational structure of the company can enable employees to maximize the effects of business tasks (Ilić, Mihajlović, 2015; Milojević et al., 2020).

However, although the employee may be competent and the organization may provide him education - all this will not be worth if the employee is not motivated for job. From the aspect of the rural tourism sector, motivation could be understood as a means of improving business performance - attracting tourists to rural areas. In this way, motivated human resources would be able to maximize business effects (Podovac et al., 2019). The ability of employees to achieve effects can be possible through their on-the-job training. The structure of the rural household and "how to do better business" in these households, provide an opportunity for employees to achieve better results (Košić et al., 2015). However, employees in rural tourism, as in any other field, can be competent to achieve performance, only if the household or organization in which they work can enable them to achieve performance. Thus, all factors are closely related and interdependent.

Considering the results of numerous researches and experiences, the answer is that there is no universal solution for building a motivational system for any company, including a tourist company, but it largely depends on the policy of an individual organization and specific solutions (Milićević et al., 2015). One of the main tasks is to define the goals of the reward policy and system, and the condition is better knowledge and understanding of human motivation. The system of rewarding and motivating cannot depend on the individual behavior and attitude of managers but is an integral part of business and development policy, defined rules and norms that arise from it. The motivational system of a tourist facility (households for example) must provide three types of behavior important for the functioning of the organization and development (Torrington et al., 2004): 1. people need to be attracted to the system and they must stay in it, 2. employees must perform the assumed tasks and obligations adequately, 3. The innovative and creative activity must be developed to achieve the development goals of the organization.

The research methodology

The authors tested the motivation of employees in rural tourist households in a case study of eastern Serbia and the Timok Region. The paper applied the methodology of field research because the secondary data were not enough to shed light on the phenomenon of motivation of employees in rural tourism in this part of the country. The applied Survey method belongs to the scope of marketing research, which is the systematic and comprehensive collection and processing of data needed to make strategic managerial decisions. Research on the behavior of employees, in this case, participants in achieving economic benefits through smaller rural households, put respondents/employees at the very center of the research - their attitudes, needs, and opinions. The following basic hypothesis was tested by the method of surveys and interviews: "If it is clearly determined what motivates employees in the rural tourism sector the most (motivation factors), it will be easier for the main bearers, ie household managers, to motivate employees, and the tourist product will indirectly be more valued by consumers." The authors emphasize that the indirect evaluation of the tourist product would result from the greater commitment of employees in the rural tourism sector. Inother words, if they were adequately rewarded, the performance in the business would be better and thus consumers of rural products would be more satisfied with the services provided. To research the motivation of employees in rural tourism, more precisely in 50 rural catering facilities in the Timok Region, an adequate survey questionnaire was prepared, which is the purpose of the research.

During the survey, the governing bodies were contacted, ie the heads of rural households, who gave their consent for the survey. The questionnaire contained seventeen questions, 7 of which were of a general nature (gender, education, age), and 10 related to the degree of motivation of employees and the attitude of superiors towards employees in households. The time frame of the research covered the period from April 1, 2021. by the end of September 2021. The territory around all major cities of the Timok Region (Zajecar, Bor, Majdanpek, Kladovo, Negotin, Sokobanja, Knjazevac) is included. Data from the survey questionnaires were processed by the SPSS (Statistical Package for the Social Sciences) statistical method, Kaiser-Meyer-Olkin Measure of Sampling Adequacy, and Bartlett's Test of Sphericity.

Results and discussion

The first part of the research belongs to the descriptive method, by which the authors presented the structure of employees in the rural tourism sector, by age, gender and education. The authors also pointed out how familiar employees are with the concept of motivation and what the employees in the rural tourism sector mostly associated this concept (motivation) with. The authors pointed out that the research included rural households that have been engaged in rural tourism for more than 5 years and belong to larger rural households. Rural households employ up to seven workers and offer services of approximately hotel character (accommodation, food preparation, and service). A total of 97 respondents participated in the survey, the most represented were from 46 to 55 years (43), then 1/3 of respondents were in the age group of 36 to 45 years (30), from 18 to 35 years, there were a total of 12 respondents, as and persons over 55 years of age (12). There were 65 women and 32 men. Most respondents had secondary and higher education, 87%. Significant differences were evident in the ratio of the gender of respondents and education, ie given the specifics of jobs in the rural tourism sector, specifically larger rural households and smaller catering facilities, women who performed jobs at the operational level were mostly degree (53). Out of a total of 97 respondents, 70 respondents answered that they are familiar with the conceptual meaning of motivation and that motivation is a very important factor that should be directed to the human resources employed in the rural tourism sector. They connected motivation with material satisfaction, but also with intangible support from their superior employer. A slightly higher percentage of respondents were those who were more familiar about the concept of motivation (conecting this concept not only to money but also to praise, opportunities for career advancement, additional education, etc.). Only 5.7% of employees believe that fair motivation is implemented in the households where they are employed. Percent of 79.5% of respondents thought that motivation was insufficiently implemented, while 14.8% thought that the motivation was not implemented at all. The first indicators were answers to questions related to personal satisfaction, the second indicators were related to managerial staff (heads of rural households, managers of catering facilities), and the third indicators were related to interpersonal skills.

The analysis of basic issues was related to employees' opinions about the importance of the following 10 items: Managers support employees` ideas; Managers are personally involved in the rural organization (household); Employees receive clear instructions from the manager (what is expected of employees); Possibility to choose an independent way of performing tasks; Possibility of decision-making within the domain of employee work; Cooperation with colleagues in the rural household; Communication with superiors; Individual evaluation of results (amount of income); Possibility of advancement in the service depending on the achieved work results; Opportunity for professional development. Respondents rated these items on a scale of 1 to 5 (where 1 was the lowest grade and five was the highest grade). The statistical data collected from the surveys were processed by SPSS - descriptive statistics, arithmetic means, standard deviation, tabular presentation, ie analytical statistics, frequency distribution analysis, gradation of features, and observations by statistical method for nominal variables (chi-square, distribution). Based on employee evaluations, the analysis of the main components for these issues, which were treated as variables, is shown in Table 1, as a correlation matrix. Table 1. allows determining the strength of the relationship between the variables from the survey through the correlation coefficient. The correlation range of the coefficient is from -1 to +1. The level of the coefficient of dependence among the variables is over 0.3. The table shows that there are correlation coefficients that are greater than 0.3 and that the data are suitable for decision-making, ie questions from the correlated survey. The methodology of the analysis was conducted through another confirmation, ie. access to other tests for a more precise assessment of the significance of the use of the so-called Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity.

Table 1. Correlation matrix between variables or questions

		p6A	*p6B*	*p6C*	*p6D*	*p6E*	*p6F*	*p6G*	*p6H*	*p6I*	*p6J*
Correlation coefficient	*p6A*	*1,000*	*,546*	*,526*	*,289*	*,228*	*,354*	*,360*	*,179*	*,317*	*,327*
	p6B	*,546*	*1,000*	*,639*	*,500*	*,415*	*,359*	*,425*	*,261*	*,361*	*,337*
	p6C	*,526*	*,639*	*1,000*	*,485*	*,454*	*,459*	*,359*	*,303*	*,494*	*,377*
	p6D	*,289*	*,500*	*,485*	*1,000*	*,675*	*,373*	*,282*	*,394*	*,519*	*,364*
	p6E	*,228*	*,415*	*,454*	*,675*	*1,000*	*,492*	*,372*	*,414*	*,498*	*,416*
	p6F	*,354*	*,359*	*,459*	*,373*	*,492*	*1,000*	*,721*	*,380*	*,391*	*,408*
	p6G	*,360*	*,425*	*,359*	*,282*	*,372*	*,721*	*1,000*	*,337*	*,373*	*,324*
	p6H	*,179*	*,261*	*,303*	*,394*	*,414*	*,380*	*,337*	*1,000*	*,665*	*,587*
	p6I	*,317*	*,361*	*,494*	*,519*	*,498*	*,391*	*,373*	*,665*	*1,000*	*,767*
	p6J	*,327*	*,337*	*,377*	*,364*	*,416*	*,408*	*,324*	*,587*	*,767*	*1,000*

Source: Author's processing

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was greater than 0.7, while the second Bartlett's Sphericity Test was significant at the 0,000 error level. These values of throughput tests for the analysis of the main components showed that the parameters set by the respondents, ie the scale as a method, justified the measurement of this phenomenon. After previous checks, the methodology was conducted to calculate the common variation that the variables had among themselves through the so-called extracted variance.

Table 2. Communality explained by variance in variables

Indicators	**Initial**	**Extracted variance**
p6A Managers support employees` ideas	1,000	0,389
p6B Managers are personally involved in the rural organization (household)	1,000	0,784
p6C Obtaining clear instructions from the manager on what is expected from employees within the work.	1,000	0,591
p6D Possibility to choose own way of working.	1,000	0,430
p6E Possibility of decision-making within the domain of employee work.	1,000	0,413
p6F Cooperation with colleagues in the rural organization (household).	1,000	0,999
p6G Communication with superiors.	1,000	0,547
p6H Individual evaluation of results (amount of income)	1,000	0,492
p6I Possibility of advancement in the service depending on the achieved work results	1,000	0,939
P6J Opportunity for professional development	1,000	0,633
Extraction Method: Maximum Likelihood.		

Source: Author's processing

Table 2. explains and shows the utility variance and variables. Maximum variation weighs on a unit, which means that values closer to it had more in common in terms of variation with other variables. There was a common variability between the indicators explained by absolute variation over variance. The explained amount of variance (component saturation) can correlate to a maximum with some indicators. The purpose of the analysis was to identify indicators that simultaneously vary to a new dimension that forms a group of common factors that affect a phenomenon. This further implies the use of a test that will calculate the total variability, ie the amount of the same. The Kaiser criterion is used, through which the common variability is extracted and which is declared with a score higher than one. Which indicators to keep in the analysis are decided only after the application of the so-called rotation of the factor space to facilitate the interpretation of the results. Orthogonal rotation was also used via one of the defaults “Virimax”. Indicators are shown that high values of variance vary in new impact factors. Table 3. shows the explained variability of the main components.

