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VILLAGE AND AGRICULTURE

30. SEPTEMBER AND 1.OCTOBER 2022.
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PREFACE

“Village and agriculture“ proceedings include selected scientific articles that were entirely presented at the International scientific conference „Village and agriculture“ held from September 30 until October 1 2022 at the Faculty of Agriculture of Bijeljina University.

Papers of the authors from the Republic of Srpska, Bosnia and Herzegovina, neighbouring countries as well as closer and wider surroundings that Faculty of agriculture has achieved scientific, professional and technical cooperation are presented in the proceedings.

Through two sections and an introductory panel lecture, the proceedings address a wide scientific and professional audience and are actually aimed at all segments of agricultural production, agricultural economics and rural development as life in the countryside today.

The publisher and editors are not responsible for the content of the published articles and the opinions expressed in them, because they represent the point of view of the paper's author. The editorial office owes a special thank to the organizing committee of the conference, as well as to all participants from the country and abroad.

A number of scientific and teaching institutions from the country and abroad participated in the coorganization of the conference, and its realization was carried out in cooperation with the project VIRAL - Vitalization of the importance of information and communication technology in agricultural education, reference number 609755-EPP-1-2019-1-BAEPPKA2-CBHE-JP.

In Bijeljina,

November, 2022

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Prof. dr Boro Krstić

Doc. dr Miroslav Nedeljković

Prof. dr Milivoje Ćosić

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PLENARY SESSION

SESSION: AGRICULTURE AND FOOD INDUSTRY

SESSION: AGRICULTURAL ECONOMICS AND RURAL DEVELOPMENT

THE IMPACT OF THE ANIMAL PRODUCTION SECTOR ON THE ENVIRONMENT

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Abstract

Changes in climate will significantly affect agricultural production and especially plant and animal production worldwide. Climate change threatens global food supply as certain crops become more expensive due to reduced production and supply. The global human population is projected to increase to over 9 billion people by the year 2050. Forecasted population growth will result in an increase in demands for food by about 50–60% approximated to the current demands. This study aimed to show the models and the possibilities of improving productivity while reducing emissions. Precision animal farming by using various sensors and big data management contributes improvement of the system in terms of animal health, productivity, and welfare. It will make it possible for farmers to optimize the management of the farm and consequently realize an efficient and sustainable production system from the economic and environmental point of view.

Key words: Animal production sector, environmental impact, GHG emission, climate change, resources

Introduction

In the world of growing human population, there is a significant rise in food demands, especially for animal base food. On the other hand, the resources necessary for the production of the increased amount of food are getting smaller. Of course, there is a question of the impact of the increased animal production on the environment. There are lots of studies that deal with the impact of animal production on the global environment, from various points: climate change (FAO, 2006), nitrogen cycles (Galloway et al., 2009), and usage of Phyto mass (Wirsenius, 2003). It could be debated how significant is the environmental impact of animal production, but it cannot be debated whether should we produce food. Also, there is a huge mitigation potential in the animal production sector.

First, we should define the characteristics of the world that we should produce in. Accordingly, to the EPRS (2016), agricultural production worldwide in the future period will encounter a number of major challenges as follows: rapid population growth, climate change, increasing demand for energy, resource shortages, accelerated urbanization, dietary changes, ageing populations in rural areas in developed countries, increased competition in world markets, as well as lack of access to credit in developing countries.

Human population growth

Accordingly, to some forecasts (US Census Bureau, 2016), the global human population is projected to increase to over 9 billion people by the year 2050 (Figure 1). Forecasted population growth will result in an increase in demands for food by about 50–60% approximated to the current demands (FAO, 2011).

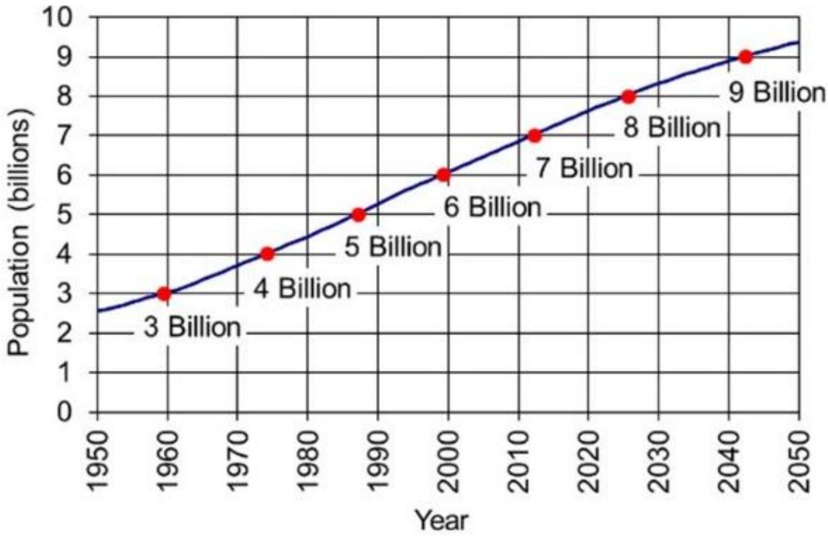


Figure 1. Forecasted increase of human population (US Census Bureau, 2016)

Since the global population will become wealthier, the expected significant increase in demands for animal products (meat, milk and eggs, Figure 2) implies the necessity for a substantial increase in the number of domestic land animals as well as in productivity per animal.

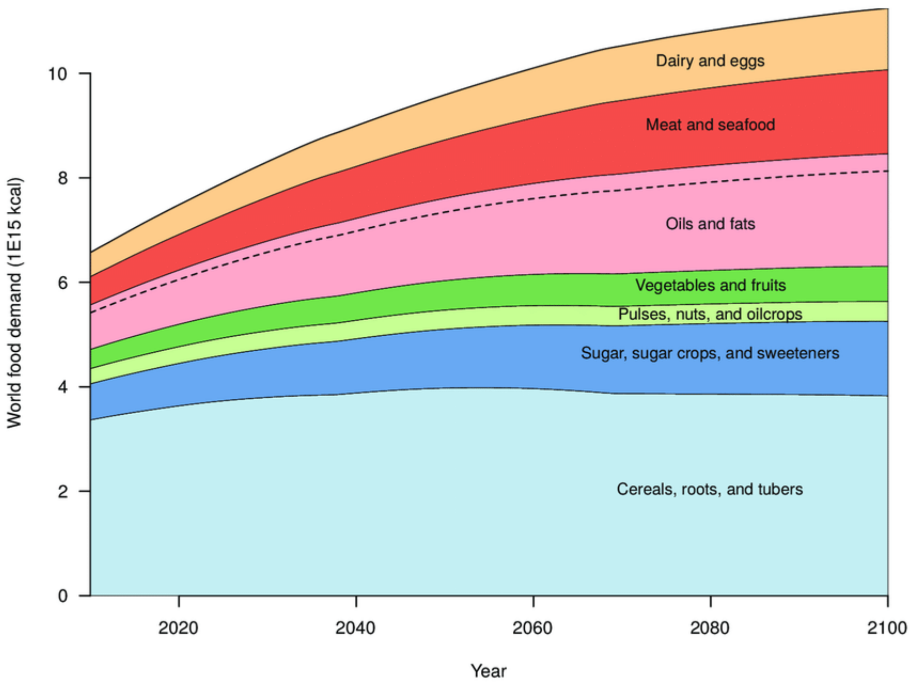


Figure 2. Projection of food demand from year 2010 to year 2100 (Gouel and Guimbard, 2018)

Regardless of the fact whether the human population will really grow so rapidly or if we are expecting some other scenario (as a consequence of the reduction of the birth rate in developed countries and the significant decline in the number of births in China), we must ensure sustainable food production.

Climate change

Another undisputable challenge for total agricultural and especially animal production is climate change. In the last decades, we have noticed increasingly enunciated changes in climate worldwide. These changes are altering the environmental conditions in different areas resulting in deterioration of conditions for living and agricultural production. Climatic extremes have demonstrated the sensitivity of agriculture to climate change. Climate changes shift climate variables: temperature, precipitation, humidity, evaporation, sunlight, wind speed, etc. Climatic change has created challenges for the agricultural sector, adding to pressures on global agricultural and food systems. Climate change threatens global food supply as certain crops become more expensive due to reduced production and supply. Many crops have negative impacts, including lower yields from extreme weather, droughts, floods, higher temperatures and season shifts that climate change brings (Popovic et al., 2015, 2020), which is reflected in the reduction of food in the world.

Accordingly, to the European Commission (2016) in Europe, it could be expected following: changes in rainfall that tend to cause serious problems in many regions, rising temperatures, and an increase in the frequency of extreme events like heatwaves, droughts, storms and floods (Figure 3).

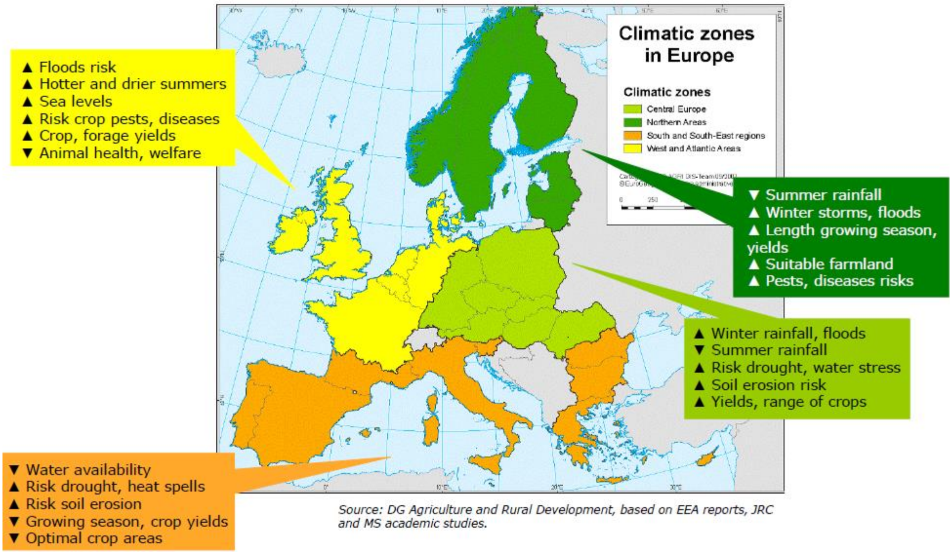
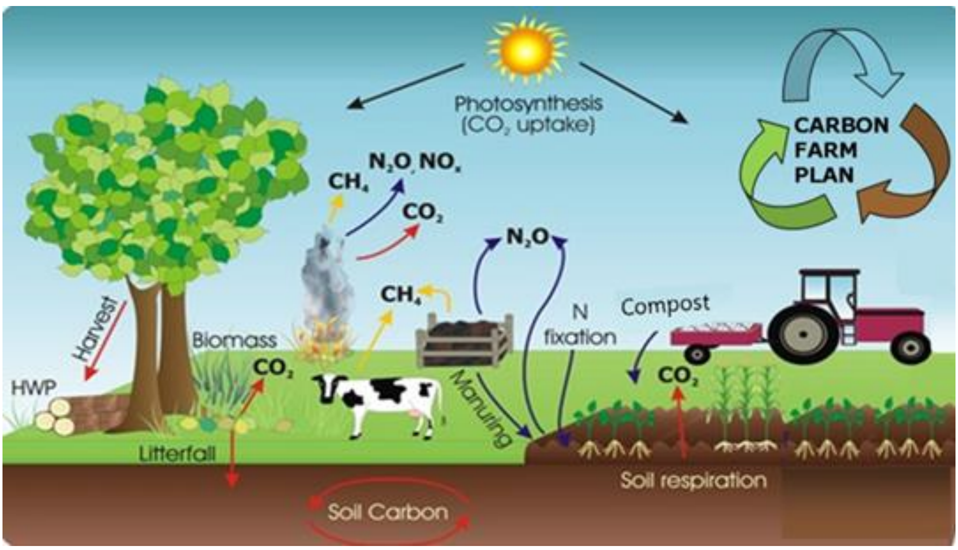


Figure 3. Forecasted changes in climatic conditions in EU (EC, 2016)

Furthermore, the studies of IPCC (2007) emphasized that the changes in climate will significantly affect agricultural production and especially animal production worldwide. Accordingly, to some opinions, agricultural production plays a significant part in global environmental problems, such as climate change, degradation of land, pollution of water and loss of biodiversity.



Picture 1. Relationship between the agriculture and environment

Consequently, necessary increases in food production especially animal-based food must be realized in the terms of the increasing insufficiency of natural resources (agricultural land, water and nutrients) and the crucial reduction of waste and greenhouse gasses (GHG) emissions.

The animal production sector, within agriculture, significantly affects the environment. In the terms of the increase in animal-based food demands, the intensification (increase in the number of animals and increase in productivity per animal) of the sector becomes necessary. Therefore, the sector becomes increasingly demand-driven, and fast-growing ultimately resulting in greater environmental impact.

The emission of GHG from the animal production sector

Accordingly, to IPCC (2007), total GHG emissions from animal production supply chains (meaning production of feed, animal production on farms, and post-processing) are evaluated at 7.1 giga tones of CO_2-eq/year (the year 2005), representing 14.5% of all anthropogenic emissions (49 giga tones CO_2-eq for the year 2004, Figure 4). Furthermore, it is estimated (IPCC, 2007) that the animal production supply chains produce 2 giga tones CO_2-eq of CO_2/year (5% of anthropogenic CO_2 emissions), 3.1 giga tones CO_2-eq of CH_4/year (44% of anthropogenic CH_4 emissions), 2 giga tones CO2-eq of N_2O/year (53% of anthropogenic N_2O emissions) while emissions of hydrofluorocarbons (HFCs) are negligible on a global scale. The majority of the sector's emission comes in the form of CH_4 (44% of the sector's emission) while the remaining part represents the emissions of N_2O (29%) and CO_2 (27%).

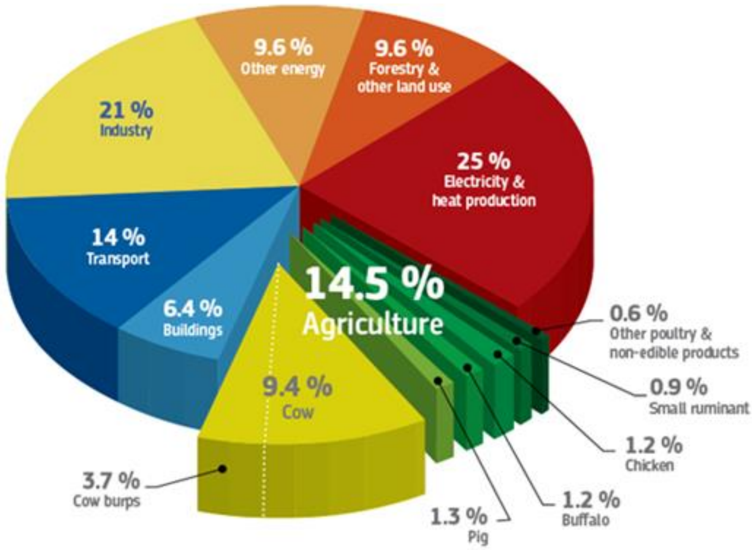


Figure 4. The greenhouse gasses emission regarding the economic sector

Furthermore, the intensity of contribution to GHG emission highly depends on animal species. Cattle are the major contributor to the sector's emissions since they produce about 4.6 giga tones CO_2-eq (65% of sector emissions), while pigs, poultry, buffaloes and small ruminants contribute from 7 – 10% of the sector's emissions (FAO, 2013a; Figure 1).

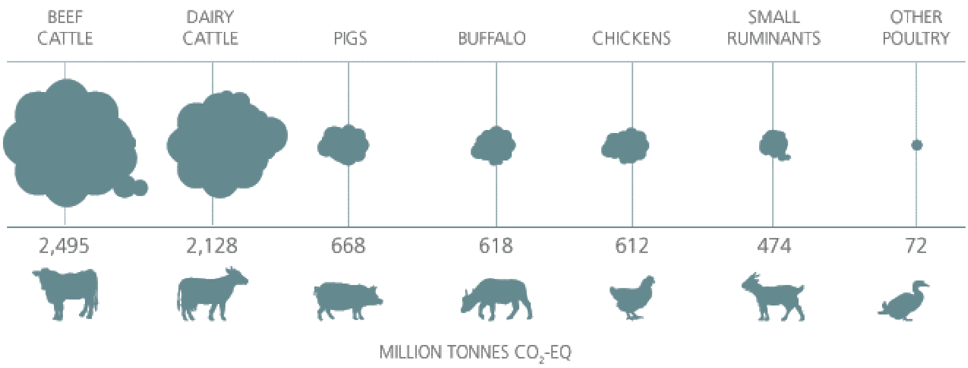


Figure 5. The emission of GHG regarding the animal species (FAO, 2016)

Also, the emission of GHG also depends on the commodity (Figure 6, FAO, 2013a). The main sector's contributor is beef which contributes 2.9 giga tones of CO_2-eq, or 41% of the total sector's emission. Beef is followed by cattle milk with the contribution of 1.4 giga tones of CO_2-eq (or 20%, of total sector emissions). Lower emission has production of pig meat (0.7 giga tones of CO_2-eq, or 9% of emissions), buffalo milk and meat (8%), chicken meat and eggs (8%), as well as small ruminant milk and meat (6%) products).

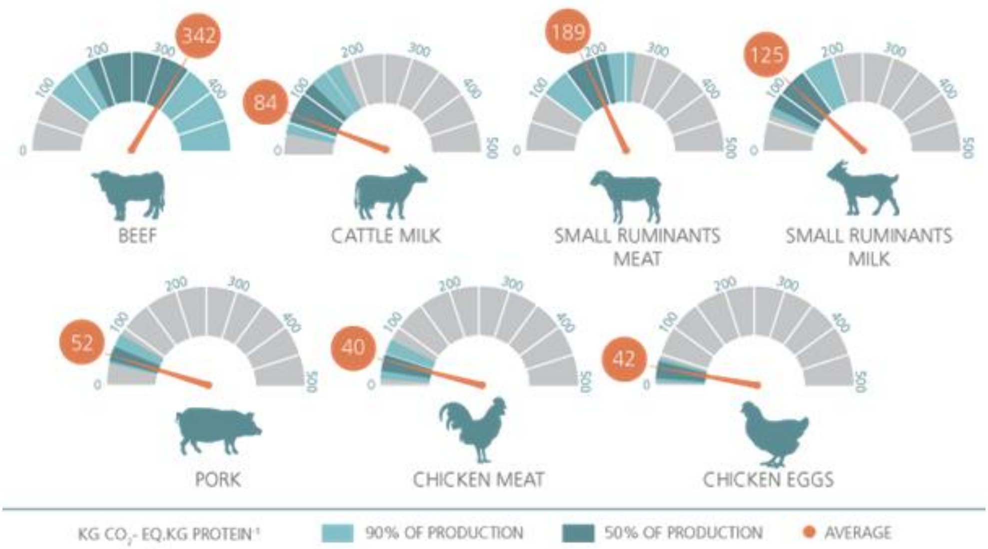


Figure 6. The emission of GHG regarding the commodity (FAO, 2016)

The intensity of GHG emission also varies regarding the region of breeding. These differences occur due to different species bred as well as due to differences in production (and emission) intensities (FAO, 2016).

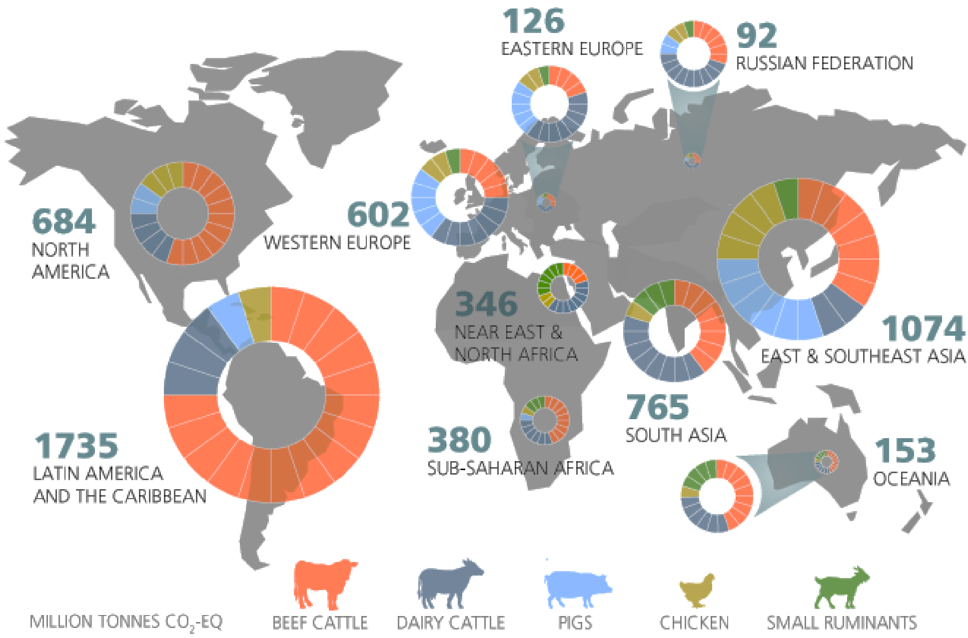


Figure 7. The emission of GHG regarding the breeding region (FAO, 2016)

The variability in GHG emission intensities among the different production systems could be explained by different agroecological conditions, farming practices and supply chain management (FAO, 2013a). These differences in emission intensity enable the application of adequate mitigation solutions.

Furthermore, it is very important to emphasize, that the GHG emission intensity highly depends on system productivity. Generally speaking, the higher productivity is, the lower is GHG emission per kg of product. For instance, in dairy cattle production systems, there is a strong negative relationship between animal's productivity and emission intensity (Figure 8).

Accordingly, to FAO (2013b) higher GHG emissions in low production systems are mainly the consequence of lower digestibility of feed (leads to higher enteric and manure emissions), inadequate animal husbandry and lower slaughter weights (slower growth rates also lead to more emissions per kg of meat produced), and older animals at slaughter (longer life led to higher emissions).

It could be observed that the global animal production sector, particularly beef meat production, significantly contributes to emissions of GHG of anthropogenic origin. On the other hand, this sector can also provide a significant share of the required mitigation action.

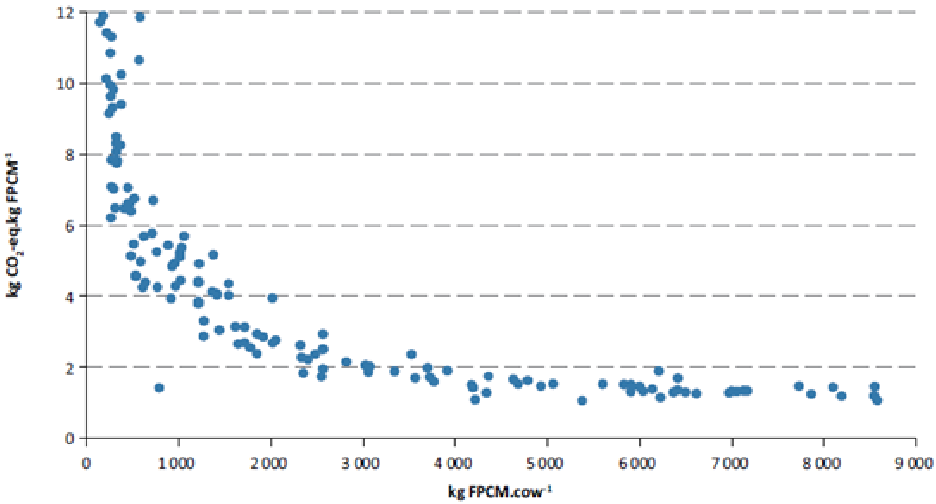


Figure 8. The relationship between milk production and emission per kg of produced milk (Gerber et al., 2011.)

The potential for mitigation

The potential for mitigation is estimated based on the differences in emission intensities between the various production systems as well as different agroecological breeding regions (FAO, 2013a). The projection of mitigation potential presented in Figure 9 is based on the premise that producers in a given system, region and agroecological zone use the practices of the 10th percentile of producers with the lowest emissions intensities while keeping unchanging output. Based on that premise the estimation for mitigation is about 30% (1.8 giga tones CO_2-eq), that is in the interval from 14 to 41% depending on the selected specie, production system and world's region.

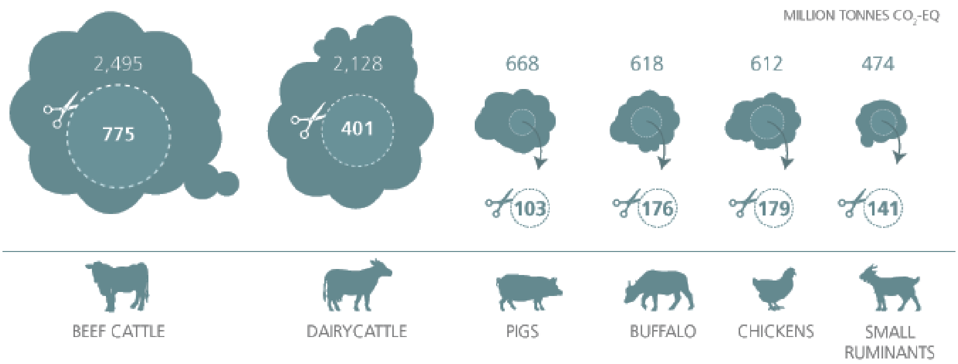
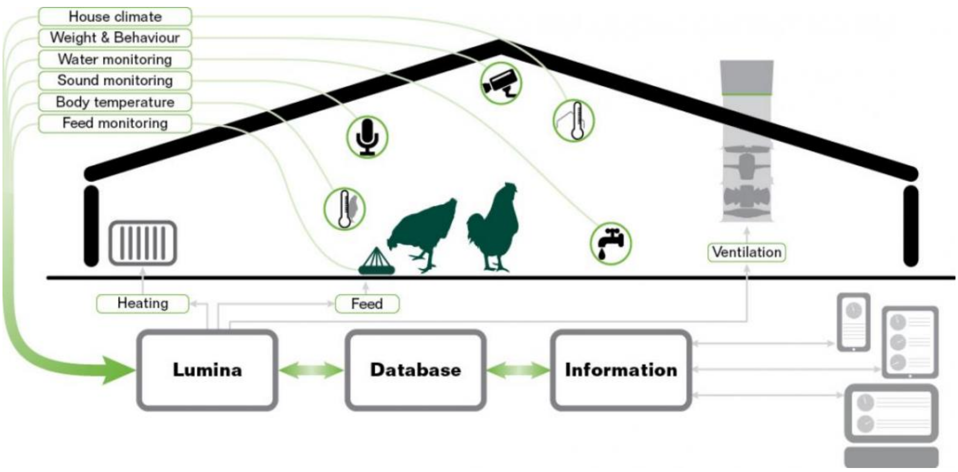


Figure 9. The potential for mitigation regarding the animal species (FAO, 2016)

According to FAO (2013a), the reduction of the animal production sector emissions could be accomplished through the application of many technologies and practices. Technical options for the mitigation of GHG emissions along animal production supply chains could be divided into the following categories: options related to feed supplements and feed/feeding management (for CH_4 only), options for manure management (dietary management, storage, handling and application phases of manure management), animal husbandry options (animal and reproductive management practices and technologies). Furthermore, practices and technologies that decrease the emissions of GHG can usually simultaneously increase productivity, consequently contributing to food security and economic development (FAO, 2013a).

Precision animal farming

Since the main role of agricultural production, is to prevent global food insecurity, it is necessary to enable sustainable intensification of total agricultural and especially animal production under the following conditions: increased demand for animal products, decreased available resources needed for production (agricultural land, water), and availability of various tools and production methods. In these conditions, animal production intensification implies an increase in animal density and a decrease in the stockperson per animal ratio. In the case of increasing herd size and decreasing workforce availability, precision animal farming (Picture 2.) imposes as the optimal solution.



Picture 2. I Farming system for animal housing (Fancom, 2022)

Precision animal farming implies the usage of various sensors and big data management in order to provide a simple score regarding animal health, productivity, and welfare. By collecting and analyzing a large amount of data precision animal farming can provide farmers with information regarding the production, reproduction and welfare at the individual and herd levels. That information enables a farmer to optimize the management of the farm and consequently realize an efficient and sustainable production system from the economic and environmental point of view.

Conclusion

Changes in climate will significantly affect agricultural production and especially plant and animal production worldwide. The global agricultural and particularly animal production sector significantly contributes to emissions of GHG of anthropogenic origin. On the other hand, this sector can also provide a significant share of the required mitigation action. Since precision animal farming technologies significantly improve the efficiency of the production process, these technologies represent one of the effective mitigation options. Precision animal farming by using various sensors and big data management contributes to the improvement of the production system in terms of animal health, productivity, and welfare. The application of different technologies of precision animal farming will make it possible for farmers to optimize the management of the farm and consequently realize an efficient and sustainable production system from the economic and environmental points of view.

Acknowledgements

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References

1. EC, DG AGRI, European Commission, DG Agriculture and Rural Development. (2016). http://ec.europa.eu/
2. European Parliament Research Service, EPRS (2016). Precision agriculture and the future of farming in Europe. Scientific Foresight Study.
3. Fancom (2022). New Precision Livestock Farming technology contributes to animal welfare. https://www.fancom.com/blog/precision-livestock-farming
4. Food and Agriculture Organization of the United Nations. FAO (2006). Livestock's Long Shadow: Environmental Issues and Options. Rome: Food and Agriculture Organization.
5. Food and Agriculture Organization of the United Nations. FAO (2016). http://www.fao.org/gleam/results/en/
6. Food and Agriculture Organization of the United Nations. FAO. (2011). World Livestock 2011 – Livestock in food security. Rome.
7. Food and Agriculture Organization of the United Nations. FAO. (2013a). Tackling climate change through livestock. A global assessment of emissions and mitigation opportunities, by Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A., Tempio, G. Rome.
8. Food and Agriculture Organization of the United Nations. FAO. (2013b). Greenhouse gas emissions from pig and chicken supply chains – A global

life cycle assessment, by MacLeod, M., Gerber, P., Mottet, A., Tempio, G., Falcucci, A., Opio, C., Vellinga, T., Henderson, B., Steinfeld, H. Rome.

9. Galloway, J. N., Dentener, F., Burke, M., Dumont, E., Bouman, A. F., Kohn, R. A., ... & Kroeze, C. (2010). The impact of animal production systems on the nitrogen cycle. In: Steinfeld H, et al., editors. Livestock in a Changing Landscape. Vol. 1. Washington, DC: Island Press; 2009. pp. 83–95.

10. Gerber P.J., Vellinga T., Opio C., Steinfeld H. (2011). Productivity gains and greenhouse gas intensity in dairy systems. Livestock Science, 139: 100–108.

11. Gouel, C., Guimbard, H. (2018). Nutrition Transition and the Structure of Global Food Demand. American Journal of Agricultural Economics. 101. 10.1093/ajae/aay030.

12. IPCC, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE. (2007). Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave & L.A. Meyer, eds. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

13. Popović V. (2015). The concept, classification and importance of biological resources in agriculture. (Ed) Milovanovic J., Đorđević S.: Conservation and enhancement of biological resources in the service of ecoremediation. Monograph. Belgrade. ISBN 978-86-86859-41-9; 29-51**;** 1-407.

14. Popović V., Jovović Z., Marjanović-Jeromela A., Sikora V., Mikić S., Bojovic R., Lj. Šarčević Todosijević (2020): *Climatic change and agricultural production.* GEA (Geo Eco-Eco Agro) Inter. Conference, Podgorica; 27-31.05.2020, p. 160-166.

15. US CENSUS BUREAU (2016). https://www.census.gov/library/publications .html.

16. Wirsenius, S. (2003). The biomass metabolism of the food system: A model-based survey of the global and regional turnover of food biomass. J Ind Ecol. 2003;7: 47–80.

CHANGES OF CLIMATIC CONDITIONS AND BIOCLIMATE VITICULTURAL INDICES, WITH PROJETIONS FOR FUTHURE

Zorica Ranković-Vasić[1], Ana Vuković Vimić[1], Marija Ćosić[1], Vladimir Đurđević[2], Mirjam Vujadinović Mandić[1], Dragan Nikolić[1]

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Abstract

Climatic conditions and the appropriate choice of grape varieties are among the most important factors for the success of grape and wine production. The most important bioclimate indices, which are also recommended by the International Organization of Vine and Wine (Resolution OIV-VITI 423-2012), are analyzed and obtained results are used to evaluate climatic conditions, define the boundaries of winegrowing regions, as well as to recommend grapevine varieties the most suitable for growing. In this paper showed are values of the most important bioclimate viticultural indices (AVG, NTN15, NTX35, NTN0, WIN, CI, HI, DI) in seven vineyard regions, in different administrative regions of the Republic of Serbia, for the periods of twenty (2000-2019) and ten (2010-2019) years, based on the processed meteorological data from the Hydro-meteorological Service of Serbia. The obtained results were compared with the results from the current Zoning of Viticultural Production (1961-2010), and the differences in the categories of indices are shown. The shift is found for all temperature-related indices across the winegrowing regions. The NTX35 index stands out in particular, since changes in the number of days with maximum temperatures above 35°C increased substantially. In the Niš Region, in the last 10 years, there were in average 15.1 days with such high temperatures, which is double compared to the period used for the zoning (1961-2010). Climate change simulations for the three periods (2021-2040, 2041-2060 and 2081-2100) projected changes in all viticultural indices over the entire territory of the wine-growing Serbia. These changes indicate the need to plan the adaptation of wine production and the entire wine sector in order to make the best use of terroir's potential.

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Key words: Viticulture, bioclimate indices, terroir, adaptation

Introduction

Climatic conditions and the appropriate choice of grape varieties are among the most important factors for the success of grape and wine production (Vujadinović et al., 2020). They tightly control the microclimatic conditions in the vineyard, growth and development of the vine, the physiology of the grapevine, yield and composition of berries, thus playing a vital role in the *terroir* of a specific wine-growing region (Ranković-Vasić et al., 2015; Ruml et al., 2016). Climatic classifications of wine regions are important because they allow one to describe and to compare wine regions that share similar characteristics (Puga et al., 2022). Bioclimatic indices are used in viticultural zoning, locality and grapevine variety selection, assessment of the impact of climate change on viticulture, etc. (Hall and Jones, 2009). The last 7 years in the territory of wine-growing Serbia represent a record warmest 7 years, which means that the increase in temperature has been accelerating over the last decade and will continue to grow (Đurđević et al., 2018). Changes in the phenological phases of many grape cultivars have been observed in some vineyard regions in Serbia, mainly as a consequence of changes in thermal conditions, flowering, ripening and harvesting of grapes are significantly shifted, while a minor change was observed at budding. Climate change will have a major impact on the sustainability of the grapevine in the future (Vuković Vimić et al., 2022). Various papers and studies on the significant impacts of climate change on viticulture are available (Ruml et al., 2012; Vuković et al., 2018; Muždalo et al., 2019). The main results on the potential impacts of future climate change are described as changes in the phenological stages of grapevine development, changes in the grape and wine composition, effects on grape yield, expansion of vineyards to areas previously unsuitable for grape growing and significant geographical shifts in traditional wine-growing regions. The high-resolution spatial analysis gives an assessment of the climate change influence on the grapes production (Vujadinović Mandić et al., 2022). Results analyses climate changes indicate the need to plan the adaptation of wine production and the entire wine sector in order to make the best use of potential of *terroir*. The aim of this study is to analyses changes of climatic conditions and bioclimate viticultural indices, with projections for future over the last two decades in selected wine-growing regions of Serbia, and to compare them to the standard climatological period.

Material and methods

In this paper analyzed of the most important bioclimate viticultural indices (AVG, N15, N35, N0, WIN, CI, HI, DI) in seven vineyard regions (Pocer-Valjevo, Negotin, Niš, Vranje, Three Morava, Subotica and South Banat), in different administrative regions of the Republic of Serbia, for the periods of twenty (2000-2019) and ten (2010-2019) years, based on the processed meteorological data from the Hydro-meteorological Service of Serbia. The obtained results were compared with the results from the current Zoning of viticultural production (1961-2010), and the differences in the categories of indices are shown. Within the regionalization of vineyard areas, three wine-growing regions have been singled out, within which there are a total of 22 regions with 77 vineyards and several wine-growing oases with their specific climatic characteristics. The climate analysis for the Zoning viticulture, was done on the basis of daily data from meteorological stations for a period of 50 years. Daily data for the 1961-2010 period were used from 103 stations. The indices were calculated for each year separately, and then averaged over the number of years with available data (Viticulture Atlas, 2015). Daily data for the 2000-2019 and 2010-2019 periods were used from stations RHMZ in Serbia and calculated viticultural indices. Chosen bioclimate viticultural indices are:

Mean temperature during the vegetation period (AWG - Average mean daily temperature for the standard vegetation period from 1 April to 31 October), Winkler index (WIN, Winkler et al., 1974), Huglin index (HI, Huglin, 1978), Cool nigth index (CI, Tonietto and Carbonneau, 2004), Drought index (DI, Riou et al., 1994), High summer temperatures (N35 - Number of days with a maximum daily temperature higher than 35°C), Low winter temperatures (N15 - Number of days with a minimum daily temperature below -15°C), and Temperatures in vegetation (N0 - Number of days with a minimum daily temperature below 0°C). The obtained results are shown in tables.

In this work, the RCP8.5 scenario was chosen (Relative Concentration Pathway) from the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2014), for the analysis of climate change in the future. Although this scenario does not envisage the application of mitigation measures, and can be considered the "worst option", Serbia has already reached the values of temperature change that the scenario predicts over the next 20 years, so the choice of milder scenarios, in this case, would be inadequate. The choice of the integration of climate models is taken from the "Development of Internet application and platform for vulnerability assessment to climate change and adaptation" Project which is implemented within the UNDP project "Improvement of medium and long-term adaptation planning in the Republic of Serbia" and includes an ensemble of 8 regional climate models with a spatial resolution of 0.1° (about 12 km) from the EURO-CORDEX project database (https://www.euro-cordex.net/). In accordance with the mentioned project, the three twenty-year future periods, 2021-2040, 2041-2060 and 2081-2100, were selected. Maps were created for six selected indices (AVG, WIN, HI, CI, DI, N35).

Results

Based on the results shown in Table 1, and According to the classification based on the AVG index, the vineyard regions of Serbia mostly fall into the warm category (17-19ºC), which is suitable for ripening of a very large number of cultivars. Vineyard regions of Serbia, on average (more than half) belong to the Winkler (WIN II) region (1389-1667ºC). Three viticultural climates, defined in the Multicriteria classification system (indices HI, CI and DI), are present in investigated winegrowing regions in Serbia: 1. moderately warm, humid with very cold nights (HI+1 DI-2 CI+2), examples are the region of: Subotica, 2. moderately warm, sub humid to humid, with very cold nights (HI+1 DI-1/DI-2 CI+2) like South Banat; 3. Some regions (Vranje, Pocer/Valjevo, etc) partially have a temperate (HI-1), humid (DI-2) climate, and they also have very cold nights (CI+2). The number of days in the vegetation period (April-October) with a maximum daily temperature greater than or equal to 35ºC indicates the risk of very warm days. The highest number of days with a temperature higher than 35ºC was determined in the Niš region (Niš station) and it was 7.7. High temperatures, if they occur during the ripening period of grapes (from the phenophase of veraison to the harvest), can affect the reduction of synthesis and degradation of anthocyanins, and thus the weaker color of grapes and produced wine.

Table 1 The most important bioclimate viticultural indices in the past climate (1961-2010; viticulture zoning)

Station/Indices	AVG	WIN	HI	CI	DI	N0	N35	N15
Pocer-Valjevo region								
Valjevo	17.0	1559.1	2092.6	10.8	246.2	4.6	3.3	2.2
Negotin region								
Negotin	17.8	1717.9	2278.1	11.5	127.5	3.8	4.6	2.8
Niš region								
Niš	17.8	1713.8	2259.7	11.3	138.0	3.6	7.7	1.2
Vranje region								
Vranje	16.8	1512.1	2064.1	10.4	154.0	4.7	3.3	1.4
Three Morava region								
RC Kruševac	17.1	1571.5	2130.0	10.4	173.5	5.5	4.9	2.9
Subotica region								
Palić	17.1	1583.2	2102.5	11.2	151.2	3.6	1.8	2.2
South Banat region								
Vršac	17.3	1627.2	2140.7	11.4	192.6	6.3	2.5	3.3

Table 2 and 3 shows the values of wine-growing indices in seven vineyard regions for the periods of twenty (2000-2019) and ten (2010-2019) years. In relation to the results from the regionalization of wine-growing areas (Table 1) changes in the values of the index are observed, which occurred both due to the calculation period and due to changes in the values of temperature and precipitation. The N35 index stands out in particular, where in some vineyard regions there was an increase in the number of days with temperatures higher than 35ºC. In the Niš Region, in the last 10 years, there were 15.1 days with high temperatures, which is twice as much as in the period analyzed for the needs of regionalization (1961-2010). Other surveys also analyses vineyard indices or have already confirmed their changes. High temperatures during the ripening period of grapes can adversely affect the synthesis and content of phenolic substances, which leads to a decrease in the quality of grapes and wine.

Table 2. The most important bioclimate viticultural indices in the current climate (2000-2019)

Period	Region/Station	AVG	N15	N35	N0	WIN	CI	HI	DI
2000-2019	Negotinska krajina/Negotin	19.1	2.0	9.2	2.2	1968.4	12.9	2530.0	52.7
	Niš Region/Niš	19.0	1.0	14.7	2.5	1946.6	12.3	2499.1	53.7
	Subotica/Palić	18.3	1.2	4.3	1.9	1807.2	12.2	2331.4	82.3
	Three Morava/RC Kruševac	17.7	0.6	2.8	1.3	1709.2	12.8	2113.1	93.0
	Vranje Region/Vranje	17.7	1.3	7.9	4.1	1686.5	10.8	2275.1	75.5
	South Banat/Vršac	18.5	2.3	6.8	4.7	1852.4	12.2	2388.1	91.9
	Pocer-Valjevo/Valjevo	18.3	1.5	8.0	2.8	1802.8	12.0	2327.0	116.5

Table 3. The most important bioclimate viticultural indices in the current climate (2010-2019)

Period	Region/Station	AVG	N15	N35	N0	WIN	CI	HI	DI
2010-2019	Negotinska krajina/Negotin	19.4	2.1	9.4	1.5	2035.8	13.5	2607.5	29.1
	Niš Region/Niš	19.2	0.7	15.1	1.8	1990.0	13.0	2537.9	32.8
	Subotica/Palić	18.4	1.0	5.7	1.1	1840.0	12.7	2371.4	75.8
	Three Morava/RC Kruševac	18.0	0.6	2.8	0.5	1761.3	13.5	2174.0	77.4
	Vranje Region/Vranje	18.0	1.0	9.0	3.4	1750.7	11.4	2346.0	56.3
	South Banat/Vršac	18.7	1.7	8.0	4.2	1898.3	12.6	2444.0	89.7
	Pocer-Valjevo/Valjevo	18.6	1.3	9.5	1.7	1873.4	12.7	2397.1	96.2

Climate projections for the period the future show changes in all viticultural indices. Based on the analysis of projected values of temperatures for the vegetation period (AVG) which are shown in Figure 1 it can be concluded that in the last 40 years of this century (periods 2041-2060 and 2080-2100) there will be significant changes in these temperatures in relation to the first period of the future (2021-2024).

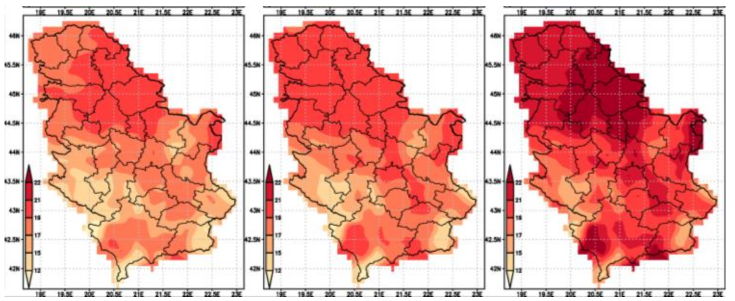
Period/ Probability of occurrence	**2021-2040**	**2041-2060**	**2080-2100**
75%			

Figure 1. Mean projected values of temperatures for the vegetation period (AVG) – probability of occurrence

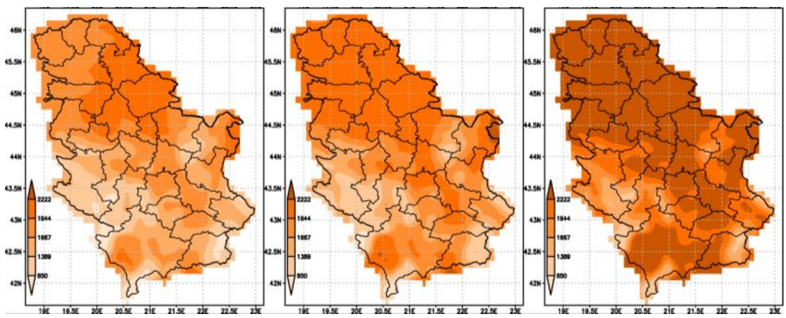
Period/ Probability of occurrence	**2021-2040**	**2041-2060**	**2080-2100**
75%			

Figure 2. Projection of Winkler Index (WIN)

It is predicted that in the next twenty years the Winkler Index will move to the WIN III zone (1668-1944°C) for most wine regions of Vojvodina and zone IV (1945-2222°C) for parts of Banat. In the second period (2041-2060) entire Vojvodina, except for small parts of the Subotica region and parts around Fruška Gora, will be WIN IV (1945-2222°C), and in the last projected period of the future (2081-2100) the region of Vojvodina, eastern and southern parts of Serbia, the region of Three Morava, Pocer-Valjevo region will be in the highest WIN V zone with over 2222°C (Figure 2).

The Huglin Index (HI) also predicts a move towards a warmer climate that almost all wine-growing regions will have. Also, Pocer-Valjevo and the region of Three Morava will be in this highest class, as well as parts of Niš, the region of Negotinska Krajina, etc. (Figure 3). The mean minimum temperature in September (CI) in the present period belongs to the category of very cold nights (CI<12°C) in the entire territory of Serbia, except for separate parts of Banat and the far east where CI is 12-14°C (cold nights) (Figure 4).

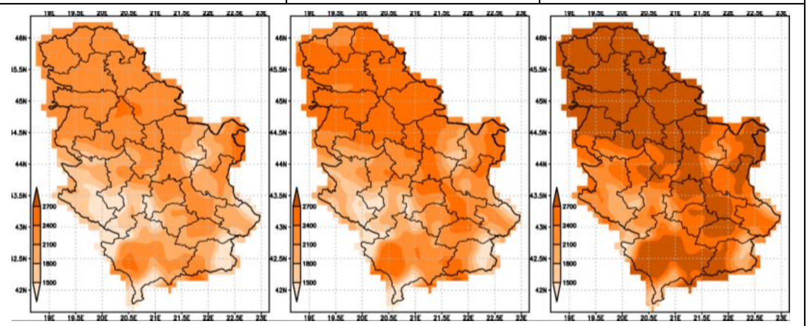
Period/ Probability of occurrence	2021-2040	2041-2060	2080-2100
75%			

Figure 3. Projection of the Huglin Index (HI) for future

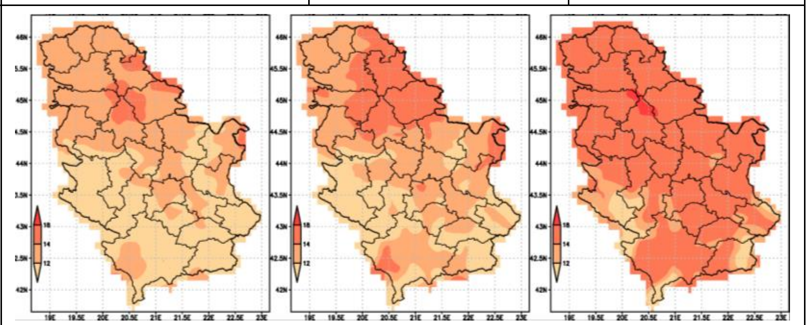
Period/ Probability of occurrence	2021-2040	2041-2060	2080-2100
75%			

Figure 4. Projection of the Cool night index (CI) for future

The changes projected for the end of the 21st century (2081-2100) very characteristic also in terms of the drought index (DI) shown in Figure 5. The transition of the wine-growing regions of Vojvodina, Pocer-Valjevo, Niš, Vranje regions, vineyards in eastern Serbia is envisaged, as well as the vineyards of the Three Morava region from the subhumid climate category (DI-1) to the dry category (DI+1).

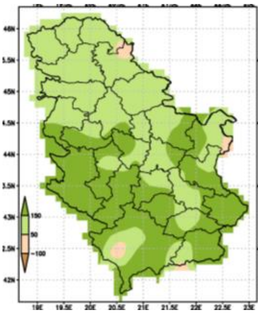
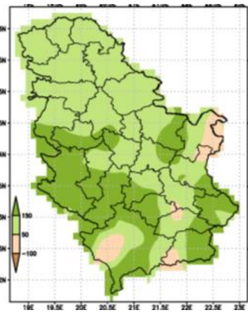
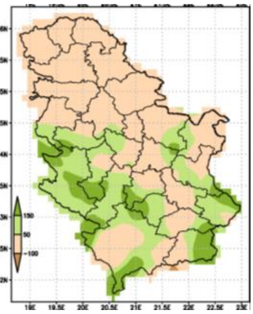
Period/ Probability of occurrence	2021-2040	2041-2060	2080-2100
75%			

Figure 5. Projection of Dryness index (DI) for future

Projections for the future show that the probability of occurrence of two consecutive days with a temperature higher than 35°C (N35 index) will grow significantly, especially in the last twenty years of this century (Figure 6).

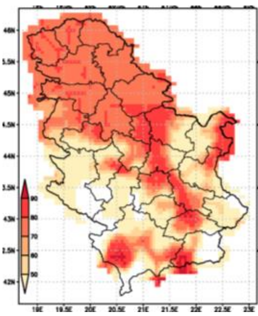
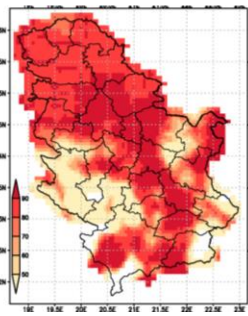
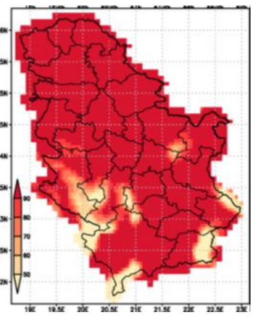
Period/ Probability of occurrence	2021-2040	2041-2060	2080-2100
75%			

Figure 6. Probability of occurrence of the very warm days (Tx>35°C) (N35)

Climate is a limiting factor determining phenology, vegetative growth, physiological development, fruit production and consequently wine quality (Van Leeuwen et al., 2004; Costa et al., 2019). Geographical distribution of vineyards is determined by climatic factors. Weather parameters: temperatures, solar radiation, precipitation, and the inter-annual seasonal variability leads to annual changes in vine productivity (Jones and Davis, 2000; Fraga and Santos, 2017; Fraga et al., 2019). Temperature plays a significant role of grapevine. Increase in mean temperature prolongs the vegetative and reproductive cycle of grapevine and hence berry developmental and maturity stages are shifted in warmer months (Van Leeuwen and Destrac-Irvine, 2009). Temperature also affects the synthesis of various substances in grapes (sugars, acids, phenolic substances, etc.). The phenolic substances are very important compounds of grapes. Different climatic conditions such as air temperature, rainfall, relative humidity, wind, altitude, and topographic features play vital role in the polyphenol biosynthesis pathway in grapes. Accumulation and degradation of already synthesized anthocyanins was noticed due to elevated temperatures during the ripening period (Mori et al., 2007; Poudel et al., 2009).

Conclusion

The results of the analysis of bioclimate viticultural indices show changes in climatic conditions in the vineyard regions of Serbia. Climate change will have a negative impact on viticulture and wine industry in the future. Higher temperature during the growing season will affect grapevines because it is a major driver of development stages of grapevine. Heat stress during ripening period will abruptly reduce grapevine metabolism. It may result in higher sugar content and lower acidity, lower content of phenolic compounds in berry with potential lower grape and wine production and quality. Extreme high temperature and water stress, under future climates, may threaten yields and productivity. These changes indicate the need to plan the adaptation of grape production and the entire viticulture and wine sector in order to make the best use of terroir’s potential for production.

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References

1. Costa, R., Fraga, H., Fonseca, A., García de Cortázar-Atauri, I., Val, M.C., Carlos, C., Reis, S., Santos, J.A. (2019). Grapevine phenology of cv. Touriga Franca and Touriga Nacional in the Douro wine region: Modelling and climate change projections. Agronomy, 9:210.
2. Đurdjević, V., Vuković, A., Vujadinović Mandić, M. (2018). Observed Climate Change in Serbia and Projections of Future Climate Based on Different Scenarios of Future Emissions; United Nation’s Development Program: Belgrade, Serbia, p. 24. (In Serbian).
3. Fraga, H., Santos, J.A. (2017). Daily prediction of seasonal grapevine production in the Douro wine region based on favourable meteorological conditions. Australian Journal of grape and wine research, 23:296-304.
4. Fraga, H., Pinto, J.G., Santos, J.A. (2019). Climate change projections for chilling and heat forcing conditions in European vineyards and olive orchards: A multi-model assessment. Climatic Change, 152:179-193.

5. Hall, A., Jones, G.V. (2009). Effect of potential atmospheric warming on temperature-based indices describing Australian winegrape growing conditions. Australian Journal of Grape and Wine Research, 15(2), 97-119.

6. Huglin, P. (1978). Novaue mode d'evalutaion des possibilite heliothemiques d'un milieu viticole. Proceedings of the Symposium International sur l'ecologie de la Vigne. Ministere de l'Agriculutre et de l'Industrie Alimentarie, Contanca.

7. IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

8. Jones, G.V. (2006). Climate and Terroir: Impacts of Climate Variability and Change on Wine. In Fine Wine and Terroir - The Geoscience Perspective. Macqueen R.W., and Meinert L.D. (eds.), Geoscience Canada Reprint Series Number 9, Geological Association of Canada, St. John's, Newfoundland, 247.

9. Jones, G.V., Davis, R.E. (2000). Climate influences on grapevine phenology, grape composition, and wine production and quality for Bordeaux, France. American Journal of Enology and Viticulture, 51:249-261.

10. Mori, K., Goto-Yamamoto, N., Kitayama, M., Hashizume, K. (2007). Loss of anthocyanins in red-wine grape under high temperature. Journal of Experimental Botany, 58:1935-1945.

11. Muždalo, S., Vujadinović, M., Vuković, A., Ranković-Vasić, Z., Mircov, VD, Dobrei, A. (2019): Climate cnahge in vineyards of Serbian-Romanian Banat, Research Journal of Agriculture Science, 50: 3-8.

12. Poudel, P.R., Mochioka, R., Beppu, K., Kataoka, I. (2009). Influence of temperature on berry composition of interspecific hybrid wine grape 'Kadainou R-1' (*Vitis ficifolia var. ganebu*× *V. vinifera* 'Muscat of Alexandria'). Journal of the Japanese Society for Horticultural Science, 78:169-174.

13. Puga, G., Kym Anderson, K., Jones, G., Doko, F., Tchatoka3, and Wendy Umberger, T., Umberger, W. (2022). A climatic classification of the world's wine regions. American association of wine economists AAWE working paper, No. 271, Economics.

14. Ranković-Vasić, Z., Sivčev, B., Vuković, A., Vujadinović, M., Pajić, V., Ruml, M. Radovanović, B. (2015). Influence of meteorological factors on the quality of 'Pinot Noir' grapevine grown in two wine-growing regions in Serbia. Acta Horticulturae (ISHS), pp. 1082, 389-396.

15. Riou, C.H., Becker, N., Sotes Ruiz, V., Gomez-Miguel, V., Carbonneau, A., Panagiotou, M., Calo, A., Costacurta, A., Castro De, R., Pinto, A., Lopes, C., Carniero, L., Climaco, P. (1994). Le determinisme cliatique de la

maturation du raisin: application au zonage de la teneur em sucre dans la communaute europeenne. Office des Publications Officielles des Communautes Europeennes, Luxembourg.

16. Ruml, M., Korać, N., Vujadinovć, M., Vuković, A., Ivanišević, D. (2016). Response of grapevine fenology to recent temperature change and variability in the wine producing area of Sremski Karlovci, Serbia. Journal of Agriculture Science, 154 (2): 186-206.

17. Ruml, M., Vuković A., Vujadinović M., Djurdjević, V., Ranković-Vasić, Z., Atanacković, Z., Sivcev, B., Marković, N., Matijašević, S., Petrović, N. (2012). On the use of regional climate models: Implications of climate change for viticulture in Serbia. Agric. For. Meteorol., 158-159, 53–62.

18. Tonietto, J., Carbonneau, A. (2004): A multicriteria climatic classification system for grape-growing regions worldwide. Agricultural and forest meteorology, 124(1-2), 81-97.

19. Van Leeuwen, C., Friant, P., Chone, X., Tregoat, O., Koundouras, S., Dubourdieu, D. (2004). Influence of climate, soil, and cultivar on terroir. American Journal of Enology and Viticulture, 55:207-217.

20. Van Leeuwen, C., Destrac-Irvine, A. (2017). Modified grape composition under climate change conditions requires adaptations in the vineyard. OENO One, 51:147-154.

21. Vujadinović Mandić, M., Vuković Vimic, A., Rankovic´-Vasic, Z., Đurovic, D., Ćosić, M., Sotonca, D., Nikolić, D., Đurđević, V. (2022). Observed Changes in Climate Conditions and Weather-Related Risks in Fruit and Grape Production in Serbia. Atmosphere, 13, 948, 1-18.

22. Vujadinović, M., Vuković, A., Jaksić, D., Đurdjević, V., Ruml, M., Ranković-Vasić, Z., Przić, Z., Sivčev, B., Marković, N., Cvetković, B., La Notte, P. (2020). Climate change projections in Serbian wine-growing regions. IVES - International viticulture and enology society, 65-70.

23. Vuković Vimić, A., Đurđević, V., Ranković-Vasić, Z., Nikolić, D., Ćosić, M., Lipovac, A., Cvetković, B., Sotonica, D., Vojvodć, D., Vujadinović Mandić, M. (2022). Enhancing Capacity for Short-Term Climate Change Adaptations in Agriculture in Serbia: Development of Integrated Agrometeorological Prediction System, Atmosphere, 13, 1337, 1-32.

24. Vukovic, A., Vujadinovic, M., Ruml, M., Vasic, Z., Przic, Z., Beslic, Z., Matijasevic, S., Vujović, D., Todic, S., Markovic, N., Sivcev, B., Zunic, D., Zivotic, L., Jaksic, D. (2018). Implementation of climate change science in viticulture sustainable development planning in Serbia. E3S Web of Conferences. 50.

25. Winkler, A.J., Cook, J.A., Kliewer, W.M., Lider, L.A. (1974): General Viticulture. University of California Press, Berkeley, USA, pp. 710.

THE INFLUENCE OF THE CURRENT YEAR'S YIELD ON THE NEXT YEAR'S SOWING STRUCTURE OF THE MOST IMPORTANT FIELD CROPS IN THE REPUBLIC OF SERBIA

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Abstract

This paper analyzes the production characteristics of important field crops grown in the Republic of Serbia. The subject of the research is the areas, yields and total production of important field crops in the Republic of Serbia (wheat, corn, sugar beet, sunflower and soybeans). The aim of this paper is to determine, based on the analyzed values of yields and areas, whether there is a connection between the realized yields from the current year and the sown areas in the following year. The analysis was performed for the period 2005-2021. years. Statistical processing of production parameters of observed crops was performed using descriptive statistical analysis, and the method of linear regression was applied to determine the impact of yields from the current year on the sowing structure of the following year. The results of the research showed that the areas under the observed field crops were relatively stable in the observed period, except for the areas of sugar beet which decreased at the rate of 3.39% per year and soybean areas which grew at the average rate of 3.78% per year. Yields of all observed crops, except corn and soybeans, show a growth trend, and the total production of all crops, except corn and sugar beet, also shows a growth trend. The results of the regression analysis indicate that the yield in the current year of certain field crops: wheat, sunflower and soybean, had an impact on the seed structure in the following year.

Key words: Field crops, production, Republic of Serbia, regression

Introduction

Crop production accounted for about 66% of the total agricultural production in 2019 and recorded a rise of 1.9% compared to the previous year. Arable agricultural land and kitchen gardens accounted for 74.1% of the total utilised agricultural land in 2019, while the area of arable land and kitchen gardens had 65.9% of wheat and 19%, of industrial crops, while vegetable crops participated with 1.9% and fodder crops with 9.4% (Statistical Yearbook, 2020). We defined the subject and the aim of our research based on the results achieved in this period.

The research presented in the paper studies the area, yield, and total production of the main field crops (wheat, maize, sugar beet, sunflower, and soybeans) in the Republic of Serbia. The experience acquired in the past is the most deciding factor influencing the decision-making process in the future (Mutavdžić et al., 2006). Following this principle, we defined the initial hypothesis of this research that the yield of the current year affects the sowing structure in the following year. In other words, we assumed that an increase in the yield of certain crops in the current year, i.e., increased production, will additionally motivate farmers to increase the area under this crop in the following years.

Many authors have studied the production of field crops in the Republic of Serbia. Mutavđžić et al. (2006) analysed how the current year's production affects the next-year sowing structure of the main field crops in the Republic of Serbia in a ten-year period. Based on the results of regression models, authors found a statistically significant effect of the current year's production of industrial crops (sunflower, soybean and sugar beet) on the sowing structure of these crops in the following year. Bošnjak et al. (2013) analysed soybean yields produced from 1949 to 2012. The main goal was to evaluate the level and stability of soybean yields in order to find ways to improve the production of this crop in the future. Ilić et al. (2016) studied the production of maize in the Republic of Serbia and made predictions about its future trends. Observing the period from 1947-2014 and using the ARIMA model, the authors made predictions about the production of maize for the period from 2015 to 2017. According to the results of their research, a reduction was expected in the production of maize in the forecast period. Popovic and Kovljenić (2017) studied the efficiency of wheat production in the Republic of Serbia. Based on the data about the production farms in 2015 and 2016 and using the DEA method, the authors concluded that the size of the property and investments in new equipment are the key factors affecting the farms. Novković et al. (2019) analyzed the prices of wheat and maize in the period from 2002 to 2017 and based on the results predicted what the prices would be in the next five years (2018-2022). Using the ARIMA model, the authors estimated that wheat would cost about 139 euros per ton in that period, while the price of maize would range from 127.5 to 134 euros per ton. Novković et al. (2020) conducted research to make predictions about the production features of the main species of wheat in the Republic of Serbia. The study encompassed the period from 2005 to 2018, and the estimates were made for 2019-2023. According to the results of this research, the production of wheat, barley and triticale is expected to rise, and maize, oats and rye to fall in the forecast period.

Material and method of work

The research was based on secondary data and applied the standard quantitative method. The observed features were processed using the standard statistical instruments:

1. Average value of the occurrence – arithmetic mean $(\bar{X})$
2. Extreme values of the occurrence (min and max)
3. Coefficient of variation (CV)

4. Annual change rate in % (r)

The change rate was calculated directly from the absolute data of the analyzed series with the application of the following formula:

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

where: r - annual change rate, G- constant relative change of the occurrence, Yn - absolute value of the last member in the series, Y1- absolute value of the first member in the series, and n- total number of the series members (Tekić et al., 2019).

The model of linear regression was applied to determine the influence of the current year's yield on the sowing structure in the following year. Regression analysis can be defined as the estimation of relationships between a dependent variable and one or more independent variables. (Mutavdžić, Đorić, 2018).

The applied regression model has the following form:

$$\hat{Y} = \alpha + \beta X_i + \varepsilon_i$$

where $\hat{Y}$ – dependent variable, X_i – independent variable, β – coefficient of regression that shows the change in the dependent variable for the unit of change in the independent variable. Parameter α represents the average initial level of the dependent variable, and ε_i – random error of the model (Hadživuković, 1991).

Analysis of variance was used to assess the statistical significance of the defined regression model. In order to obtain a more precise interpretation of the obtained results, we used other indicators such as coefficient of correlation and coefficient of determination (adjusted coefficient of determination), while the predictive power of the model was determined using the standard error of the regression (Novaković, 2019).

The data used in the analysis were taken from the website of the Statistical Office of the Republic of Serbia (RSO). The data refer to the area, yield and total production of the main field crops in the Republic of Serbia from 2005 to 2021. The STATISTICA program package was used for statistical data processing.

Research results

The main parameters of the descriptive statistics for production characteristics of some field crops are shown in the table below (Table 1).

Table 1. Descriptive statistics of the selected dependent and independent variables applied in the analysis

Crop	Production parameter	Average	The minimum	The maximum	Coefficient of variation	Change rate
Wheat	Area (ha)	607,779.90	556,115.00	643,083.00	3.83	-0.32
	Total production (t)	2,589,107.00	2,085,529.00	3,442,308.00	12,23	1.96
	Yield (t/ha)	4.26	3.40	5.70	12.37	2.24
Maize	Area (ha)	998,389.30	901,753.00	1,057,877.00	3.67	0.09
	Total production (t)	6,215,041.00	3,532,602.00	7,951,583.00	21.64	-1.01
	Yield (t/ha)	6.22	3.60	7.90	21.78	-1.15
Sugar beet	Area (ha)	58,108.06	37,418.00	84,085.00	23.84	-3.39
	Total production (t)	2,784,525.00	2,018,215.00	3,551,074.00	19,24	-2.93
	Yield (t/ha)	48,67	35.90	54.70	10.46	0.50
Sunflower	Area (ha)	191,507.00	154,793.00	239,148.00	12.76	0.45
	Total production (t)	492,142.70	294,502.00	733,706.00	27,31	3.49
	Yield (t/ha)	2.55	1.80	3.30	17.62	3.03
Soybean	Area (ha)	176,671.90	130,936.00	237,036.00	18.88	3.78
	Total production (t)	477,955.80	280,638.00	751,578.00	28.74	2.43
	Yield (t/ha)	2.69	1.70	3.50	6:35 p.m	-1.22

Source: Authors' calculation

The total area under wheat amounted to an average of 607,779.9 hectares and ranged from 556,115 ha to 643,083 ha. The areas under wheat were relatively stable in the study period, with a coefficient of variation of 3.83%. Looking at the annual rate of change, we can see that the areas under wheat decreased slightly in the study period, at a rate of 0.32% per year. The average wheat yield in the study period was at the level of 4.26 t/ha, with variations of 12.37%. The average annual yield growth rate was 2.24%. The total wheat production in the study period averaged around 2.6 million tons and ranged from 2.08 to 3.44 million tons. The total production of wheat shows somewhat larger variations (CV=12.23%), which were primarily conditioned by yield variations. The total production of wheat grew at an annual rate of 1.96%. The total area under maize in the study period was, on average, 998,389.3 ha, with a variation range from 901,753 ha to 1,057,877 ha. The total area under maize was relatively stable, with a low coefficient of variation of 3.67% and an annual growth rate of 0.09%. The average maize yield in the study period was 6.22 t/ha, and it ranged from 3.60 to 7.90 t/ha. The coefficient of variation of maize yield was high and amounted to 21.78%. The average annual rate of decline in maize yield was 1.15%. Maize production averaged 6.22 million tons, with a wide interval of variation from 3.53 to 7.95 million tons. Maize production was characterised by high variability (CV=21.64%) and an annual rate of decline of 1.01%, which was caused by highly variable yields. The average area under sugar beet in the study period was 58,108 ha, and ranged from 37,418 ha to 84,085 ha, with a high coefficient of variation of 23.84%. The area under sugar beet was characterised by an average annual rate of decline of 3.39%. In the study period, the sugar beet yield averaged 48.67 t/ha, with a variability of 10.46% and an average annual growth rate of 0.50%. The total production of sugar beet averaged around 2.78 million tons and ranged from 2.02 to 3.55 million tons. Sugar beet production was also highly variable, which was due to the variability of the planted areas. The total production of sugar beet decreased at the rate of 2.93% per year. The areas under sunflowers amounted to an average of 191,507 ha in the study period, and ranged from 154,793 to 239,148 ha, with variations of 12.76%. These areas were relatively stable in the study period, with an annual growth rate of 05%. The average sunflower yield was 2.55 t/ha, ranging from 1.80 t/ha to 3.30 t/ha. Sunflower yield was characterised by high variability (CV=17.62%) and growth at an annual rate of 3.03%. The total sunflower production averaged about 492 thousand tons, with a wide range of variation from 294 to 734 thousand tons. Sunflower production was characterised by high variability (CV=27.31%) and an annual growth rate of 3.49%. The total area under soybeans in the study period amounted to an average of 176,671.9 ha and ranged from 130,936 ha to 237,036 ha. The areas under soybeans were characterised by high variability, with a coefficient of variation of 18.88%. In the study period, the area under soybean grew at an annual rate of 3.78%. The average soybean yield was 2.69 t/ha, and it ranged from 1.70 t/ha to 3.50 t/ha, with a variability of 18.35%. The average annual rate of soybean yield decline was 1.22%, but it must be emphasised that this low value was due to the low yield in the last year of observation, when the yield was only 2.3 t/ha. The total soybean production in the study period amounted to an average of 478 thousand tons, and it varied at a rate of 28.74%. Soybean production recorded an increase at an annual rate of 2.43%.

The above-presented variables were then used to create the first regression model to determine the dependence of the next year's sowing structure on the wheat yield produced in the previous year. We first tested the significance of the model using the analysis of variance (Table 2). The initial hypothesis in the case of testing the regression model was $H_0: \beta_1 = \beta_2 = \cdots = \beta_k = 0$, if this hypothesis is confirmed, we can conclude that the model is not statistically significant.

Table 2. Analysis of variance for the regression model: dependence of sowing structure on wheat yield

Effect	Analysis of Variance; DV: Area (Spreadsheet23)				
	Sums of Squares	df	Mean Squares	F	p-value
Regress.	2,369761E+09	1	2,369761E+09	5,773150	0,030707
Residual	5,746717E+09	14	4,104798E+08		
Total	8,116478E+09				

Source: Author's calculation

Based on the results of the analysis of variance for the observed regression model, the null hypothesis was rejected, and the model was statistically significant ($p<0.05$).

The estimated parameters of the regression model of the dependence of the wheat sowing structure in the following year on the current year's yield are shown in the table below (Table 3).

Table 3. Regression model: dependence of sowing structure on wheat yield

N=16	Regression Summary for Dependent Variable: Area (Spreadsheet23) R= ,54034171 R²= ,29196916 Adjusted R²= ,24139553 F(1,14)=5,7731 p<,03071 Std.Error of estimate: 20260,					
	b*	Std.Err. of b*	b	Std.Err. of b	t(14)	p-value
Intercept			742137,8	56729,85	13,08196	0,000000
Yield	0,540342	0,224886	32566,7	13554,01	2,40274	0,030707

Source: Author's calculation

Based on the obtained results presented in Table 3, we can form the following regression model:

$\hat{Y}=742,137.8+32,566.7X+\varepsilon$

The obtained regression coefficients (b) indicate the high statistical significance of parameter β that profiles the independent variable representing the current year's wheat yield. This variable has a positive direction, so we can conclude that with a yield increase of one t/ha, the area under wheat can be expected to increase by 32,566.7 ha in the next sowing season. As seen in Table 3, the coefficient of correlation is 0.54, and the coefficient of determination is 0.29%. The obtained coefficient of determination shows that 29% of the variability of the sowing structure, i.e., the wheat area in the next year, can be explained by the impact of the current year's yield.

We continued our research by developing the second regression model in which the maize area in the following year was taken as the dependent variable and the current year's maize yield as the independent variable. As in the case of the first model, we first assessed the significance of the regression model as a whole using the analysis of variance (Table 4).

Table 4. Analysis of variance for the regression model: dependence of sowing structure on maize yield

Effect	Analysis of Variance; DV: Area (Spreadsheet12) Sums of Squares	df	Mean Squares	F	p-value
Regress.	5,661904E+08	1	5,661904E+08	0,380398	0,547290
Residual	2,083783E+10	14	1,488416E+09		
Total	2,140402E+10				

Source: Author's calculation

Based on the results of the analysis of variance for the observed regression model, the null hypothesis was confirmed, and the obtained model was not statistically significant (p>0.05). In other words, there was no statistically significant correlation, i.e., the current year's yield had no influence on the sowing structure of maize in the following year.

The estimated parameters of the second regression model are shown in the table below (Table 5).