Table 3. Totally explained the variability of major components

Components	Basic equivalents of variance			Extracted summarized component variability		
	Total	% from the variance	Cumulative %	Total	% from the variance	Cumulative %
1	4,846	48,463	48,463	2,861	28,614	28,614
2	1,295	12,949	61,412	2,272	22,722	51,337
3	1,003	10,032	71,443	1,083	10,830	62,167
4	,888	8,876	80,319			
5	,448	4,476	84,795			
6	,425	4,254	89,049			
7	,381	3,808	92,857			
8	,308	3,081	95,938			
9	,259	2,593	98,531			
10	,147	1,469	100,000			

Source: Author’s processing

According to the rules of analysis, only those components (factors) with which the Kaiser criterion was over 1 (units) are retained. These were the first three components with which the variance of the indicator correlates in 62% of cases. Three groups of components have been retained, which will be named later. Tables 4, 5. and 6. show the matrices of rotated components with their saturations based on each indicator of the first, second and third components.

Table 4. Matrix of rotated components based on each indicator of the first component

Indicators	The first component
p6A	0,153
p6B	0,134
p6C	0,305
p6D	0,400
p6E	0,395
p6F	0,230
p6G	0,220
p6H Individual assessment work results (amount of income)	0,654
P6I Opportunity to progress at work depending on the results achieved	0,925
P6J Opportunity for professional development	0,739

Source: Author's processing

Table 5. Matrix of rotated components based on each indicator of the other component

Indicators	The second component
p6A Managers support employees` ideas	0,569
p6B Managers are personally involved in the rural organization (household)	0,863
p6C Obtaining clear instructions from the manager on what is expected from employees within the work.	0,657
p6D Possibility to choose own way of working	0,487
p6E	0,380
p6F	0,221
p6G	0,307
p6H	0,145
p6I	0,258
p6J	0,217

Source: Author's processing

Table 6. Matrix of rotated components based on each indicator of the third component

Indicators	The third component
p6A	0,204
p6B	0,145
p6C	0,258
p6D	0,183
p6E	0,335
p6F Cooperation with colleagues in your rural organization (household)	0,947
p6G Communication with with superiors	0,636
p6H	0,209
p6I	0,128
p6J	0,201

Source: Author's processing

According to the results of the research, about 1/3 of the respondents from the surveyed area of Timok Region decided on the motivation factor and personal satisfaction in terms of income. Almost 23% of respondents said that the factors of fair relations with superiors and business ethics are second in importance for the good motivation of employees in the rural tourism sector. Almost 11% of respondents opted for factors motivating good collegial relations and cooperation. The overall analysis of the main components and results obtained by surveying employees in rural tourism organizations concluded that personal satisfaction was the best form of motivation factor for employees, although the relationship with superiors, ie household owners, managers, was also very important factor. The third component, or motivational factors, which united one-fifth of the respondents, referred to the desire for good interpersonal relationships.

In rural tourism, the heads of private households are in one way the managers of the entire business process that is being carried out. Rural households can be explained and treated as entrepreneurial small firms, which do not employ a large number of workers. Therefore, managers of farms or small catering facilities in rural tourism should focus their activities on comprehensive support to employees in rural tourism, which includes: introducing employees to safety measures (especially in emergencies such as the COVID-19 pandemic), proposing health care with the appropriate use of protective equipment, because in this way improved and safer working conditions are created, which indirectly affects the satisfaction and motivation of employees In this way, employees would get the image that their employer takes care of them and that they are important for the business. According to Nedeljković Knežević et al. (2020), it is recommended that in tourism enterprises (hotels or rural households) management engage around employee perception, provide sufficient feedback and improve mutual communication; to timely inform employees about the results of work; to organize meetings with employees to have the opportunity to express their views on improving working conditions and work processes, which also applies to the activities of rural tourism, for example providing sufficient information, ie improving mutual communication (Vuković et al., 2018). This could be expressed in the way that the manager of a rural household or a small catering facility can and should accept the ideas that his employees have, regarding work processes and working conditions (Laban et al., 2021). Only the improvement of the entire country on the European map of tourist offers will contribute to the better positioning of rural tourism in Serbia and its regions. Therefore, the recommendation could be made in the part related to advertising rural tourism products through information technologies, social networks, portals, which every manager of a rural household could and should afford, especially if he is a member of the younger generation. This would mean the promotion of a rural enterprise - household through a web portal. For this reason, the general manager of a rural enterprise must have an appropriate level of awareness for the use of information technology, even by the human resources in the enterprise, as this affects the achievement of better economic performance. Environmental impacts are significant for rural tourism, i.e. the correlation of rural tourism and greater awareness of environmental protection leads to significant and turbulent changes. Ecological protection of rural areas and their revitalization creates conditions for the provision of high-quality tourist services (Cvijanović et al., 2021).

Conclusion

The paper and research of the authors indicate the importance of human resources, their motivation, and job satisfaction, directing managers to a more adequate approach to the motivation process, as one of the four main pillars of management (POMK - Planning, Organizing, Motivating and Control). In that way, the better economic performance of a certain organization would be influenced. Given that the surveys were conducted within the rural tourism sector in Serbia, knowledge, and application of employee motivation factors could affect the satisfaction of consumers of rural products (or services) and thus attract more domestic and foreign tourists. The overall analysis of the results obtained by surveying employees in the rural tourism sector, in the area of Eastern Serbia and the Timok Region, determined that personal satisfaction, ie material reward, is the best form of employee motivation. Another important factor was the relationship with superiors. The desire for good interpersonal relations, ie a good work climate, was also expressed to a large extent, although it united a fifth of the respondents.

The authors confirmed the main hypothesis of the paper. In the research conducted, the authors wanted to show the main factors motivating employees, as well as their opinion about the relationship they have with their superior/boss or household manager. The application of adequate motivation factors would have a positive effect on the best possible execution of work tasks.

Given the fact that better motivation, gives better performance in the work and quality of employees, consumers of rural tourism products would be more satisfied with the services provided. On the other hand, rural households/organizations would get loyal and loyal consumers, who would always return to the place with the best business (tourism) performance.

It can be emphasized that adequate internal and external communication is crucial in understanding, but also in creating good mutual relations between the heads of households and their employees. A high level of internal communication among employees (in addition to material satisfaction, which is primary), could contribute to a higher level of motivation. Based on the research of the literature as well as from the conversations with the heads of households (and smaller catering facilities), the authors in the concluding part emphasize the special importance of external communication of “local managers” with state management. However, this could be classified as a future direction of new research. Future directions of research could also focus on ways to obtain the necessary financial resources, as well as on attracting foreign direct investment for rural tourism development, innovating existing infrastructure, and providing resources for information and communication technologies to a better brand of Serbian rural tourism. Based on the fact that human resources are one of the most important links in tourism, especially in service industries, motivational factors by which employees could provide excellent services play a crucial role in achieving the desired quality of rural tourism products in Serbia.

Conflict of interests

The authors declare no conflict of interest.

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EXPORT OF AGRICULTURAL PRODUCTS FROM SERBIA TO THE EU - PANEL GRAVITY MODEL

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A B S T R A C T

This paper will analyse the export of agricultural products of Serbia to the EU during the period from 2001 to 2017. A panel gravity model was used to assess the effects of trade flows. The main advantage of the gravity model is the application of basic indicators of the economy and the ability to evaluate panel series. The obtained results show that the size of the economy, measured by gross domestic product, the size of the market of foreign trade partners, measured by population, and the distance between trading partner countries, have measurable effects on the export of agricultural products from Serbia to the EU. Using a simple econometric model, we analysed the effects of Serbia's international trade and noticed that there is significant room for improving the exchange between Serbia and EU members. A multi-variable model would provide more information to trade policy makers.

Introduction

Economic integration has been attracting public attention for decades. This is particularly evident at the regional level, with the escalation of regional integration agreements (RIAs) from free trade areas (FTAs) to customs unions (CUs), all the way to monetary union (MU) such as the EU. For small economies, this type of international cooperation can be of great importance.

For Serbia, a small and open economy, an important development component is foreign trade relations, especially those related to the export of agricultural and food products. Agriculture is the core of the economy and the engine of rural development, but also an important component of the EU accession process. Trade liberalization and the ever-widening global market for agricultural and food products are a chance to improve the export range of agricultural products from Serbia. At the same time, market opening

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can pose a serious threat to certain branches of agriculture, so it is necessary to timely adjust the production structures of the agricultural sector.

Therefore, it is important to consider all relevant parameters and key factors related to agricultural products that are an important topic of international trade, whose characteristics in terms of price and quality are constantly being examined in an open economy.

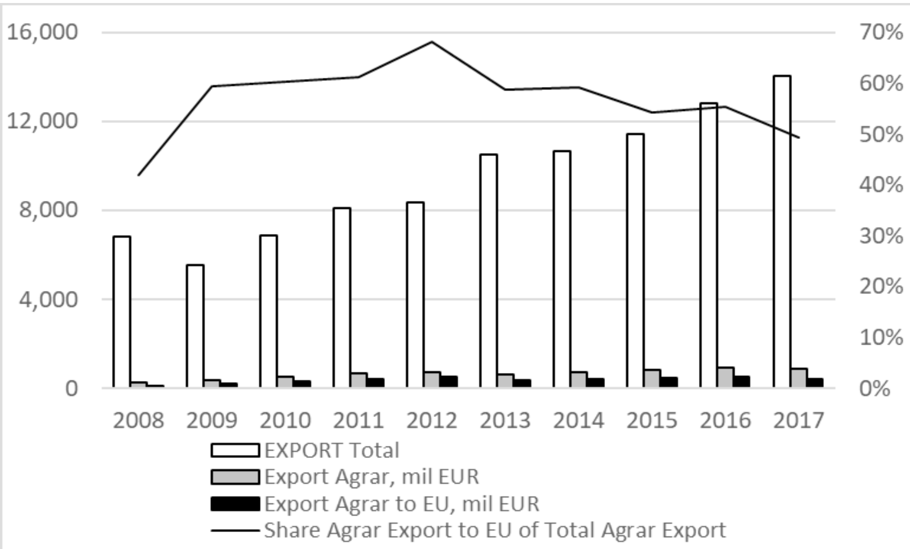
In this analysis, a gravity model was used to estimate the effects of trade flows of agricultural products. The gravity model was estimated on the basis of mutual data exchange between Serbia and 28 EU member states. The emphasis is not on the overall trade potentials, but on the regional orientation of the export of Serbian agricultural products.

Serbian agrarian products export

For decades now, Serbia has had the largest volume of exchange with the EU member states. In 2018, the EU was a key trade partner of Serbia with a share of 67% in its total exports and over 60% in total imports. Exports of Serbian products to the EU in 2018 amounted to 10.9 billion euros.