Table 5. Regression model: dependence of sowing structure on maize yield

Regression Summary for Dependent Variable: Area (Spreadsheet12)
R= ,16264235 R²= ,02645253 Adjusted R²= -----
F(1,14)=,38040 p<,54729 Std.Error of estimate: 38580,

N=16	b*	Std.Err. of b*	b	Std.Err. of b	t(14)	p-value
Intercept			970553,3	45535,09	21,31440	0,000000
Yield	0,162642	0,263703	4395,9	7127,43	0,61676	0,547290

Source: Author's calculation

In the next part of the research, the third regression model was developed. It had the following year's sugar beet area as the dependent variable and the current year's sugar beet yield as the independent variable. As in the case of previous models, we first assessed the significance of the regression model applying the analysis of variance (Table 6).

Table 6. Analysis of variance for the regression model: dependence of sowing structure on sugar beet yield

Effect	Analysis of Variance; DV: Production (Spreadsheet29)				
	Sums of Squares	df	Mean Squares	F	p-value
Regress.	1,226712E+11	1	1,226712E+11	0,441039	0,517410
Residual	3,893978E+12	14	2,781413E+11		
Total	4,016649E+12				

Source: Author's calculation

Based on the results of the analysis of variance for the observed regression model, it can be concluded that the null hypothesis was confirmed and the model was not statistically significant ($p>0.05$). There was no statistically significant correlation, i.e., the current year's yield had no influence on the sowing structure of the sugar beet in the following year.

The estimated parameters of the third regression model are shown in the table below (Table 7).

Table 7. Regression model: dependence of sowing structure on sugar beet yield

N=16	Regression Summary for Dependent Variable: Production (Spreadsheet29) R= ,17475893 R²= ,03054068 Adjusted R²= ----- F(1,14)=,44104 p<,51741 Std.Error of estimate: 5274E2				
	b*	Std.Err. of b*	b	Std.Err. of b	t(14)	p-value
Intercept			3681611	1288281	2,857770	0,012654
Yield	-0,174759	0,263148	-17573	26461	-0,664108	0,517410

Source: Author's calculation

Next, we made a model that measured the dependence of the following year's sowing structure of sunflowers on the current year's sunflower yield. The analysis of variance was used to assess the significance of the model as a whole (Table 8).

Table 8. Analysis of variance for the regression model: dependence of sowing structure on sunflower yield

Effect	Analysis of Variance; DV: Area (Spreadsheet37)				
	Sums of Squares	df	Mean Squares	F	p-value
Regress.	2,406604E+09	1	2,406604E+09	4,742079	0,047029
Residual	7,104997E+09	14	5,074998E+08		
Total	9,511601E+09				

Source: Author's calculation

Based on the results of the analysis of variance for the observed regression model, we can conclude that the null hypothesis was rejected and the model was statistically significant ($p<0.05$).

The estimated parameters of the regression model showing the dependence of the following year's sowing structure of sunflowers on the current year's yield are shown in the table below (Table 9).

Table 9. Regression model: dependence of sowing structure on sunflower yield

	Regression Summary for Dependent Variable: Area (Spreadsheet37) R= ,50300871 R²= ,25301776 Adjusted R²= ,19966188 F(1,14)=4,7421 p<,04703 Std.Error of estimate: 22528,					
N=16	b*	Std.Err. of b*	b	Std.Err. of b	t(14)	p-value
Intercept			120644,2	32845,82	3,673047	0,002508
Yield	0,503009	0,230989	27907,6	12815,59	2,177631	0,047029

Source: Author's calculation

Based on the obtained results shown in Table 9, we can form the following regression model:

$$\hat{Y} = 120.644{,}2 + 27.907{,}6X + \varepsilon$$

The obtained coefficients of regression (b) point to the high statistical significance of parameter β that profiles the independent variable representing the current year's sunflower yield. This variable has a positive direction, so it can be concluded that with a yield increase of one t/ha, the area under the sunflower can be expected to increase by 27,907.6 ha in the next sowing. As seen in Table 9**,** the coefficient of correlation is 0.50, and the coefficient of determination is 0.25%. The obtained coefficient of determination shows that 25% of the variability of the sowing structure, i.e., the area sown in the sunflower in the next year, can be explained by the impact of the current year's yield.

The following model shows the impact of the current year's soybean yield on the sowing structure in the next year. The analysis of variance was performed to assess the significance of the regression model as a whole (Table 10).

Table 10. Analysis of variance for the regression model: dependence of sowing structure on soybean yield

Effect	Analysis of Variance; DV: Area (Spreadsheet43)				
	Sums of Squares	df	Mean Squares	F	p-value
Regress.	5,411419E+09	1	5,411419E+09	7,445487	0,016315
Residual	1,017527E+10	14	7,268052E+08		
Total	1,558669E+10				

Source: Author's calculation

Based on the results of the analysis of variance for the observed regression model, we can conclude that the null hypothesis was rejected and the model was statistically significant ($p<0.05$).

The estimated parameters of the regression model of the dependence of the soybean sowing structure in the following year on the current year's yield are shown in the table below (Table 11).

Table 11. Regression model: dependence of sowing structure on soybean yield

N=16	Regression Summary for Dependent Variable: Area (Spreadsheet43) R= ,58922150 R²= ,34718198 Adjusted R²= ,30055212 F(1,14)=7,4455 p<,01631 Std.Error of estimate: 26959,					
	b*	Std.Err. of b*	b	Std.Err. of b	t(14)	p-value
Intercept			76174,50	38473,09	1,979942	0,067715
Yield	0,589221	0,215939	38015,95	13932,19	2,728642	0,016315

Source: Author's calculation

Based on the obtained results shown in Table 11, we can form the following regression model:

$$\hat{Y} = 76.174{,}50 + 38.015{,}95X + \varepsilon$$

The obtained coefficients of regression (b) point to the high statistical significance of parameter β that profiles the independent variable representing the current year's soybean yield. This variable has a positive direction, so we can conclude that with a yield increase of one t/ha, the area under soybean can be expected to increase by 38,015.95 ha in the next sowing. As can be seen in Table 11, the coefficient of correlation is 0.59, and the coefficient of determination is 0.35%. The obtained coefficient of determination shows that 35% of the variability of the sowing structure, i.e., the area sown in soybean in the next year, can be explained by the impact of the current year's yield.

Conclusions

During the study period from 2005 to 2021, the areas under the main field crops were relatively stable, except for sugar beet areas which decreased at a rate of 3.39% per year and soybean areas which increased at a rate of 3.78% per year. The yields of all crops, except for maize and soybeans, had an increasing tendency in the study period, and the total production increased for all crops, except for maize and sugar beet.

Following the aim of the research to determine how the current year's yields affect the sowing structure of the main field crops in the Republic of Serbia, five regression models were developed. The area under individual crops grown in the following year was taken as the dependent variable and the current year's yield of the same crop was the independent variable. Based on the results of the regression models, it was observed that in the case of wheat, sunflower and soybeans, the current year's yield had a statistically significant and positive effect on the sowing structure in the following year, while in the case of maize and sugar beet, no dependence was established between the current year's yield and the sowing structure of the following year.

Based on the values of the regression coefficients, we can conclude that with an increase in the wheat yield of one t/ha, we can expect that the area will increase by 32,566.7 ha in the following year. With an increase in sunflower yield by 1 t/ha, an increase in area by 27,907.6 ha can be expected in the following year, and with an increase in soybean yield by 1 t/ha, an increase in area by 38,015.95 ha can be expected in the following year.

The obtained results should prove useful to all interested parties in agribusiness and creators of agrarian policy.

References

1. Bošnjak, D., Rodić, V., Karapandžin, J. (2013). *Possibilities for the improvement of soybean production in Serbia*. Contemporary Agriculture, Vol. 62, No. 3-4, pp. 266-275.
2. Hadživuković S. (1991): *Statistical methods*, Faculty of Agriculture, Department of Agricultural Economics and Village Sociology, Novi Sad.
3. Ilić, I., Jovanović, S., Janković-Milić, V. (2016). *Forecasting maize production in Serbia using ARIMA model*. Economics of Agriculture, Vol. 63, No. 4, pp. 1141-1156.
4. Mutavdžić, B., Đorić-Nikolić, E. (2018): *Statistics (in veterinary medicine),* Faculty of Agriculture, Department of Agricultural Economics and Village Sociology, Novi Sad
5. Mutavdžić, B., Novković, N., Nikolić-Djorić, E., Radojević, V. (2006). *The influence of total production on sowing structure in some plant products*. Economics of Agriculture, Vol. 53, No. 2, pp. 389–401.

6. Novaković T. (2019). *Analysis of the gross added value of agriculture in the Republic of Serbia*. Economic ideas and practice, Vol. 32, pp. 39-55.

7. Novković, N., Vukelić, N., Janošević, M., Nikolić, S., Arsić, S. (2020). *Analysis and forecast of the production parameters of major cereal crops in Serbia*. Journal on Processing and Energy in Agriculture, Vol. 24, No. 2, pp. 45-49.

8. Novković, N., Mutavdžić, B., Ivanišević, D., Drinić, L., Vukelić, N. (2019). *Models for forecasting the price of wheat and maize in Serbia*. Journal on Processing and Energy in Agriculture, vol. 23, No.3, pp. 138-141.

9. Popović, R., Kovljenić, M. (2017). *The efficiency of wheat production in the Republic of Serbia*. Agricultural Economics, Vol. 64, No. 4, pp. 1499-1511.

10. Tekić, D., Mutavdžić, B., Užar, D., Novaković , T. (2019). *Analysis of sales of tobacco products in the Republic of Serbia and countries in the region.* Agroeconomics, Vol. 48, No. 85, pp. 11-17.

AGRICULTURAL INSURANCE – EXPERIENCES OF THE REPUBLIC OF SERBIA AND THE REPUBLIC OF Srpska

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Abstract

Agricultural insurance, in the current conditions of increasingly pronounced climate changes, can be considered a necessary agrotechnical measure. The aim of the paper is to analyze the current development of agricultural insurance in the Republic of Serbia and in the Republic of Srpska. For this purpose, a statistical, descriptive, as well as analysis and synthesis method is used. The authors conclude that both in the Republic of Serbia and in the Republic of Srpska, agricultural insurance is insufficiently developed, despite significant financial support from the state, as well as satisfactory offers on the agricultural insurance market. In both countries, the subjective need of agricultural farms for insurance is insufficiently expressed due to the fact that most farmers do not have a developed awareness of the importance of economic protection of their production or have bad experiences with insurers, related to inadequate damage assessment.

Key words: Agricultural insurance, agricultural holdings, development, Republic of Serbia, Republic of Srpska.

Introduction

Agricultural production is exposed to numerous risks, and is considered one of the riskiest economic activities. Plant production is particularly exposed to risks and they primarily relate to the risks of unfavorable weather conditions, which are increasing in conditions of increasingly pronounced climate changes. Risks in livestock production primarily relate to animal diseases and accidents. However, there are numerous other risks to which agricultural production is exposed.

The authors (Radović and Pejanović, 2015) divide agricultural risks into operational, financial, and market risks, but also include the potential risk of terrorism. In addition to production risks, the mentioned authors also include a drop in product quality due to inadequate storage conditions, transportation, lack of technical infrastructure, inadequate advisory services, and the input market. The cited authors also mention the most significant financial risks, namely: insufficient subsidies and agricultural loans, sudden changes in agricultural policy, untimely payments for sold products, etc. Market risks include sudden changes in prices of raw materials or finished products, unfair competition, lack of demand for certain products, as well as non-compliance with signed contracts by contractors. Also, the quoted authors warn that in the future, the risk of terrorism directed against the environment, as well as agro-terrorism, as one of the forms of terrorist activity, must not be ignored.

There are points of view in the literature (Vasiljević et al, 2020), which especially point out that in agriculture there is also a risk that the agricultural holding will not be able to settle its financial obligations within the required period due to the specifics of the production cycle and the slow turnover of capital. The group of authors (Jeločnik et al, 2019) believes that in agricultural production, the risk related to the labor force is increasingly present. This risk arises due to the fact that agricultural work must be done in a short time frame, which is optimal for that type of work, and that the lack of labor can cause a significant risk to agricultural production.

Bearing in mind the mentioned risks, it is clear that in order to realize agricultural production, especially in conditions of climate change, special attention must be focused on the development of the risk management system. At the global level, the most widespread system of risk management in agriculture is agricultural insurance. Therefore, the objective need for agricultural insurance is great. When analyzing the subjective need of farmers for the economic protection of their production, they most often emphasize the lack of financial resources as the reason for its insufficient application.

Based on the opinion of many authors, the costs of agricultural insurance are negligible in relation to the benefits it provides to the insured - agricultural producers. According to research results, (Počuča et al, 2013), insurance costs are very low and on average participate from 1.5% to 2% in the total costs of agricultural production. Older and more educated farmers more often decide to conclude an insurance contract (Finger, Lehmann, 2012).

Methodology

The aim of the paper is the analysis of current opportunities for development, as well as the analysis of the development of agricultural insurance in the Republic of Serbia and the Republic of Srpska. The authors start from the fact that agriculture is of great economic importance for both countries. The authors analyze the representation of agricultural insurance among agricultural holdings, bearing in mind that in both countries, they are the most numerous in the structure of agricultural entities. The research uses a statistical method, descriptive, as well as the method of analysis and synthesis.

The sources of data used in the research are legislative regulations, data from the Ministries of Agriculture, conditions for agricultural insurance of insurance companies, statistical data, as well as reports on the results of agricultural insurance in the Republic of Serbia and the Republic of Srpska.

Research results - opportunities for the development of agricultural insurance

Possibilities for the development of agricultural insurance in both countries are analyzed from the aspect of supply on the agricultural insurance market, as well as from the aspect of financial support of the state in terms of allocation from the agricultural budget for agricultural insurance premium regressions.

Possibilities for the development of agricultural insurance in the Republic of Serbia

In recent years, agricultural insurance is increasingly present in the offers of insurance companies operating on the insurance market in the Republic of Serbia. However, four insurance companies have a dominant share in this market segment. They are: Dunav osiguranje a. d. o, Belgrade, Đenerali osiguranje a. d. o, Belgrade, Triglav osiguranje a. d. o, Belgrade and DDOR Novi Sad a. d. o, Novi Sad.

By analyzing the legal regulations, it can be concluded that farmers can insure their plant production, i.e. crops and fruits, against basic and supplementary risks. The basic risks include: hail, fire and lightning, and the additional ones include: storm, flood, spring and autumn frost (Rule, 2017, 2018). According to the results of the research (Radović, 2018a), there is a satisfactory offer on the market for crop production insurance. The shortcoming is the non-coverage of the risk of drought, which, although it is officially represented in the offer of one insurer, is not applied in practice. Regarding the insurance of domestic animals, there is an adequate offer on the market for insurance against the most significant risks of livestock production. The limitation for the development of this type of insurance is a small livestock fund (Radović, 2018b).

Regression of the agricultural insurance premium from the agricultural budget has been in effect since 2006. Recourses for insurance premiums for crops, fruits, perennial plants, nurseries and animals are defined by the Law on Agriculture and Rural Development (Law, 2009, 2013, 2016) and the Law on Incentives in Agriculture and Rural Development (Law, 2013-2016). In accordance with the current legislation, recourses are paid in the amount of 40% of the paid agricultural insurance premium. Farmers who work in difficult business conditions have the right from 2019 to rebates in the amount of 45%, and those whose production is located in the area of the district where agricultural production is particularly threatened by bad weather, have the right to rebates of the insurance premium of 70%. These are: Moravički, Zlatiborski, Kolubarski, Šumadijski and Podunavski districts. Local self-governments can also participate in the co-financing of the costs of agricultural insurance premiums, with the possibility of cumulatively adding percentages, which reduces the amount of insurance costs to be paid by agricultural entities.

The right to agricultural insurance premium rebates, in accordance with the current Rulebook on the conditions, method and form of requests for exercising the right to incentives for insurance premiums for crops, fruits, perennial plants, nurseries and animals, have only registered agricultural holdings, which during the year can submit only one request. The request may include regressions of insurance premiums on several grounds, but in total, during one-year, agricultural subjects can collect a maximum of 2.5 million dinars from the agricultural budget, on this basis (Regulations, 2017, 2018). The Regulation on the distribution of incentives in agriculture and rural development defines the amount of funds reserved in the agricultural budget for agricultural insurance premium rebates every year. In the period from 2016 to 2021, on average, less than 1% of the agricultural budget was allocated for agricultural insurance premium regressions (Radović, Pejanović, 2022).

Possibilities for the development of agricultural insurance in the Republic of Srpska

According to the data of the Insurance Agency of the Republic of Srpska, four insurance companies based in the Republic of Srpska and four branches of insurance companies from the Federation of Bosnia and Herzegovina were active on the agricultural insurance market in the Republic of Srpska in 2021. Insurance companies based in the Republic of Srpska. the court. D. "Brčko-gas osiguranje", "Drina osiguranje" a.d., "Dunav osiguranje" a.d. and "Wiener Insurance" a.d. Branches of insurance companies from the Federation of Bosnia and Herzegovina are: "Asa osiguranje" d.d., "Adriatic osiguranje" d.d., "Croatia osiguranje" d.d. and "Sarajevo Insurance" d.d. (www.azors.rs.ba).

Based on the analysis of the general and special insurance conditions of the mentioned insurers, it can be concluded that they have satisfactory coverage of basic and supplementary insurable risks in agricultural production. Also, it can be concluded that "on the market of agricultural insurance in the Republic of Srpska there are conditions for development, viewed from the aspect of the size and assortment of the offer" (Radović, 2022).

Regression of the agricultural insurance premium from the agricultural budget has been in effect since 2010. Insurance premiums were subsidized in the amount of up to 30%, with a maximum of 30,000 KM per beneficiary (www. poljoprivredaiselo.com). In 2013, the Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska canceled the subsidization of the agricultural insurance premium, although the Regulation on Incentives for 2013 provided for these subsidies. According to some points of view, the reason for the Government's decision to abolish agricultural insurance premium subsidies was the weak interest of farmers in the economic protection of their production. On the other hand, farmers believed that insurers are to blame for the poor representation of agricultural insurance, that is, that the insurance conditions are unfavorable in the poor agricultural insurance market (www.capital.ba).

Table 1. Agricultural insurance premium returns and their participation in the agricultural budget in the Republic of Srpska in the period 2018-2021.

Year	Paid for recourse to agricultural insurance premiums (in KM)	Agrarian budget (in KM)	Participation of agricultural insurance recourse in the agricultural budget (in %)
2018	217,750.93	71,000,000	0.3
2019	261,705.60	71,000,000	0.4
2020	466,443.14	75,000,000	0.6
2021	391,155.74	75,000,000	0.5
Average participation in the agricultural budget:			0.4

Source: Agency for Agrarian Payments of the Republic of Srpska. Author's calculation.

In recent years, the relevant ministry renewed the subsidization of the agricultural insurance premium. Subsidies are paid in the amount of up to 50% of the agricultural insurance premium, and the amount of the subsidy per beneficiary cannot exceed 25,000 KM. According to the data shown **in table number 1,** it can be stated that in the analyzed period, the share of funds paid for agricultural insurance premium regressions in the agricultural budget varied from 0.3 to 0.6%, but the average was only 0.4%.

Research results - development of agricultural insurance

The development of agricultural insurance in the Republic of Serbia and Republic of Srpska is analyzed from the aspect of trends in the number and structure of agricultural insurance policies in the analyzed period, as well as the share of agricultural insurance premiums in total non-life insurance premiums. Also, the number of agricultural holdings that applied for agricultural insurance premium rebates in the observed period and the participation of this number in the total number of registered agricultural holdings are analyzed.

Development of agricultural insurance in the Republic of Serbia

Records on the number of agricultural insurance policies, as well as other types of insurance, are kept by the National Bank of Serbia.

Based on the data shown in table number 2, it can be concluded that the number of plant production insurance policies recorded growth, with slight fluctuations, in the entire analyzed period. The number of animal insurance policies had significant fluctuations, and in the last four years of the observed period, a continuous decline was recorded. In the structure of the total number of agricultural insurance policies, in the entire analyzed period, as well as the average, crop production insurance policies have a dominant share.

Table 2. Number of agricultural insurance policies 2006-2021.

Year	Number of crop production insurance policies	Number of animal insurance policies	Share of the number of plant production insurance policies in the total number of agricultural insurance policies (%)	Share of the number of animal insurance policies in the total number of agricultural insurance policies (%)	Total number of agricultural insurance policies
2006	9,351	2,278	80	20	11,629
2007	10,305	2,582	80	20	12,887
2008	15,186	2,250	87	13	17,436
2009	10,165	1,807	85	15	11,972
2010	11,172	1,212	90	10	12,384
2011	11,548	1,487	89	11	13,035
2012	14,871	5,259	74	26	20,130
2013	18,658	4,167	82	18	22,825
2014	19,768	5,466	78	22	25,234
2015	27,652	5,564	83	17	33,216
2016	28,749	5,313	84	16	34,062
2017	30,346	3,642	89	11	33,988
2018	39,212	4,506	90	10	43,718
2019	45,093	4,472	91	9	49,565
2020	42,603	3,376	93	7	45,979
2021	45,297	3,280	93	7	48,577
Total:	379,976	56,661	87	13	436,637

Source: National Bank of Serbia. Author's calculation.

Analyzing the data shown in table number 3, it can be concluded that in the observed period, with minor fluctuations, there was an increase in the share of the total agricultural insurance premium in the total non-life insurance premiums. The average participation, for the period 2006-2021, was 3.91%.

The above data points to the fact that agricultural insurance does not have a significant position on the non-life insurance market in the Republic of Serbia. When the data is analyzed by individual years, we notice that in 2021 the stated share was the highest, but also that since 2015, a continuous increase in the share of total agricultural insurance premiums in total non-life insurance premiums has been recorded. This leads to the conclusion that in the last seven years of the analyzed period, the growth of the agricultural insurance market in the Republic of Serbia was recorded.

Table 3. Share of agricultural insurance premium in total on-life insurance premiums 2006-2021.

Year	Total agricultural insurance premium (in 000 RSD)	Total non-life insurance premium (in 000 RSD)	Share of the total agricultural insurance premium in the total non-life insurance premium (in %)
2006	1,021,428	34,283,087	2.98
2007	1,268,080	39,840,510	3.18
2008	1,616,455	45,839,596	3.53
2009	1,124,236	45,653,453	2.46
2010	1,077,053	47,168,218	2.28
2011	1,238,126	47,321,292	2.62
2012	1,564,760	49,608,308	3.15
2013	1,909,174	49,976,051	3.82
2014	2,044,639	53,399,931	3.83
2015	2,194,861	61,561,494	3.56
2016	2,653,992	66,010,278	4.02
2017	2,970,456	70,336,633	4.22
2018	3,371,427	76,121,610	4.43
2019	3,791,729	82,385,409	4.60
2020	4,166,001	83,753,833	4.97
2021	5,042,558	92,297,462	5.46
Total:	37,054,975	945,557,165	3.91

Source: National Bank of Serbia. Author's calculation.

The total number of paid claims of agricultural holdings for agricultural insurance premium rebates, by year, in the period 2016-2021. it is shown in table number 4.

Table 4. Number and amounts of paid subsidy requests agricultural insurance premiums 2016-2021.

Year	Number of claims paid	Total disbursed funds (in RSD)
2016	20,112	580,220,156.22
2017	22,171	603,349,470.96
2018	22,475	683,040,250.63
2019	16,303	609,933,174.90
2020	28,100	1,252,880,000.00
2021	28,738	1,218,904,661.45

Source: Directorate for Agrarian Payments of the Ministry of Agriculture, of Forestry and Water Management of the Republic of Serbia.

Analyzing the data presented in table number 4, we observe the illogicality that in 2019, when the percentage of agricultural insurance premium recourse was significantly increased (from 40% to 70% in five administrative districts), the number of requests for agricultural insurance premium recourse was reduced by 27%.

Bearing in mind that according to the current regulations, an agricultural holding registered in the Republic of Serbia has the right to submit only one request for recourse during the calendar year, the number of paid requests is equal to the number of agricultural holdings that have exercised the right to recourse to the agricultural insurance premium in certain years of the analyzed period. If we start from the logical belief that all agricultural farms that ensure their production used the right to recourse, we can conclude that in 2021, as the last analyzed year, only 9.5% of the total number of registered agricultural farms insured their production. The above conclusion is based on the latest published data of the Republic Institute of Statistics, according to which there are 301,028 registered agricultural farms in the Republic of Serbia (Group of authors, 2018).

Development of agricultural insurance in the Republic of Srpska

The Insurance Agency of the Republic of Srpska keeps records of the number of policies of all types of insurance, including agriculture. The data presented in tables number 5, 6 and 7 include the overall data on agricultural insurance for the insurance market of the Republic of Srpska. The data includes the number of agricultural insurance policies and the calculated premium of agricultural insurance and insurance companies based in the Republic of Srpska and branches of insurance companies whose headquarters are in the Federation of Bosnia and Herzegovina and which operate on the market of agricultural insurance in the Republic of Srpska.

The movement of the total number of agricultural insurance policies and their structure, in the period 2014-2021, are shown in table number 5**.** Based on the data presented, it can be concluded that the total number of crop production policies and insurance, and especially animal insurance, recorded significant fluctuations in the analyzed period. When their total average participation is analyzed, it is stated that the number of animal insurance policies has more than twice the participation in the total number of agricultural insurance policies in the Republic of Srpska in the analyzed period.

Table 5. Number of agricultural insurance policies 2014-2021.

Year	Number of crop production insurance policies	Number of animal insurance policies	Share of the number of plant production insurance policies in the total number of agricultural insurance policies (%)	Share of the number of animal insurance policies in the total number of agricultural insurance policies (%)	Total number of agricultural insurance policies
2014	53	103	34	66	156
2015	131	96	58	42	227
2016	335	1,056	24	76	1,391
2017	245	1,174	17	83	1,419
2018	330	1,445	19	81	1,775
2019	253	83	76	24	336
2020	288	53	84	16	341
2021	256	35	88	12	291
Total:	1,891	4,045	32	68	5,936

Source: Insurance Agency of the Republic of Srpska. Author's calculation.

Based on the data presented in table number 6, the data on the total premiums of agricultural insurance and their participation in the total premiums of non-life insurance are presented.

Table 6. Share of agricultural insurance premiums in total non-life insurance premiums 2014-2021.

Year	Total agricultural insurance premium (in KM)	Total non-life insurance premium (in KM)	Share of the total agricultural insurance premium in the total non-life insurance premium (in %)
2014	593,083	144,101,451	0.4
2015	555,416	152,208,722	0.4
2016	1,302,413	165,468,861	0.8
2017	1,117,321	178,431,097	0.6
2018	1,218,939	188,306,600	0.6
2019	825,178	193,200,598	0.4
2020	1,342,529	192,658,164	0.7
2021	1,085,081	204,830,704	0.5
Total:	8,039,960	1,419,206,197	0.6

Source: Insurance Agency of the Republic of Srpska. Author's calculation.

Based on the analysis of the data presented in table number 6, it can be stated that in the analyzed period the average share of total agricultural insurance premiums in total non-life insurance premiums was only 0.6%. The mentioned data testifies to the very small participation of agricultural insurance in the insurance market of insurance companies operating in the territory of the Republic of Srpska.

Table 7. Number of agricultural holdings that have obtained the right to agricultural insurance premium rebates in 2018-2021.

Year	**Number of agricultural of the farms that exercised the right to the premium rebates of the Farm. Insurance**	**Total number of registered agricultural holdings**	**The participation of the number of farmers which have exercised the right to recourse in the total number of reg.agric.holdings (%)**
2018	195	42,829	0.5
2019	119	40,502	0.3
2020	153	41,085	0.4
2021	132	40,305	0.3

Source: Agency for Agrarian Payments of the Republic of Srpska. Author's calculation.

In the analysis of the representation of agricultural insurance among agricultural farms, we start from the fact that all agricultural farms, which insured their production and used the right to recourse to agricultural insurance premiums. Based on the data, whose source is the Agency for Agrarian Payments of the Republic of Srpska, and which are shown in table number 7, it can be stated that there was a decline in the number of agricultural farms that insured their production in the total number of registered agricultural farms in the last, in relation to the first year of the analyzed period. Therefore, neither the significant regressions of the agricultural insurance premium, nor the solid conditions for agricultural insurance, offered by insurers, had a significant impact on the interest of farmers in the economic protection of their production.

Conclusion

Based on the conducted research, it can be concluded that both in the Republic of Serbia and in the Republic of Srpska there are conditions for the development of agricultural insurance, but that it is insufficiently developed.

There is an adequate offer on the agricultural insurance market, and the state regresses insurance premiums, up to 50% in the Republic of Srpska, and from 40% to 70% in the Republic of Serbia. Despite the above, a small number, in relation to the total number of registered agricultural farms, ensures its production, and the total premium of agricultural insurance has a small share in the total premiums of non-life insurance. Specifically, in the Republic of Serbia, agricultural holdings that ensure their production make up 9.5%, and in the Republika Srpska, 0.3% of the total number of registered agricultural holdings. The share of the total premium of agricultural insurance in the total premium of non-life insurance in the Republic of Serbia is about 4%, and in the Republic of Srpska 0.6%. Based on the results of the research, it can be concluded that there is a difference in the structure of agricultural insurance policies. In the Republic of Serbia, crop production insurance policies have a dominant share (about 90%), and in the Republic of Srpska animal insurance policies (about 70%).

In order to further develop agricultural insurance in both countries, it is necessary to influence the development of demand on the agricultural insurance market. In order to achieve this, continuous education of farmers is needed, through which the development of their awareness of the importance of agricultural insurance, which in the current conditions of climate change, takes on the importance of a regular agrotechnical measure, would be influenced. On the other hand, a correct attitude of the insurer is needed, in terms of timely intervention when the insured event occurs, objective assessment and compensation of damages, because this is also a significant cause that leads to mistrust of farmers and insufficient application of agricultural insurance.

References

1. Agency for Agrarian Payments of the Republic of Srpska, https://www.vladars.net/sr-SP-Cyrl/Vlada/agencije/aap/Pages/default.aspx.
2. Insurance Agency of the Republic of Srpska, http://www.azors.rs.ba/azors/index.html.
3. Finger R, Lehmann N (2012): *The influence of direct payments of farmers' hail insurance decisions*, Agricultural Economics, No 43, pp. 343-354.
4. Grupa autora (2019): Anketa o strukturi poljoprivrednih gazdinstava, 2018: Struktura, ekonomska snaga i marketing proizvoda poljoprivrednih gazdinstava, Republički zavod za statistiku, Beograd, Republika Srbija (dostupno na: https://www.stat.gov.rs/publikacije).
5. Jeločnik M, Zubović J, Zdravković J. (2019): *Estimating efect of weather* factors on wheat yields by using panel model approach – The case of Serbia, Agricultural water management, Vol 221, pp. 493-501.
6. National Bank of Serbia, https://www.nbs.rs/export/download/osg-izv-y/god.pdf).
7. Počuča M, Petrović Z, Mrkšić D. (2013): *Insurance in Agriculture*, Economics of Agriculture, 1/60, pp. 163-177.
8. Pravilnik o uslovima, načinu i obrascu zahteva za ostvarivanje prava na podsticaje za premiju osiguranja useva, plodova, višegodišnjih zasada, rasadnika i životinja, Službeni glasnik Republike Srbije, br. 61/2017, 44/2018 – dr. zakon.
9. Radović V, Pejanović R. (2015): Rizici u poljoprivredi, Poljoprivrednikov poljoprivredni kalendar 2015, Dnevnik-Poljoprivrednik AD, Novi Sad, str. 59-62.

10. Radović G (2018a): Komparativna analiza posebnih uslova za osiguranje biljne proizvodnje na tržištu poljoprivrednog osiguranja u Srbiji. Tokovi osiguranja, broj 1/2018, str. 75-94.

11. Radović G (2018b): Uporedna analiza posebnih uslova za osiguranje životinja na tržištu poljoprivrednog osiguranja u Srbiji. Tokovi osiguranja, broj 3/2018, str. 81-98.

12. Radović G, Pejanović R. (2022): Osiguranje poljoprivrede u Srbiji u uslovima pandemije Covid – 19, Ekonomska politika u Srbiji i svetu u uslovima nezavršene pandemije, rastućih deficita budžeta, puzajuće inflacije i štampanja novca, Naučno društvo ekonomista Srbije sa Srpskom akademijom nauka i Ekonomski fakultet u Beogradu, Beograd, str. 75-88.

13. Radović G. (2022): Osiguranje poljoprivrede u Republici Srpskoj, Tokovi osiguranja br. 2/2022, str. 75-84.

14. Directorate for Agrarian Payments of the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia (www.uap.gov.rs).

15. Vasiljević Z, Radović G, Kovačević V. (2020): Inovacije u upravljanju rizicima u poljoprivredi. Naučni skup: Značaj razvojnih istraživanja i inovacija u funkciji unapređenja poljoprivrede i šumarstva Srbije, Akademija inženjerskih nauka Srbije – AINS, Beograd, Zbornik radova, str. 120-128.

16. Zakon o poljoprivredi i ruralnom razvoju, Službeni glasnik Republike Srbije br. 41/2009, 10/2013 – dr. zakon i 101/2016.

17. Zakon o podsticajima u poljoprivredi i ruralnom razvoju, Službeni glasnik Republike Srbije br. 10/2013, 142/2014, 103/2015, 101/2016.

18. http://poljoprivredaiselo.com/2010/06/zasto-poljoprivrednici-zaobilaze-osiguranje.

19. http://www.capital.ba/ukinuti-podsticaji-za-osiguranje-imanja.

20. http://www.capital.ba/ukinuti-podsticaji-za-osiguranje-imanja.

CONCEPTUAL BLOCKCHAIN MODEL FOR HONEY SUPPLY CHAIN SYSTEM

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Abstract

Increased global demand for honey has encouraged fraud. In order to better monitor the honey supply chain and prevent frauds, in this paper is created a traceability scheme for honey processing and trade in Serbia, based on which a conceptual blockchain model for the honey supply chain system was proposed. This research can contribute to the improvement of the electronic record system designed to ensure the traceability of honey through the proposed blockchain-based conceptual model. The concept covers the monitoring of honey through the stages of production, processing and distribution in order to improve the implementation of good production and processing practices through smart monitoring. Through information and relevant images provided by beekeepers, consumers receive additional information about the origin of honey, which is of great importance for today's consumers.

Key words: Honey supply chain, blockchain, system

Introduction

Honeybee colonies are essential for agriculture and the environment. The great importance of honey and honey products is reflected in its nutritional composition and medicinal properties. Since the eighties of the last century, the production of honey in the world has been constantly increasing. The EU plan is to spend €240 million on national apiculture programs in the EU for the apiculture years 2020-22, which is an increase of 11% compared to the funding available for 2017-19. According to the European Commission pilot study (2022), new bee diseases are appearing, under the influence of intensification of agricultural practices as well as climatic changes and globalisation.

The demand for honey is increasing, especially with the rising demand from consumers and popularity of honey-based pharmaceutical and cosmetic products. It is estimated that this is the fastest growing market for honey. As a consequence of increase in global demand for honey, various frauds appear.

“Honey fraud is a threat to national food security.”[1] Great efforts are being made to increase the level of technology used in honey production and packaging. However, practices that can result in the contamination of honey and related products are still used. Furthermore, different formats are used to record the various production, processing and distribution procedures, without any standardization, which makes it impossible to ensure proper product traceability. The absence of standardization prevents or makes product traceability very difficult. This paper proposes a concept based on blockchain technology that can improve the traceability of the honey records.

Honey is mainly traded in spot markets, either by direct sale to consumers or by sale to customers (mead houses or retailers). The high administrative costs of contracting with a large number of small producers encourage contracting with bigger players. In their research (Shrestha et al., 2017) analysed honey value chain in Lamjung District of Nepal and came to know about the horizontal and vertical linkages among the value chain operators. It is spotlighting a relatively short chain from producers and ending in consumers and includes actors like input suppliers and service providers, producers, wholesalers, retailers and consumers. it is insufficient numbers of researches dealing with the analysis of honey supply Serbia. Research by Ignjatijević et al. (2015) pointed that honey sales channels are not sufficiently developed in Serbia.

In the literature, many models based on blockchain technology have been proposed in the function of food supply chain monitoring (Ehsan et al., 2022; Pandey et al., 2022). Rünzel et al. (2021) proposed smart agricultural system that can improves food security and food safety, and reduces honey fraud. Image-based traceability system is built on blockchain technology with pollen signature verification with the help of machine learning algorithms. Image-based traceability of the honey is suggested in the work of He et. al (2018).

In this paper we proposed conceptual Blockchain Model for Honey Supply Chain System for Serbia.

Honey market and honey fraud

The main product of the beekeeping industry is honey. It is very hard, to obtain data on the production of pollen, royal jelly, wax and other related products. China is the biggest producer of honey, with approximate 500.000 tonnes, followed by the EU (near 240.000 tonnes) and Turkey (over 100,000 tonnes) in 2020. Russia and Ukraine participate with 4% each of the Word productions. The EU imports the most honey, scooping up 200,000 tonnes. Main EU honey suppliers are Ukraine (31,1%), China (27,7%) and then Mexico with 8,9% in 2021. This structure will certainly be changed in 2022.

[1] Norberto Garcia, Chairman of the U S Pharmacopeia Expert Panel on Honey Quality and Authenticity (As told to the Economist)

Honey from Serbia is of excellent quality thanks to favourable climatic conditions and diverse flora. Serbia is a relatively small country, so the international market is an important element of a good economy and successful beekeeping production. In order to increase exports, and thereby increase domestic production, in 2007, the Ministry of Agriculture included for the first-time honey among the products that are subject to production subsidies. Beekeeping technology has advanced in the Republic of Serbia, which can be seen from the increase in the number of hives. Until now, the beekeeping area received help from the state for massification, but now it is necessary to take certain measures to help the development of beekeeping as an economic activity. For the further development of this sector, greater placement on foreign markets is needed, which is why both a good reputation of honey and its traceability are needed.

Frauds in production and other honey supply chain processes are different. It is often deliberately labelled and adulterated (dilution of honey using for example corn syrup, with banned chemicals like antibiotics or pesticides etc.). The quality of honey can also deteriorate due to improper technological processes of obtaining, processing and storing it, such as heating at a high temperature, storing in unfavourable conditions, pollution (location of hives in densely urbanized or industrialized zones, including agricultural pesticide use), etc. Furthermore, the practice is to use old and dark combs and/or brood combs for higher acidity and faster aging, use of combs with residual honey from a previous year (possibility of faster fermentation; premature crystallization, contamination of unifloral honeys). The problem of adulteration is not only in adulterated honey but in the export of the methods for adulterating honey.

In “Honeygate” scandal Chinese honey was being transhipped through Germany (and thereby labelled as German honey) and imported to the USA by a number of food suppliers (Graham, 2011; Swaine, 2013). It is interesting to mention that at Apimondia 2019, the prestigious World Beekeeping Congress held in Canada, in the competition for the best honey there was 46% counterfeit honey. “Fake honey” has presented a challenge for governments and reputational concerns for some of the biggest honey producers.

Large retail chains procure honey from large buyers. Often, such honey is a mixture of honey from several producers, so consumers who want varietal honey from a well-known beekeeper will not go to the supermarket, but will look for it at the local apiary. Beekeepers must try to convince consumers they have a clean, healthy, natural product.

There are different types of forgeries. Some can be detected based on the analysis of basic physicochemical parameters according to the rulebook, while the detection of some others requires more complex analyzes and more expensive equipment. There is no universal method for detecting counterfeits. We can only talk about the methodology, the combination of several methods and the comprehensive analysis of the results obtained.

As clearly described in the Apimondia Statement on Honey Fraud (Apimondia, 2020), the preservation of honey quality and purity becomes absolutely essential for the sustainability of the honey chain whose foundation begins with beekeepers. Apiculture programmes in EU for 2020-22 were approved by EU Implementing Decision 2019/974 in all EU countries. Under the EU programmes, eight specific measures are eligible for funding, for technical assistance for beekeepers, combatting beehive invaders and diseases, rationalization of transhumance, analyses of apiculture products, restocking of hives, applied research, market monitoring, enhancement of product quality.

Proposed model

A value chain refers to the full range of activities required to bring a product or service from conception through the different phases of production, delivery to consumers and disposal after use (Kaplinsky and Morris, 2001). Value chain mapping can be complex due to some actors are involved at several activities (Roduner, 2004). A beekeeper can be a producer, consumer and a trader and is involved in few chains. Moreover, mapping of a value chain leads to identification of the principal functions at each stage, agents arraying out these functions and principal products developed.

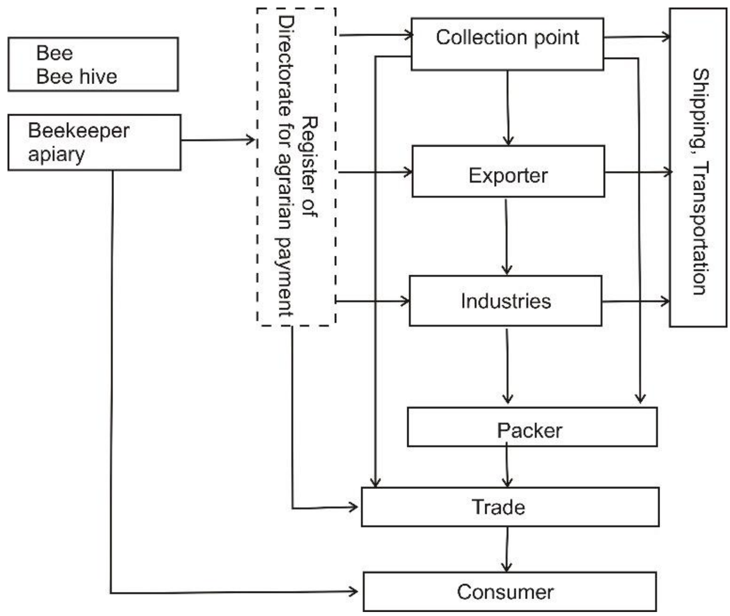

Figure 1. Traceability of honey processing and trade

In Serbia, it is obligatory for a beekeeper to register as an agricultural farm if he intends to participate in those chains. Before that, it is necessary to do an analysis of honey in certified laboratories. On the other hand, it is a very common case of direct cooperation between beekeepers and consumers with lack of laboratory analysis of honey. With some types of honey (acacia, lavander), deviations from the values of the evaluation indicators are allowed. In addition, monofloral types of honey (acacia, lavender, linden, etc.) are more expensive, and this requires proof of plant origin by microscopic examination. Such an examination of honey was first carried out by Pfister in 1895, but in recent decades interest in this method has grown especially due to the great possibilities it provides for determining both the geographical and plant origin of honey, as well as its quality and purity. Microscopic analysis of honey is used for the following determination: quantity and composition of sediments (solid insoluble ingredients), geographical origin and botanical origin.

Nowadays, applications and microscopes are available at affordable prices for smart phones that are widely used, and the proposed model suggests their use for the purpose of traceability of honey. In addition, consumers are increasingly demanding, and are interested in the origin of honey. Smartphones can be used to provide information in the form of images about area, bee hive, pollen, origin, weather, etc. More details about microscopic pollen image analysis can be find in He et al. (2019).

Blockchain is a set of contemporary technologies that in synergy create a network that ensures trust among users. Blockchain is a decentralized and distributed database in which data cannot be changed or deleted and which enables the verification of transactions. The main parts of blockchain are block, chain and network. Cryptographic techniques enable encryption of all important data records in the blockchain, important for consistent data and record integrity.

A block is a list of transactions recorded in a book/register over a period of time. Transaction data is stored on various computers on the network, which are connected using the peer-to-peer protocol. The registry consists all transactions between participants chronologically. The network consists of "full nodes". The function of nodes is to continuously check the authenticity of records in the chain, and in the case of verification fail, to reject the proposed data blocks.

The approach of selecting an initially valid block of transactions is called proof-of-work which protects the network from abuse. In the end, the validated block gets its own unique timestamp and signature (hash), and as such is propagated to other nodes in the network. As adding validated block, the certificate counter for previously blocks increases and the probability that they are false decreases further. The reliability of the recorded data increases over time.

The process ensures that each block is formed in such a way that the previous and the next are irrefutably linked, and constricting blockchain. A chain is a hash that connects blocks. A hash is formed from the data previously present in the block. A hash can be thought of as a fingerprint of data locked into blocks based on order and time. Hash function creates an algorithm to map data of any size to a set of fixed-size bits.

Even if only one symbol is changed the algorithm will produce different hash value. SHA256 algorithm generates an almost-unique, fixed size 256-bit (32-byte) hash. The SHA (Secure Hash Algorithm) is one of many cryptographic hash functions. Examples of hashes are given below. It is noticed that if only one letter is changed, the algorithm produces a different hash value. The SHA256 algorithm generates an almost unique 256-bit (32-byte) fixed-size hash.

Example of SHA256:

moj med

4df2af8645dbd1f83f16a6639487db9f5791259f64c9358afb5e0bc1f26fac2d

Moj med

e5f2b75f47230ad08ec3ee91930e8865883a6bb71f337fd8a81736961c8e05db

my honey

9db37284dcf0f16d4c12441d813dc27fbad07b8b14bf90039f1239b2f7ef784b

My honey

89a3db5c54730ffd2afdbab7e1527c998f58b03bafdbe6aeb5292d45361a7994

Blockchain process is illustrated on the next figure.

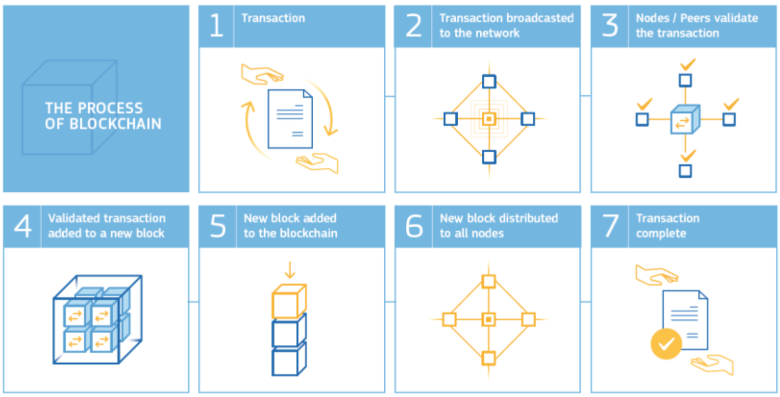

Figure 2: The Blockchain process

Source: European Union (2019).

The advantages provided by the application of blockchain technology in different domains is a combination of key features: decentralization, immutability, transparency and security. Proposed concept described below has the advantage of proving honey authentication at the beginning of the process rather than trying to identify adulterated honey at the end of the process.

The system starts with collecting data during production. Beekeeper uploads the detail document to the network. To register, the beekeeper sends a message to the system from a verified communication platform. According to the valid national regulations, honey is labelled in accordance with the Rulebook on the quality of honey and other bee products and the Rulebook on the declaration, labelling and advertising of food. The declaration states whether the honey is flower (nectar) or honeydew by origin, filtered according to the method of production, etc. Additional information on the plant species, regional origin or some special quality characteristic can also be stated.

After registration, in the quick access, in addition to identification data, information on the number of hives and yard, and the type of beekeeper is recorded, as well as a certificate if the beekeeper has it. Additional information can be complementary attributes, for example the type of honey processing, rewards, or other information that the beekeeper finds useful. In the next stage, the beekeeper can upload pictures of the apiary, the environment, the floral source, etc. The blockchain records the transactions relating to this information, images, results of analysis and certification.

Figure 3. Proposed conceptual model

In the second phase, depending on the desired process (see figure 1), flow data is recorded in the blockchain (figure 3). For example, some processor in the system can place a purchase order directly to beekeeper and can oversee the smart contract. Approval procedure is actually the execution of smart contracts and sending the outcome results further in the network to check the veracity and reach a consensus (Bjelobaba et al., 2022). In case of agreement of both parties, the distributor (or beekeeper) ships the orders to the consumer. Information about transportation (shipping) uploading by distributor. Similar process is with intermediaries in the chain, where retailers sell honey to consumers.

System transactions are stored in the blockchain as the central system point, and all the participants involved in the system interact with the blockchain (Bjelobaba et al., 2022). All transactions and information are recorded, so that the end user can see them. Smart contracts permit communication between two sides. A smart contract embeds the terms of the contract in a combination of hardware and software, making them difficult to breach and prohibitively expensive. Therefore, smart contracts increase security by reducing attacks. In other words, a smart contract automates processes in blockchain technology. The application of blockchain technologies ensures data authenticity.

In this concept is possible to introduce cryptocurrency or sustainability tokens through blockchain technology. The introduction of cryptocurrency can help in maintain and developing the system, but it also brings specific problems in implementation, such as regulatory policies. One more problem of implementation of the system is the low level of knowledge of blockchain technology and therefore lack of trust in this technology. Additionally, blockchain technology generally brings high operating costs and high-power consumption. New solutions bring possibility to implement green blockchain solutions consensus mechanism (Varavallo et al. 2022) based on minimal computational power.

Conclusion

The proposed concept brings the possibility of reducing fraud through smart tracking of the honey supply chain. Additional value is obtained through information about the beekeeper, apiary, area, relevant images as a universal tool of communication and other relevant information. In addition, today's consumers want additional information about the origin of honey, which can be achieved through the proposed system concept.

However, some limitation remains related to privacy and transparency of data, costs of implementations, limitations of the regulatory framework and willingness to use new technologies. The lack of funds for implementing the new technologies is the main problem, especially in low-income countries and developing countries where funding for agriculture is still relatively low.

References

1. Apimondia (2019): *Apimondia statement on Honey fraud*, Apimondia (available at: https://www.apiservices.biz/documents/articles-en/apimondia_statement_on_honey_fraud_v_2.pdf
2. Bjelobaba, G., Paunovic, M., Savic, A., Stefanovic, H., Doganjic, J., Miladinovic Bogavac, Z. (2022): *Blockchain Technologies and Digitalization in Function of Student Work Evaluation*, Sustainability, vol. 14 no. 9:5333. https://doi.org/10.3390/su14095333
3. Ehsan, I., Irfan Khalid, M., Ricci, L., Iqbal, J., Alabrah, A., Ullah, S.S., Alfakih, T.M. (2022): *A Conceptual Model for Blockchain-Based Agriculture Food Supply Chain System*, Scientific Programming, vol. 2022, Article ID 7358354. https://doi.org/10.1155/2022/7358354
4. European Commission (2022): European honey Bee breeding and Selection Team, Restructuring of the honey bee chain and varroa resistance breeding and selection programme, Brussels, Belgium. https://ec.europa.eu/info/news/beekeeping-sector-results-pilot-study-honey-bee-selection-2022-mar-15_en
5. European Union (2019): Blockchain now and tomorrow. Assessing multidimensional impacts of distributed ledger technologies. Luxembourg: Publications Office of the European Union.
6. Graham, N. (2011): *Honey laundering conspiracy is largest food fraud in US history*, Huffpost (available at:

https://www.huffingtonpost.com/2011/01/07/honey-laundering-conspira_n_805707.html)

7. He, P. Glowacki, G., Gkantiragas, A. (2019): *Unsupervised Representations of Pollen in Bright-Field Microscopy*, presented at the Thirty-sixth International Conference on Machine Learning, Workshop on Computational Biology, Long Beach Convention Center, Long Beach.
8. He, P., Glowacki, G., Gkantiragas, A. (2018): *Honey Authentication with Machine Learning Augmented Bright-Field Microscopy*, presented at the 32nd Conference on Neural Information Processing Systems (NIPS 2018), Montréal, Canada.
9. Ignjatijević, S., Ćirić, M., Ĉavlin, M. (2015): *Analysis of honey production in Serbia aimed at improving the international competitiveness*, Custos e Agronegocio, vol 11, no.2, 194-213.
10. J. Swaine. (2013):'Honeygate' uncovered in US sting, The Telegraph UK (available at: https://www.telegraph.co.uk/news/worldnews/northamerica/usa/9886508/Honeygate-uncovered-in-US-sting.html)
11. Kaplinsky, R., Morris, M. (2001): *A handbook for value chain research*, vol. 113, Ottawa: IDRC.
12. Pandey, V., Pant, M., Snasel, V. (2022): *Blockchain technology in food supply chains: Review and bibliometric analysis*, Technology in Society, vol. 69, 101954, https://doi.org/10.1016/j.techsoc.2022.101954.
13. Roduner, D. (2004): *Report on Value Chains: Analysis of existing theories, methodologies and discussions of value chain approaches within the development cooperation sector*, prepared for SDC by Daniel Roduner. LBL.
14. Rünzel, M. A. S., Hassler, E. E., Rogers, R. E. L., Formato, G, Cazier, J.A. (2021): *Designing a Smart Honey Supply Chain for Sustainable Development*, IEEE Consumer Electronics Magazine, vol. 10, no. 4, pp. 69-78, doi: 10.1109/MCE.2021.3059955.
15. Shrestha, S., Pandey, B., Mishra, BP. (2017): *Honey value chain Analysis - A case study of gahate Village, Lamjung District of Nepal*, International Journal of Multidisciplinary Research and Development, vol. 4, Issue 6, pp. 107-112.
16. Varavallo, G., Caragnano, G., Bertone, F., Vernetti-Prot, L., Terzo, O. (2022):*Traceability Platform Based on Green Blockchain: An Application Case Study in Dairy Supply Chain*. Sustainability**,** vol. *14*, 3321. https://doi.org/10.3390/su14063321.

INFLUENCE OF AQUATIC EXTRACT BANANA AND NEETLE WITH COMMON COMFREY COMBINATION ON WEIGHT OF PLANTS AND WEIGHT OF 1000 GRAINS SOYBEANS

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Abstract

Aqueous plant extracts contain nutrients and physiologically active substances that affect plant growth and development. they are easy to prepare and apply, and many aqueous extracts have fungicidal action and repellent action on pests. The aim of this research is to analyze the impact of the application of aqueous extracts of banana and nettle with comfrey on plant weight and weight of 1000 grains in three soybean cultivars. In both years of research, aqueous extracts of banana and nettle with comfrey statistically significantly increased the weight of plants and the weight of 1000 soybeans.

Key words: Soybean, weight of plants, second, year, variety.

Introduction

Fertilizing soybeans with different fertilizers is a continuous research challenge (Miladinov et al., 2018). For proper fertilization of soybean crops, we must know the characteristics and agrochemical properties of the soil, the plants' nutrient needs, climatic conditions, crop rotation, application of manure and Fertilizing soybeans with different fertilizers is a continuous research challenge (Miladinov et al., 2018). For proper fertilization of soybean crops, we must know the characteristics and agrochemical properties of the soil, the plants' nutrient needs, climatic conditions, crop rotation, mineral fertilizers, plowing of the harvest residues of the pre-crops, the intensity of production on the plot in previous years, the yield of the pre-crops and the expected yield of soybeans (Mamlić et al., 2021). Aqueous extracts of plant material, in addition to macro and microelements, also possess physiologically active substances that stimulate the growth and development of plants, often have fungicidal and insecticidal effects, are easily prepared on the farm, do not require large investments and are suitable for organic production since their application has no negative effect on environment. Nettle is suitable for making extracts because it has fungicidal and insecticidal effects, and when fermented it becomes a significant source of nutrients for plant nutrition through feeding (Dozet et al., 2019), it also contains growth stimulators (Di Virgilio 2013), and the banana fruit is rich in potassium, phosphorus, calcium, manganese, magnesium, selenium, contains vitamins C and B and vitamin A.

The weight of the plant and the weight of 1000 soybeans are morphological traits that directly affect soybean yield. In recent decades, climate changes have been observed in the form of an increase in average daily temperatures in the vegetation and on an annual basis, with increasing precipitation oscillations, i.e. alternating rainy and extremely dry years, and these conditions are very unfavorable for soybean production (Đukić et al., 2018). Oscillations of yield and morphological traits in certain years confirm that weather conditions during the growing season have a great influence on soybean yield (Đukić, 2009; Đukić et al., 2018, Miladinov et al., 2018a; Dozet et al., 2019; Đukić et al., 2019). , 2019).

The aim of this research is to investigate the influence of water extract of banana and water extract of nettle with comfrey in different years and in three different varieties on the weight of plants and the weight of 1000 soybeans.

Material and methods

In order to study the effect of foliar application of aqueous extracts of banana and nettle with comfrey on the mass of plants and weight of 1000 grains, an experiment was set up on the plots of the Institute for Crop and Vegetable Agriculture in Rimski šančevi during 2020 and 2021. The experiment was set up in four repetitions, with three varieties differing in the length of the vegetation period (Valjevka, Sava and Rubin) and four variants of fertilization (control, control with water where the amount of water applied foliarly is identical to the amount of water extracts, foliar application of water extract of banana fruit and aqueous extract of nettle with comfrey). Aqueous extracts were prepared from 1 kg of plant material (ripe banana fruits (*Musa x paradisiaca*), i.e. 0.75 kg of the above-ground part of the nettle (*Urtica dioica*) and 0.25 kg of the above-ground part of the comfrey (*Symphytum officinale*)), the plant material was chopped, poured with 10 liters of rainwater and with daily stirring we waited for the end of fermentation. Aqueous extracts were filtered and diluted with water in a ratio of 1:15 before use. The basic plot was 10m ^{2} in size, and fertilizing with NPK nutrients was done based on soil analysis (300 kg ha^{-1} NPK fertilizer 8:15:15). In the stage of technological maturity, ten plants were taken from the central part of each plot for morphological analysis, the mass of the plants and the weight of 1000 grains were measured. The results were processed by the analysis of variance of the three-factorial experiment (Statistical program "Statistica 10"), and the significance of the differences was tested by the LSD test. The results are tabulated.

Results and discussion

Temperatures and precipitation for the examined years are shown in Table 1.

Table 1. Weather conditions in the examined years

	Average monthly temperatures (°C)			Precipitation (l m-2)		
Month	2020	2021	Long-term average 1964-2019	2020	2021	Long-term average 1964-2019
IV	12.9	9.5	11.8	11.1	49.8	47.8
V	16.1	15.6	17.0	47.3	58.2	69.1
VI	20.7	22.6	20.2	161.9	16.8	88.1
VII	22.4	24.8	21.8	77.3	68.6	65.9
VIII	23.2	20.9	21.4	137.5	42,6	58.5
IX	19.1	18.5	17.0	31.4	20.0	47.9
Average (Sum)	19.1	18.7	18.2	466.5	256.0	377.2

Source: Authors (based on data from the Serbian Hydrometeorological Institute)

The average temperatures for the soybean growing season in 2020 (19.1 °C) and 2021 (18.7 °C) were above multi-year values (18.2 °C). In 2020, compared to multi-year values, April was warmer by 1.1 °C, June by 0.5°C, July by 0.6°S, August by 1.8 °C and September by 2.1 °C, while May was colder by 0.9 °C. In 2021, April was colder by 2.3 °C, May by 1.4 °C and August by 0.5 °C, while June was warmer by 2.4 °C, July by 3.0 °C and September by 1.5 °C.

In 2020, during the soybean vegetation period, 466.5 l m^{-2} of precipitation was recorded, which is 89.3 l m-2 above the long-term average (377.2 l m^{-2}), while in 2021 there was significantly less precipitation, only 256.0 l m^{-2}, which is 121.2 l m^{-2} below the multi-year average. During 2020, the precipitation deficit compared to multi-year values was recorded in April (by 36.7 l m^{-2}), May (by 21.8 l m^{-2}) and September (by 16.9 l m^{-2}), and in 2021 year in May (by 10.9 l m^{-2}), June (by 71.3 l m^{-2}), August (by 15.9 l m^{-2}) and September (by 27.9 l m^{-2}). Large amounts of precipitation in June and August 2020 (161.9 l m^{-2} and 137.5 l m^{-2}) contributed to significantly higher yields in soybean production, while cold weather during April and May and very high temperatures during June and July with the lack of precipitation in 2021, they were not favorable for soybean production (Dozet et al., 2021a). For soybeans, the amount of precipitation is very important in the critical stages of plant development, namely germination and sprouting, the period of pod formation and grain filling (Đukić et al., 2018). Dozet (2009), Đukić (2009), Dozet et al. (2021b), Bajagić et al., (2021).

The average mass of plants in 2020 (Table 2) was 37.0 g, which is a statistically very significantly higher value compared to 2021 (22.6 g), and the analysis by varieties shows that in varieties Rubin (33.8 g) and Sava (30.0 g) had a statistically very significantly higher value of plant weight compared to the variety Valjevka (25.5 g), while there was a statistically significant difference in weight between the varieties Rubin and Sava plants.

The lowest value for the mass of the plants was achieved in the control (25.9 g), which is a statistically very significantly lower value compared to the application of aqueous banana extract (33.6 g) and nettle with comfrey (31.2 g). The mass of plants on the control variant with the application of water (28.5 g) was statistically very significantly lower compared to the variant with the application of aqueous banana extract and statistically significantly lower than the variant with the application of aqueous extract of nettle and comfrey.

Observing the same year and different fertilizations, it is observed that the mass of plants in 2020 with the application of aqueous banana extract (40.9 g) is statistically very significantly higher compared to the control (33.4 g) and the control with the application of water (35.6 g), while with the application of water extract of nettle and comfrey (38.1 g), the mass of plants is statistically very significantly higher compared to the control and statistically significantly higher compared to the control with the application of water. A statistically significant difference was also achieved between the variants with the application of aqueous banana extract compared to the variants with the application of aqueous extract of nettle and comfrey. In 2021, the mass of plants with the application of aqueous banana extract (26.3 g) is statistically very significantly higher compared to the control (18.3 g) and the control with water (21.4 g), and with the application of aqueous of nettle and comfrey extract (24.3 g), a statistically very significantly higher mass of plants was achieved compared to the control and a statistically significantly higher mass of plants compared to the control variant with the application of water. On the control variant with the application of water, the mass of plants is statistically significantly higher compared to the control variant of the experiment.

Table 2. Mass of soybean plants with different types of fertilization

Year (A)	**Variety (B)**	**Treatment* (C)**				**Average AxB**	**Average A**
		1	**2**	**3**	**4**		
2020	Valjevka	27.3	29.2	33.7	30.9	30.3	37.0
	Sava	34.1	36.2	42.8	40.4	38.4	
	Rubin	38.7	41.3	46.1	43.0	42.2	
	Average AxC	33.4	35.6	40.9	38.1	-	
2021	Valjevka	16.1	19.2	25.4	22.1	20.7	22.6
	Sava	17.2	19.9	25.3	24.1	21.6	
	Rubin	21.6	25.1	28.2	26.8	25.4	
	Average AxC	18.3	21.4	26.3	24.3	-	
Average BxC	Valjevka	21.7	24.2	29.6	26.5	Average B	25.5
	Sava	25.7	28.1	34.1	32.2		30,0
	Rubin	30.2	33.2	37.1	34.9		33.8
Average C		25.9	28.5	33.6	31.2	-	-
Average 2020-2021							29.8
Treatment*: 1. Control, 2. Control + water, 3. Aqueous banana extract, 4. Aqueous extract of nettle with comfrey							

LSD	**A**	**B**	**C**	**AxB**	**AxC**	**BxC**	**AxBxC**
1%	6.43	4.06	3.39	4.36	3.82	4.15	5.07
5%	4.28	2.54	2.06	2.87	2.4	2.62	3.11

Source: Authors

Observing the same variety, but different varieties of fertilization, it can be observed that in the Valjevka variety, the mass of plants with the application of aqueous banana extract (29.6 g) is statistically very significantly higher compared to the control (21.7 g), the control with water (24.2 g) and statistically significantly higher compared to the application of water extract from nettle and comfrey (26.5 g). A statistically very significantly higher mass of plants was also achieved with the application of water extract of nettle and comfrey compared to the control variant of the experiment.

In the Sava variety, the mass of plants with the application of aqueous banana extract (34.1 g) is statistically very significantly higher compared to the control variant of the experiment (25.7 g) and the control variant with the application of water (28.1 g), while with the application of water extract of nettle and comfrey (32.2 g) statistically very significantly higher compared to the control and statistically significantly higher compared to the control with the application of water.

In the Rubin soybean variety, the mass of plants is statistically very significantly higher with the application of aqueous banana extract (37.1 g) and aqueous extract of nettle and comfrey (34.9 g) compared to the control (30.2 g). The mass of plants on the control variant with the application of water (33.2 g.) is statistically significantly higher in relation to the control variant of the experiment and statistically significantly lower in relation to the application of aqueous banana extract.

The weight of 1000 grains (Table 3) in 2020 (180.0 g) is statistically very significantly higher compared to 2021 (153.8 g), and in the case of the Rubin variety (173.8 g) it was statistically very very significantly higher value compared to the Valjevka variety (160.6 g).

Table 3. Weight of 1000 grains with different types of fertilization (g)

Year (A)	Variety (B)	Treatment* (C)				Average AxB	Average A
		1	2	3	4		
2020	Valjevka	164.3	172.5	178.7	176.3	172,9	180.0
	Sava	175.8	180.2	183.6	185.5	181,3	
	Rubin	178.5	184.6	192.3	188.1	185,9	
	Average AxC	172.8	179.1	184.9	183.3	-	
2021	Valjevka	131.8	142.4	162.4	156.7	148,3	153.8
	Sava	138.5	145.7	159.2	162.5	151,5	
	Rubin	152.5	157.3	170.4	166.8	161,7	
	Average AxC	140.9	148.4	164.0	162.0	-	
Average BxC	Valjevka	148.0	157.4	170.6	166.5	Average B	160.6
	Sava	157.2	163.0	171.4	174.0		166.4
	Rubin	1655	171.0	181.3	177.4		173.8
Average C		156.9	163.8	174.4	172.6	-	-
Average 2020-2021							166.9
Treatment*: 1. Control, 2. Control + water, 3. Aqueous banana extract, 4. Aqueous extract of nettle with comfrey							

LSD	A	B	C	AxB	AxC	BxC	AxBxC
1%	24.23	10.23	8.14	12.74	9.25	12.23	15.04
5%	16.27	8.41	6.52	9.42	7.58	9.08	10.67

Source: Authors

Observing the weight of 1000 grains by fertilization variants, it is observed that a statistically very significantly higher value was recorded with the use of water extract of banana (174.4 g) and nettle with comfrey (172.6 g) compared to the control variant of the experiment (156.9 g) and the control variant with the application of water (163.8 g). A statistically significantly higher value was also recorded in the control variant with the application of water compared to the control variant of the experiment.

Observing the same year and different fertilizations, it can be seen that in 2020, the application of aqueous banana extract (184.9 g) and nettle with comfrey (183.3 g) statistically significantly increased the weight of 1000 grains compared to the control sample variant (172.8 g), while in 2021 the water extract of banana (164.0 g) and the water extract of nettle and comfrey (162.0 g) statistically significantly increase the weight of 1000 grains compared to compared to the control variant (140.9 g) and the control variant with the application of water (148.4 g).

Analyzing the same variety and different fertilizations, it is observed that in Valjevka, the application of aqueous banana extract (170.6 g) statistically significantly increases the weight of 1000 grains compared to the control (148.0 g) and the control with the application of water (157.4 g). Water extract of nettle with comfrey (166.5 g) statistically significantly increased the weight of 1000 grains compared to the control, and the weight 1000 grains was statistically significantly higher in the control variant with the application of water compared to the control variant.

In the case of the Sava variety, the application of aqueous extract of nettle and comfrey (174.0 g) and aqueous extract of banana (171.4 g) statistically significantly increased the weight of 1000 grains compared to the control variant of the experiment (157.2 g) and the weight of 1000 grains is statistically significantly higher when water extract from nettles and comfrey is applied compared to the control variant with the application of water (163.0 g).

In the Rubin soybean variety, water extract from banana (181.3 g) statistically significantly increased the weight of 1000 grains compared to the control variant of the experiment (165.5 g) and statistically significantly compared to the control variant with the application of water (171, 0 g.), while the aqueous extract of nettle and comfrey (172.6 g) statistically significantly increased the weight of 1000 grains compared to the control variant of the experiment.

By growing soybean varieties of different ripening groups, the most critical stages of development occur in different periods, which leads to safer production and achieving satisfactory yields (Miladinov et al., 2017).

Conclusion

Water extracts of banana and nettle with comfrey significantly increase the mass of plants and the weight of 1000 soybean grains, and the year, with its climatic conditions, has a very pronounced effect on the observed properties.

Later soybean varieties usually have a larger habit, which is also confirmed in these studies, where the Rubin variety has the highest plant weight, and the results show that this variety also had the highest value for the weight of 1000 grains.

The use of water extracts can influence the increase in the mass of plants and the weight of 1000 soybean grains, which is reflected in the increase in the yield of soybeans.

References

1. Bajagić M., Đukić V., Miladinov Z., Dozet G., Cvijanović G., Miladinović J., Cvijanović V. (2021). Effects of autumn and spring primary tillage on soybean yield and 1000-grain weight in the agro-ecological conditions of Serbia, Agro-knowledge Journal, Univesity of Banjaluka, Faculty of Agriculture, vol. 22, no. 2,37-47.
2. Di Virgilio, N. (2013). Stinging nettle: a neglected species with a high potential as multi-purpose crop. National Research Council of Italy. Institut of Biometeorology. Catania, Italy, 23.
3. Dozet Gordana (2009). Uticaj đubrenja predkulture azotom i primene Co i Mo na prinos i osobine zrna soje. Doktorska disertacija, Megatrend univerzitet Beograd, Fakultet za biofarming-Bačka Topola, 1-154.

4. Dozet G., Đukić V., Miladinov Z., Đurić N., Ugrenović V., Cvijanović V., Jakšić S, (2019). Prinos soje u organskoj proizvodnji. Zbornik naučnih radova Instituta PKB Agroekonomik, Vol. 25, br. 1-2, 173-180. Beograd, Srbija.
5. Dozet G., Đukić V., Cvijanović G., Đurić N., Cvijanović V., Miladinović J., Marinković J. (2021a). Uticaj folijarnog đubrenja na prinos soje. Zbornik radova Nacionalnog naučno-stručnog skupa sa međunarodnim učešćem „Biotehnologija i savremeni pristup u gajenju i oplemenjivanju bilja" 15. decembar 2021. Smederevska Palanka, 301-308.
6. Dozet G., Đukić V., Mamlić Z., Miladinović J., Đurić N., Jovanović Todorović M., Jakšić S. (2021b). Uticaj jesenjeg i prolećnog đubrenja soje na prinos zrna i sadržaj ulja. Uljarstvo, vol. 52, br. 1, 27-33.
7. Đukić V. (2009). Morfološke i proizvodne osobine soje ispitivane u plodoredu sa pšenicom i kukuruzom. Doktorska disertacija, 127 str. Univerzitet u Beogradu, Poljoprivredni fakultet Zemun, Srbija.
8. Đukić V., Miladinov Z., Balešević-Tubić S., Miladinović J., Đorđević V., Valan D., Petrović K. (2018). Kritični momenti u proizvodnji soje, Zbornik referata 52. Savetovanja agronoma i poljoprivrednika Srbije (SAPS), Zlatibor, 21-27. Januar 2018. Institut za ratarstvo i povrtarstvo, Novi Sad, 34-44.
9. Đukić V., Dozet G., Miladinov Z., Cvijanović M., Vasiljević M., Cvijanović G., Ranđelović P. (2019). Promena morfoloških osobina soje pri različitom sklopu biljaka. Zbornik radova 1, XXIV Savetovanje o biotehnologiji sa međunarodnim učešćem, 215-220. Čačak, 15-16 Mart, 2019., Srbija.
10. Miladinov Z., Stojanović D., Đukić V., Balešević-Tubić S., Miladinović J., Cvijanović M., Dozet G. (2017). Prinos i kvalitet novopriznatih NS sorti soje. Zbornik radova 58. Savetovanja industrije ulja: „Proizvodnja i prerada uljarica“, 18-23. Jun., 75-82. Herceg Novi, Crna Gora.
11. Miladinov Z., Đukić V., Ćeran M., Valan D., Dozet G., Tatić M., Ranđelović P. (2018). Uticaj folijarne prihrane na sadržaj proteina i ulja u zrnu soje. Zbornik radova 59. Savetovanje Proizvodnja i prerada uljarica, 17-22. Jun, *Herceg Novi*, 73-78.
12. Miladinov Z., Dozet G., Balešević-Tubić S., Miladinović, J., Đorđević, V., Ranđelović P., Cvijanović M. (2018a). Uticaj NS Nitragina i zaoravanja žetvenih ostataka na prinos soje. Zbornik radova 1. Domaćeg naučno stručnog skupa „Održiva primarna poljoprivredna proizvodnja u Srbiji – stanje, mogućnosti, ograničenja i šanse“. Bačka Topola, 26. Oktobar 2018. 211-217.
13. Mamlić Z., Abduladim A., Đukić V., Vasiljević S., Katanski S., Dozet G., Uhlarik A. (2021). Jesenja i prolećna primena NPK đubriva u proizvodnji soje. Zbornik radova Nacionalnog naučno-stručnog skupa sa međunarodnim učešćem „Biotehnologija i savremeni pristup u gajenju i oplemenjivanju bilja“, 15. decembar 2021., Smederevska Palanka, 285-292.