Among the EU member states, which are traditionally represented with the largest share in foreign trade with Serbia, in 2018 are Italy (12.2%), Germany (11.9%) and Romania (5.9%). In addition to EU members, Russia, China and Bosnia and Herzegovina are at the very top of Serbia's most important trade partners (SORS, 2019).

Figure 1. EU share in total export and agro-food export 2008 - 2017



Source: Authors' calculations

In the observed period, Serbia was mostly focused on the trade with the EU countries, both in total and for agricultural products. The EU market is of great importance for Serbia, especially for agricultural products, where it sells almost half of its agricultural products annually. Having in mind the growing openness of Serbia, high dependence on imports and the deficit in foreign trade, the agricultural sector is becoming a significant factor in balancing the overall trade balance (Božić and Nikolić, 2016).

According to SORS (2019), the export of agricultural products from Serbia has more than doubled in the last decade, with almost 1.3 billion euros in 2018. Producers of cereals, industrial plants and fruits gained profit, and vegetable producers were at a loss, while cattle breeders had almost identical results as in 2017.

Food production is an area in which Serbia has significant export potential, however, as the comparative advantage is not sufficient in itself, domestic export potential of food production is not adequately used due to low competitiveness of domestic food companies, but also the products themselves (Jovović and Jovović, 2018). In order to encourage and increase the level of export of agricultural products to the international market, a gravity model will be presented to assess the effects of trade flows so as to try to understand the decisive factors for improving Serbia's trade with EU member states.

Materials and methods

The gravity model in its basic form, in the literature, has a significant application in the process of explaining bilateral trade. There are numerous research papers (Smarzynska, 2001; Eita and Jordaan, 2007; Viorică, 2012; Waheed and Abbas, 2015; Bialynicka-Birula, 2015; Ristanović et al, 2017; Ranilović, 2017; Ristanović et al, 2019) that explain the effects different economic determinants have (economy size, commodity prices, foreign direct investment, exports, foreign exchange reserves, population, exchange rate, etc.), but GDP, population and distance between countries are the ones which dominate (Oguledo and MacPhee 1994; Eita and Jordaan 2007; Bergstrand 1985 and 1989; Porojan, 2000; Chan-Hyun 2001; Smarzynska, 2001; Ševela, 2002). According to the theory of the gravitational model, exports are positively correlated with the degree of economic growth, negatively correlated with the population of the exporting country, and negatively correlated with the distance between the two economies.

Within the gravity model, the aggregate size of GDP reflects the size or economic strength of the economy, the number of inhabitants in the model represents the size of the market, while distance is a substitute for trade barriers (transport costs in international trade, export / import tariffs, dumping prices, etc.). Through the introduction of a set of three regional variables into the model, it is possible to simultaneously test the effects of grouping on intra-union, non-union, and export trade. Such estimates require the use of panel data to verify potentially inconspicuous factors that are specific to each pair of countries, which will have an impact on trade between them (Trotignon, 2010). In order to examine the individual characteristics of the countries, which participate in the analysis of trade flows, and through which we want to see the mutual trade relations, artificial variables are included in the model.

The influence of specific factors in the gravity model is examined by regression equations with the help of panel series. The advantage of panel series is that they provide the possibility of simultaneous analysis of both comparative data (N) and time series data (T). This increases the sample size (NT) and increases the amount of information from a limited number of observations (sample). The larger the sample, the greater the efficiency of model estimates, at the same time the greater the degree of variability and the greater the degree of freedom. Such a model has less correlation of explanatory variables. Also, the gravity panel model allows simultaneous analysis of both export structures and changes in exports over time. The evaluated results of the model should show the relationship between the size of the economy, the market and the distance, on the one hand, and the export capacities, on the other hand.

All data used to estimate the model parameters come from official sources. The definitions of the model variables and data sources are shown in Table 1. The analysis of trade exchange between Serbia and 28 EU member states covered the period from 2001 to 2017.

Table 1. Defining variables

Variable	Definition	Data Source
exp	Export in current dollars	*Eurostat* and *Trade statistics for international business development*
GDP	Gross Domestic Product of the domestic country in current dollars	*Eurostat* and *Trade statistics for international business development*
GDP*	Gross Domestic Product of the foreign country in current dollars	*Eurostat* and *Trade statistics for international business development*
POP	Population of the domestic country	World Bank annual statistics
POP*	Population of the foreign country	World Bank annual statistics
distance	Distance in kilometres (represents the distance between the capitals)	*CEPII – le Centre d'études prospectives et d'informations internationales*
border	Dummy variables, 0 is the one that takes the value 1 if the countries *i* and *j* have a common boundary, otherwise it is 0	
language	Dummy variables, 0 is the one that takes the value 1 if the countries *i* and *j* have a common boundary, otherwise it is 0	

We assessed the effects of economic development, market size and distance (distance between countries) on the volume of exports of Serbian products to the EU using the gravity model. In addition to these explanatory variables, artificial variables are included in the model. Thus, the extended gravity panel model was tested and evaluated through the impact on exports and from the aspect of common border and common language. To evaluate the model variables, we used two random effect models (RE) and a fixed effect model (FE). In the case of a random effect model, the regression parameters with explanatory variables are invariant, while the random error, i.e. the random variable of the model, reflects variations by units of observation and over time. In the fixed effect model, the random error u_{ijt} has a normal distribution, with zero mean and constant variance, while the explanatory variables are non-stochastic and error-independent. The choice of the model by which the variables will be evaluated are given by the Hausman test. It shows which model, the random effect model or the fixed effect model, will give the best results when testing and evaluating the coefficients with the model variables. Descriptive statistics show that the model contains 280 observations [N = 28; T = 10]. We evaluated the regression model through the statistical software Stata S / E, version 13.0.

Method of Research – Gravity Model

The gravity model was first introduced to economic analysis during the 1970s. It all started with the modeling of trade flows by Tinbergen (1962) and Pöyhönen (1963), and the increasing application to the field of international trade by Linnemman (1966). Aitken (1973) shows that trade between EEC members increased significantly with their integration. In the following decades, the application of the gravity model spread, especially during the 1990s, when the exchange potential of Central and Eastern European countries, on the one hand, and developed Western European countries, on the other hand, was assessed (eg Hamilton and Winters, 1992; Baldwin, 1994; Egger and Pfaffermayr, 2003; Bussière et al. 2005). The differences in results between authors arise not only due to different periods of analysis, but also due to the presence or absence of explanatory variables of the model.

According to the gravity model, potential foreign trade between the two countries is determined by the following determinants of bilateral flows:

1. Demand for imports from the importing country (as a rule, is directly proportional to GDP, and inversely proportional to population),
2. Supply of the exporting country (is represented by the size of GDP and the size of the country - the degree of openness of the economy),
3. Trade barriers: natural constraints, such as transaction costs and transportation costs, other constraints such as, for example, customs and the like.

The Gravity Model has the following form:

$$X_{ijt} = \beta_0 Y_{it}^{\beta_1} Y_{jt}^{\beta_2} POP_{it}^{\beta_3} POP_{jt}^{\beta_4} DIST_{ijt}^{\beta_5} F_{ijt}^{\beta_6} e^{v_{ijt}} \quad (1)$$

where generally speaking *Xijt* shows the total export of the economy *i* to the economy *j* in year *t*; *Yi (Yj)* reflects the *GDP* of the economy *i* and the economy *j* in year *t*; *POPi (POPj)* is the population of economy *i* and economy *j* in year *t*; *DISTij* is a measure of the distance between major economic centers; *Fij* represents any other factors (variables) within the model. The random error of the model is marked with a v_{ijt}. In the general case, a random error consists of three components: individual effects (μ_{ijt}), time effects $(\lambda_t,)$ and the remainder of the random error (u_{ijt}).

$$X_{ijt} = \beta_0 Y_{it}^{\beta_1} Y_{jt}^{\beta_2} POP_{it}^{\beta_3} POPpc_{jt}^{\beta_4} DIST_{ij}^{\beta_5} Bord_{ij}^{\beta_6} Lang_{ij}^{\beta_7} v_{ij} \quad (2)$$

where two artificial variables - common border (Bord) and common language (Lang) -

were introduced. This model basically shows the existence of a linear relationship. The values of some variables vary by country and time, while the values of others vary by country, but are constant over time.

The gravity model uses cross section data, which is a limiting factor because there is a problem of choosing a representative year. Using a panel model solves this limitation. Namely, the gravity panel model can evaluate bilateral exchange in a certain period of time.

As a rule, when using the gravity model to estimate export flows in bilateral trade, the estimated coefficients with variable GDP of the exporting country, *i*, (importer, *j*) are negative, while the coefficients with variable population of the exporting country, *i*, (importer, *j*) are positive. In other words, the growth of the GDP of the importing country, *j*, reflects the growth of the demand for imports, and also with the growth of the GDP of the exporting country, *i*, the export supply is higher. In the model, the variable population is an approximation of market size. The larger the population in the importing country, *j*, the higher the demand for imported products, so the effects on the exporting country, *i*, are positive. However, population growth in the exporting country, *i*, has an ambiguous impact. This impact depends on the effect of absorption, population structure and economies of scale.

The estimated gravity model in a logarithmic form is presented in Equation 3:

$$X_{ijt} = \beta_0 + \beta_1 BDP_{it} + \beta_2 BDP_{jt} + \beta_3 POP_{it} + \beta_4 POP_{jt} + \beta_5 DIST_{ij} + \beta_6 Bord_{ij} + \beta_5 Lang_{ij} + \varepsilon_{it} \quad (3)$$

The model was evaluated by the method of least squares (two-step procedure). Using the Breusch-Pagan test, a standard test to examine the existence of individual effects (variations by country) and time effects (variations over time), their existence was confirmed. Housman's specification test shows that there is no correlation between regressors and individual effects (as components of random error). In other words, the estimates of the regression parameters of the random error component model are unbiased and consistent. This leads to the conclusion that the specification of the panel model of the random error component is more suitable for the model, i.e. model with stochastic effects.

We used the above model to estimate export flows between different countries. In this paper, an analysis of the export potential of agricultural products in regards to the EU economies was conducted based on the results of econometric evaluation of the panel gravity model, for the period from 2001 to 2017. Specifically, the main goal of the analysis is to examine the directions of exchange of Serbian agricultural products with EU countries.

Results and Discussion

We tested the nature of individual effects (fixed and random) using the F-test. The obtained values of the F-test statistics indicate that we accept the null hypothesis - all coefficients in the model are different from zero, the difference that occurs between standard deviations is a consequence of random errors. In other words, the set model is correct. The rule is that if the test shows that we should not reject the zero hypothesis, then the use of a model with a fixed effect is not recommended. In the model, the dependent variable (Y) is explained with the independent variables of the model (*Xi*), which reflects a high level of the determination coefficient (R^2). According to other results, the choice is on the model of random effects. Also, according to the Breusch and Pagan Lagrangian multiplication test for the random effect model, we obtained values that are significant. This means that we reject the hypothesis - there are no individual effects, (Chi-square = 16.77; Prob = 0.0000). In this way, the right choice was additionally confirmed - a panel regression model of random effects. In addition, diagnostic tests were performed, which eased the assumptions of the random effects model (more details in the Appendix).

The results of Table 2 show the regression estimates of the gravity model obtained on the basis of Equation 4. First, the least squares estimation (OLS model) was performed, followed by the estimation of the fixed and random effects models. The evaluation was performed for all variables during the entire observed period. In Table 2, the estimates obtained by the basic least squares model (OLS model) are effective, but the estimates are biased (individual heterogeneities are neglected). The fixed effect model, as a rule, does not estimate coefficients that are time invariant, i.e. variables that do not change over time - distance, common language. In contrast to the fixed effect model, the random effect model encompasses the heterogeneity of all explanatory variables. This allows us to simultaneously estimate the parameters of all model variables, both time-varying and time-invariant.

Table 2. Estimated results for Serbia

Dependent variable: X			
Variables	**OLS model**	**Random effects model**	**Fiksed effects model**
gdp	-5.271971**	-3.646479***	-3.756649***
gdp*	.6336992**	.4144392	1.246826
pop	-23.77332**	-26.66919***	-27.01553***
pop*	.6816342**	.8711883*	-6.877642**
dis	-2.918302***	-3.732251***	0
bord	.1446244**	.082204	0
lang	1.234424***	.9606135	0
_cons	432.1311**	466.3214***	562.1839***
obs	227	227	227
R^2	69.48	70.38	30.13

Note: ***; **; * are statisticaly significant at the level of 1%; 5%; 10%.

Table 2 presents the estimated coefficients from the model. In part, certain signs have been realized, while others are contrary to theory and expectations. The coefficient in front of the variable GDP of Serbia (*gdp*) is statistically significant, and shows a negative impact on the export of agricultural products from Serbia, in all three models. This is contrary to expectations and theory. How to describe the existence of the opposite of the expected impact of Serbia's GDP on the export of agricultural products. In the observed period, the volume of investments in the agricultural sector decreased. The second reason is the structure of household income in Serbia that comes from agriculture and is distributed within the farm. This is especially the case with small farms, which are represented in a high percentage in Serbia (Tošović-Stevanović et al, 2020). At the same time, we should not overlook the fact that the conditions and standardization for access to the EU market are rigorous and almost unattainable for certain agricultural products. The impact of foreign GDP (*gdp**) on exports of Serbian agricultural products is positive (statistically significant), low and reflects the stated expectations. This is understandable if we know that there are high subsidies for agriculture within the EU and that they produce enough food for their own needs. Thus, an increase in the GDP of EU member states of 1% would affect the growth of exports of agricultural products from Serbia by only 0.41%, according to the random effect model. Therefore, by directing exports to the EU, high positive results cannot be expected. Here we are talking about the export of raw agricultural products, not agricultural products of higher stages of processing. Investing in agricultural products of higher stages of processing gives a better export result and highlights the growing contribution of GDP (Dimitrijević et al., 2020). This does not mean that it is necessary to further intensify agricultural production at all costs, as it is often of a devastating nature for the land. Unless there is an intention to introduce innovative, more resource-saving technologies.

The size of the market, which we determined in the model according to the population, has the expected results. Population coefficient for Serbia (*pop*) is statistically significant and has a negative impact on the export of agricultural products from Serbia. This is due to the stronger absorption effect. On the other hand, the impact of the importer population (*pop**) is significant but too low. As with the level of development, we have low elasticity of demand from the EU for these agricultural products from Serbia. The signs of the geographical distance coefficients are statistically significant for Serbia, the exporting country and the EU countries, the countries importing agricultural products (*dis* and *dis**), and they are in line with the expectations. As the distance between the two countries expands, the impact on the export of agricultural products decreases. The common border (*bord*) and the common language (*lang*) do not show significant influence.

Conclusions

Through this paper, we have analysed bilateral trade between Serbia and the EU member states. In addition to assessing the effects of agricultural exports from Serbia to the EU, we used the gravity panel model, a dynamic econometric model that has been presented in practice as a convenient approach to examining multilateral trade flows. We assessed the export-import trade for 28 EU economies and Serbia, in the period 2001-2017.

The presented results of the regression model show that they are statistically significant and explain about 70% of Serbian agricultural exports to the EU using three variable explanations: economic development, market size and distance between countries *i* and *j*. Specifically, based on the gravity model of exports of agricultural products from Serbia to the EU member states, it can be stated that there is a statistically significant positive correlation between economic development and market size, and a statistically significant negative correlation when it comes to the distance. Taking into account the defined gravity model, it must be pointed out that the potential inclusion of additional variables in the model could lead to new conclusions important for trade flows.

The model results are expected. All the conclusions derived from the above analysis can be valuable for the makers of economic decisions in finding the best model for improving trade flows between Serbia and the EU members in the future.

Conflict of interests

The authors declare no conflict of interest.

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Appendix

Table A1. Descriptive statistics of Serbian export of the agrarian products in the EU, 2001-2017

Panel A: Descriptive statistics

stats	exp	GDP	GDP*	POP	POP*	distance	border	language
mean	13.55505	33171.69	491187.8	7189280	1.81e+07	1534.393	.1428571	.0714286
max	385.566	36795.4	3263350	7350220	8.27e+07	3283	1	1
min	.0	29766.3	6128.7	7040270	409370	389	0	0
sd	44.88181	1927.727	744402.2	104115.3	2.30e+07	826.1124	.3505537	.2580005
N	280	280	280	280	280	280	280	280

Panel B: Correlation

	exp	gdp	gdp*	pop	pop*	dis	bord	lang
exp	1.0000							
gdp	-0.0860	1.0000						
	0.1969							
gdp*	0.2685*	0.0404	1.0000					
	0.0000	0.5009						
pop	0.0035	-0.6943*	-0.0466	1.0000				
	0.9577	0.0000	0.4570					
pop*	0.4495*	0.0025	0.9125*	-0.0037	1.0000			
	0.0000	0.9674	0.0000	0.9505				
dis	-0.5897*	-0.0000	0.2452*	0.0000	0.0349	1.0000		
	0.0000	1.0000	0.0000	1.0000	0.5614			
bord	0.4493*	0.0000	-0.2106*	0.0000	0.0365	-0.6584*	1.0000	
	0.0000	1.0000	0.0004	1.0000	0.5428	0.0000		
lang	0.1715*	-0.0000	-0.2450*	-0.0000	-0.1917*	-0.3678*	0.2831*	1.0000
	0.0096	1.0000	0.0000	1.0000	0.0013	0.0000	0.0000	

Table A2 Breusch-Pagan/Cook-Weisberg test heteroscedasticity

Breusch-Pagan / Cook-Weisberg test for heteroscedasticity
Ho: Constant variance
Variables: fitted values of exp
chi2(1) = 16.77
Prob > chi2 = 0.0000

Table A3. The variance inflation factor of independent variables

Variable	VIF	1/VIF
gdp*	12.40	0.080644
pop*	10.98	0.091084
bord	2.29	0.437370
dis	2.14	0.467006
pop	1.96	0.509658
gdp	1.96	0.510793
lang	1.28	0.780487
Mean VIF	4.71	

Note: A vif > 10 or a 1/vif < 0.10 indicates trouble.

Table A4. Hausman test

	Coefficients		(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
	(b) fixed	(B) random		
gdp	-3.756649	-3.646479	-.1101695	.
gdp*	1.246826	.4144392	.832386	.6939323
pop	-27.01553	-26.66919	-.3463429	.9249085
pop*	-6.877642	.8711883	-7.74883	3.100887

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(4) = (b-B)’[(V_b-V_B)^(-1)](b-B) = 6.33

Prob>chi2 = 0.1761

(V_b-V_B is not positive definite)

TRANSITION FROM CONVENTIONAL TO AGROECOLOGICAL SYSTEMS, CASE STUDY OF BOSNIA AND HERZEGOVINA

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ABSTRACT

The main objective of the research is to analyze the possibility of introducing the agro-ecological concept through appropriate agro-ecological measures in agricultural policy of Bosnia and Hercegovina. For this purpose, theoretical and empirical studies have been conducted. Theoretical research included analysis of the strategic and regulatory framework in the European Union and Bosnia and Hercegovina and analysis of the development of the concept of agro ecology. Empirical research has included surveying holders of agricultural holdings of subjects according to the Eco Stack project methodology. The survey results confirm that farmers are generally not familiar with the concept of agro ecology, but do apply some of the agro-environmental measures. On the basis of the research results, steps have been proposed to introduce a new model of support for the application of the agro-environmental concept and measures in the framework of agricultural policy of Bosnia and Hercegovina.

Introduction

Agro ecology as a practice has developed gradually in recent decades, but it has only recently been promoted through various movements, organizations and institutions, farmers' groups and schools. Agro ecology is not yet clearly part of EU legislation (although it is part of a funding scheme under the existing CAP), but it is recognized as a

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way to improve the environmental characteristics of production. On the other hand, the conservation of biodiversity, including agrobiodiversity, has been a goal of European policy for decades. Measures to support rural development include measures of agro-environmental practices that reduce food losses and waste, soil protection, conservation of water systems, prevention of deforestation and maintenance of biodiversity and ecosystem health.

According to the definition of the United Nations Food and Agriculture Organization (FAO, 2018), agro ecology is an integrated approach that simultaneously applies environmental and social concepts and principles in the design and management of food and agricultural systems. This approach seeks to optimize the interactions between plants, animals, humans and the environment, taking into account the social aspects that must be addressed for a sustainable and equitable food system. Agro ecology is also part of FAO's shared vision of achieving a sustainable food and agriculture system. Until the late 1990s, agro ecology was defined as the ecology of the overall food chain (Francis et al., 2003). The agroecosystem is not only observed at the farm level, but includes all aspects and participants in the food system.