INFLUENCE OF THE YEAR ON THE PRODUCTIVITY OF ALTERNATIVE CEREAL SPELT ON DEGRADE SOIL

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Abstract

In the last forty years, about 30% of agricultural soil has undergone degradation processes, especially in developed countries. There are attempts to repair or recultivate degraded soils, but the results both in the world and in our country are mostly symbolic. Spelt achieves good results on degraded soil. It is more and more cultivated, because spelled grain has a high protein content, up to 25%, more proline, tyrosine, glutamic and aspartic acids, lipids and unsaturated fatty acids from common wheat. It is resistant to low temperatures, diseases and pests and suitable for organic production. The paper presents the results of two-year tests on the spelt productivity grown on degraded soil. The average value for grain yield in the examined years was 3.951±0.53 t/ha. The Nirvana variety had a statistically significantly higher grain yield in 2020 (4.40±0.10 t/ha) compared to 2021 (3.50±0.30 t/ha). Positive and very strong correlations were found between grain yield and volumetric mass (r=0.97) and a strong positive correlation between yield and mass of 1000 grains (r=0.67*).*

Key words: Cereals, degraded soil, spelt Nirvana, productive traits, correlations.

Introduction

Soil productivity depends on: soil properties, climate, variety, agricultural techniques and organization of agricultural production (Lakić et al., 2018; 2019; 2020; 2022). Soil management is the process by which land resources are maintained in an effectively good condition and includes all land management activities as an ecological and economic resource. Land degradation is a consequence of multiple processes that both directly and indirectly reduce the usefulness of land. There are about 30,000 hectares of degraded areas in Serbia. They are slightly exploited, which seriously affects domestic agriculture. The dynamics of the degradation of our lands is such that every year about 4,000 hectares of agricultural land are "destroyed" (Đorđević et al., 2010). The greatest damage of land is caused by mining operations, surface mining, industry, roads, hydro reservoirs, and landfills and tailing ponds (Dražić et al., 2011). At recent years, research has been undertaken to improve and exploit these lands. For this purpose, appropriate tests are performed, and the obtained results are published. It is concluded that certain cultivated plants, including alternative grains, achieve satisfactory success on degraded lands. Tangible results in this regard have already been shown by some types of alternative grains, such as spelt, buckwheat, miscanthus, etc. (Glamočlija et al., 2012, 2015). Spelt achieves good results on degraded land. It is increasingly cultivated in the world, because the spelt grain has a high protein content, 12 to 25%, more proline, tyrosine, glutamic and aspartic acid, lipids and unsaturated fatty acids than ordinary wheat. It is resistant to low temperatures, diseases and pests and suitable for organic production.

Spelt is an ecological potential in the field of grain production, it is an irreplaceable source of nutritional and most complete foods for human life. It is important to draw attention to the new possibility of production, in an ecologically acceptable way, through the introduction into production of domestic populations or varieties of small grains, intended for organic production, with as many positive agronomic and technological traits as possible, i.e. populations that should be an integral part of agricultural production in rural areas both in terms of quantity and quality. Spelt is also an element of biodiversity that will stand up to unfavorable climatic conditions, and take advantage of the favorable elements of the environment.

The aim of the work was to determine the mean values of the tested components of wheat yield (weight of 1000 grains, volumetric mass and grain yield) and the correlation between them in different meteorological conditions of growing wheat on degraded land.

Material and method

Investigations were set up and carried out during 2020 and 2021 on degraded soils of the deposol type in Ilandža. Experiments were set up according to a random block system in four repetitions. The following parameters were tested: weight of 1000 grains (g), volumetric mass (kg) and yield (t/ha). Standard cultivation technology was applied. Classic basic tillage, soil preparation with harrows and manual sowing were carried out. Spelt was sown in mid-March. Care measures were included manual weeding and crop hoeing in order to maintain a clean inter-row space. In the stage of technological maturity, manual harvesting was carried out and the yield was determined, using the method of measuring the yield of aboveground biomass from each elementary plot.

Soil analysis. Before setting up the experiments, the agrochemical properties of soil were determined in accredited laboratories (Table 1).

Table 1. Agrochemical properties of soil fertility (the deposol-type soil)

Values	pH		Organic matter (%)	Humus (%)	N (%)	Easy accessible forms	
	H2O	KCl				P2O5 mg/100g	K2O mg/100g
0-30 cm	5.4	4.2	1.6	0.01	0.2	0.36	1.90

Agrochemical analyzes of the soil showed that the soil in the investigated locality had a very acidic pH reaction. According to the content of readily available phosphorus and potassium, they are also classified as very poor.

Statistical analysis. The analysis of the obtained experimental data was performed by means of analytical statistics with the help of the statistical package STATISTICA12 for Windows (StatSoft). The results were analyzed by the method of analysis of variance of the one-factor model (ANOVA), and the significance of the differences in the mean values of the treatments was tested by the LSD test.

Meteorological conditions

During the research, the most important meteorological indicators were monitored and analyzed - the distribution and amount of precipitation and thermal conditions during the vegetation period of plants. Monthly precipitation and average air temperatures data for 2020/2021. year were obtained from the Hydrometerological Institute and are shown in Table 2.

Table 2. Temperatures and precipitation for growing season, 2020-2021, Ilandža

Parameter	Month						
Temperature (^{0}C)	III	IV	V	VI	VII	VIII	Average
2020	10.2	11.6	17.2	22.4	24.2	21.3	17.82
2021	9.45	11.3	16.8	22.2	23.7	20.8	17.38
Precipitation (mm)	Month						
	III	IV	V	VI	VII	VIII	Total
2020	42.4	51.0	83.0	40.0	21.0	52.0	289.40
2021	52.4	68.0	82.0	32.0	31.0	65.0	330.40

Total precipitation in 2021 (330.40 mm) was 41 mm higher than in 2020, while average monthly temperatures in 2021 (17.38 0C) were 0.44 0C lower.

Results and discusion

Based on the variance analysis, it can be concluded that there are significant differences in the values for the weight of 1000 grains (Fekp=126.01*) and the hectoliter mass (Fekp=120.30*) in the examined years (Table 3). Based on the analysis of variance, it can be concluded that there are significant differences (p<0.05) in grain yield in relation to the year of the test (Fekp=24.122*), Table 3, Graph. 3.

Table 3. Anova for mass of 1000 grains, volumetric mass and grain yield

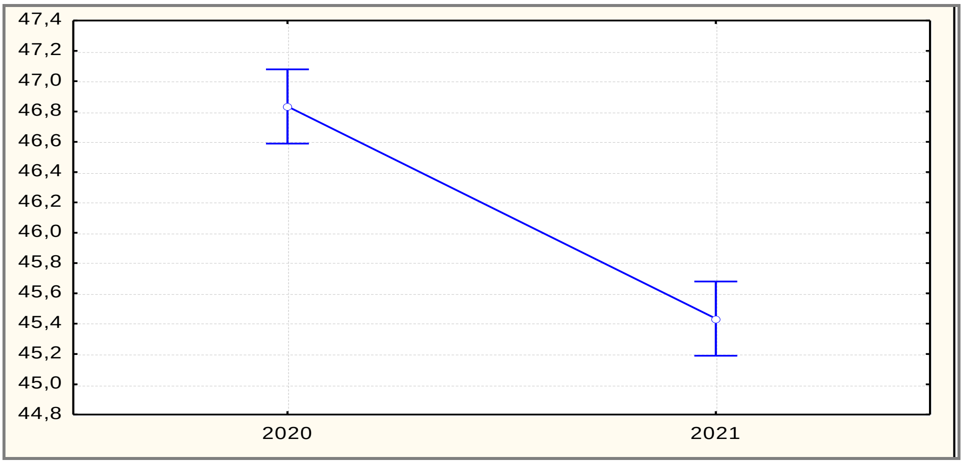
Parameter	SS	Degr. of Fredom	MS	F	p
Mass of 1000 grains					
Intercept	12769.71	1	12769.71	547273	0.00000
Year	2.94	1	2.94	126.01*	0.00035
Error	0.09	4	0.02		
Volumetric mass					
Intercept	38352.02	1	38352.02	697309.01	0.00000
Year	6.62	1	6.62	120.30*	0.00039
Error	0.09	4	0.02		
Grain yield					
Intercept	93.69	1	93.69	1873.26	0.00002
Year	1.21	1	1.21	24.112*	0.00798
Error	0.09	4	0.02		

The average value for the mass of 1000 grains for the examined years was 46.13±0.78 g. The results of the research indicate that the variety Nirvana had a statistically significantly higher mass of 1000 grains in 2020 (46.83±0.15 g) compared to 2021, Table 4, Graph 1.

Table 4. Descriptive statistics for volumetric mass, mass of 1000 grains and yield

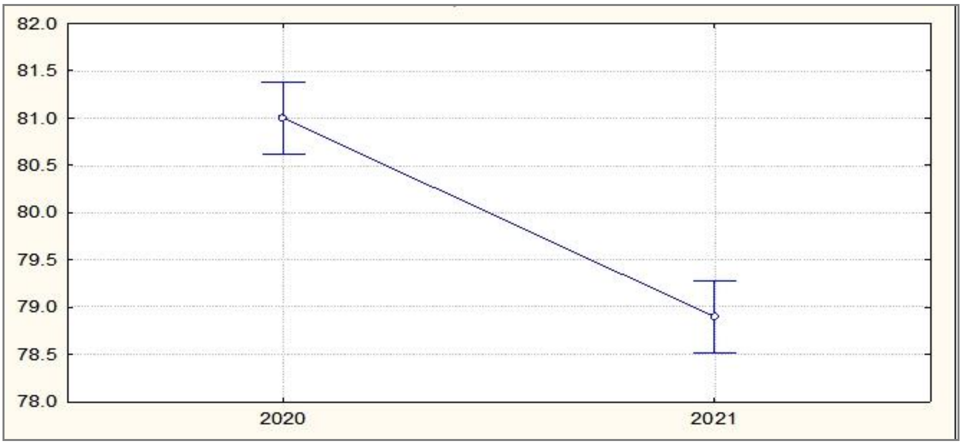
Parameter		No.	Average	Std.Dev.	Std.Err	-95,00%	+95,00%
Mass of 1000 grains (g)							
Total		6	46.13	0.78	0.32	45.32	46.95
Year	2020	3	46.83	0.15	0.9	46.46	47.21
	2021	3	45.43	0.15	0.09	45.05	45.81
Volumetric mass (kg)							
Total		6	79.95	1.17	0.47	78.72	81.18
Year	2020	3	81.00	0.20	0.12	80.50	81.49
	2021	3	78.90	0.26	0.15	78.24	79.56
Yield (t/ha)							
Total		6	3.951	0.531	0.216	3.395	4.508
Year	2020	3	4.400	0.100	0.058	4.152	4.648
	2021	3	3.503	0.300	0.173	2.758	4.248

Parameter	LSD	Mass of 1000 grains	Volumetric mass	Yield
0.05		0.346	0.532	2.459
0.01		0.574	0.882	4.13



Graph. 1. Influence of the year on the mass of 1000 grains

The average value of volumetric mass for the examined years was 79.95±1.17 kg. The variety Nirvana had a statistically significantly higher volumetric mass in 2020 (81±0.20 kg) compared to 2021 (78.90±0.26 kg), Table 4, Graph 2.

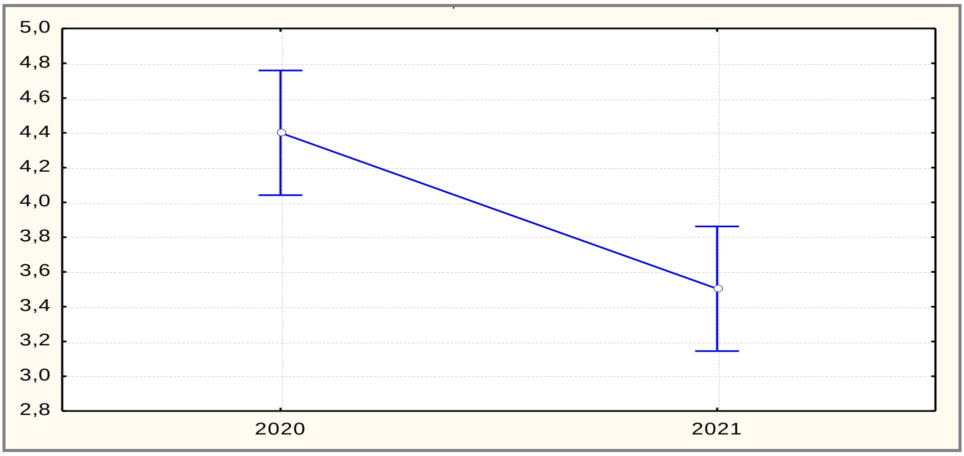


Graph 2. Effect of year on volumetric mass

The average value for grain yield in the examined years was 3.951±0.53 t/ha. The variety Nirvana had a statistically significantly higher grain yield in 2020 (4.40±0.10 t/ha) compared to 2021 (3.50±0.30 t/ha), Table 4, Graphs 3 and 4.

The presented results confirm the opinion of many authors that the analyzed traits are genetically determined, but are strongly modified by the environment and weather conditions (Popović et al., 2013; 2020a; 2020b; Ikanović et al., 2013; 2022; Rajičić et al., 2020).

Varietal tests by locality give us information about the influence of the year on the productivity of the tested genotypes. In order to evaluate the influence of the year on the productivity of genotypes, it is necessary to conduct tests in several environments and/or years (Vasileva, Kostov, 2015; Babić et al., 2019; Rajičić et al., 2020; Mandić et al., 2020; Stojiljković et al., 2021; Ikanović et al., 2022; Zejak et al., 2022).



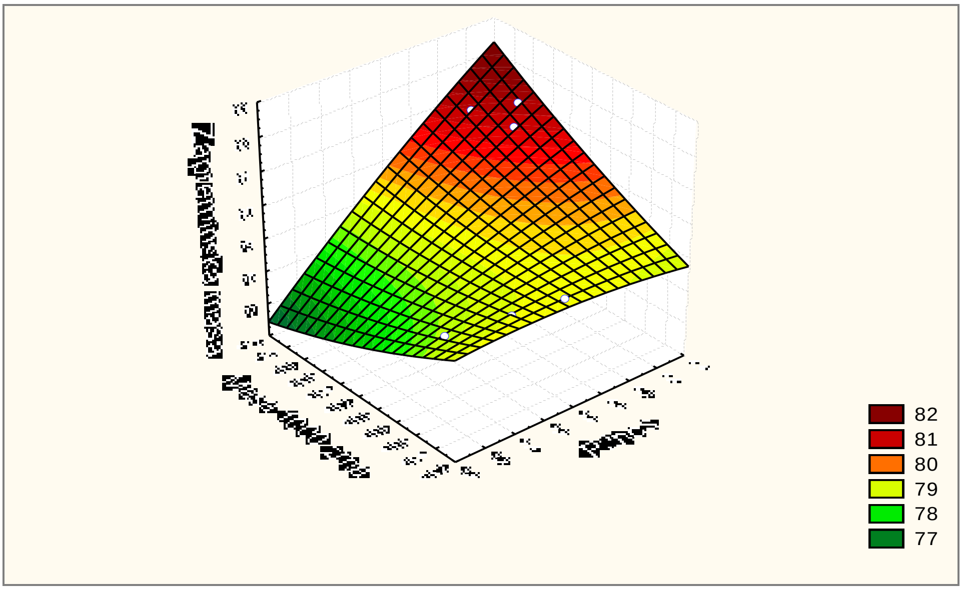
Graph 3. Effect of year on grain yiel

Correlations of the studied traits

Knowledge of the association between plant traits is particularly important for traits of low genetic variability, where genetic progress can be achieved through indirect selection. Table 5 shows the linear correlation and level of significance for the analyzed traits. Positive and very strong correlations were established between grain yield and volumetric mass (r=0.97*) and a strong positive correlation between yield and mass of 1000 grains (0.67*), Table 5, Graph 4. Positive correlations were also achieved between mass of 1000 grains and volumetric mass (r=0.73*), Table 5.

Table 5. Correlations of the studied traits

Parametar	**Mass of 1000 grains**	**Volumetric mass**	**Grain yield**
Mass of 1000 grains	1.00	0.73*	0.67*
Volumetric mass	0.73*	1.00	0.97**
Grain Yield	0.67*	0.97**	1.00



Graph 4. 3 D Surface plot between 1000 grain mass, volumetric mass and grain yield

Wheat (Triticum sp.) is one of the most represented plant species in the sowing structure in the world and in our country because it is the basis of human nutrition for the largest part of the world's population, which is why it has great economic importance for every country. Spelt was cultivated back in the Stone Age and is among the oldest grain. The latest scientific research indicates that it was created around 7,000-9,000 years ago in the territory of the Middle East, by spontaneous crossing of wild grass species. Newer, higher-yielding varieties have replaced it in production. Thanks to its qualitative features, spelt is starting to be cultivated again in the mountainous areas of Germany, Switzerland and Austria, and with the expansion of organic production, it is found on arable land in Western Europe, Central Europe and Western Europe. In our country, at the beginning of this century, an interest in growing spelt started again, and it is mainly produced in hilly and mountainous areas and in lowland areas (Vojvodina). Today, there are several agricultural producers of spelt in Serbia whose production encompass whole cycle, from primary production, to final products, bread and pasta (Glamočlija et al., 2015).

A statistically significant and strong correlation (0.807) was established between the mass of grain per ear and the number of grains per ear (0.807), while the coefficient values for the other correlation pairs show strong and medium strong relationships (Banjac et al., 2010). Main role in grain yield forming has a greater number of properties. The contribution of each individual trait may be different in different environmental conditions so that the correlation between two quantitative traits is not fixed. Diversity arises from the interaction between traits within each genotype and the interaction of the genotype with environmental factors.

Conclusion

Thanks to its qualitative features, spelled is starting to be cultivated again in mountainous areas, and with the expansion of organic production, it is found more and more on arable land and in lowland areas (Vojvodina). The average value for grain yield in the examined years was 3.951±0.53 t/ha. The Nirvana variety had a statistically significantly higher grain yield in 2020 (4.40±0.10 t/ha) compared to 2021 (3.50±0.30 t/ha).

Unfavorable environmental conditions for plant development (degraded soil and weather conditions) have led to reduced mean values of examined components of the yield of Spelled wheat. The results of the correlation analysis show strong and medium strong correlations between volumetric mass and grain yield and mass of 1000 grain and grain yield. Examining the correlation interdependence between yield components of Spelt is very important in wheat breeding, because the selection within one, condition the change of another trait.

Acknowledgments

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References

1. Babić M, Canak P, Vujošević B, Babić V, Stanisavljević D (2019). Importance of field trial data cleaning process for making more reliable breeder decisions. Selection and Seeding, 25, 2, p. 23-30.
2. Banjac B., Petrović S., Dimitrijević M., Dozet D. (2010): Assessment of the correlation of wheat yield components under stress conditions. Annals of scientific works, 34, 1, p. 60-68.
3. Glamočlija Đ., S. Janković and R. Pivić (2012a): Alternative grain: economic importance, growing conditions, species and agricultural techniques. Institute for Land, Zemun, ul. 42-43.
4. Glamočlija Đ., Janković S., Popović V., Kuzevski J., Filipović V., Ugrenović V. (2015): Alternative field crops in conventional and organic farming systems. Monograph. White City. ISBN 978-86-81689-32-5, p. 1-355.
5. Dražić, G. (2010): Biodegradation and ecoremediation of soil in Serbia - project activities of the "Futura" faculty. At the international conference "Degraded areas and ecoremediation", ul. 245-259.

6. Dražić, G. (2011): Ecoremediation. Singidunum University, Faculty of Applied Ecology, Futura, Belgrade, p. 162.

7. Dragićević, S. and M. Stepić (2008): Natural potentials and degraded areas of Obrenovac municipality. Monograph, Jantar Group, Belgrade.

8. Đorđević, Ana, Tanja Cupać, Tijana Čoporda-Mastilović (2010): Identification of degraded areas in the area of Soko banja municipality. International Conference Degraded Spaces and Ecoremediation Proceedings, Belgrade, p. 349-35.

9. Ikanović J., Popović V., Trkulja V., Živanović Lj., Lakić Z., Pavlović S. (2013): Morphological characteristics of interspecies hybrid of sorghum and Sudan grass under intensive nitrogen nutrition. Genetika, Belgrade, 45, 1, p. 31-40. DOI:10.2298/GENSR1301031I

10. Ikanović J, Popović D., Popović V., Jaćimović G, Đurović I., Kolarić Lj., Ćosić M, RakasčanN. (2022). Genotype interaction analysis by year for Secale cereale L. productive traits and circular economy. Agriculture and Forestry, 68, 1, p. 297-319.

11. Kostić M., Ljubičić N., Ivošević B., Radulović M., Popović S., Blagojević D., Popović V. (2021): Spot-based proximate sensing for field-scale evaluation of winter wheat yield and economic production. Agriculture and Forestry, DOI: 10.17707/AgricultForest.67.1.09, ISSN: 1800-9492,67,1: 103-113.

12. Lakić Ž., Glamočlija Đ., Kondić D., Popović V., Pavlović S. (2018): Fodder plants and grains in the function of soil protection against degradation. Monograph. Banja Luka, ISBN 978-99938-93-47-9, p. 1-403.

13. Lakić Ž., Antić M., Đurđić I., Popović V. (2019): Morphological characteristics of alfalfa genotypes tolerant to low soil pH values. Genetika, 51, 3, p. 907-922. https://doi.org/10.2298/ GENSR1903907L

14. Lakić Ž, Predić T, Đurđić I, Popović V (2020): Recultivation of degraded soil due to mining activity without adding organic soil layers using alfalfa and grass-legume mixtures. Agriculture and Forestry, 66, 4, p. 223-237.

15. Lakić Z., V. Popović, M. Cosic, M. Antic (2022). Genotypic variation of Medicago sativa (L.) seed yield components in acidic soil under cross-fertilization conditions - Genetika, Vol. 54, 1, p. 1-14. https://doi.org/10.2298/GENSR2201001

16. Ljubičić N., Popović V., Ćirić V., Kostić M., Ivošević B., Popović D., Pandžić M., El Musafah Seddik, Janković S. (2021): Multivariate interaction analysis of winter wheat grown in an environment of limited soil conditions. Plants–Basel.10, 3, p. 604; https://doi.org/10.3390/plants10030604

17. Mandić D, Pržulj N, Đurašinović G, Jovović Z (2020): Julija - a new variety of winter wheat. Julia - New variety of wheat. Selection and Seeding, 26, 2, p. 15-20. doi: 10.5937/SelSem2002015M

18. Popović V., Malešević M., Miladinović J., Marić V., Živanović Lj. (2013): Effect of agroecological factors on variation in yield, protein and oil content of soybeans. Romanian Agricultural Research, 30, p. 241-247.

19. Popović V, Ljubičić N, Kostić M, Radulović M, Blagojević D, Ugrenović V, Popović D, Ivošević B (2020a): Genotype and Environment Interaction for Wheat Yield Traits Suitable for Selection in Different Seed Priming Conditions. Plants. 9,12, p. 1804; https://doi.org/10.3390/plants9121804

20. Popović, V., Vučković, S., Jovović, Z., Ljubičić, N., Kostić, M., Rakasčan, N., Glamočlija-Mladenović, M., Ikanović, J. (2020b): Genotype by age interaction effects on soybean morpho-productive traits and biogas production. Genetika, Belgrade, 52, 3, p. 1055-1073. https://doi.org/10.2298/GENSR2003055P

21. Rajičić V, Popović V, TerzićD, GrčakD, Dugalić M, Mihailović A, GrčakM, UgrenovićV (2020): Impact of Lime and NPK Fertilizers on Yield and Quality of Oats on Pseudoglei Soil and their Valorisation. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 48, 4, p. 2134-2152.

22. Stojiljković J., Rajičić V, Terzić D., Radojević V., Đurić N., Ljubičić Lj., Popović V. (2021): The influence of ameliorative measures on the productivity of alfalfa on an acidic Vertisol type soil. Selection and Seeding, 27, 1, p. 15-20.

23. Zejak D., Spalevic B., Popovic V., Markoski M., Dudic B., Ouallali A., Hysa A., Luiz Mincato R., Kader S. (2022). Analysis of the presence of heavy metals in the soils of the hilly-mountainous areas of Balkan Penisula with the assessment of its potential for the fruit growing: Case study of the Ljubovidja River Basin, Polimlje, Montenegro. 26. Intrnational Eco Conference, 2022, 21-23.9.2022., Novi Sad, 2022.

PRODUCTION TECHNOLOGY OF Panicum miliaceum - MILLET IS FUNCTIONAL FOOD FOR ANEMICAL PEOPLE - RICH WITH MAGNESIUM AND IRON

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Abstract

Panicum miliaceum - millet is a gluten-free cereals with high nutritional value, rich in proteins, carbohydrates, phytic, phenolic and salicylic acids, minerals and vitamins: phosphorus, magnesium, iron, calcium, potassium, zinc and B complex vitamins. Millet flour is added to wheat flour to make bread and pastries and the aim is to obtain products with improved nutritional value. Before use, millet should be soaked in water for 6-12 hours, and only then thermally processed (cooked). Heat treatment affects the reduction of phytic acid content. Due to the high content of salicylic acid, millet is used in cosmetics, and it also has antifungal and anticancer properties. The grain is rich in magnesium and iron, which is why it is used by people suffering from anemia and cardiovascular diseases. The aim of this study is to indicate the importance of millet, production technology, yielding potential, nutritional value of the Biserka variety and impact on health.

Key words: Millet Biserka, functional food, production technology, antifungal and anticancer properties.

Introduction

Common millet (*Panicum miliaceum* L.) is a gluten-free, alkaline grain of high nutritional value. In China, it was used in food 7,000 years ago. It is used in food, for the production of beer, alcohol, etc. The protein content of millet is similar to that of wheat, but the content of amino acids leucine, isoleucine and methionine is higher in millet. It is an alkaline food and one of the few plants that has salicylic acid in a warm form, so it is easily used by the body. The phenolic components present in millet grains, as well as the high calcium content, make millet an important food in the human diet. It contains magnesium and iron, which is why it is used by people suffering from anemia and cardiovascular diseases. Magnesium is important for the metabolism of insulin, whose influence is crucial for maintaining normal blood sugar levels, by contributing to the secretion of the insulin hormone and its better uptake into the cell. It is also an antioxidant, reduces the tendency to stress and increases the absorption of calcium and phosphorus and improves bone mineralization.

The mineral composition of millet has a positive effect on the work of the nervous system, and it has a special place in the diet, due to its alkalinity, for people suffering from arthritis. Millet is also an important raw material for people allergic to gluten and suffering from celiac disease, of which there are more than three million in the world (Pragyani et al., 2011; Popović et al., 2020, 2021). Based on the above, we can say that millet is also a functional food.

Food is any substance or product, processed, partially processed or unprocessed, that is intended for human consumption or can reasonably be expected to be used for human consumption (Law on Food Safety, "Official Gazette of RS", No. 41/2009 and 17/2019). In 1998, the European Union, in coordination with the International Life Science Institute Europe (ILSI Europe), adopted the definition: "A food can be considered functional if it has been satisfactorily shown to have a beneficial effect on one or more functions of organism, beyond the scope of usual nutritional effects and on in a way that is significant for general health or for reducing the risk of disease." Functional foods have positive effects on human health and are most often used to preserve optimal gastrointestinal functions, increase the level of activity of the body's antioxidant defenses, and reduce risk factors involved in the etiology of cardiovascular diseases and cancer. The enumerated effects of functional foods are often due to the presence of one or more bioactive components in their composition, which scientific research has determined that, in the quantities in which they are present in the food, have positive effects on certain physiological or biochemical processes in the body (Miletić et al., 2008).

Food variety, nutrient profile, glycemic index, and lower salt and trans-fat intake are important factors in a healthy anti-inflammatory diet recommended for the prevention of diabetes and cardiovascular disease. A variety of foods with a high nutritional profile is a basic principle of functional food security (Singh et al., 2020). By testing the nutritional treatment of diabetic patients who received a diet rich in functional nutrition based on millet (millet 60%, soy 20%, brown rice 10%, peanut 8% and flax seed 2%) for 12 weeks it has been noticed a significant reduction in fasting blood glucose and 2 hours after a meal, indicating that this diet can prevent diabetes-diabetes mellitus and reduce total cholesterol, triglyceride, systolic and diastolic blood pressure, parameters of oxidative stress, and increase antioxidant vitamins: A, E, C and beta- carotene. Among the women, hemoglobin and serum calcium and magnesium were significantly increased, indicating that a millet-based diet has an extremely beneficial effect. The aim of this study was to analyze the importance of millet as a functional food, show the production technology of the Biserka variety, yielding potential, nutritional value and impact on health.

Materials and method

In this study, the results of millet production in the world are presented (FAO, 2022), the production technology of the millet variety, Biserka, is presented and indicate the importance of millet, yielding potential, nutritional value of the Biserka variety and millet impact on health. Statistics were applied during data processing and all results were presented figures and graphically.

Results and discussion

Millet production technology

Millet is grown in a crop rotation after legumes, annual and perennial grass-leguminous mixtures and all other broad-row crops of intensive agro-technics. Maize is not favorable prerequisites due to the attack of maize borer. As a pre-crop, millet is suitable for all arable and vegetable plant species, except for maize, sorghum and buckwheat (Lakić et al., 2018). The tillage system depends on the pre-crop (Popović et al., 2021; Ikanović et al., 2022) and the time of sowing millet. For crops sown in spring, it is best to carry out standard tillage with plows at a depth of 20 cm during the fall, with plowing of the harvest residues of pre-crops and NPK mineral nutrients. Reduced tillage is carried out for subsequent and sowing after small grain with shallow, heavy disc harrows in order to preserve water in the soil as well as possible. Pre-sowing soil preparation is carried out in the spring. Millet absorbs nitrogen the most, followed by potassium, calcium and phosphorus, in the amount: 80-90 kg ha^{-1} of nitrogen, 100-150 kg ha^{-1} of phosphorus and 70-80 kg ha^{-1} of potassium (in a ratio of 1:1 .5:0.9). Half of NPK is fertilized during autumn, and the other half is added with pre-sowing soil preparation (Lakić et al., 2018).

Varietal pure seeds with high germination are sown. The minimum temperature for germination and sprouting of millet is 10-12 °C. As the main crop, millet is sown in lowland areas from mid-April to the end of June. When millet is grown for biomass for animal feed or as a cover crop, sowing is done in narrow-row and is done with seed drills, at an average distance of 12 cm. About 40 kg ha^{-1} (with the recommendation to sow 10-20% more) of ordinary millet is needed for narrow-row sowing. For wide-row sowing, usually at an average distance of 50 cm, about 20 kg ha^{-1} seed of ordinary millet is needed. Wide-row sowing is carried out with grain seed drills, with the closure of individual sowing devices or pneumatic wide-row drills with greater seed saving. The sowing depth on well-prepared, slightly compacted and moderately moist soil is 2-3 cm. On dry and sandy soils, as well as sowing after small-grain, millet seeds are introduced into the soil 1-2 cm deeper. After sowing, the sown surface under millet can be rolled with light rollers. Weeds can be controlled by inter-row cultivation and hoeing. Irrigation is preferred in the crops that follow small-grain. If there is a need for weed protection, the herbicides Basagram (1.5 l ha^{-1}) + Terbis (1 l ha^{-1}) and others can be used. From insects, the most damage is caused by the corn borer, plant pests, but also soil pests, while economic damage from pathogenic fungi is not significant, which is why disinfection of seed and crop rotation are optimal protection measures against parasites (Glamočlija et al., 2015; Lakić et al., 2018). The genetic potential of the Biserka variety is over 4 t ha-1 seeds. It has a short vegetation period. Its plants are low and it is resistant to flattening. It is suitable for sowing after small-grain. The Biserka millet variety achieved a grain yield of 2.95 kg ha^{-1} in 2021 and excellent technological quality. Ground seeds contained over 14% protein, 56% starch, 2-3% mineral materials and up to 3% fat, graph. 2. Seeds, dried to a humidity of 13-14% and cleaned of impurities, are stored in bulk or in cloth bags in warehouses for grainy products with constant control of temperature (Lakić et al., 2018), humidity and health condition.

Milet production in the world

According to FAO (2022), global millet production in 2020 was 30.5 million tons, Figure 1. Millet was mostly produced in developing regions, in India and Africa, due to its high tolerance to drought. Millet also thrives in arid regions with unfavorable climatic conditions. The average worldwide grain yield is 920 kg ha^{-1}. India is the world's largest producer, with a 33.3% global market share in 2020, graph. 3a. In 2018, the Council of the Food and Agriculture Organization (FAO) approved India's proposal to mark 2023 as the "International Year of Millet". African countries, mainly Niger, Mali, Nigeria, Burkina Faso and Sudan, hold more than 40.0% of global millet consumption.

Millet plays an important role in the food safety and economy of many countries in Africa and consumption of this gluten-free grain is expected to be high. Popović et al. (2021) point out that the area under millet in the world in 2019 was 31,653,878 ha, the average grain yield was 900 kg ha-1, and the production was 28,371,792 t. The largest areas were in Africa (20.4 million ha; 64.52 %), Asia (10.55 million ha; 33.32 %), Europe (457,384 ha; 1.45 %), and America (190 .38 %) ha; 0.61 %) and the least in Oceania (35,814 ha; 0.12%). America had the highest yields (2.02 t ha^{-1}), followed by Europe (1.38 t ha^{-1}), Asia (1.29 t ha^{-1}) and Oceania (1.02 t ha^{-1}) and the lowest Africa (671 kg ha^{-1}), graph. 1. The world's largest producers are India, Nigeria, Sudan, Burkina Faso, China, Russia and Senegal. In European countries, millet was grown the most in Russia (409,303 ha, yield 1.5 tha^{-1}) and in EU countries (582,516 ha, yield 1.9 tha^{-1}). Significant production was in Serbia, Slovenia and Croatia (107ha; 390ha; 196ha), (Popović et al., 2021).

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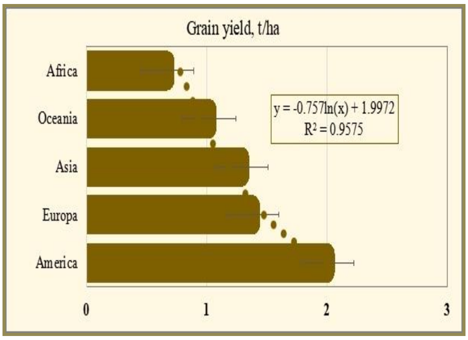
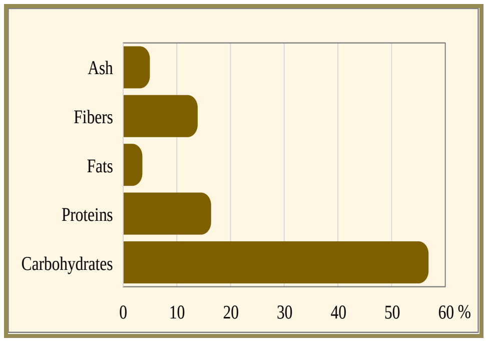




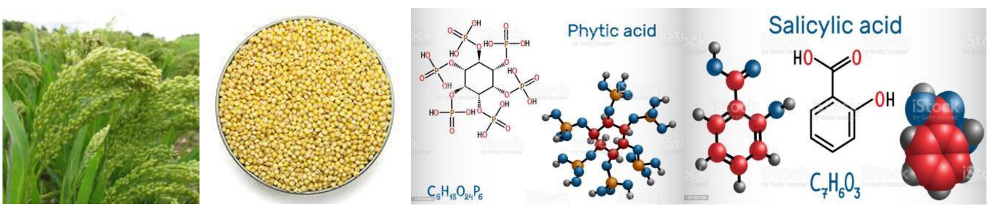
Graph 1. Millet grain yields in the world (t ha-1)

Graph 2. Nutritional quality of millet, variety Biserka, %

a. b.

Graph 3. Share of millet production (%) in the world, %, 2020. a.) Millet is functional food b.)

Millet grains contains salicylic acid and phytic acid (0.8-1.2 g/100g dm), which contains hightly bound phosphorus, which cannot be used by humans and animals. Phytic acid binds minerals from our body and makes them unavailable and unused (calcium, magnesium, iron and zinc), so there may be a decrease in minerals in our body (Lakić et al., 2018; Popović et al., 2018; 2020; Singh et al., 2020), Figure 4a-d.

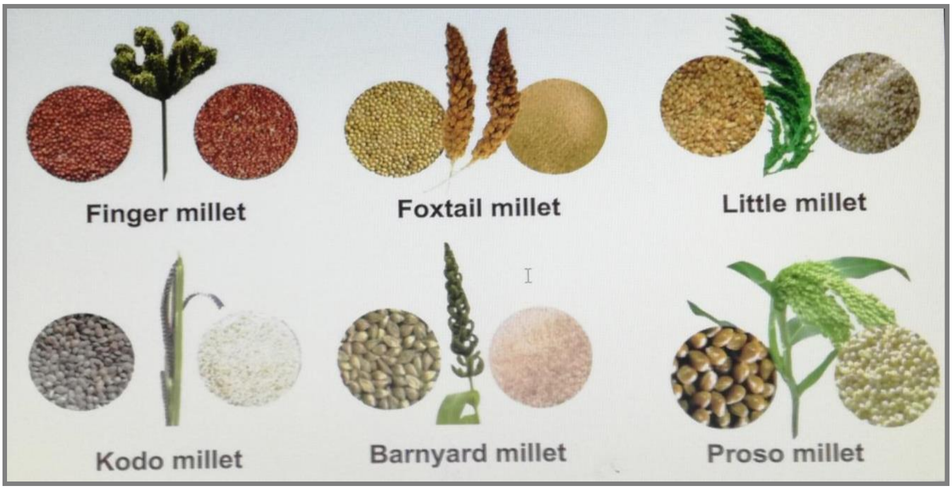


a. b. c. d.

Figure 4. Millet crop, c. Biserka (a.), millet grain (b.), phytic acid (c.), and salicylic acid (d.)

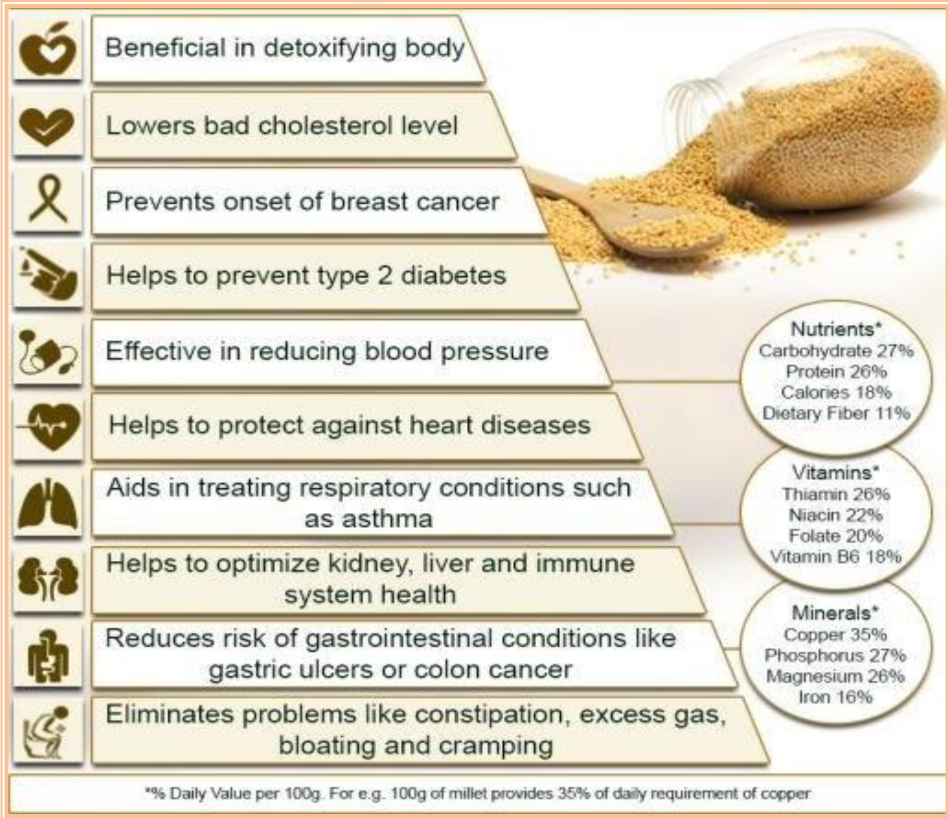
Phytic acid also affects some enzymes that we need to digest food, namely pepsin, trypsin and amylase. In order to reduce the content of phytic acid, before use, millet should be left in water for 6-12 hours and only then thermally processed. Heat treatment affects the reduction of phytic acid and activates the phytase enzyme that neutralizes phytic acid. Due to the high content of salicylic acid, millet is considered a real cosmetic preparation - it has an excellent effect on nails, skin, hair and teeth (Lakić et al., 2018; Popović et al., 2018; 2020; Singh et al., 2020).

Millet is a food rich in nutrients such as copper, magnesium, phosphorus and manganese. A diet based on millet causes a decrease in blood glucose, oxidative stress, blood pressure, blood lipoproteins and an increase in antioxidant vitamins, magnesium, calcium and hemoglobin (Popović and 2018; 2020; 2021). The rich nutritional content in millet helps in maintaining a healthy life and is an ideal food for people suffering from chronic diseases such as diabetes, obesity and heart disease. Millet contains fiber that aids in digestion. The consumption of millet has a preventive effect on gastrointestinal complaints and diseases related to the kidneys and liver, Picture 1-3.



Picture 1. Types of millet

Picture 2. Small millet has big benefits



Picture 3. Health benefit of Millet.
(https://in.pinterest.com/pin/216102482099737789/)

Millet is rich in niacin, which helps our body manage more than 400 enzyme reactions. Niacin is also important for healthy skin and organ function. Millet, is an excellent source of beta-carotene. This natural pigment acts as both an antioxidant and as a precursor to vitamin A, helping your body fight off free radicals and supporting the health of your eyes. Millet is rich in dietary fiber, both soluble and insoluble. The insoluble fiber in millet is known as a "prebiotic," which means it supports good bacteria in your digestive system, Singh et al., 2020. This type of fiber is also important for adding bulk to stools, which helps keep you regular and reduces your risk of colon cancer. The soluble fiber in millet can help reduce the amount of "bad" cholesterol in your blood—a risk factor for atherosclerosis, Figure 7. Due to all of the above, we can say that millet is a functional food and is increasingly in demand on the market. Growing consumer demand for millet will increase both its share at the total world market.

Conclusion

Millet is a gluten-free grain of high nutritional value and it is used in the diet as a functional food, due to its positive effect on human health. Millet is also successfully cultivated in arid regions. The NS millet variety Biserka has good technological quality and gives high grain yields. Millet has an excellent perspective for cultivation in Serbia and neighboring countries.

Due to the high content of salicylic acid, millet is used in cosmetics, and it also has antifungal and anticancer properties. Millet is rich in dietary fiber. This fiber is important for adding bulk to stools, which helps keep you regular and reduces your risk of colon cancer. Because cholesterol is such a big risk factor for heart disease, eating millet regularly may help keep your heart healthier. The grain is rich in magnesium and iron, which is why it is used by people suffering from anemia and cardiovascular diseases.

Acknowledgements

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References

1. Glamočlija Đ., Janković S., Popović V., Kuzevski J., Filipović V., Ugrenović V. (2015): *Alternativne ratarske biljke u konvencionalnom i organskom sistemu gajenju*. Monografija. Beograd. ISBN 978-86-81689-32-5, str. 1-355.

2. Govindaraji M, Selvi B, Rajarathinam S, Sumathi P (2011). Genetic *Variability and heritability of grain yield components and grain mineral concentration in India's Pearl Millet (Pennisetum glaucum (L.) R. Br.) accessions.* Afr. J. Food Agric. Nutr. Dev. 11(3): 4758-4771.

3. FAO(2022). *https://www.fao.org/faostat/*,23.08.2022.

4. Ikanović J, Popović D., Popović V., Jaćimović G, Đurović I., Kolarić Lj., Ćosić M, Rakaščan N. (2022). *Analysis of genotype-by-year ineraction for Secale cereale L.productive traits and circular economy.* Agriculture and Forestry, 68, 1, str. 297-319.

5. Lakić Ž., Glamočlija Đ., Kondić D., Popović V., Pavlović S. (2018): *Krmne biljke i žita u funkciji zaštite zemljišta od degradacije.* Monografija. Banja Luka, ISBN 978-99938-93-47-9, pp. 1-403.

6. Miletić I., Šobajić S., Đorđević B. (2008). *Functional foods and their role in the improvement of health status*. Journal of Medical Biochemistry, 27, 3, pp. 367-370.

7. Popović, V., Mikić, S., Jovović, Z., Čurović, M., Ignjatov, M., Rajičić, V., Ikanović, J., Maksimović, L. (2018).*Effects of foliar nutrition on production biomass of broomcorn millet (Panicum miliaceum L.).* Int. GEA (Geo Eco-Eco Agro) Conference, PG, 1-4.11.2018. pp. 60-67

8. Popović, V., Ikanović, J., Rajičić, V., Ljubičić, N., Kostić, M., Radović, M., Mačkić, K., Šarčević- Todosijević, Lj. (2020).*Millet–Panicum miliaceum L.*

*production trend in the world. Importance of millet in nutrition and for bioenergy.*XXIV InternationalEco-Conference[@] 2020**,**XI Safe Food, 23-25.9.2020. Novi Sad, pp. 297-306.

9. Popović V., Ignjatov M., Jovović Z., Ljubičić N., Đurić N., Đokić M., BačkonjaB., Rajičić V.(2021).*Biserka i Rumenka - domaće visokoprinosne sorte prosa kao funkcionalna hrana.* Zbornik radova, Biotehnologija i savremeni pristup u gajenju i oplemenjivanju bilja, Smederevska Palanka, 15. decembar 2021., pp. 261-268.
10. Pragyani, B., Sanaa, R., Massimo, M. (2019). *Characterisation of several types of millets as functional food ingredients,* Intern.Journal of Food Sciences. and Nutrition, 70(6): 714-724.
11. *Pravilnik o uslovima u pogledu zdravstvene ispravnosti dijetetskih namirnica koje se mogu stavljati u promet*, Sl list SFRJ, 1985, 4, 120.
12. Singh, R.B., Fedacko, J., Mojto, V. (2020). *Effects of millet based functional foods rich diet on coronary risk factors among subjects with diabetes mellitus: a single arm real world observation from hospital registry*. MOJ Public Health. 9(1):18-25.
13. Law on Food Safety, "Official Gazette of RS", No. 41/2009 i 17/2019)

STRUCTURE OF LIVESTOCK PRODUCTION IN THE SOUTHWESTERN PART OF SERBIA

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Abstract

Agriculture, as one of the most important branches of the economy, still brings profit even in difficult conditions and circumstances. The decline in livestock production in Serbia is precisely indicated by statistical data and indicators with a tendency for further decline. Compared to the period from 1985 to 1990, beef production decreased by 24.60% in the period from 1995 to 2000, and by 29.20% in the period from 2006 to 2011. The fact that the international trade in meat is expanding significantly indicates the need to pay more attention to animal husbandry and the meat industry. Due to the geographical diversity of Serbia, the authors decided to conduct the research on the underdevelopment of animal husbandry on a smaller territorial unit. The results of the research indicate that the number of cattle compared to the reference year of 1991 increased by 3.65%, while the number of sheep decreased by 40.06%. If the year 2000 is taken as the reference year, the number of cattle in the examined area increased by 7.61%, and the number of sheep by 1.59%.

Key words: Animal husbandry, number of heads, plateau, Serbia

Introduction

According to the data presented in the announcement issued by the Statistical Office of the Republic of Serbia (RSO) on December 1, 2017, the total number of cattle increased by 0.7%, sheep by 2.4%, and poultry by 0.6%, while the total number of pigs decreased by 3.7% and goats by 8.8% compared to the previous period. Cattle are mostly raised in the Šumadija and Western Serbia Region (45.9% of the total number of cattle in the territory of the Republic of Serbia), and pigs in the Vojvodina Region (41.9%). Compared to the ten-year average (2007–2016), the total number of cattle is lower by 6.2%, pigs by 13.5%, goats by 23.2% and poultry by 10.6%, while the number of sheep is higher by 5 .8%. Compared to the period from 1985 to 1990, beef production decreased by 24.60% in the period from 1995 to 2000, and by 29.20% in the period from 2006 to 2011. Such changes in the production of beef in Serbia are the result of a constant decrease in the number of cattle over the past twenty-five years (Dokmanović et al., 2014).

Statistical data clearly indicate that Serbian livestock has been decimated and is still far from being recovered. One of the reasons for the decline in the number of cows is the desire of primary producers to improve the breeding traits of dairy cows by eliminating less productive breeds. However, the main reasons for the declining numbers of dairy cows include fragmentation of primary production, rural-urban migration, rising prices of animal feed and other necessary inputs, large fluctuations in market variables (primarily in the milk retail price) and significantly unpredictable and inconsistent implementation of state measures in this sector. Highly-developed agriculture and the economy of a country cannot be achieved without livestock production. Modern concepts of rural development envisage Business Support Centers that should primarily upgrade outputs of the primary production in terms of geographical origin, quality control, sorting, calibration, storage, packaging, branding, promotion, placement, billing, etc. The lack of support of this kind contributes to the collapse of the weak economy of rural areas.

Per-capita meat consumption has often been used as a measure of animal husbandry level and related to the living standard of a country (Grgić and Zrakić, 2015). In high-income countries, consumption ranges between 80 and 130 kg of meat per year and this is considered the upper limit of consumption per person (Steinfeld et al., 2006).

Work methodology

The research presented in the paper was carried out in the area of Novi Pazar, Tutin and Sjenica with the aim of identifying obstacles, problems and perspectives of sustainable development of livestock production. This is an extremely poor and rural region of Serbia, which was another reason to conduct our research here. The paper aimed to point out the importance of stable and continuous livestock production.

To conduct the study presented in this paper, we applied general scientific methods, such as analysis, synthesis, induction and deduction. To compare the land ownership structure of the study area with data at the national and EU levels, the study also used the comparative method. The data were obtained from secondary sources (Statistical Office of RS), mathematically processed, interpreted and presented in tables and graphs.

Results and discussion

The predominant part of the study area is the Pešter Plateau, which has natural potential with exceptional agroecological values. This plateau has all predispositions for cattle breeding and traditional agricultural production. Livestock production is the main activity that has always been an important source of income for the inhabitants of the plateau. Livestock production in the examined area primarily relates to cattle and sheep breeding, given that the number of pigs, poultry and goats is negligible. Huge pasture meadows of this area make perfect conditions for sheep and, to a lesser degree, cattle breeding.

Sjenica and Tutin are the centers of livestock production, and the largest number of cattle and sheep are raised on the Pešter Plateau.

Table 1. Livestock of the study area

City/municipality	Cattle	Pigs	Sheep	Poultry
Sjenica	27 288	1 708	30 324	43 003
Tutin	15 675	82	21 028	39 062
Novi Pazar	9 645	3 304	16 091	49 368
In total	52 608	5 094	67 443	131 433
RS	908 102	3 407 318	1 736 440	2 671 0921

Data source: RSO, Municipalities and regions in Serbia, 2017

Sjenica (2111) and Tutin (1767) have the greatest number of farms that own 3-9 cows, and Novi Pazar (1722) with 1-2 cows. Farms that own 3-9 sheep in Sjenica are the most numerous (297), as is the case in the Republic of Serbia. The situation in Tutin (222) and Novi Pazar (223) is somewhat more favourable, with the most numerous farms being the ones that own 20-49 sheep.

The number of livestock in Sjenica and Tutin increases in the period when livestock is driven out to pasture and decreases before housing livestock indoors in winter. The main reason for the oscillating seasonal trends is the lack of fodder in the winter and the small barn capacities.

Table 2. Number of farms and number of cattle according to herd size

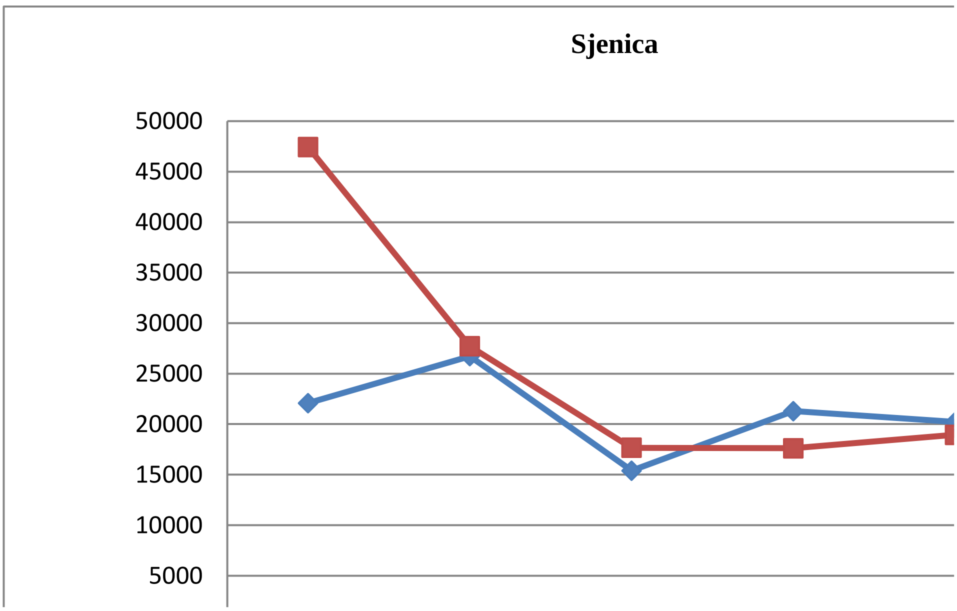
City/ Municipality	farms	1-2 heads		3-9 heads		10-19 heads		20-29 heads	
		farms	cattle	farms	cattle	farms	cattle	farms	cattle
Sjenica	4027	980	1654	2111	11013	761	9857	131	2985
Novi Pazar	3110	1722	2679	1294	5774	90	1086	3	66
Tutin	3557	1498	2551	1767	8347	247	3138	28	660
Serbia	177252	88457	134321	70977	330513	12121	157655	2914	68543
City/ Municipality		**30-49 heads**		**50-99 heads**		**100 and more**			
		farms	**cattle**	**farms**	**cattle**	**farms**	**cattle**		
Sjenica		38	1292	5	314	1	173		
Novi Pazar		1	40						
Tutin		7	244	8	494	2	241		
Serbia		1701	62757	810	52848	272	101465		

Data source: RSO, Municipalities and regions in Serbia, 2017

Table 3. Number of farms and number of sheep according to herd size

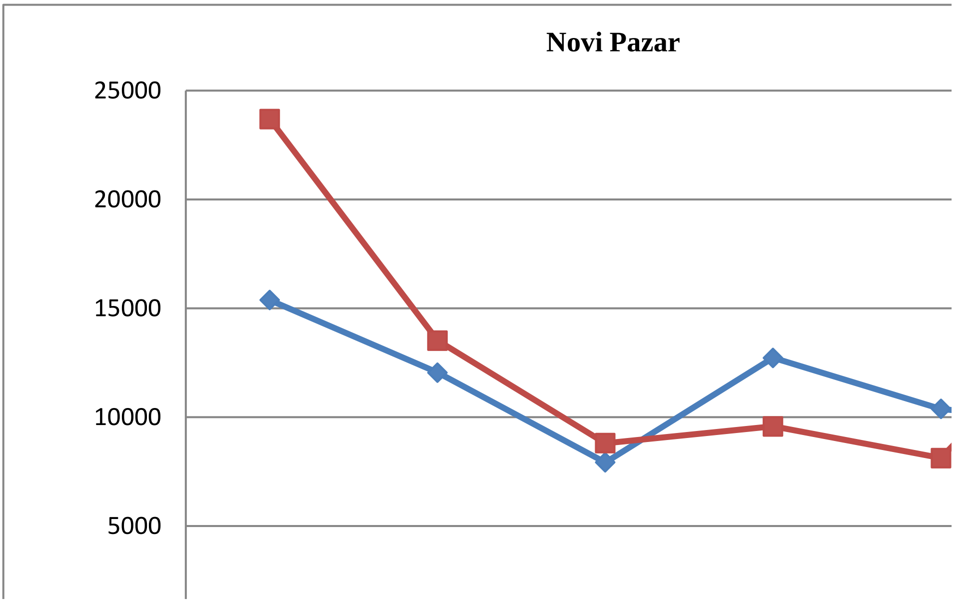
City/ Municipality	farms	1-2 heads		3-9 heads		10-19 heads		20-49 heads	
		farms	sheep	farms	sheep	farms	sheep	farms	sheep
Sjenica	974	87	156	297	1555	196	2359	197	5731
NP	758	39	66	211	1176	207	2663	223	6777
Tutin	533	4	7	69	360	102	1337	222	6581
Serbia	154972	12750	22673	82461	468937	42264	535495	14346	387722
City/ municipality		**50-99 heads**		**100-199**		**200-499**		**500 heads and more**	
		farms	**sheep**	**farms**	**sheep**	**farms**	**sheep**	**farms**	**sheep**
Sjenica		128	8274	49	6099	19	4573	1	1577
NP		67	4186	11	1223				
Tutin		89	5876	40	5122	7	1745		
Serbia		2159	138321	729	93556	230	61211	33	28525

Data source: RSO, Municipalities and regions in Serbia, 2017



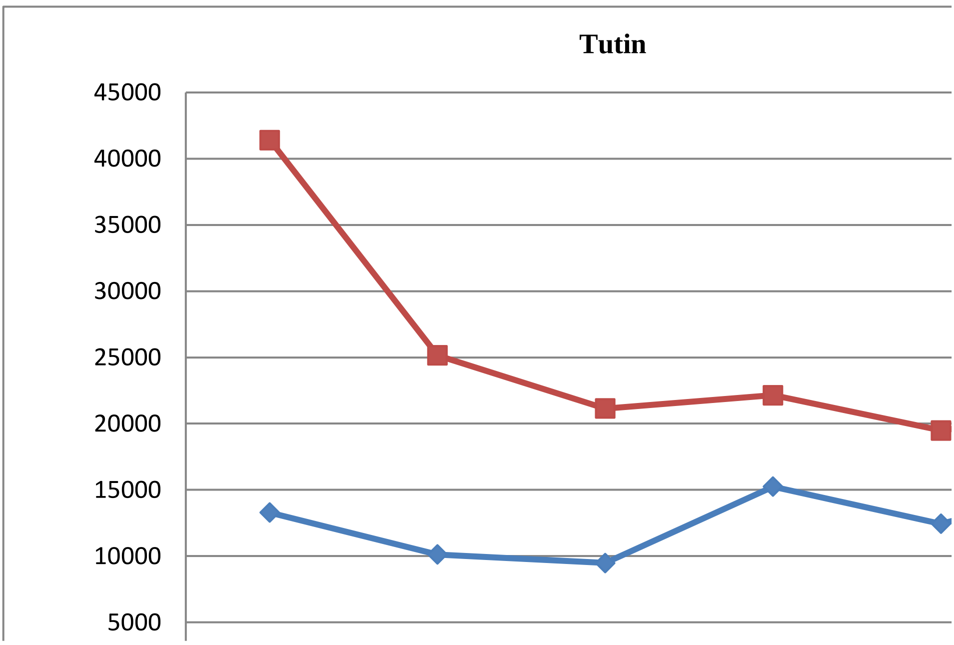
Graph 1. Trends in the number of cattle and sheep in Sjenica from 1991 to 2017

Source: Authors' calculation based on RSO data



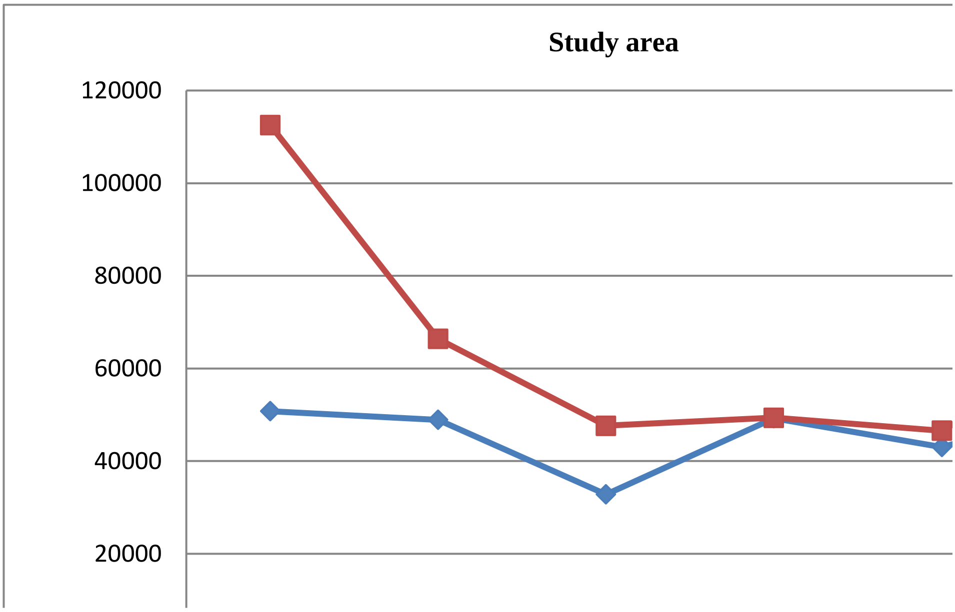
Graph 2. Trends in the number of cattle and sheep in Novi Pazar from 1991 to 2017

Source: Authors' calculation based on RSO data



Graph 3. Trends in the number of cattle and sheep in Tutin from 1991 to 2017.

Source: Authors' calculation based on RSO data



Graph 4. Trends in the number of cattle and sheep in the study area from 1991 to 2017

Source: Authors' calculation based on RSO data

Of the total cattle raised in the Republic of Serbia (908,102), 5.8% are raised in the study area. Dairy cows account for 65% of the cattle raised in the study area and 49% in the Republic of Serbia. Of the total number of sheep raised in the Republic of Serbia (1,736,440), 3.90% are raised in the study area. The data clearly indicate that there are sufficient raw material resources for the production and processing of milk. The percentage of milk purchased in the study area is far below the national average (50%) because all the sheep and buffalo milk and a great deal of cow milk are processed by households.

The trend in the number of cattle and sheep in the study area from 1991 to 2017 differs from the trend prevailing in Serbia. Regarding the whole country, the number of cattle decreased by 23.5%, and the number of sheep increased by 17.3%. On the other hand, the number of cattle in the study area increased by 3.65% compared to the reference year of 1991, while the number of sheep decreased by 40.06%. If we take the year 2000 as the reference year, the number of cattle in the study area increased by 7.61%, and the number of sheep by 1.59%.

Table 4. Livestock structure (cattle and buffalo)

Municipality City	Cattle up to 1 year	Cattle 1-2 years old		Cattle over 2 years old			Others	Total cattle	Buffaloes
		Male heads	Female heads	Male heads	Heifers	Dairy cows			
Sjenica	3649	570	1667	538	3650	17077	137	27288	35
N. Pazar	2446	160	418	227	in 2015	10158	251	15675	148
Tutin	1275	138	478	133	796	6731	94	9645	320
In total	7370	868	2563	898	6461	33966	482	52608	503

Source: Authors' calculation based on data from RSO, Municipalities and regions in Serbia, 2017

Regardless of all the reasons that motivate farms to produce their own dairy products, there is a trend in this area for larger farms to give up cheese production and gradually switch to selling milk to dairies. The percentage of milk delivered to dairies is far from the national average but it is certain to increase in the future. As for cow milk, about 55% of the milk produced is used to feed calves, 25% is processed by households, and only 20% is sold to dairies. Households retain higher amounts of milk because calves are raised on milk for longer.

Esad Hodžić[2]**,** director of the Regional Center for Agricultural and Rural Development in Sjenica**,** says that sheep cheese is mostly produced on the farms, i.e., shepherds' huts, where sheep graze at the time they are milked.

"In the geographical area of Sjenica Municipality and part of Tutin Municipality, where this cheese is produced, around 35,000 to 40,000 sheep are raised. The number of sheep is often significantly higher in summer. Of the total number of sheep, a small number are not milked, only about 10%-15%, so it is estimated that cheese is produced in this area from about 30,000 to 35,000 sheep".

According to Hodžić, cheese produced per sheep in this area ranges from 10 kg to 12 kg, which means that an estimated 300 to 350 tons of "Sjenica sheep cheese" are produced in this area every year. The natural resources of this area are such that a significantly larger number of sheep could be reared. Better long-term financial support for the development of sheep farming could increase the number up to 150,000 sheep. Hodžić adds that mixed cheese is produced in

[2]Taken from the website: https://www.agroklub.rs/stocarstvo/naci-nova-trzista-za-sjenicki-sir/37627/#photo (12/19/2018)

much smaller quantities, and the estimated production of mixed cheese is around 50-70 tons per year. This cheese is mainly produced by agricultural farms. Cow cheese is produced by small plants, dairies, registered milk processing companies, and registered agricultural farms. They use raw materials of a specific geographical indication and apply traditional technology.

Table 5. Livestock structure (sheep)

Municipality/ City	Lambs	Sheep	Rams	In total
Sjenica	5 015	21,950	1 098	30 324
Novi Pazar	5 101	14 274	729	21 028
Tutin	3 576	11 585	704	16 091
In total	13 692	47 809	2 531	67 443

Source: Authors' calculation based on data from RSO, Municipalities and regions in Serbia, 2017

"The registered farms, whose milk is not purchased due to bad roads and small processing capacities, also produce cheese. It is estimated that around 400 to 450 tons of Sienica cow cheese are produced annually on these farms. "It is estimated that the current annual production of Sjenica cow cheese on the territory of the Sjenica-Pešter plateau ranges from 900 to 1,000 tons," says Hodžić.

Table 6. Sale and purchase of livestock products

City/municipality	Purchase of milk (in 000 l)	Cattle (in t)
Sjenica	11 229	332
Tutin	4 343	140
Novi Pazar	4 199	15
In total	19 771	487
Republic of Serbia	837 069	41 884

Data source: Calculation based on data from the RSO, Municipalities and Regions in Serbia, 2017.

Conclusion

The trend in the number of cattle and sheep in the study area from 1991 to 2017 differs from the trend in Serbia, where the number of cattle decreased by 23.5%, and the number of sheep increased by 17.3%. In the study area, the number of cattle increased by 3.65% compared to the reference year of 1991, while the number of sheep decreased by 40.06%. If we take the year 2000 as the reference year, the number of cattle in the study area increased by 7.61%, and the number of sheep by 1.59%.

References

1. Babić, V. (2012): Intenzivnost stočarske proizvodnje na području Požeško-slavonske županije, final thesis - undergraduate study, University of Osijek, Faculty of Agriculture in Osijek
2. Zelenović, V., Željko Vojinović, Ž., Cvijanović, D. (SERBIAN AGRICULTURE LOANS WITH THE AIM OF IMPROVING THE CURRENT SITUATION, *Economics of Agriculture* 1/2018 UDC: 336.77/.78:338.43(497.11), doi:10.5937/ekoPolj1801323Z
3. Dokmanović, M., Lukić, M., Baltić, M. Ž., Ivanović, J., Marković, R., Grbić, S., & Glamočlija, N. (2014). Analysis of the beef production volume in Serbia from 1985 to 2011. *"Meat Technology", 55* (1), 73-80.
4. Grgić, I., M. Zrakić (2015): Self-sufficiency of the Republic of Croatia in the production of beef. Meat, the first Croatian magazine about meat. XVII (1): 73-77
5. Deže, J., Lj. Ranogajec, I. Štefanić (1998): Međuovisnost veličine zemljišnog posjed obujma stočarske proizvodnje u obiteljskim gospodarstvima. *Agriculture* 4(1): 25-30
6. Jandrić, MF (2019). *Organizaciono-ekonomska obeležja proizvodnje i prerade mleka na Pešterskoj visoravni* (doctoral dissertation, University of Belgrade - Faculty of Agriculture).
7. Jobber, D., Fahy, J. (2006): Basics of marketing, Data status, Belgrade
8. Mažić, M. (2018): Mogućnosti poboljšanja konkurentske pozicije Republike Srbije na međunarodnom tržištu mesa, doctoral dissertation, Faculty of Agriculture, University of Novi Sad
9. Madžar, L. ZNAČAJ I IZVOZNI POTENCIJAL PRIVREDE REPUBLIKE SRBIJE SA POSEBNIM OSVRTOM NA STANJE STOČNOG FONDA.
10. Steinfeld H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales, C. de Haan (2006): Livestock's long shadow: environmental issues and options. Rome, Italy: FAO.
11. Cvijanović, D., Cvijanović Gorica, Puškarić, A. (2011): Marketing i ekološka poljoprivreda, Monograph, Institute for Agricultural Economics, Belgrade.)

TUBER YIELD AND STARCH CONTENT IN POTATO OF A DIFFERENT RIPENING IN AGRO-ECOLOGICAL CONDITIONS OF NORTHERN MONTENEGRO

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Abstract

The results of multi-year research on tuber yield and starch content of several potato varieties in the agro-ecological conditions of northern Montenegro are presented. The investigated varieties were of different ripening times, from early varieties (Riviera), medium early (Almera, Aladin and Bounty) to medium late (Agria, Margarita, Kennebec and Desiree). Research was conducted in 2015., 2016. and 2017, on acidic, brown soil. The experiments were placed at three different altitudes and therefore at three different climatic locations: Nedakusi (556 m), Sutivan (680 m) and Orahovica (900 m). Trials were set up in three replicas, using standard methodology in a random block design. Analysis of variance showed that the yield of tubers for sale and the total yield of tubers varied significantly depending on the genotype, year and altitude, that is, the location of the experiment, as well as their interactions.

Key words: Potato, variety, yield, tuber, starch

Introduction

Potato (Solanum tuberosum L.) holds an important place in the world food system as the fourth most important crop and is one of the leading agricultural and vegetable crops in Europe and the Balkans (Camire et al., 2009, Bishvong and Svarnima, 2016). Cultivated species originate from wild species that occur in spontaneous flora in a broad region of South America. Tubers have been used as food for more than 12,000 years. The Spanish brought the potato to Europe in 1536, but it was grown as a decorative plant in botanical gardens of Europe for almost two centuries (Đurić et al. 2015). It is used for human consumption and has a huge roal in the industry and as fodder (Donnelly and Kubov, 2011). Potatoes were brought to Montenegro later, in the 18th century, when St. Petar of Cetinje gave some cachets to be planted in the courtyard of the Monastery in Cetinje, from where it spread to other regions.

Potatoes first arrived in Montenegro by sea, and it was believed that they came from Russia. Russian early potato varieties were brought to Montenegro in 1786 (Ražnjatović, 1962). In the structure of arable land in Montenegro, potatoes occupy more than 23% (http://www.monstat.org). Areas under potatoes and yields in the world, Europe and Montenegro for the 2010-2019 period are presented in Table 1 (FAO, 2019).

Table 1. Areas under potatoes and yields in the world, Europe and Montenegro for the period 2010-2019

Year	World		Europe		Montenegro	
	Area (ha)	Yield (t ha^{-1})	Area (ha)	Yield (t ha^{-1})	Area (ha)	Yield (t ha^{-1})
2010	18,173,634	18. 08	6,013,351	17.85	1,214	14.60
2011	18,699,577	19. 68	6,146,793	21.24	1,286	16.50
2012	18,698,323	19. 31	5,962,821	19.56	1,327	11.80
2013	18,507,308	19. 73	5,725,810	20.15	1,345	14.90
2014	18,052,066	20. 50	5,619,154	22.17	1,645	14.78
2015	18,068,799	20. 26	5,540,376	21.04	1,616	16.83
2016	17,409,789	20. 34	4,883,324	22.35	1,613	18.55
2017	17,443,203	21. 22	4,832,677	23.81	1,616	17.02
2018	17,164,096	21. 28	4,733,273	22.14	1,619	16.12
2019	17,340,986	21. 36	4,696,336	22.84	1,620	16.40

Source: FAOSTAT-http://www.fao.org/faostat/en/#data/QC (retrieved on 1 April 2021).