To change the overall food system, it was necessary to provide both political and economic focus (IPES-Food, 2016). This has led to the further development of the definition of agro ecology which can be summarized as follows: "Agro ecology is the integration of research, education, action and change that brings sustainability to all parts of the food system (environmental, economic and social aspects). It is transdisciplinary in value all forms of knowledge and experience in a modified food system. It is participatory in that it requires the participation of all stakeholders - from the farm to the table and all others in between. It is action-oriented as it confronts the economic and political structures of the current industrial food system with alternative social structures and political actions. The approach is based on environmental thinking and a holistic understanding of the sustainability of the food system". This means that agro ecology is science, practice and social movement and all three elements together are needed to drive the transformation of the food system (Gliessman, 2018).

Agro-environmental measures in Europe were defined in the early 1980s. Initially, the measures were defined as a means of resolving conflicts between farmers and government institutions responsible for land conservation measures in important semi-natural areas such as lowland wetlands and mountain areas. The first program of agro-environmental measures under the auspices of the CAP was introduced in 1985 and is designed to protect the habitats and landscapes of agricultural land in environmentally sensitive areas that are threatened by intensification of agriculture. The evaluation of these measures carried out during the 1990s showed that they were justified because they led to significant benefits in the conservation of valuable semi-natural habitats, biodiversity, landscapes, water and land. Based on the results of the socio-economic evaluation, it was concluded that these measures may be a decisive factor that will determine farmers to stay in the agricultural business in situations where they are hesitant. By the end of the last century, these measures have become mandatory in all EU member states by farmers concluding agreements on a voluntary basis on the implementation of agro-environmental measures under the new EU Rural Development Policy. These measures are supported through the European Agricultural Fund for Rural Development (EAFRD), which has identified a wide range of measures for different environmental, social and economic needs in rural areas (Cooper et al., 2010).

The main goal of the research is to analyze the possibility of introducing the agro-ecological concept through appropriate agro-ecological measures in agricultural policy of Bosnia and Hercegovina, which should contribute to sustainable development of agriculture and rural areas through sustainable use of natural resources, ecosystem conservation, biodiversity conservation and resources to produce and access sufficient quantities of food.

Materials and methods

Theoretical and empirical research has been conducted to assess the possibility of introducing agro ecology as an agricultural system through appropriate agro-environmental measures in the agricultural policy of Bosnia and Hercegovina (BiH).

Theoretical research included analysis of documents at the UN - FAO level, review of selected scientific papers and analysis of strategic and regulatory framework in the EU and BiH. The analysis of relevant strategies and other documents (international and domestic) related to the introduction of the agro-environmental concept in the framework of agricultural policy, at the level of the EU and RS, provides an assessment of the compliance of these acts.

Empirical research has included surveying holders of agricultural holdings of subjects according to the Eco Stack project methodology[5]: survey of subjects, analysis of the possibility of introducing the concept of agro ecology and biometric and statistical data processing. Farmers of different ages, genders and levels of education were interviewed. The list of farmers was obtained from the RS Ministry of Agriculture, Forestry and Water Management (MAFWM) for the Eco Stack project. The households in which the survey was conducted were selected by random sampling within the Farm Household Register of the Republic of Srpska entity of Bosnia and Hercegovina. In total 250 households were sampled from 25 municipalities. The questionnaire included general questions about the farmer and the property and questions related to the application of any agro-environmental measures in practice. Based on the results of the survey, the level of application of agro-ecological measures in BiH agriculture was determined, as well as the level of knowledge of the concept of agro ecology, the importance of sustainable development, biodiversity conservation and introduction of ecosystem measures.

5 The paper is part of the research project “Stacking of ecosystem services: mechanisms and interactions for optimal crop protection, pollination enhancement, and productivity - EcoStack”. Horizon 2020 project, Grant Agreement No. 773554. https://www.ecostack-h2020.eu/

The analytical-synthetic method of studying the mentioned documents and the obtained data of the conducted survey assessed the possibilities for the introduction of a new model of support for the application of the agro-ecological concept and measures within the existing agricultural policy of Bosnia and Hercegovina.

Results and Discussions

Measures that encourage green farming and enforce environmental rules form a central part of the EU CAP[6]: cross-compliance (standards link financial support to EU rules on the environment, as well as human, plant and animal health); green direct payments put in place mandatory actions (maintaining permanent grassland, crop diversity and ecological focus areas) and rural development policy supports investments and farming activities that contribute to climate action and the sustainable management of natural resources. Out of 13 agro-environmental measures identified in EU strategic framework, 11 EU like measures are found in Bosnia and Hercegovina strategic documents (Table 1).

Table 1. Comparison on AEM and practices in EU and BiH as defined in legal documents

Focus areas and AEM measures in EU		**AEM like measures in BiH**
FA 4A: Restoration, conservation and enhancement of biological diversity; FA 4B: Improving water management; FA 4C: Prevent soil erosion and improve land management.	M01 - Knowledge transfer and information actions M02 - Advisory services M04 - Investments in physical assets M07 - Basic services and reconstruction of villages M08 - Investments in forest areas M10 - Agricultural-environmental-climate M11 - Organic agriculture M12 - Nature	-Improving fertility, quality and cultivation of agricultural land -Sustainable use and maintenance of pastures and natural meadows -Support for the production of organic products -Support for integrated agricultural production -Support for measures to protect biodiversity and sustainable use od genetic resources
FA 5A: Increasing the efficiency of water use in agriculture;	M01 - Knowledge transfer and information actions M02 - Advisory services M04 - Investments in physical assets M10 - Agro-environment-climate M16 - Cooperation	Improving water supply in rural areas

6 https://ec.europa.eu/info/food-farming-fisheries/sustainability/environmental-sustainability/cap-and-environment_en

Focus areas and AEM measures in EU		AEM like measures in BiH
FA 5B: Increasing energy efficiency in agriculture and food processing;	M01 - Knowledge transfer and information actions M02 - Advisory services M04 - Investments in physical assets M16 - Cooperation	
FA 5C: Facilitating the supply and use of renewable energy sources;	M01 - Knowledge transfer and information actions M02 - Advisory services M04 - Investments in physical assets M06 - Development of agriculture and business M07 - Basic services and reconstruction of villages M08 - Investments in forest areas M16 - Cooperation	Investment in renewable energy sources on agricultural holdings - solar and geothermal energy, energy from organic waste
FA 5D: Reduction of greenhouse gas and ammonia emissions from agriculture;	M01 - Knowledge transfer and information actions M02 - Advisory services M04 - Investments in physical assets M06 - Development of agriculture and business M10 - Agricultural-environmental-climate M11 - Organic agriculture M16 - Cooperation	
FA 5E: Promoting the protection and sequestration of carbon in agriculture and forestry	M01 - Transfer of knowledge and action M02 - Advisory services M04 - Investments in physical assets M08 - Investments in forest areas M10 - Agro-environment-climate M13 - Restricted areas M16 - Cooperation	Identification and special support to areas with natural constraints Research and protection of natural heritage

Source: own research

However, although many agro-environmental measures are envisaged in the strategic documents at various levels of competences[7], there are no such measures in relevant laws and bylaws, i.e. in the rulebook on financial incentives for agricultural and rural development. Most measures are only indirectly related to agro ecology. Conservation of biodiversity, protection and sustainable use of genetic resources, conservation of natural landscapes and agricultural systems of high natural value are not recognized as essential values of cultural and natural heritage. In the table below an comparative view is presented of agro environmental support measures in EU and BiH strategic framework.

The results of the survey are given in the following sections: general data on surveyed farmers, application of agro-environmental measures and analysis of applied agro ecological measures.

By analyzing the general data on surveyed farmers, it can be concluded that the average respondent is a male, 46.8 years old, with experience in managing property less than 10 years, he is the owner of the farm, the farm is less than 5 ha in size of agriculture area that is fully in use, it is registered as a commercial farm, it has 1-2 permanent employees or a family member, they practice mixed agricultural production, with corn as the main crop. The average respondent does not apply any standards in production, however, this general picture of the average producer indicates an extensive way of production that largely corresponds to the principles of environmental sustainability. This was confirmed by the answers from the second part of the research. In terms of farm size, this sample corresponds to the average of all farms registered in the Register of Agricultural Farms in the Republic of Srpska: there were 190,861 ha of registered agricultural land in the register, which is an average of 4.48 ha per farm (Strategic Plan for Agriculture and Rural Development, 2016 -2020). In terms of age, the sample also confirms the results of the Pilot Census of Agriculture, according to which the average age of members of mixed farms is 45.8 years (Šegrt, 2019). According to the same survey, 1.49 GRJ (annual work units) are engaged in agriculture on mixed farms, which also coincides with the results of this survey.

The analysis of the Application of agri-environmental measures found that 56% of respondents apply some of the agri-environmental measures. As reasons for the application of these measures, the producers themselves state the following:

7 According to the Dayton Peace Agreement, Bosnia and Herzegovina (BiH) is a decentralized state consisting of two Entities, Republic of Srpska (RS) and the Federation of Bosnia and Herzegovina (FBiH). In addition, District Brcko was established as a single administrative unit of local self-government and exists under the sovereignty of BiH.

mandatory measures in a certain production system (integrated production, organic production), production for their own use; "healthier" products, less pathogens (Table 2).

Table 2. Agro-environmental measures applied

Agro-environmental measures	**Reasons for applying the measure**
Hotels for wild bees	Better pollination than with honey, especially with pears
Organic compost; grass strips; mulch	Generally healthier products and biodiversity conservation
Nettle solution; garlic solution	Mandatory measures in organic production; Generally healthier products; Preservation of beneficial organisms
Nitrogen fixation with Alfilaria, bee flight control	Bees are important pollinators in our system and their conservation is crucial
Crop rotation.	Crop rotation reduces the total number of pathogens Better yield and fewer pests in general
Nettle spraying; red onions around crops to cut the path of land insects; tomato leaf as a semi-mulch against Phyllotret; crop rotation	Fewer pests and diseases in general
Crop rotation; spraying with nettle and garlic floral ribbons; grass strips; traps; local varieties	I believe in the ecosystem as a whole and try to have such behavior inside and outside the cultivated fields
Crop rotation; manure	Production for own use
Mulch grass;	Integral production in a perennial plantation

Source: own research

On the other hand, when it comes to pest control measures, the majority of respondents (56%) use chemical protection measures, citing economy and efficiency as the main reasons. Among other methods of pest control, respondents state the following: use of chemicals in specific conditions: organic preparations (8%), integrated production (4%), a combination of mechanical weed control and chemical pest control (4%), without chemicals except herbicides for maize (4%), mechanical weeding (28%), application of herbal preparations like nettle and garlic solution (8%). A significant number of farmers (24%) are aware that the measures still cause negative effects in the environment (fewer birds, bees, bumblebees), although they do not see the shortcomings of the applied measures in the production itself and consider them effective. Some are aware that these measures do damage to biodiversity, but they do not have enough knowledge or will to switch to sustainable production systems. Those who apply mechanical weed control measures, as the main drawback state that these measures are time and labour demanding.

By analysing individual agro-environmental measures (Table 3), it can be concluded that the mixture of varieties, wild species, crop rotation and sett-aside measure are the most commonly used.

Table 3. Application of individual agro-environmental measures

Measure	**Share of farmers who apply the measure**
Crop rotation	44%
Cover plants	4%
Intermediates (beans in corn)	16%
A mixture of varieties (Combinations of several varieties in orchards and field crops)	60%
Local varieties	40%
Direct sowing	4%
Biological control of harmful organisms	28%
Grass strips	32%
Floral ribbons	16%
Sett-aside of the land	44%
Wild species of animals and plants	56%

Source: own research

When analyzing the answers to the question about future plans, 40% of the surveyed farmers have a plan to introduce some agro-environmental measures and practices, 8% of which plan specifically to switch to agro-ecology as a way of production. Out of the 60% farmers who have stated that they do not plan to introduce these practices, 16% farmers are still considering introducing these measures. The reasons why they are not being introduced now are different:

- not enough information,
- if he had good advice, he would introduce it,
- significant measures that can only be introduced under the supervision of experts,
- has no plan now but is willing to introduce them.

Basically, most of the answers are positive towards the introduction of agro-environmental practices, but the main limiting factors are lack of information, insufficient knowledge, the need for professional support and an environment that is not ready to go in that direction.

The findings of other authors also confirm neglecting of agro environmental measures. In its analysis of the agricultural sector in Southeast Europe (Albania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia, Kosovo, Montenegro and Serbia), the OECD states in its 2018 publication: “the current structure of agricultural producer support across the region is market distorting, and thus unlikely to bring about long-term productivity gains. Regulations for agricultural inputs are largely in place, while those for encouraging efficient natural resource use and pollution prevention are being developed. Mrdalj et al. (2016) also conclude that: “The strategic objectives of rural development policy in the Republic of Srpska are largely aligned with the strategic framework at EU level, especially for Axis 1 and 3, while Axis 2 at the Republic of

Srpska level doesn't recognize any of the EU instruments for support of environment and countryside". Žurovec and others (Žurovec and others, 2015) state that: "current BH policy resembles the EU policy in the mid-80s, which will not directly promote productivity increases in BH's agriculture. Budgetary transfers related to direct support to producers and payments based on output form more than 40% of the total agricultural budget". Bajramović also confirm this statement stating that:" identified structure of direct payments in BiH and its entities and a considerable share of output based direct payments are not in favor of European integration and harmonization with the EU CAP " (Bajramović et al., 2016).

Conclusions

Based on the analysis of the possibility of introducing the agro ecological concept as a way of applying agro ecological measures in agriculture of Bosnia and Hercegovina, conducted through theoretical and empirical research, the following conclusions can be made:

1. The strategic documents for Agricultural and Rural Development for the period 2016-2021 identified a number of measures that correspond to agro-environmental measures at the EU level.
2. The regulatory framework for the implementation of strategic guidelines for agricultural and rural development provides an incentive for only a small number of measures that correspond to agro-environmental measures planned in the strategic framework.
3. Preservation of biodiversity, protection and sustainable use of genetic resources, preservation of natural landscapes and agricultural systems of high natural value are not recognized as essential values of cultural and natural heritage.
4. Surveyed farmers apply a number of agro-environmental measures, although they do not receive incentives for them.
5. Farmers are generally unfamiliar with the concept of agro ecology or schemes of agro-environmental measures, except for the concept of organic agriculture and partly with the concept of integrated agriculture.

Based on all the above, having in mind the preserved natural values of agricultural landscapes of BiH, the share of rural population, the existence of educational programs at agricultural faculties, a small number of support measures that can be classified as agro-environmental measures, the latest CAP proposal and clear calls for transition to agro ecology, the following steps can be proposed to introduce a new model to support the implementation of agro-environmental concepts and measures within the framework of BiH agricultural policy:

1. Establishment of an expert body for the development and application of agro ecology and agro-environmental measures in agriculture in BiH, which will include all actors: producers, consumers, local authorities, protected areas, food industry,

companies in the field of seed and planting material production; local initiatives, the so-called “seed keepers”; schools, kindergartens, scientific and professional institutions, relevant ministries, etc. This body, in cooperation with the authorities, would propose programs to strengthen public awareness, workshops, training, etc., with the aim of establishing a system of changing values on the importance of nature and natural resources as the basis of life.

2. Clear and concrete support for the transition of society to agro ecology, starting from 0) the starting point where there is no integration of agro ecology in agricultural practice on the farm, through several steps: 1) increasing the efficiency of external inputs on the farm; 2) replacement with alternative practices and inputs; 3) design of the overall agro-ecosystem; 4) re-establishing links between those who “grow” and those “who eat”, developing alternative food networks until the final transition to 5) a newly built food system that is sustainable and equal for all.

The first three steps take place at the level of the agroecosystem and the last two at the level of the overall food system; the first two steps are gradual, and the next three steps are really transformation and transition to another system.

Conflict of interests

The authors declare no conflict of interest.

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ANALYSIS OF SCIENTIFIC AND LEGAL TREATMENT OF PROTECTED NATURAL AREAS WITH REFERENCE TO THE MOST SIGNIFICANT ELEMENTS OF THE IMPACT OF TOURISM ON THE ENVIRONMENT

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A B S T R A C T

One of the main goals of the normative approach in the field of tourism development is a sustainable concept in tourism development. In this context, it is very interesting to look at the essence of the scientific and legal treatment of protected areas and the impact of tourism on the environment. The subject of analysis in the paper in the theoretical part was the relevant conceptual framework, and a brief elaboration of the scientific approach in the study of the characteristics and significance of tourism, natural values, protected natural assets, and protected areas in Serbia. In the research part of the paper, the subject of analysis was the legal treatment of protected areas, as well as the analysis of the impact of tourism on the environment, mostly determined by the network of primary and secondary impacts of tourism activities on elements and parameters of environmental quality. The purpose is to see the importance of protection and preservation of protected areas, and the pressures that the environment suffers due to tourism development, to emphasize the importance of timely understanding and assessment of the type and scope of impact of tourist activities on destination resources.

Introduction

Tourism is a very important economic branch, which has experienced a strong expansion in the last two decades and is continuously developing every year.

The development of tourism is conditioned by numerous factors, and the largest number of them is determined by the characteristics of a specific locality. In that sense, a significant foundation for the development of tourism is certainly the predispositions

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that a certain space has at its disposal, and which are mostly conditioned by the natural values of a given space. Therefore, over time, it has become quite certain that the development of tourist potential is, among other things, conditioned by many natural attractions, as well as the spatial diversity of natural potentials.

However, a significant feature of the expansive development of tourism is certainly the impact on the environment, which has its primary and secondary effects, so in this context, it is often pointed out that the development of tourism is associated with numerous opportunities for environmental pollution. The attitude of tourism towards the environment is conditioned not only by natural values and benefits that a locality has but also by the level of economic development of the country, cultural approach nurtured in the field of environmental protection, natural values, and natural assets, as well as adequate normative solutions (constitutional provisions, laws, and bylaws) in the field of management and protection of the environment and natural values of a particular area.

Therefore, what and how much impact tourism will have on the environment, natural values, protected natural assets, and within them, protected areas, largely depends on the attitude of the community expressed in clearly defined, sufficiently comprehensive, and following European standards, harmonized legal provisions.

According to Article 3, item 3 of the Law on Environmental Protection ("Official Gazette of Republic of Serbia", no. 135/2004, 36/2009, 36/2009 – other law, 72/2009 - other law, 43/2011 – decision of the CC, 14/2016, 76/2018, 95/2018 - other law and 95/2018 - other law), "natural values are natural resources that make up: air, water, land, forests, geological resources, flora, and fauna." The same article defines the concept of protected natural asset, in such a way that "a protected natural asset is a preserved part of nature of special values and characteristics (geodiversity, biodiversity, landscapes, landscapes, etc.), which has a lasting ecological, scientific, cultural, educational, health - recreational, tourist and other significance, due to which it enjoys special protection as good of general interest" (item 4). In Article 4, item 60 of the Law on Nature Protection ("Official Gazette of the Republic of Serbia", No. 36/2009, 88/2010, 91/2010 - corrigendum, 14/2016, 95/2018 - other law and 71/2021), "natural values are parts of nature that deserve special protection due to their sensitivity, endangerment or rarity, to preserve biological, geological and morphological and landscape diversity, natural processes and ecosystem services or for scientific, cultural, educational, health-recreational and other public interest."

Having this in mind, the paper will deal with the conceptual definition of relevant concepts, and a brief elaboration of the scientific approach in studying the characteristics and significance of tourism, natural values, protected natural assets, and protected areas in the Republic of Serbia. treatment of primarily protected areas, as the most important types of protected natural assets, as well as the impact of tourism on the environment, primarily determined by the network of primary and secondary impacts of tourism activities on the elements and parameters of environmental quality.

The paper is methodologically based on a theoretical analysis of relevant contemporary attitudes, in theory, normative analysis of applicable laws, and a qualitative assessment of particular conclusions, on the subject of research.

Literature review

The environment "represents everything that surrounds us, that is, everything with which human life and production activity is directly or indirectly connected" (Hamidović, 2012: 235; Trišić, 2020; Luković et al., 2021; Živković et al., 2019). Therefore, the human right to a healthy environment is one of the basic human rights, which is defined as such in Article 74 of the Constitution of the Republic of Serbia.