Determining the optimal areas for growing potatoes is directly related to climatic conditions. Production of early potatoes is mainly located in the Zeta-Bjelopoljska plain and the littoral, with a share in the total production of 16.8%. Production of potatoes intended for storage is the dominant type of production (83.2%) and refers to the central-mountainous region (Jovović et al., 2012). Potato yield depends on the variety, genetic potential, agro-ecological conditions, level of applied agrotechnical measures and tuber viability, seed tuber size, number of stems per plant and number of tubers per plant (Bus and Wustman, 2007; Poštić et al. 2012; Poštić et al. 2013; Momirović et al. 2016; Arslanović Lukač et al., 2021). As a result of global warming in the next 30 years, for the region of Southeast Europe, including Montenegro, a decrease in potato yields of 10-26% is predicted, which could be reduced to 5-11% by using tolerant varieties and applying good agricultural practices (Hijmans, 2003). The quality of potato tubers and their chemical composition is influenced by genetics, factors, soil fertility, weather conditions and chemical treatments applied (Ritell et al., 2013). Quality of potato tubers is determined by many features, the most important of which are dry matter content, type and amount of starch and protein (Van Eck, 2007). Hoffler and Ochieng, (2008) point out that the high energy content of the potato and the simplicity of its production have made it a suitable component of urban agriculture, which globally ensures food security for at least 800 million people. Thus, potatoes are a crop vith high potential for solving the possible needs of low-income households, both in urban and in rural areas (FAO, 2008). Also, it has significant untapped potential to further increase yields and productivity, especially in some marginal farming societies, where other crops have extremely low yield potential (FAO, 2008). Potato yields in Montenegro are very unstable and very susceptible to the influence of meteorological conditions (Jovović et al., 2012; Arslanović Lukač et al., 2021).

With a correct selection of varieties, it is possible to overcome the negative impact of agro-ecological factors, especially the water and air regime of the soil and high temperatures during the growing season in the area of northern Montenegro. Therefore, the goal of this research was to examine the tuber yield and starch content in the tubers of different genotypes under the agro-ecological conditions of northern Montenegro and to find genotypes that will give satisfactory and stable yields.

Materials and methods

Experiments were done in 2015, 2016 and 2017 at three locations in the north of Montenegro. Subjects of the research were: early (Riviera), medium early (Almera, Aladin and Bounty) and medium late potato (Agria, Margarita, Kennebec and Desiree) varieties. Experiments were done under different agro-ecological conditions and on the same types of acid brown soil in: Nedakusi (556 m), Sutivan (680 m) and Orahovica (900 m). Experiments were laid out in a randomized block design with three replications. The size of a plot was 16 m^2. Potatoes were planted by hand with a distance of 70 cm between rows and 40 cm within the row, creating a density of 35,714 plants per hectare. Planting material belonged to the category of original (certified) seed, the fraction of 35-55mm. Sowing in all locations was done at the end of April. Cultivation was under dry farming conditions, usual for potato production. Appropriate plant protection products were used to control diseases and pests. After harvesting, the market yield of tubers and the total yield were precisely established. Data was converted into tons per hectare.

The soil on which experiments were conducted, like most soils in the western region of Montenegro, is characterized by favorable water and air properties and a high humus content. On the other hand, these soils have a high acidic pH, are poor in phosphorus and calcium and have a low (Nedakusi) to high potassium content (Sutivan and Orahovica), Table 2.

Table 2. Chemical characteristics of soil

Depth (cm)	Location	pH		$CaCO_3$ %	Humus %	mg 100 g^{-1} content	
		H_2O	n KCl			P_2O_5	K_2O
30	Nedakusi	5.00	4.41	2.57	2.77	5.27	8.33
	Sutivan	5.17	4.57	2.60	5.04	3.53	25.13
	Orahovica	4.63	4.03	2.47	3.62	3.17	24.60

Data in Tables 3 and 4 shows that that meteorological data differed significantly in different locations and between years. Average air temperatures decreased with higher altitude, while precipitation during the potato vegetation period was unevenly distributed, with a deficit during the period of intensive growth and tuber filling. This deficit was most pronounced in 2015, leading to a significant decrease in yield in that year under review.

Table 3. Average monthly air temperatures (°C) at all locations during the 2015, 2016 and 2017 trials

Year	Location	Month						
		April	**May**	**June**	**July**	**August**	**Sept.**	**Average**
2015	Nedakusi	9.7	16.9	18.9	23.4	22.6	18.7	18.37
	Sutivan	9.0	16.4	18.3	22.9	21.8	18.2	17.77
	Orahovica	8.4	15.8	17.9	22.5	21.2	18.0	17.3
2016	Nedakusi	13.6	13.9	20.5	21.5	19.8	16.6	17.65
	Sutivan	12.9	13.4	19.9	21.0	19.1	16.0	17.05
	Orahovica	12.3	12.9	19.5	20.4	18.4	15.7	16.53
2017	Nedakusi	10.3	15.3	20.0	21.3	21.9	16.7	17.58
	Sutivan	9.7	14.7	19.4	20.8	21.0	16.2	16.97
	Orahovica	9.2	14.1	18.8	20.3	21.5	15.8	16.62

Table 4. Amount and distribution of precipitation (mm) at all locations during the experiment in 2015, 2016 and 2017

Year	Location	Month						
		April	**May**	**June**	**July**	**August**	**Sept.**	**Total**
2015	Nedakusi	53.5	35.5	90.4	15.5	30.7	59.0	284.6
	Sutivan	56.1	38.4	34.0	8.2	22.3	63.8	222.8
	Orahovica	61.4	42.5	47.1	20.3	16.7	48.6	236.6
2016	Nedakusi	48.2	120.0	86.0	76.0	85.3	74.6	490.1
	Sutivan	50.6	126.1	90.3	79.8	88.1	78.2	513.1
	Orahovica	53.0	132.8	95.1	89.2	97.3	82.5	549.9
2017	Nedakusi	49.0	78.9	75.4	102.4	44.8	19.4	369.9
	Sutivan	51.4	83.0	79.8	106.7	47.5	22.4	390.8
	Orahovica	60.5	89.6	87.2	117.3	53.0	25.8	433.4

Obtained results were analyzed by analysis of variance (ANOVA, F-test; $P \leq 0.05$, $P \leq 0.01$ and $P \leq 0.001$) and the effect of factors (year, genotype, location and their interaction). Data was processed using the STATISTICA program, version 8 (StatCoftInc, Tulsa, OK, USA).

Results and discussion

Analysis of market yield (Table 5) showed very significant statistical differences under the influence of year (Factor A), location (Factor B) and variety (Factor

C). A very high significance of the mutual effect of examined factors in terms of the trend for market yield was obtained for all mutual interactions of the examined factors A x B, A x C, B x C and A x B x C.

On the average the highest market yield of tubers (25,46 t ha^{-1}) was established in 2016, followed by 2017 (21,21 t ha^{-1}), while the lowest market yield (18,19 t ha^{-1}) was established in in 2015. Observing the effect of the year on average (Table 5), a very significantly higher yield of marketable tubers was recorded in 2016, compared to market yields established in 2015 and 2017. A very significantly higher market yield was established in 2017, compared to the market yield established in 2015.

Observed by locations, the highest market yield of tubers (29.20 t ha^{-1}) was established at the Nedakusi location, followed by the Sutivan location (19.90 t ha^{-1}), while the lowest market yield (15.80 t ha^{-1}) was realized at the Orahovica location. Statistical analysis of the yield of marketable tubers revealed a very significantly lower market yield of tubers at the Sutivan and Orahovica locations, compared to the recorded yield of marketable tubers at the Nedakusi location. A significantly higher market yield of tubers was established at the Sutivan location, compared to the market yield achieved at the Orahovica location.

Table 5. Effect of year, location and variety on the yield of marketable tubers (t ha^{-1})

Variety (C)	Year (A)											
	2015				2016				2017			
	Location (B)											
	Ne	Su	Or	X(A)	Ne	Su	Or	X(A)	Ne	Su	Or	X(A)
Riviera	36.19	19.69	7.75	21.21	19.37	19.69	14.73	17.93	15.73	16.18	12.50	14.8
Almera	40.68	9.87	10.59	20.38	21.59	27.25	22.00	23.61	17.11	22.12	17.28	18.84
Aladin	38.96	9.16	12.06	20.06	37.35	36.46	24.37	32.73	31.79	33.04	20.38	28.4
Bounty	33.83	2.17	8.33	14.78	25.56	28.01	17.81	23.79	20.26	23.30	15.13	19.56
Agria	32.08	7.20	10.78	16.69	35.99	29.28	24.82	30.03	30.98	25.73	20.00	25.57
Margarita	43.13	5.61	12.43	20.39	26.89	29.48	21.56	25.98	21.92	25.24	18.29	21.82
Kennebec	32.29	5.22	8.03	15.18	25.71	23.05	15.95	21.57	18.11	19.06	13.58	16.92
Desiree	33.71	7.05	9.70	16.82	33.14	28.49	22.57	28.07	28.90	23.93	18.36	23.73
X(C)	36.36	8.25	9.96	18.19	28.20	27.71	20.48	25.46	23.1	23.58	16.94	21.21

	A	B	C	AB	AC	BC	ABC
F	65.52**	242.7**	18.34**	111.6**	6.11**	1.55**	2.18**
$LSD_{0.05}$	1.26	1.25	2.05	2.18	3.56	3.55	6.16
$LSD_{0.01}$	2.15	2.15	3.51	3.73	6.08	6.09	10.54

The yield of marketable tubers (> 70 g) depends on the genetic potential of the variety, agro-ecological conditions, applied technology (fertilization, irrigation, protection, cultivation system) and the length of the vegetation period, which means that under conditions of longer tuber filling, larger tubers are formed and the total yield is higher (Knowles et al., 2003; Khan et al., 2004; Doring et al., 2005; Kar and Kumar, 2007; Singh and Ahmet, 2008; Momirović et al., 2010; Poštić et al., 2012; Poštić 2013; Gvozden, 2014; Poštić et al., 2015; Momirović et al., 2016; Gvozden, 2016; Oljača, 2016). However, this does not always have to be confirmed in practice, because early and mid-early varieties, characterized by early tuberization and rapid filling of tubers in dry summer conditions usually give higher yields than native mid-late and late varieties. The yield of commercial tubers in 2016 (Table 5) was on average significantly higher compared to 2015 and 2017, as a result of more favorable weather conditions in 2016 (Table 3 and Table 4). Such results are in agreement with the research of numerous authors (Momirović et al., 2010; Jovović et al. 2011; Poštić et al. 2012; Poštić, 2013; Gvozden, 2016; Momirović et al., 2016; Oljača, 2016), who state that production conditions significantly affect the yield of mercantile or marketable tubers.

Analysis of total yield (Table 6) showed statistically very significant differences under the influence of year (Factor A), location (Factor B) and variety (Factor C). Very significant interactions of the examined factors in terms of total yield were seen with the mutual effect of factors A x B, A x C and B x C, while there was no effect of the interaction A x B x C.

On average, the highest total yield (26.73 t ha^{-1}) was established in 2016, followed by 2017 (23.92 t ha^{-1}), while the lowest total tuber yield (19.47 t ha^{-1}), was recorded in 2015. When observing the average effect of the year (Table 6), a significantly higher total yield of tubers was recorded in 2016, compared to the total yields recorded in 2015 and 2017. A very significantly lower total yield was established in 2015, compared to the total yield established in 2017.

Observed by locations, the highest total yield of tubers (31.40 t ha^{-1}) was established at the Nedakusi location, followed by the Sutivan location (21.40 t ha^{-1}), while the lowest total yield (17.40 t ha^{-1}) was recorded at the Orahovica location. Statistical analysis of the yield of marketable tubers revealed a very significantly lower total yield of tubers at the Sutivan and Orahovica locations, compared to the recorded total yield of tubers at the Nedakusi location. A significantly higher total tuber yield was recorded at the Sutivan location, compared to the total yield recorded at the Orahovica location.

Table 6. Effect of year, location and variety on total tuber yield (t ha^{-1})

Variety (C)	Year (A)											
	2015				2016				2017			
	Location (B)											
	Ne	Su	Or	X(A)	Ne	Su	Or	X(A)	Ne	Su	Or	X(A)
Riviera	38.10	15.93	8.67	20.9	20.58	21.19	15.81	19.19	18.56	19.18	14.79	17.51
Almera	41.73	11.29	11.98	21.67	23.06	28.75	23.05	24.95	19.48	25.45	20.09	21.67
Aladin	40.48	10.24	13.04	21.25	38.76	38.27	25.35	34.13	35.36	34.95	23.02	31.11
Bounty	34.96	3.73	9.33	16.01	26.11	29.15	18.63	24.63	23.09	26.13	17.28	22.17
Agria	34.02	8.18	11.83	18.01	37.22	30.55	26.09	31.29	33.60	27.23	23.11	27.98
Margarita	45.32	6.63	13.48	21.81	28.16	30.77	22.64	27.19	24.95	27.64	20.86	24.48
Kennebec	34.04	6.19	9.24	16.49	27.28	24.59	17.00	22.96	23.67	21.28	15.66	20.2
Desiree	39.43	8.78	10.68	19.63	34.5	30.26	23.75	29.5	31.29	26.14	21.30	26.24
X(C)	38.51	8.878	11.03	19.47	29.46	29.19	21.54	26.73	26.25	26.00	19.51	23.92

	A	B	C	AB	AC	BC	ABC
F	64.20**	250.8**	19.43**	120.3**	4.72**	1.61**	1.49ns
$LSD_{0.05}$	1.28	1.28	2.09	2.21	3.62	3.63	
$LSD_{0.01}$	2.19	2.19	3.58	3.79	6.19	6.20	

When choosing an assortment, fertility is one of the most important qualitative characteristics. In the last few years, in the production of all agricultural plant species, the aim is to precisely recommend the assortment for a certain region (Arslanović-Lukač et al. 2012; Poštić, 2013; Oljača, 2016; Gvozden, 2016). Such a strong influence of location on total tuber yield agrees with the results of other authors (Hassanpanah, 2010; Jovović et al., 2012; Poštić et al., 2012; Momirović et al., 2016; Oljača, 2016; Gvozden, 2016). Owing to their ability to grow quickly, good coverage and earlier formation of tubers (Desiree), some varieties go through critical stages of development more easily (tolerant varieties) reducing the negative impact of environmental factors (Rukaaczevska, 2015; Momirović et al., 2016).

Analysis of starch content in the tuber (Table 7) showed statistically very significant differences under the influence of year (Factor A), location (Factor B) and variety (Factor C). A very high significance of the mutual influence of the examined factors in terms of starch content was seen for all mutual interactions of the examined factors A x B, A x C, B x C and A x B x C.

On average, the highest starch content (18.41%) in the tuber was established in 2015, followed by 2017 (18.22%), while the lowest starch content in the tuber (17.33%) was recorded in 2016. Observing the influence of the year on average (Table 7), a significantly higher starch content in the tuber was recorded in 2015, compared to the starch content established in 2016 and 2017. A significantly higher starch content in the tuber was found in 2017, compared to the starch content in 2016.

Observed by locations, the highest starch content in the tuber (18.9%) was found at the Sutivan location, followed by the Orahovica location (18.4%), while the lowest starch content in the tuber (16.7%) was achieved at the Nedakusi location. Statistical analysis of the starch content in tubers revealed a significantly lower starch content at Nedakusi and Orahovica locations, compared to the recorded starch content in tubers at the Sutivan location. A significantly higher starch content in tubers was found at the Orahovica location, compared to the starch content in tubers at the Nedakusi location.

Table 7. Effect of year, location and variety on starch content in tubers (%)

Variety (C)	Year (A)											
	2015				2016				2017			
	Location (B)											
	Ne	**Su**	**Or**	**X(A)**	**Ne**	**Su**	**Or**	**X(A)**	**Ne**	**Su**	**Or**	**X(A)**
Riviera	15.12	15.34	16.43	15.63	13.29	20.31	13.87	15.82	16.24	16.43	15.65	16.11
Almera	15.46	15.21	18.75	16.47	12.11	15.17	12.59	13.29	15.02	16.89	17.24	16.38
Aladin	17.19	18.75	19.22	18.39	16.89	20.12	14.82	17.28	17.42	19.31	20.08	18.94
Bounty	19.27	19.74	22.42	20.48	19.36	24.05	16.34	19.92	18.05	18.84	19.21	18.70
Agria	17.67	14.99	22.52	18.39	14.55	21.56	17.99	18.03	18.32	19.73	20.42	19.49
Margarita	16.83	16.16	20.74	17.91	15.99	19.68	13.53	16.40	17.24	18.52	18.17	17.98
Kennebec	19.97	19.81	20.14	19.97	15.70	20.40	19.14	18.41	17.69	19.63	19.56	18.96
Desiree	19.17	20.25	20.65	20.02	14.78	21.99	21.66	19.48	18.04	19.71	19.85	19.20
X(C)	17.59	17.53	20.11	18.41	15.33	20.41	16.24	17.33	17.25	18.63	18.77	18.22
	A	B	C	AB	AC	BC	ABC					
F	2870**	10829**	8714**	9287**	676.1**	589.9**	740.1**					
$LSD_{0.05}$	0.03	0.03	0.05	0.05	0.09	0.09	0.15					
$LSD_{0.01}$	0.05	0.05	0.08	0.09	0.15	0.15	0.25					

Measurement results presented in the table show that the highest starch content in the tubers was recorded in the variety Bounty (19.70%), followed by the varieties Desiree (19.57%), Kennebec (19.11%), Agria (18.64 %) and Aladin (18, 20%), while the lowest starch content in the tuber (15.38%) was recorded in the variety Almera. On average, the highest starch content (18.41%) in the tuber was recorded in 2015, followed by 2017 (18.22%), while the lowest starch content in the tuber (17.33%) was achieved in 2016. Starch content of in our research decreases with the increase in precipitation, which is not in agreement with the research of Rudack et al., (2014) and Gvozden (2016), who state that the deficit of precipitation and drought stress reduce the starch content in tubers.

The nutritional value of potato tubers is determined by the content of chemical components (starch, proteins, vitamins, total sugars, reducing sugars and minerals) that play a very important role in human nutrition, as well as by the concentration of toxic compounds (glycoalkaloids, nitrates, heavy metals, pesticides), Lisinska, (2006); Love and Pavek, (2008). Eilers and Hanf, (1999) believe that for industrial processing, the optimum starch content in tubers is around 15%. Singh et al., (2008) state that the starch content in tubers is an indicator of quality, i.e., its purpose, whether it is for cooking or processing. Starch content in the total chemical composition of tubers is 8.0-29.4% (on average 14.1%). The quality of puree, the flouriness and the texture of the boiled potato are determined by the starch content in the tuber (Van Eck, 2007).

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Conclusion

Based on three-year research on tuber yield and starch content of potato varieties with different ripening times in different agro-ecological conditions of northern Montenegro, the following can be concluded:

Different locations and years individually and via their interactions significantly influenced the production properties of studied varieties (genotypes).

It can be concluded that under agro-ecological conditions of northern Montenegro at locations of Nedakusi, Sutivan and Orahovica, the highest total yield within the three-year average was recorded for the medium-early variety Aladin, which had the highest market yield. The Aladin variety was followed by mid-late varieties Agria and Desiree that also had a high and stable total yield at the experiment locations.

For the three-year average, the lowest total tuber yield at experiment locations was established with the early variety Riviera.

Contrary to the assumption and results of other authors, the highest starch content in tubers by year, was recorded in 2015 (when the amount of precipitation was the lowest and the average air temperature the highest), followed by 2017, while the lowest starch content was recorded in 2016.

To achieve high yields with a high share of marketable tubers, the varieties Aladin, Agria and Desiree should be grown, due to their high tolerance to drought, good resistance to potato pathogens and high yield potential.

For production of potatoes for industrial processing, where a high proportion of large A-class tubers is required, as well as a high starch content, we recommend varieties Agria, Kennebec and Desiree.

The region of northern Montenegro is a favorable location for the production of high-quality and health-safe potatoes.

References

1. Arslanović, S., Zečević, V., Balijagić, J., Jovančević, M., Vreva, M., Fetić, E., Čizmađia, H. (2012): Ispitivanje uticaja organskih i mineralnih đubriva na yield i kvalitet krompira sorte Kenebek. I međunarodni simpozijum XVII naučno-stručno savjetovanje agronoma Republike Srpske. Zbornik sažetaka. Trebinje. str. 162
2. Arslanović Lukač, S., Đurić, N., Zečević, V., Balijagić, J., Poštić, D. (2021): The effect of year and genotype on productivity and quality of potato. Genetika, Vol 53, No.1, 305-322. UDC 575.630, ISSN 0534-012

3. Bishwoyong, B., Swarmina, K.C., (2016): Effect of potassium on quality and yield of potato tubers a review. International Journal of Agriculture & Environmental Science, 3, 9-14.

4. Bus, C.B. and Wustman, R. (2007): The Canon of Potato Science: 28. Seed Tubers. Potato Research Vol. 50: 319-322.

5. Camire, M.E., Kubow, S., Donnelly, D.J., (2009): Potatoes and human health. Critical Reviews in Food Science and Nutrition, 49(10), 823-840,

6. Donnelly, D., Kubow, S. (2011): Role of Potato in Human Health. Collegue sur la pomme de terre. 1-6.

7. Döring, T. F., Brandt, M., Heß, J., Finckh, M. R., Saucke, H. (2005). Effects of straw mulch on soil nitrate dynamics, weeds, yield and soil erosion in organically grown potatoes. Field crops research, 94(2-3), 238-249.

8. Đurić, N., Kresović, B., Glamočlija, Đ. (2015): Sistemi konvencionalne i organske proizvodnje ratarskih useva. Monografija, 1-380, Institut PKB Agroekonomik. ISBN 978-86-89859-01-0, COBISS.SR-ID 218749452, CIP 633.1/.7, 631.147

9. Eilers, C., Hanf, C.H. (1999): Contracts between farmers and farmers' processing cooperatives: A principal-agent approach for the potato starch industry. In: Galizzi G., Venturini L. (Eds.) Vertical Relationships and Coordination in the Foos.

10. FAOSTAT-http://www.fao.org/faostat/en/#data/QC (retreived on 1 June 2021).

11. Gvozden, G. (2014): Uticaj veličine međurednog rastojanja na produktivne osobine sorti krompira za industrijsku preradu. Magistarska teza. Poljoprivredni fakultet, Beograd, 1-120.

12. Gvozden, G. (2016): Ispitivanje uticaja konvencionalnog, integralnog i organskog sistema gajenja na produktivnost, kvalitet i biološku vrednost krompira. Doktorska disertacija. Poljoprivredni fakultet, Beograd, 1-212.

13. Hassanpanah, D. (2010): Analysis of G x E interaction by using the additive main effects and multiplicative interaction in potato cultivars. International Journal of Plant Breeding and Genetics, 4:23-29.

14. Hijmans, R.J. (2003): The effect of climate change on global potato production. American Journal of Potato Research, Vol. 80, pp 271-280.

15. Hoffler, H. And Ochienge, B.O. (2008) High commodity prices Who gets the money? Preliminary findings for World Food Day 2008. Heirich BollFoundation.

16. Jovović, Z. (2011): Utjecaj gustoće sadnje na yield i druga produktivna svojstva krumpira. Proceedings. 46th Croatian and 6th International Simposium on Agriculture.Opatija: 672-676

17. Jovović, Z., Dolijanović, Ž., Kovačević, D., Velimirović, A., Biberdžić M., (2012): The productive traits of different potato genotypes in mountainous region of Montenegro. Genetica, Vol. 44, (2), 389-397.

18. Kar, G., Kumar, A., (2007): Effects of irrigation and straw mulch on water use and tuber yield of potato in eastern India. J. Agr. Water Management, 94, 109–116.

19. Khan, I.A., Deadman, M.L., Al-Nabhani, H.S., Al-Habsi, K.A. (2004): Interactions between Temperature and yield components in exotic potato cultivars grown in Oman. Plant Breeding Abstracts, Vol. 74, (6): 1011.

20. Knowles, R., Knowles, L. and Kumar, G.N.M. (2003): Stem number & set relationships for Russet Burbank, Ranger & Umatilla Russet patotes in the Columbia Basin. Potato Progress., 3 (13).

21. Lisińska, G. (2006):Wartość technologiczna i jakość konsumpcyjna polskichodmian ziemniaka. Zeszyty Problemowe Postępów Nauk Rolniczych, 511, 81-94.

22. Love, S.L., Pavek, J.J. (2008): Positioning the potato as a primary food source of vitamin C. American Journal of Potato Research, 85 (4), 277-285.

23. Momirović, N., Broćić, Z., Poštić, D., Jasna Savić (2010): Effect of fertilization level on potato yield for processing under subsurface drip Irrigation. Novenyterm, Vol. 59. Suppl. 4: 365-368.

24. Momirović, N., Broćić, Z., Stanisavljević, R., Štrbanović, R., Gvozden, G., Stanojković-Sebić, A., Poštić, D. (2016): Variability of Dutch potato varieties under various agro-ecological conditions in Serbia, Genetika, Vol.48, No.1, 109-124.

25. Oljača, M. J. (2016): Uticaj sorte i tehnologije gajenja krompira na otpornost prema stresu. Doktorska disertacija. Poljoprivredni fakultet. Beograd. 1-144.

26. Poštić, D., Momirović, N., Koković, N., Oljača, J., Jovović, Z. (2012a): Yield krompira (Solanum tuberosum L.) u zavisnosti od uslova proizvodnje i mase matične krtole. Zbornik naučnih radova XXVI Savetovanje agronoma, veterinara i tehnologa., Vol. 18, (1-2): 99-107.

27. Poštić, D., Momirović, N., Broćić, Z., Dolijanović, Ž., Aleksić, G. (2012): The evaluation biological viability of potato seed tubers grown at different altitudes. African J. of Agricultural Research, Vol. 7(20): 3073-3080.

28. Poštić, D., Starović, M., Popović, T., Bosnić, P., Stanojković-Sebić, A., Pivić, R., Jošić, D. (2013): Selection and RAPD analysis of Pseudomonas ssp. isolates able to improve biological viability of potato seed tubers. Genetika, Vol. 45, No 1, 237-249.

29. Poštić, D., Momirović, N., Iman, Omar Alrhammas, Stanisavljević, R., Štrbanović, R., Đukanović, L., Gavrilović, V. (2015): The yield of early potato in the conditions of western Serbia. 50th Croatian and 10th

International Symposium on Agriculture, February 16-20, 2015. Opatija, 368-372.

30. Ražnatović, V. (1962): Rezultati trogodišnjih ogleda sa krompirom na Krnovu. Naša poljoprivreda i šumarstvo, Br. 1-2, str. 49-54, Titograd.
31. Rytel, E., Lisinska, G., Tajner-Czopek, A., (2013): Toxic Compound Levels in Potatoes are Dependent on Cultivations methods. Acta Alimentaria 42, 308-317.
32. Rudack, K., Seddig, S., Ordon, F. (2014): Characterization of starch potatoes grown under drought. 19th Triennal Conference of the European Association for Potato Research, 6-11 July 2014, Abstract book. 212.
33. Rykaczevska, K. (2015): The Effect of High Temperature Occurring in Subsequent Stages of Plant Development on Potato Yield and Tuber Physiological Defects. Amer. J. Potato Res., 92: 339-349
34. Singh, N. and Ahmed, Z. (2008): Effect of mulching on potato production in high altitude cold arid zone Ladakh. Potato J., 35 (3-4): 118-121.
35. Singh, J., McCarthy, O.J., Singh, H., Moughan, P.J. (2008): Low temperature post-harvest storage of New Zealand Taewa (Maori potato): Effects on starch physico-chemicaland functional characteristics. Food Chemistry, 106, 583–596.
36. Van Eck, H.J. (2007): Genetics of morphological and tuber traits. In: Vreugdenhil, D., Bradshaw, J., Gebhard, C., Govers, F., MacKerron, D.K.L., Taylor, M.A., Ross, H.A. (Eds.), Potato biology and biotechnology: Advances and perspectives. Elsevier, Oxford, pp. 91–115.

ANALYSIS OF THE CHARACTERISTICS OF THE RURAL SPACE OF THE REPUBLIC OF SERBIA AND THE REPUBLIC OF CROATIA

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Abstract

The aim of this paper was a detailed analysis of the state of the rural area of the Republic of Serbia and the Republic of Croatia, from the aspect of opportunities and economic assumptions that this area has, using SWOT, PESTLE analysis and HDI methodology. The analysis showed that the rural area of the two analyzed countries is significantly behind the EU average. The results showed that political and legal factors have the greatest impact on the state of rural areas, while other factors in terms of development are not sufficiently represented. Furthermore, the results of the analysis show that over 90% of the population is literate, while the level of investment attraction is below the EU average. For this reason, it is necessary to raise labor productivity, that is, to initiate investment absorption measures to improve technology, and the production process, which would ultimately increase GDP per product unit. Therefore, it can be concluded that the rural areas of the analyzed countries have development potential, and it is necessary to use it adequately.

Key words: Rural area, SWOT analysis, PESTLE analysis, HDI methodology, economic development

Introduction

Rural areas represent specific and complex economic, social, ecological and spatial areas that in most countries cover over 70% of the national territory and where up to 50% of the population lives (Portnov and Felsenstein, 2005). The characteristics of the largest part of the rural area in the Republic of Serbia and the Republic of Croatia are sparse population, depopulation with a distinct trend of demographic extinction, as well as a high age of the population, a considerable representation of daily migrations of the young population, then poor equipment with traffic, utilities and standard of living facilities, the dominance of agriculture and poor diversification of other productive and non-productive activities, etc.

The neglect of rural settlements, as well as the intolerant attitude towards rural areas in general, initiated an increase in concern about their planning, which became more intense only in the last decade of the last century. This concern was also encouraged by the European regional policy, which pays significant attention to the rural area and its development, agriculture and its alternative activities. Economic growth is an integral and continuous process, which is characteristic of systems capable of evolving over time and thus moving into higher levels of the organization and more efficient states (Čulo, 2002). In other words, local economic processes are an integral part of social processes that, with the help of human ability, are organized in business according to legislative rules to reach the highest possible level of economic development.

Economic development observed at the local level means an increase in the production of goods and services, along with simultaneous structural transformations and changes in the functioning of the local economy (Hirt and Block 2005). Therefore, it is necessary to put the policy of rural development into the function of overall economic development. One of the ways is the implementation of the concept of integrated development policy and investment attraction policy. In this case, a strategy for attracting investments should be defined at the regional level.

In the market competition of local self-government units, LGUs can use several indicators to monitor the effect of investments on the implementation of development policy, but also to monitor the state of competition. Among other things, the task of development policy is to absorb as much investment as possible, so that the benefits that investment brings are as great as possible, and competitiveness is increased to the highest possible level. Providing incentives (subsidies), as part of an integrated development policy, can improve the entrepreneurial climate, and thus help the economic sector. Incentives can be (Liedtka, 1998): fiscal (tax benefits, temporary or permanent exemptions from paying local fees) and financial (direct subsidies in the form of non-returnable contributions, reduction of production factor costs, or construction of additional infrastructure).

The rural development policy in Serbia and Croatia is not integrally defined in any official document. Certain aspects of rural development are partly, with more or less attention, mentioned in the framework of national development strategies. This kind of policy has its justification in the fact that by stimulating investments, prerequisites are created for the growth of competitiveness and the progress of the economy over a longer period. In strategic documents, it is necessary to consider development priorities and ways of achieving them by the set period in a consistent manner. Rural areas are, from the aspect of their specific problems and development limitations, very sensitive areas in terms of inconsistent regional development. The backwardness of rural areas compared to developed areas is reflected in the basic development parameters demographic features (future population migrations, natural increase, etc.), economic structures, human development, infrastructure and economic development.

A successful rural development policy requires an integrated approach to the complex process of socio-economic development in rural areas. Currently, in both countries, there is a lack of coordination when adopting systemic and strategic documents, including those related to rural development. In the process of planning and directing state aid funds, a system of coordination between numerous institutions and entities involved in various aspects of rural development has not yet been established. Decentralization of institutions that constantly undergo changes, adoption and/or harmonization of legislation, improvement of knowledge as well as coordination of support programs through domestic and foreign funds are a prerequisite for more efficient implementation of support programs for rural development. The analysis of strengths, weaknesses, opportunities and threats, i.e., SWOT analysis shows the main economic and social features and points to potentials as well as critical segments of development.

Analysis of the effect of political, economic, social, technological, legal and ethical environmental factors on economic development, or PESTLE analysis, represents a useful tool for understanding the environment. The mission of PESTLE is to provide access to available information that analyzes external risk impacts, namely the impact of political, economic, social, technological, legal and ethical environmental factors (Peng and Nunes 2007) on the economic development of rural areas of two countries. Furthermore, the method used to measure social development is called the HDI method. This method represents a combination of indicators of education, income and life expectancy through the Human Development Index (HDI). The rise in the importance of the HDI and the use of the HDI is due to the introduction of a standard statistical calculation that serves as a framework for social and economic development (Human Development Report, 2015). The value of the index ranges between the minimum and maximum value for each factor, after which it is observed where each area is located in relation to all these factors. The HDI is calculated using a formula that measures the level of literacy, poverty, education, life expectancy, and other factors. Accordingly, to the value of HDI, the areas are classified into developed areas, developing areas and underdeveloped areas.

The index measures three basic parameters in human development (Human Development Report, 2015): 1. length and quality of life, measured by the duration of life from the moment of birth; 2. knowledge measured by literacy, the share of primary and secondary education in the total educated population and the percentage of school enrollment; and 3. standard of living measured by GDP according to purchasing power parity. Purchasing power parity (PPP) refers to a price index comparison that corrects official exchange rates and is based on the rule that goods must be sold at the same prices in all places. Furthermore, the index was created to emphasize that people and their abilities should be a criterion for evaluating the development of an area. It is also used as one of the criteria for choosing a country's national policy, i.e., how two countries with the same level of GDP may end up with different human development outcomes.

The aim of this paper is a detailed analysis of the state of the rural area of the Republic of Serbia and the Republic of Croatia, from the aspect of opportunities and economic assumptions that this area has, using SWOT, PESTLE analysis and HDI methodology.

Material and Methods

This work aimed to determine the economic, demographic and social situation based on a detailed analysis of the rural areas of the Republic of Serbia and the Republic of Croatia through several segments, and to point out possible perspectives for the development of rural areas. A SWOT and PESTLE analysis makes it possible to see the potential and specific problems of rural areas. The condition of the rural area of the two analyzed countries and the study of possibilities for its development represents a sufficient motive to point out the value of the rural area because it is precisely those with the highest percentage of the rural and agricultural population and ecologically, they belong to the healthy area of the two countries. Applying OECD criteria, the state of rural areas in the two analyzed countries is shown in the following table 1.

Table 1: Rural areas, settlements and population of Serbia and Croatia according to OECD criteria

Country	**OECD criteria**					
	Total area, km2	**%**	**No of settlements**	**%**	**Population size**	**%**
Serbia	65,952	85.10	3,904	82.8	4,161,660	55.5
Croatia	51,872	91.64	6,001	88.7	2,110,988	47.6

To identify the strengths and weaknesses of the rural area, a typology of rural areas was created through cluster analysis, and four homogeneous units were identified, according to economic activity:

• A region characterized by highly productive agriculture and an integrated economy - this region has favorable land and climate conditions as well as an appropriate structure of agricultural production dominated by activities with more intensive use of capital compared to other rural areas. Compared to other parts of the two countries, this region has an adequately developed human potential, strong entrepreneurship, a sufficiently diversified industry sector and a well-developed physical and economic infrastructure; as a result, this region has more favorable socio-economic indicators of overall economic development, an integrated and more advanced economy. This region includes Vojvodina, the northern part of Serbia, Slavonia and Međimurje.

• A region where the main economic branch is agriculture in which labor force is intensively used - this region includes the surroundings of urban centers and larger cities. The general economic structure and the productivity rate of certain sectors are more favourable in this region compared to other parts of the two countries. Considering the proximity of this region to the market with a large number of consumers, the structure of agricultural production is directed towards intensive agricultural production of fruits, vegetables and products of animal origin. This region includes central Serbia, the central part of Croatia, and the northern part of Istria.

• A region in which economic branches are directed towards the use of natural resources, mainly mountain areas - according to its geographical characteristics, this region is very heterogeneous. Its economic structure is based on the exploitation of rich natural resources - mining and agriculture. Unfavorable demographic trends are a special feature of this area. This area has the highest rate of rural poverty and total unemployment. This region includes the territory of eastern and southern Serbia, the area of Lika, Banija and Gorski Kotar.