Preservation and protection of the environment are imperative in modern society. The environment is one of the pillars of sustainable development. In this context, "environmental principles belong to the group of basic principles on which sustainable development, in general, is based, especially sustainable development of rural parts of a certain territory and imply above all respect for the natural diversity of the destination" (Cvijanović, Matijašević Obradović, Škorić 2017: 871). According to Jovašević (2009: 26), "finding the optimal relationship between unhindered economic growth and development and the preservation and protection of the environment is not an easy task."

Sources of pollution of the environment and its elements, according to some theoretical views, can be natural and artificial (anthropogenic). Natural sources are "all processes that take place in the biosphere against the will of man (volcanoes, earthquakes, cosmic dust). Artificial (anthropogenic) are the products of all human activities (extraction and processing of mineral raw materials, thermal and nuclear power plants, agriculture, industry, traffic, tourism, etc.)" (Đorđević, 2018: 466). Indicators of endangering the environment "give us the right to determine that the social causes of endangerment are more prevalent than natural ones and that the organization of the system of its protection and improvement depends on understanding the causes of endangerment" (Keković, Todorović, 2008: 24).

This indicates a significant interactive relationship between tourism and the environment. What is particularly noteworthy in this area are the different environmental impacts of tourism. It is clear that the planned and realized tourist potential in a certain area, with a well-done analysis of the impact on the environment, does not manifest harmful effects (or at least not to a greater extent) on natural values, protected natural assets, and areas. Before analyzing the primary and secondary impacts of tourism on the environment, several important conceptual determinants and characteristics of tourism as an economic branch will be determined here.

The basic position during the conceptual definition of tourism is that this economic branch is essentially a voluntary migration of tourist services users, where their motives, needs, and aspirations determine the type or form of tourism. Thus, "tourism is considered all the activities of tourists when visiting certain locations, regardless of their duration" (Camilleri, 2018: 4). According to Article 3, item 42 of the Law on Tourism

("Official Gazette of the Republic of Serbia", no 17/2019), a tourist trip is defined as "a combination of two or more tourist services (transport, accommodation, and other tourist services), established or prepared by the travel organizer independently or at the request of the passenger, for more than 24 hours or a shorter period if it includes one night, as well as one or more nights that include only the accommodation service for a certain period or time sold at a single price."

According to Cvijanović and associates, "a planned approach to the development of tourism is the backbone for its successful development" (Cvijanović, Vuković, Kljajić, 2011: 11.). Also, the field of tourism development necessarily includes the concept of sustainable development as a "modern development concept" (Matijašević Obradović, Škorić, 2017: 283), which "harmonizes the social, economic and environmental interests of present and future generations" (Ristić, 2013: 229), and the continuous development of modern forms of tourism can lead to a "new relationship between the environment, work, and leisure, in terms of sustainability of all, especially rural areas" (Fagioli, Diotallevi, Ciani, 2014: 166).

Tourism as an economic branch has proven to be especially important in the field of rural development. Namely, "on the one hand, tourism has a great impact on the development of rural areas, and on the other hand, the importance of tourism is reflected in the creation of markets for agricultural products, given that they are important inputs for hotels and restaurants" (Ciric, Pocuca, Raicevic, 2014: 26). In addition to the fact that the sustainable development of rural tourism must be economically justified, it must also contribute to the preservation of natural, social, and cultural characteristics of the tourist destination (Počuča, Matijašević Obradović, Drašković, 2017: 1252).

Sustainable development as a concept in the planning and implementation of tourism activities, with mandatory environmental impact analysis, greatly contributes to the preservation of natural values and protected natural assets, which include protected areas, protected species, and movable protected natural documents).

Natural resources are "elements of natural wealth, which differ from social wealth, such as buildings, equipment, and supplies of materials and goods, which are the result of combining natural goods with human labor and capital" (Milenković, 2000: 57).

The term natural resource should be understood as "those natural goods that a human being, at a given level of technological and economic organization, can transform within products or services and therefore put into economic function. Thus, for example, oil, certain minerals, and certain ore resources from the beginning of the last century were completely unusable goods - natural capital. Thus, they did not have the hallmark of economic resources. Only with fundamental, and then applied research and discoveries, oil becomes an economically usable fossil fuel, and therefore an economic category: energy, raw materials, goods, wealth, a resource important for development" (Avramović, 2014: 31).

According to the official data of the Institute for Nature Protection of Serbia, "the nature of Serbia is characterized by a high diversity of flora and fauna and represents a significant part of the wealth and diversity of European natural heritage. Its most representative, most preserved parts are placed under legal protection" (Institute for Nature Conservation of Serbia, Nature protection in Serbia, 2021).

The International Union for Conservation of Nature (IUCN) has defined the basic categories of natural resources presented in the following table.

Table 1. Protected natural assets according to the International Union for Conservation of Nature categorization

Category	Title	Purpose of protection
I (Ia i Ib)	Strict nature reserve / wilderness area	The protected area is managed only for scientific purposes or for wildlife protection
II	National park	The protected area is managed mainly for the protection of ecosystems and recreation
III	Natural monument	The protected area is managed mainly for the protection of special natural values
IV	Habitat / Species Management Area	The protected area is managed through management interventions
V	Protected land / sea landscape	The protected area is managed mainly to protect the landscape
VI	Resource management area	The protected area is managed mainly for the sustainable use of natural ecosystems

Source: Avramović, 2014: 46.

According to Article 27 of the Law on Nature Protection ("Official Gazette of the Republic of Serbia", No. 36/2009, 88/2010, 91/2010 - corrigendum, 14/2016, 95/2018 - other law and 71/2021), we distinguish the following categories of protected natural assets: protected areas (strict nature reserve, special nature reserve, national park, natural monument, protected habitat, landscape of exceptional features, nature park); protected species (strictly protected wild species, protected wild species); movable protected natural documents.

Materials and methods

The subject of the analysis is the analysis of the legal treatment of primarily protected areas, as the most significant types of protected natural assets, as well as the analysis of the impact of tourism on the environment, primarily determined by the network of primary and secondary impacts of tourism activities on environmental quality elements and parameters. The paper is methodologically based on a theoretical analysis of relevant contemporary attitudes in theory, normative analysis of applicable laws, and a qualitative assessment of conclusions, on the subject of research.

The research is based on current laws and bylaws and official data of the Institute for Nature Protection of Serbia.

The legal provisions that will be consulted below are covered by the Law on Nature Protection ("Official Gazette of the Republic of Serbia," no. 36/2009, 88/2010, 91/2010

- corr., 14/2016, 95/2018 - other law and 71/2021), and bylaws by the Rulebook on evaluation criteria and the procedure of categorization of protected areas (“Official Gazette of the Republic of Serbia”, no. 97/2015).

Research results and discussion

According to Article 28 of the Law on Nature Protection, protected areas are those areas “that have a pronounced geological, biological, ecosystem and/or landscape diversity and that are important as habitats for bird species and other migratory species significant under international regulations may be declared protected areas of general interest. Protected areas can be connected cross-border with protected areas of neighboring countries. The management plan and protection measures of the protected area, which is cross-border connected with the protected area of the neighboring state, shall be determined by agreement with the competent authorities of that state, and with the consent of the Ministry.”

According to the official data of the Institute for Nature Protection of Serbia, “based on the applied measures of institutional nature protection for seven decades, the area of protected areas in Serbia currently amounts to 678,237 ha or 7.66% of the territory of Serbia. There are 471 protected areas under protection: 5 national parks, 18 nature parks, 21 landscapes of exceptional features, 70 nature reserves, 6 protected habitats, 315 natural monuments, 36 areas of cultural and historical significance protected under the previous Law on Environmental Protection and the Law on the Protection of Cultural Monuments, as well as 1784 strictly protected wild species and 860 protected wild species of plants, animals, and fungi” (Institute for Nature Conservation of Serbia, Nature protection in Serbia, 2021).

To protect its biodiversity resources, the Government of Serbia has “established the System of Protected Areas of Serbia, whose long-term goal is to establish a scientifically based and representative regional network of well-managed protected areas that are financed sustainably, as well as to ensure effective participation of local communities and achieve social and economic benefits” (Flores, Obradovic, 2015: 9).

Protected areas are areas “that have a pronounced geological, biological, ecosystem, and/or landscape diversity and are therefore declared protected areas of general interest by the act of protection. In addition to the stated values, the habitats of bird species and other migratory species important by international regulations have been defined, which can be declared protected areas of general interest” (Institute for Nature Conservation of Serbia. Protected areas, 2021). Evaluation, i.e., determination of the value and significance of the protected area, according to the Rulebook on evaluation criteria and procedure of categorization of protected areas “is performed concerning the expression of main natural features, phenomena, and processes of interest for the protection of the area, as well as functions and purposes. Accordingly, protected areas are classified into 3 categories: of exceptional (international, national - I category), of large (regional - II category) and of local importance - III category.”

Category I, according to Article 6 of the Rulebook, includes an area that is declared: a strict nature reserve, natural monument or habitat, if it meets at least three of the mentioned criteria; special nature reserve, nature park, or landscape of exceptional features, if it meets at least four mentioned criteria; national park if it meets all seven criteria. Category II, according to Article 7 of the Rulebook, includes an area that does not meet the criteria and conditions of Article 6 and is declared: a strict nature reserve, natural monument or habitat, if it meets at least two criteria; special nature reserve, nature park or landscape of exceptional features, if it meets at least three criteria. According to Article 8 of the Rulebook, a protected area is classified in III category - local significance, if it meets the conditions for declaring protection under the law, has values of interest to the municipality or city, and does not meet the criteria from the previous two categories.

According to the provisions of the Law on Nature Protection, protected areas are classified into seven types: strict nature reserve, special nature reserve, national park, natural monument, protected habitat, the landscape of exceptional features, and nature park. An overview and normative determination of each category of protected areas are given in the following table.

Table 2. Review and normative regulation of protected areas according to the Law on Nature Protection in the Republic of Serbia

Protected area	Article of the law	Legislative provisions
Strict and special nature reserve	Article 29	The strict nature reserve is an area of unaltered natural features with representative natural ecosystems, intended exclusively for the preservation of native nature, gene pool, ecological balance, monitoring of natural phenomena and processes, scientific research that does not disturb natural features, values, phenomena, and processes. A special nature reserve is an area with unaltered or slightly altered nature, of special importance due to its uniqueness, rarity, or representativeness, and which includes the habitat of endangered wild species of plants, animals, and fungi, without settlements or with rare settlements in which man lives in harmony with nature, preservation of existing natural features, genetic fund, ecological balance, monitoring of natural phenomena and processes, scientific research and education, controlled visits and preservation of a traditional way of life.
National park	Article 30	The National Park is an area with a large number of diverse natural ecosystems of national importance, prominent landscape features, and cultural heritage in which man lives in harmony with nature, intended to preserve existing natural values and resources, overall landscape, geological and biological diversity, and meet scientific, educational, spiritual, aesthetic, cultural, tourist, health and recreational needs and other activities following the principles of nature protection and sustainable development.

Protected area	Article of the law	Legislative provisions
Natural monument	Article 31	A natural monument is a small unaltered or partially altered natural spatial whole, object or phenomenon, physically clearly expressed, recognizable and/or unique, representative geomorphological, geological, hydrographic, botanical, and/or other features, as well as botanical value formed by human work than scientific, of aesthetic, cultural or educational significance.
Protected habitat	Article 32	A protected habitat is an area that includes one or more types of natural habitats important for the conservation of one or more populations of wild species and their communities.
Landscape of exceptional features	Article 33	The landscape of exceptional features is an area of recognizable appearance with significant natural, biological-ecological, aesthetic, and cultural-historical values, which has developed over time as a result of the interaction of nature, natural potentials of the area, and traditional way of life of the local population.
Nature park	Article 34	Nature Park is an area of well-preserved natural values with mostly preserved natural ecosystems and picturesque landscapes, intended to preserve the overall geological, biological, and landscape diversity, as well as to meet scientific, educational, spiritual, aesthetic, cultural, tourist, health, and recreational needs and other activities. with a traditional way of life and the principles of sustainable development.

Source: Nature Protection Law, *Official Gazette of Republic of Serbia,* no. 36/2009, 88/2010, 91/2010 - corr., 14/2016, 95/2018 - other law and 71/2021

As can be seen from the attached table, the Law on Nature Protection in its six articles regulates each protected area, by defining the legal definition of the area, categorizing and classifying individual areas, determining measures and activities that cannot be taken in each specific area determined the manner of determining protection measures and stated the conditions of the visit to certain areas.

Thus, for example, according to Article 29 of the Law on Nature Protection, “a special nature reserve can be floristic, mycological, forest and other vegetation, zoological (ornithological, ichthyological, and others), geological, paleontological, hydrogeological, hydrological, and others. In a strict and special nature reserve, it is forbidden to perform actions and activities and perform activities that may impair the properties due to which they have been declared a protected natural asset (picking and destroying plants, disturbing, capturing and killing animals, introducing new biological species, etc.). Visiting a strict and special nature reserve for education can be done based on a permit issued by the manager of the protected area. The measures for the protection of the strict and special nature reserve are determined in more detail by the act on the proclamation of the protected area.”

According to Article 30, “actions and activities that do not endanger the originality of nature are allowed in the national park, as well as performing activities that are in the function of education, health-recreational and tourist needs, a continuation of the traditional way of life of local communities, and in the way that does not endanger the survival of species, natural ecosystems, and landscapes, following this law and the management plan issued by the manager. These activities may be limited to preserving the originality of the nature of the national park. The measures for the protection of the national park and the manner of its use are determined in more detail by a special law."

According to Article 31, "a natural monument may be geological, geomorphological, speleological, hydrological, botanical, and other. All actions and activities that endanger its features and values are prohibited on the natural monument. Measures for the protection of natural monuments and the manner of its use shall be determined in more detail by the act on the proclamation of a protected area."

According to Article 32, "the goal of habitat protection is the protection of endangered and rare habitat types, ecosystems and/or indigenous wild species at the national and/or international level; ensuring the favorable condition of populations of indigenous wild species and/or species; enabling the uninterrupted development of some of the life phases of autochthonous wild species; protection of extremely endangered and vulnerable species; enabling gene flow between populations of the species; providing migratory routes and rest areas; enabling scientific research, population management, and education. Actions and activities that endanger or damage one or more habitat types are prohibited in a protected habitat. The act on the proclamation of a protected habitat determines in more detail its significance, purpose, and protection measures."

According to Article 33, "a landscape of outstanding features may be a natural landscape of outstanding features and a cultural landscape of outstanding features. The natural landscape of exceptional features is an area of significant biological-ecological and aesthetic value, where the traditional way of life of the local population has not significantly disturbed nature and natural ecosystems. The cultural landscape of exceptional features is an area of significant landscape, aesthetic and cultural-historical value that has developed over time as a result of the interaction of nature, natural potentials of the area, and the traditional way of life of the local population. In the area of exceptional features, actions and activities that violate the primary natural and created values and the character of the landscape is prohibited. Protection measures, the manner of performing economic and traditional activities and the use of natural and created values in the area of exceptional features, are determined in more detail by the act on the proclamation of a protected area."

According to Article 34, "economic and other activities and activities that endanger its essential features and values are not allowed in the nature park. Protection measures, the manner of performing economic activities and the use of natural values in the nature park are determined in more detail by the act on the proclamation of a protected area."

Given the interactive relationship and impact of tourism on the environment, especially on protected natural assets and protected areas, and precisely because of the "potential danger that a poorly planned or implemented tourism program may have on the environment, it is necessary to develop precautions and remediation of harmful consequences" (Stojanović, 2011: 79). Because "each of the impacts on the environment entails secondary reactions, which in most cases are presented as measures for remediation and preventive protection of the environment" (Stojanović, 2011: 79). Therefore, any tourism activity should involve and include an environmental impact analysis.

In accordance with the above, the following table presents the analysis of the network of the primary and secondary impacts of tourism on the environment.

Table 3. Tourism and the network of primary and secondary impact on the environment

Activities	Pressure	Primary impact	Secondary influence - reaction
1.a Construction of necessary facilities: • Urban expansion • Traffic network • Tourist services • Marinas, ski lifts 1.b Change in land use: • Expansion of areas intended for recreation	Changes in the local environment: • Expansion of constructed facilities • Exclusion of areas from the primary purpose	1. Habitat changes 2. Changes in the population of certain species 3. Changes in people's health and satisfaction 4. Changes in visual quality	Individual: Influence on aesthetic values. Collective measures: • Expenditure on environmental improvement • Expenditure for the organization of protection • Planning for the protection of wildlife and national parks • Control of recreation area planning
2. Pollutant emissions: • Urbanization • Traffic	Pollutant deposition: • Emission • Wastewater spillage • Accumulation of solid waste • Noise (traffic, airports)	1. Changes in the quality of the environment: Water Air Land 2. Health and condition of plant and animal species 3. Human health	Individual - defensive measures: Local population, measuring air quality, waste recycling, protests and attitudes towards tourists, changes in attitudes towards the environment, decrease in tourism revenues Collective-defensive measures: Measures to eliminate pollution originating from tourism, cleaning rivers and beaches
3. Tourist activities: • Skiing • A walk • Hunting • Cycling • Collection of natural fruits	Destruction of vegetation and land by stepping or in some other way	1. Habitat changes 2. Changes in the population of plant species	Collective-defensive measures: Elimination of influence through protection management Establishment of national parks and protection of certain species Control in access to recreational areas
4. Population dynamics: • Population growth	Density	1. Overload 2. The need for natural resources: • Earth and water • Energy	Individual: Attitude towards this type of pollution Collective: Service support

Source: Stojanović, 2011: 80.

The analysis of the network of the primary and secondary impacts of tourism on the environment highlights the activities undertaken and the pressures that the environment suffers due to tourism development and expansion of tourism. Also, it especially emphasizes the primary influence and reaction (secondary influence) of the social community to the essence of the interactive relationship between tourism and the environment. The essence of this way of thinking is in the "timely understanding and assessment of the type and scope of the impact of tourist activities on the resources of the destination. The unwillingness of the population and their community to face the problem of negative impact as soon as possible will cause bigger, deeper and more serious problems, which leads to degradation with the scale of the catastrophe" (Stojanović, 2011: 80).

Conclusions

One of the basic goals of the normative approach in the field of tourism development is a sustainable concept in tourism development, as well as planned sharing in this domain. Tourism is an economic branch that is in a highly interactive relationship with both natural and social values. Namely, on the one hand, users of tourist services are increasingly insisting on the inclusion of "untouched" natural values in the tourist offer, while on the other hand, tourism is often a factor in disrupting and degrading the elements of the environment. In that sense, a sustainable, i.e., "responsible" concept in the development of tourism is an approach that enables a responsible attitude of tourism towards the natural environment, which is at the same time one of the most important levers in the further development of tourism itself.

The subject of analysis in the paper in the theoretical part was the relevant conceptual framework, and a brief elaboration of the scientific approach in studying the characteristics and significance of tourism, natural values, protected natural assets, and protected areas in the Republic of Serbia. In the research part of the paper, the subject of analysis was the legal treatment of primarily protected areas, as the most important types of protected natural assets, as well as the analysis of the impact of tourism on the environment, primarily determined by the network of primary and secondary impacts of environmental activities. The paper is methodologically based on a theoretical analysis of relevant contemporary attitudes, normative analysis of applicable laws, as well as a qualitative assessment of conclusions, about research.

In conclusion, it can be pointed out that the Law on Nature Protection in its six articles regulates each protected area, by defining the legal definition of the area, categorizing and classifying individual areas, determining measures and activities that cannot be undertaken in each specific area, determining the method of determining protection measure and stated the conditions of the visit to certain areas.

The analysis of the network of the primary and secondary impact of tourism on the environment highlights the activities and pressures that the environment suffers due to tourism development and expansion of tourism, to emphasize the importance of timely understanding and assessing the type and scope of impact of tourism activities on destination resources.

Conflict of interests

The authors declare no conflict of interest.

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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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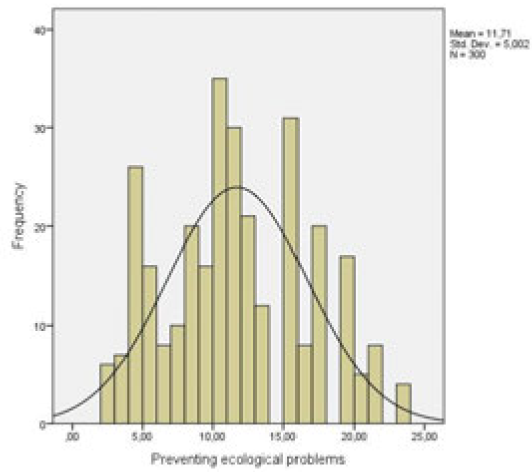

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