• The region in which tourism is the main driving force represents the part of Serbia and Croatia that has the highest tourism potential and the highest rate of participation of the tertiary sector in the economic structure. The structure of agriculture is quite underdeveloped and is mainly based on the use of natural resources, especially for feeding livestock. This region includes the territory of western and southwestern Serbia, the area of Istria and Dalmatia.

Rural areas differ economically, socially and demographically. The difference is conditioned by their geomorphological characteristics (mountainous, hilly, plain areas), changes in the number of inhabitants, economic structure, infrastructure, environmental conditions, traffic availability, etc. According to OECD criteria, the main features and trends are as follows:

• Demographic trends: rural areas until the beginning of the nineties were characterized by a strong trend of emigration due to the agrarian exodus. At the same time, there was rapid growth and development of other sectors of the economy. During the 1990s, the outflow of the population from rural areas continued. During the period 1991-2020, the number of inhabitants in rural areas decreased by a total of 27%.

• Employment trends in rural areas are most evident in agriculture. About 1/3 of the active population is employed in agriculture, while the secondary and tertiary sectors have approximately the same participation in employment. The employment rate in agriculture is among the highest in the EU and reflects the pervasive importance of agriculture in the national economy as well as the low degree of diversification of economic activities in rural areas.

• Agriculture remains the predominant activity in most rural areas, characterized by small farms, low productivity and low income per farm. A large number of farms produce only for their own needs and have small surpluses that they can market.

• The unemployment rate in rural areas is high (21%), and reflects the problem of lack of employment opportunities. Unemployment seems to be another structural problem of the rural economy.

• The capacities of the agri-food sector related to agriculture (input industry, branches of the processing industry and trade) fell drastically during the nineties.

Most of the remaining industrial capacities need to be modernized and technically improved.

• The infrastructure in rural areas, both economic and social, is weak, underdeveloped and negatively affects the competitiveness and social fabric of rural areas.

• GDP per capita in rural areas is 74% of the national average and is significantly below GDP per capita in urban areas.

• In terms of environmental protection, rural areas are rich in ecosystems and biodiversity, which are designated as protected areas (national parks, protected areas), however, changes in the intensity and structure of agricultural production are worsening at an accelerated pace.

The macroeconomic indicators of rural areas in Serbia and Croatia are shown in the table 2. The indicators shown in the rural areas of the Republic of Serbia and the Republic of Croatia in relation to the average of the rural areas of the developed EU countries have negative trends; employment in the EU is higher by an average of 33%, GDP per inhabitant in Serbia and Croatia is lower by an average of 25%, inflation is eight times higher on average, while net earnings are lower by an average of 74.3%. All these indicators indicate the absence of clear and concrete guidelines that would improve the quality of life in rural areas.

Table 2. The macroeconomic indicators of rural areas in Serbia and Croatia (created by the author according to OECD data)

Indicator	Serbia	Croatia	EU
Share of inhabitants in rural areas, %	55,5	47,6	40
Number of employees in rural areas	1.472.025	1.096.251	1.896.334
BDP, in million EUR	8.334	7.769	9.483.734
BDP po capita, in EUR	6.081	8.405	28.500
Inflation, %	12,8	3,4	0,7
Average net income, in EUR	390,16	705,31	2115,93

The HDI methodology (Human Development Report, 2015) in its calculations combines two measures of education using weighted averages; two-thirds of the adult literacy rate (ALR) and one-third of the enrollment rate in educational institutions, i.e. (EER), according to the formula (EP):

$$EP = \frac{2}{3}XALR + \frac{1}{3}XEER$$

The value of any given unit value can be converted into an index by first identifying the minimum value for which 0 is taken and the maximum value for which 100 is taken. These values are entered into the formula as a fraction, where the numerator is the difference between the education rate and minimum values, and the denominator is the difference between the maximum and minimum values:

$$EI = \frac{EP - 0}{100 - 0} = \frac{EP}{100}$$

In order to convert the life expectancy index to life expectancy, it is necessary to first identify the minimum and maximum limits of life expectancy. The value of the life span variable (LEV) is put into a fractional relationship where the numerator makes the difference between the average life span and the minimum life span limit, while the denominator makes the difference between the maximum and minimum limit. The resulting result represents the Expected Social Development Index (LEI):

$$LEI = \frac{LEV - 25}{85 - 25}$$

For the final conversion in the form of an index value, the conversion of the gross domestic product per capita in EUR to the index value is made. The base of the calculation is the logarithm. Minimum and maximum GDP per capita values are used by the United Nations and range from 100 to 40,000, respectively. The equation is a fractional relation:

$$GDPI = \frac{\log(BDP) - \log(100)}{\log(40000) - \log(100)}$$

Finally, for the HDI calculation for the rural area of both countries, the mean value or average of the three value indices EI, LEI and GDPI are taken and divided by three, according to the formula:

$$HDI = \frac{EI + LEI + GDPI}{3}$$

So, to quantitatively express the extent to which a particular area is developed, the gross domestic product per capita (GDP), the human development index (HDI), the unemployment rate and the average monthly salary are considered to measure the development of countries.

Results and discussion

In the previous part of the work, the state of the rural areas of the two countries was analyzed and a comparison was made with the EU average. To determine which internal and external factors have the most influence on the development of the rural areas of the two countries, based on the previous data, a comprehensive analysis of the features of the rural areas of the two countries will be carried out below, as well as the development assumptions and limitations that are imposed in the micro and macro environment. The following table 3 shows the characteristics of the rural areas of the EU in comparison with the current situation in the Republic of Serbia and the Republic of Croatia.

Table 3. Basic characteristics of the rural areas of the EU compared to the current situation in the Republic of Serbia and the Republic of Croatia (created by the author according to OECD data)

Characteristics	EU	Serbia and Croatia – the average of the current situation
	Basic characteristics	
Socio-economic structure	• 18% of the total population lives predominantly in rural areas, • 8% of the economically active population is employed in agriculture, • 20% of the active rural population works in agriculture.	• 51% of the total population lives predominantly in rural areas, • About 33% of employees work in the primary sector, • 45% of the active rural population works in agriculture.
The state of agriculture	• High productivity, • Technically and technologically well-equipped farms, average size 20 ha, • Support to agriculture since the 1960s.	• Low productivity, • Farms with an average size of 4.8 ha, poorly equipped machinery, low use of inputs, • Insufficient budget support for agriculture, poor user information.
Rural infrastructure	• Well developed	• Poor (physical, economic and social).
Economic structure	• Diversified, • New rural businesses and services	• Insufficiently diversified, • Underdeveloped rural businesses with a low level of social services
	Human potential	
Human capital	• High level of resources	• Low level of local human resources, education and initiatives
Education, training	• Since the beginning of the 1970s, a system of lifelong education was introduced, • A well-developed advisory sector.	• Focused on technical knowledge, • Insufficient education on management and marketing, • Advisory services insufficiently suited to needs.
Production partnership	• Established partnership, • Network of institutions on joint projects.	• Undeveloped partnership, • Slow progress in establishing production groups and associations
Local government	• Developed profit organizations and local action groups, • Innovative and efficient local administration.	• insignificant effect of local self-government and informal groups, • Inefficient decision-making system (top-down), • Low level of local government entrepreneurship.

Programs and financial support		
Funds and financial resources	• Structural funds, LEADER I, II, LEADER +, • National programs.	• Donations and pilot projects, • Small funds in municipal budgets, the agricultural budget and the Development Fund.
Participants	• State institutions, • Science/Researchers, • Strong NGO sector, • Local action groups.	• Due to bad policies, state institutions do not provide sufficient economic support, • Little influence of NGOs, • Local entrepreneurs and centralized decision-making at all levels of government.
Priorities in development		
Basic goals of rural development	• Competitiveness of agriculture, • Environmental protection, • Multifunctionality.	• Productivity growth, • Trade, processing, rural tourism, small and medium entrepreneurship.
Medium-term goals	• Diversification of economic activities	• Infrastructure development, • Institutional and organizational strengthening of all participants
Strategies and relevant factors	• Focus on the ability of local self-government through the mobilization of local potentials, • Development of local private-public partnership services.	• Focus on small and medium entrepreneurship and rural tourism, • Poor funds and financial support, • Low level of employment and opportunities to develop new jobs, • Local actors due to insufficient level of education without sufficient initiative.

From the above indicators, it follows that rural areas in both countries are followed by negative trends compared to the EU average. The reason lies in the fact that, on the one hand, the rural areas of the two countries are technologically behind compared to the EU, while on the other hand, labor productivity and significant fiscal and parafiscal levies burden entrepreneurs are evident. The current situation can be improved by systemic or reform measures, which require a lot of time, sacrifices, cuts and other negative consequences, but in the long term, it opens the perspective of economic recovery. Due to the aforementioned similarities between the rural areas of the two countries, a unique approach was used in the SWOT and PESTLE analysis below. During the preparation of the SWOT analysis, development priorities were defined to respect synergistic effects, as well as observed market limitations and obstacles.

Table 4. SWOT analysis of the rural area of the Republic of Serbia and the Republic of Croatia

STRENGTH	**WEAKNESSES**
A large area of high-quality agricultural land suitable for the cultivation of field vegetable, fruit and viticulture crops	The disconnection between agriculture and tourism; insufficient placement of agricultural products in the tourist offer
Water potential; Danube, Sava, Drava, Tisza, Morava and Drina are suitable for the development of energy potential, production of drinking water and development of fishing tourism	Low level of utilization of water potential in terms of energy production, hunting tourism is still in its infancy
Cultural, historical and natural heritage	The neglect of buildings and historical complexes that are increasingly collapsing and becoming waste disposal sites
Networked traffic infrastructure; air and river ports, branched railway networks, and branched road networks favor efficient transport of goods and services.	The uneven quality of infrastructure; the poor state of the railway infrastructure, rivers and airports require modification of equipment
Industry tradition; diversification of business activities, brands from the former state that need to be re-marketed	Low level of quality of life; lagging behind the European average in terms of GDP and income
Forest potential favors the development of the wood industry, hunting and hunting tourism	A small and underdeveloped market causes many problems for the business sector (customs duties, a long period for the flow of goods due to the frequent crossing of state borders)
A branched network of educational institutions (secondary and higher education levels)	A high unemployment rate causes unfavorable demographic trends in the population
A large number of spas and thermal springs favor the development of spa tourism	Undeveloped communal infrastructure
There are systems of quality marks for domestic products	Low level of export of products to foreign markets
A large number of registered agricultural producers	Unsettled property legal relations and low accumulation of local entrepreneurs
Incentive measures for investors	Insufficiently developed ability to attract investors, slow bureaucracy, a large number of fiscal and parafiscal levies

OPPORTUNITIES	THREATS
Geostrategic and traffic location	Lack of financial resources; a high level of corruption affects the uneven distribution of funds
Renewable energy sources	
Regional specialization and cluster development	Consequences of war and bombing
The exploitation of natural potentials to create new values	High unemployment rate
	Noticeably increasing intensity of environmental pollution
Project involvement in world associations	
Cross-border cooperation	High inflation rate; above the European average
Investing in research and development	Competition from the environment
The association of companies creates the possibility to increase the volume of production and placement of goods on free world markets	Tax policy
	Underdeveloped horizontal and vertical communication
Use of EU funds	Natural cataclysms

** prepared by the author based on data from the state development strategies of the Republic of Serbia and the Republic of Croatia*

Table 4 shows that the rural area of the two analyzed countries has a number of natural, cultural, and traffic advantages, which must be put in a function of economic development accordingly to an adequate strategy. The strategic approach should be set up in such a way that, on the one hand, the weaknesses that characterize the rural area are transformed into market opportunities, and on the other hand, the presented threats are turned into strengths by certain mechanisms. Engaging professional and competent people from academic, economic and social life who are impartial from political influence can contribute to the economic recovery of this area with their experience. Furthermore, a PESTLE analysis was performed. When creating the PESTLE analysis, each factor is assigned a weight that determines the direct and indirect impact and shows the implications and importance of each factor in the period. The results of the PESTLE analysis are presented in Figure 1.

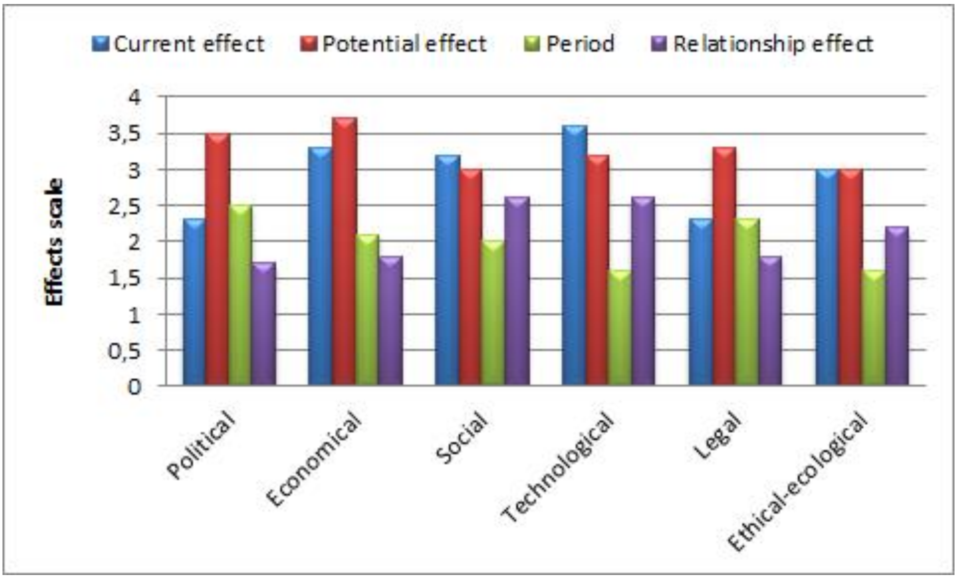

Figure 1. PESTLE analysis of the state of the rural areas of the Republic of Serbia and the Republic of Croatia

Figure 1 shows the greatest deviation in the scale of influence among political, economic and technological factors. Economic, social, technological and ethical-ecological factors have an insufficient influence on the state of rural areas. Political and legal factors have an unfavorable influence. Political and economic factors have the greatest potential influence, while the others move within the limits of medium influence. The implications of the influence are within the limits of the medium term, i.e., in the time period of 5 years with insufficient influence, i.e., political, economic and legal factors are closer to negative influence, while social, technological and ethical-ecological factors are directed towards positive tendencies. Generally speaking, the human factor has a great influence on economic development. The Human Development Index (HDI) is an indicator that monitors the state of the population in four levels of human development: poverty, literacy, education and life expectancy. According to the UN data (UN, 2022) from the following table 5, human development factors for two countries were calculated using the HDI methodology.

Table 5: Factors of human development

Factor	Serbia	Croatia
Life expectancy of the population	73.7	75.4
Literacy rate	96.4	98.1
Enrollment rate in educational institutions	78.3	79.8
GDP per capita in EUR	6,081	8,405

** prepared by the author based on UN data (UN, 2022)*

To calculate the HDI, the two measures of education are first combined using weighted averages; two-thirds of the adult literacy rate (ALR) and one-third of the enrollment rate in educational institutions, i.e. (EER). The weighted average gives the percentage value of education (EP):

Republic of Serbia EP = 90.36%
Republic of Croatia EP = 92.00%

The above result indicates that in the Republic of Serbia, 90.36% of the total population is literate, while in the Republic of Croatia, 92% of the population is literate. These values are entered into the formula in the form of a fraction, where the numerator is the difference between the education rate and the minimum value, the denominator is the difference between the maximum and minimum values, and the result is the education index:

Republic of Serbia EI = 0.96
Republic of Croatia EI = 0.92

It is evident from the above results that the value of the index is in the upper part of the value scale between 0 and 1, that is, over 0.9, which indicates that the majority of the inhabitants of rural areas are literate.

Expected Social Development Index (LEI):

Republic of Serbia LEI = 0.81
Republic of Croatia LEI = 0.84

It is evident from the above results that the value of the index is in the upper part of the value scale between 0 and 1, from which it can be concluded that the rural areas of both countries are relatively developed.

Index of investments in the gross domestic product (GDPI)

Republic of Serbia GDPI = 0.68
Republic of Croatia GDPI = 0.74

The result shows that the calculated values are also in the upper part of the limit scale, but that they are below the index of the European average, which is 0.86. This indicates that it is necessary to raise labor productivity, that is, to initiate investment absorption measures to improve technology and the production process itself.

Finally, for the HDI calculation for the rural area of both countries, the mean value or average of three value indices is taken: EI, LEI and GDPI, and the Human Development Index (HDI) is calculated.

Republic of Serbia HDI = 0.82
Republic of Croatia HDI = 0.83

The Human Development Index (HDI) shows that rural areas are below the average of European countries, ranging from 0.87 to 0.96. The cause lies in the low GDP per product unit, that is, the low level of investments in economic activities as generators of new value creation.

Conclusion

In the Republic of Serbia and the Republic of Croatia, rural areas occupy a significant part of the territory and as such have a lot of potential for development, which is shown in the paper through analysis. Analyzes have also shown that the rural area is underutilized, there is no clear development strategy, there is a low accumulation capacity of rural households, the investment environment is uncertain, and there is a limited market for the placement of products and services from rural areas, and an insufficiently educated population lives in rural areas. The basic differences in the socio-economic characteristics of the rural areas of Serbia, Croatia and the EU countries described in the paper show that despite the development potential, the rural area of the two countries lags significantly behind in their structural adjustment to European solutions. However, on the other hand, there is room for development, especially in the segment of exploitation of natural and human resources. Investments in technology and education can be returned many times over.

The analysis showed that the rural area of the two countries is significantly behind the EU average. The results showed that political and legal factors have the greatest influence on the state of rural areas, while other factors in terms of development are not sufficiently represented. Furthermore, the results of the paper show that over 90% of the population is literate, and the level of investment attraction is below the EU average. For this reason, it is necessary to raise labor productivity, that is, to initiate investment absorption measures in order to improve technology, and the production process, which would ultimately result in an increase in GDP per product unit. Therefore, it can be concluded that the rural areas of the two countries have development potential, and it is only necessary to use them in the right way.

References

1. Aćimović, S. (1993) Strategija nastupa na međunarodnom tržištu, Ekonomski institut Beograd, p.p. 124

2. Best, J. R. (2004) Market-Based Managment, third edition Prentice Hall Inc. Boardman, E.A. i dr. (2002), Cost-Benefit Analysis, Third Edition, Pearson Educations, Inc, New Jersey, p.p. 87.

3. Čulo, K. (2002) Ekonomika investicionih projekata, Sveučilište Josipa Jurja Strossmayera u Osijeku, Građevinski fakultet, Osijek, p.p. 45-49.

4. Ćirović, M. (2008) Finansijski menadžment, Naučno društvo Srbije, Beograd, p.p. 91-94.

5. Portnov, B. (2005) Regional disparities in small countries, Springer, Berlin, p.p. 97

6. Grossman,G.M., Helpman, E. (1991) Innovation and Growth in the Global Economy, MIT Press, Cambridge p.p. 68.

7. Herz, B., Vogel, L. (2003) Regional Convergence in Central and Eastern Europe: Evidence from a Decade of Transition, Macroeconomics regcon_2003-09, Department of Economics, Economics I, Bayreuth University, p.p. 71 - 77.
8. Hirt G., Block S. (2005) Managing Investments, McGraw-Hill, NY, p.p. 68.
9. Jovanović, M. (2002) Preduzetništvo, Megatrend, Beograd, p.p. 89-93.
10. Krugman, P. R. and Venables A. J. (1995) Globalization and the inequality of nations, Quarterly Journal of Economics, p.p 208.
11. Liedtka, J. M. (1998) The Scroll Investment Decision, Boston University, p.p. 101
12. McGrew, A. (1997) Transformation of Democracy: Globalization and Teritorial Democracy, Cambridge, p.p. 166.
13. Ohmae, K. (1982) The Mind of the Strategist, School of Management of BBT University in Japan, p.p. 109.
14. Peng, G.C.A., Nunes, M.B. (2007) Using PEST Analysis as a Tool for Refining and Focusing Contexts for Information Systems Research. In: ECRM 2007. 6th European Conference on Research Methodology for Business and Management Studies, 9th - 10th July 2007, Lisbon, Portugal. Academics Conference International, p.p. 229 - 236.
15. Pike, R., Neale, B. (2009) Corporate finance and investment. Pearson Education. Harlow, str. 86
16. Porter, E. M. (2000) Competitive Strategy, Harvard Business Reviw, New York, p.p. 216.
17. Rosić, I. (2003) Nacionalna makroekonomija, Ekonomski fakultet Univerziteta u Kragujevcu i Fakultet za turistički i hotelski menadžment, Beograd, p.p. 124.
18. Veličković, D. (2005) Teorija privrednog razvoja, Ekonomski fakultet Priština, Priština, p.p. 184 - 189.

THE EFFECT OF A COW'S HEALTH ON THE VALUE OF BIOCHEMICAL PARAMETERS IN BLOOD SERUM AND MILK

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Abstract

The aim of this research was to determine the effect of a cow's health status (healthy, at risk, with mastitis; indicated by the number of somatic cell counts) on the value of biochemical parameters in blood serum and milk of Holsteins regarding the month of sampling. Therefore, blood and milk samples were taken from 75 Holstein cows during May, June and July and analyzed in the laboratory. The statistical analysis of data showed that the all effects included in the used statistical model (parity, stage of lactation and classes SCC) statistically significantly (p< 0.05) affected the variability of biochemical parameters in blood plasma and milk of Holstein cows. Furthermore, variability in all analyzed parameters due to the month of sampling was observed. Obtained results indicate that, if biochemical parameters in blood serum or milk are used as a bioindicator of occurrence of inflammation of organism (mastitis or some other disorder), a correction needs to be done accordingly to animal-related effects (parity, lactation stage) and the effect of month of sampling.

Key words: Holstein cows, biochemical parameters, blood serum, milk, mastitis

Introduction

Environmentally and economically sustainable dairy production implies highly productive and healthy animals maintained in optimal condition regarding the phase of the production cycle. The occurrence of any disorder or disease results in various problems and losses in production and finally a decrease in the profitability of a farm. Inefficiency in milk production, such as the occurrence of animal diseases, can have great economic consequences. Selection of dairy animals for high production resulted in deterioration of resistance and consequently in the increase in the occurrence of various disorders / diseases in milk production. The disproportion between the genetically defined production potential and the constraints in balancing the ration energy considering milk production could cause a set of various metabolic disorders (Puppel and Kuczyńska, 2016). The increased load on the liver function of highly productive cows due to extremely high production and the consumption of a huge volume of feed results in a significant incidence of various disorders such as abomasal displacement, ketosis, mastitis, parturient paresis, placenta retention and endometritis, which often occur in the postpartum period. Metabolic disorders and mastitis represent one of the most expensive disorders in dairy production and therefore it is highly recommended to detect the occurrence in the subclinical phase before the development of the clinical condition and more severe consequences.

The definition of inexpensive biomarkers could facilitate early detection of occurrence and accordingly improve treatment procedures and thus reducing the use of antibiotics and preventing production losses. Antanaitis et al. (2021) pointed out the increase in the number of somatic cells and the decrease in lactose concentration in animals with detected subclinical mastitis. Furthermore, Gonçalves et al. (2018) noticed the effect of animal's age on the susceptibility to mastitis indicating that older cows (in II. and III. lactation) had a higher decrease in milk production associated with somatic cell counts, than did cows in the first lactation. Accordingly, to Hu et al. (2021) the values of metabolites can indicate the environment and the nutritional status of cells, the role of drugs and environmental pollutants, and the influence of other external factors. Blood parameters/metabolites indicate the physiological and biochemical status of animals therefore they could be used in the detection of the occurrence of various disorders/diseases in cows. Furthermore, different metabolites in animal milk can also indicate the possible occurrence of some disorder/disease in cows. Kuczyńska et al. (2021) emphasized that metabolic changes correspond to the occurrence of clinical and subclinical disease. Therefore, the information regarding the concentration of various biochemical parameters in blood or milk could be useful in the prevention of health disorders and in maintaining healthy animals. Since the concentration of metabolites in blood and milk varies regarding the different effects, this research aimed to determine the effect of a cow's health status (indicated by the number of somatic cell counts) on the value of biochemical parameters in blood serum and milk of Holsteins regarding the month of sampling.

Material and methods

During the research, conducted on a dairy cattle farm, blood and milk samples were taken from 75 Holstein cows with milk production of around 40.00 kg/day. Blood samples were taken from the coccygeal vein into tubes with lithium heparin anticoagulant (Becton Dickinson, Plymouth, England, UK). Then, samples were centrifuged (1.500 g/10 min at 4°C) and plasma was separated and kept at -80°C until further analyses. Milk samples were taken into clean tubes, centrifuged (12.000 g/30 min at 4°C) and milk plasma was separated and kept at -80°C until further analyses. Furthermore, biochemical parameters in blood and milk plasma were determined using the automatic clinical chemistry analyzer Beckman Coulter AU400 (Beckman Coulter, Germany). The β-hydroxybutyrate (BHB) concentration was determined using commercial kits (Randox Laboratories Ltd, Crumlin, UK) accordingly to the enzymatic colorimetric method. In order to define, the cow's health status the number of somatic cell counts as a part of test-day records was used. Test-day records of selected cows obtained during regular milk recording were taken from the central database of HAPIH (Croatian Agency for Agriculture and Food). Values of necessary variables from test-day records were corrected in regard to the ICAR guidelines (ICAR, 2017). Accordingly, to daily somatic cell count (SCC), animals were divided into three classes: healthy animals (SCC < 200,000/ml); cows in mastitis risk (SCC = 200,000 - 400,000/ml) and cows with mastitis (SCC > 400,000/ml). The basic variability of daily milk yield and somatic cell count regarding the sampling month is presented in Table 1.

Table 1. Basic statistical parameters of daily milk yield and somatic cell count regarding the sampling month

Trait	Mean	SD	CV	Min	Max
May					
Daily milk yield (kg)	39.36	9.48	24.06	18.60	59.80
Somatic cell count	1,119,310	1,736,622	155.15	35,227	9,060,568
Somatic cell count, Log	29.00	1.81	6.24	25.07	33.07
June					
Daily milk yield (kg)	38.36	8.94	23.31	24.20	54.80
Somatic cell count	1,047,060	1,496,139	142.89	53,787	7,204,545
Somatic cell count, Log	29.01	1.69	5.82	25.68	32.75
July					
Daily milk yield (kg)	40.50	8.70	21.48	19.90	55.70
Somatic cell count	2,425,111	3,279,193	135.22	31,818	10,844,296
Somatic cell count, Log	29.66	2.47	8.34	24.92	33.34

The effect of a cow's health status (indicated by the number of somatic cell counts) on the value of biochemical parameters in blood serum and milk of Holstein cows regarding the sampling month were tested using least square means in GLM procedure in SAS (SAS Institute Inc., 2019) by following statistical model:

$$y_{ijkl} = \mu + b_1(d_i/305) + b_2(d_i/305)^2 + b_3\, ln(305/d_i) + b_4\, ln^2(305/d_i) + P_j + D_k + e_{ijkl}$$

where:

y_{ijkl} = estimated biochemical parameter;

μ = intercept;

b_1, b_2, b_3, b_4 = regression coefficients (lactation curve by Ali and Schaeffer, 1987);

d_i = days in milk i (i = 11 to 537 day);

P_j = fixed effect of parity j (j = I, II, III, IV, V);

D_k = fixed effect of somatic cell count class l (l = healthy / mastitis risk / mastitis),

e_{ijkl} = residual.

The Tukey-Kramer's studentized range test in GLM procedure in SAS (SAS Institute Inc., 2019) was used to test the significance ($p < 0.05$) of the differences in biochemical parameters due to different somatic cell count classes.

Results and discussion

The statistical analysis showed that the all effects included in the used statistical model (parity, stage of lactation and classes SCC) statistically significantly ($p < 0.05$) affected the variability of biochemical parameters in blood plasma and milk of Holstein cows. The differences in the biochemical parameters in blood plasma due to animal's health status (SCC classes) separately for each sampling month (May, June, July) are presented in Table 2. The highest value of aspartate aminotransferase (AST) in blood plasma was determined in June in healthy animals with SCC < 200.000/ml while the lowest value was observed in May in animals with mastitis (SCC > 400.000/ml). In the same animals also, the lowest value of γ-glutamil transferase (GGT) was measured while the highest value of GGT was observed in animals at risk of mastitis occurrence during July. The lowest concentration of glucose in plasma was observed in healthy animals in June (in all animals regardless of health status). The concentration of urea in blood plasma also showed variability due to animals' health and sampling month with the highest value observed in July in healthy cows. The variability was also observed in protein and albumin concentration in the blood plasma with the highest value of protein in July in mastitis cows, and albumin in June in cows at mastitis risk.

Table 2. LSmeans of the biochemical parameters in blood plasma regarding SCC classes separately for each sampling month

Trait		month	SCC > 400.000/ml Mastitis	SCC 200.000/ml-400.000/ml Mastitis risk	SCC < 200.000/ml Healthy
Aspartate amino transferase (u/l)	AST	May	108.85 ^{A}	162.77 ^{A}	179.43 ^{B}
		June	116.29 ^{A}	215.46 ^{B}	238.43 ^{B}
		July	114.23 ^{A}	188.01 ^{A}	145.01 ^{A}
γ-glutamil transferase (u/l)	GGT	May	24.63 ^{A}	40.74 ^{A}	33.02 ^{A}
		June	27.45 ^{A}	48.06 ^{B}	42.62 ^{B}
		July	37.16 ^{A}	52.97 ^{A}	43.14 ^{A}
Glucose (mmol/l)	GUK	May	3.36 ^{A}	3.34 ^{A}	3.14 ^{A}
		June	2.66 ^{A}	2.55 ^{A}	2.39 ^{A}
		July	3.33 ^{A}	3.10 ^{A}	3.02 ^{A}
Urea (mmol/l)	UREA	May	4.34 ^{A}	4.67 ^{A}	4.24 ^{A}
		June	4.58 ^{A}	4.65 ^{A}	4.77 ^{A}
		July	4.27 ^{A}	3.12 ^{A}	4.81 ^{A}
Protein (g/l)	PRO	May	83.69 ^{A}	84.30 ^{A}	89.04 ^{A}
		June	82.55 ^{A}	79.43 ^{A}	84.21 ^{A}
		July	86.98 ^{A}	86.42 ^{A}	85.06 ^{A}
Albumin (g/l)	ALB	May	32.21 ^{A}	33.56 ^{A}	31.83 ^{A}
		June	32.07 ^{A}	33.76 ^{A}	30.00 ^{A}
		July	31.40 ^{A}	29.41 ^{A}	32.76 ^{A}
Triglyceride (mmol/l)	TGC	May	0.12 ^{A}	0.12 ^{A}	0.11 ^{A}
		June	0.11 ^{A}	0.11 ^{A}	0.13 ^{A}
		July	0.12 ^{A}	0.07 ^{A}	0.09 ^{A}
β-hydroxybutyrate (mmol/l)	BHB	May	0.58 ^{A}	0.58 ^{A}	0.53 ^{A}
		June	0.47 ^{A}	0.41 ^{A}	0.40 ^{A}
		July	0.45 ^{A}	0.16 ^{A}	0.36 ^{A}
Fe (µmol/l)		May	24.02 ^{A}	26.84 ^{A}	25.68 ^{A}
		June	21.19 ^{A}	28.75 ^{A}	23.72 ^{A}
		July	20.52 ^{A}	33.18 ^{A}	30.89 ^{A}
Ca (mmol/l)		May	2.27 ^{A}	2.36 ^{A}	2.28 ^{A}
		June	1.92 ^{A}	2.14 ^{A}	2.06 ^{A}
		July	2.15 ^{A}	2.20 ^{A}	2.25 ^{A}

**Values within the same row marked with different letter differ statistically highly significant (P<0.05)*

Triglyceride (TGC) showed low variability with the lowest values determined in July in healthy and animals with mastitis risk. In the same animals also, the lowest values of β-hydroxybutyrate (BHB) were determined. The concentration of Fe in blood serum varied between 20.52 – 33.18 µmol/l with the lowest values determined in cows with mastitis (indicating some inflammation of the organism). Furthermore, the lowest values of Ca concentration were observed in June and cows with mastitis.

The differences in the biochemical parameters in milk due to animals' health status (healthy, at risk, with mastitis) separately for each sampling month (May, June, July) are presented in Table 3. The highest value of AST was determined in cows with mastitis in June, while the lowest values occurred in May and in healthy animals. Similarly, the lowest values of GGT were determined in May, while the highest value was observed in mastitis cows in July. The concentration of glucose was higher in healthy animals and the highest value was observed in July. Urea concentration varied in the interval from 3.08 to 7.01 mmol/l with the highest concentrations in June in healthy animals.

The lowest concentration of protein and albumin was observed in the milk of healthy cows in May. A lower concentration of Fe was determined in the milk of animals with mastitis with the lowest value determined in May. Finally, the concentration of Ca was lower in healthy animals and in May with an increasing trend until July.

Table 3. LSmeans of the biochemical parameters in milk regarding SCC classes separately for each sampling month

Trait		**month**	**SCC**		
			> 400.000/ml	**200.000/ml-400.000/ml**	**< 200.000/ml**
			Mastitis	**Mastitis risk**	**Healthy**
Aspartate amino transferase (u/l)	AST	May	10.56 ^{A}	7.31 ^{A}	3.53 ^{B}
		June	26.43 ^{A}	16.48 ^{A}	9.96 ^{A}
		July	17.95 ^{A}	12.44 ^{A}	12.33 ^{A}
γ-glutamil transferase (u/l)	GGT	May	314.02 ^{A}	322.10 ^{A}	245.59 ^{B}
		June	345.37 ^{A}	355.74 ^{A}	281.34 ^{A}
		July	402.92 ^{A}	348.62^{A}	322.63^{A}
Glucose (mmol/l)	GUK	May	0.49 ^{A}	0.49 ^{A}	0.57 ^{A}
		June	0.44 ^{A}	0.70 ^{A}	0.65 ^{B}
		July	0.47 ^{A}	0.72 ^{A}	0.81 ^{A}
Urea (mmol/l)	UREA	May	5.28 ^{A}	5.42 ^{A}	4.95 ^{A}
		June	5.99 ^{A}	6.27 ^{A}	7.01 ^{A}
		July	4.46 ^{A}	3.08 ^{A}	5.20 ^{A}
Protein (g/l)	PRO	May	32.88 ^{A}	31.30 ^{A}	29.41 ^{A}
		June	39.90 ^{A}	40.18 ^{A}	39.25 ^{A}
		July	36.60 ^{A}	36.34 ^{A}	33.50 ^{A}
Albumin (g/l)	ALB	May	21.70 ^{A}	21.69 ^{A}	19.97 ^{A}
		June	22.84 ^{A}	23.79 ^{A}	23.02 ^{A}
		July	22.73 ^{A}	24.42 ^{A}	23.11 ^{A}
Fe (µmol/l)		May	12.75 ^{A}	16.66 ^{A}	12.80 ^{A}
		June	27.93 ^{A}	28.08 ^{A}	33.14 ^{A}
		July	28.41 ^{A}	33.89 ^{A}	29.52 ^{A}
Ca (mmol/l)		May	2.94 ^{A}	3.00 ^{A}	2.59 ^{A}
		June	3.30 ^{A}	3.60 ^{A}	2.93 ^{A}
		July	3.54 ^{A}	3.91 ^{A}	3.15 ^{A}

**Values within the same row marked with different letter differ statistically highly significant (P<0.05)*

The raised concentration of different enzymes in milk is often the consequence of the increased permeability of capillaries in the tissues under the inflammation. Aspartate aminotransferase (AST) and γ-glutamyltransferase (GGT) represent crucial catabolic enzymes that play an important role in the animals' liver function. Increased concentration of AST and GGT in milk is usually associated with the occurrence of various disorders (abomasal displacement, ketosis, mastitis, parturient paresis, retained placenta and endometritis). The effect of the lactation stage on AST activity was also determined in the research by Djokovic et al. (2017). Those researchers determined the higher activity of AST in blood serum of early lactation cows compared to animals in the middle lactation, while the AST activity in milk did not significantly ($P > 0.05$) differ due to the stage of lactation. Similarly like in this research, Liu et al. (2012) determined significantly ($P<0.001$) higher AST activity in blood plasma compared to milk, as well as significantly ($P<0.001$) lower GGT activity in blood plasma in relation to the activity in milk. Batavani et al. (2003) found no significant differences in the concentration of AST in the milk of healthy and mastitic cows, while Babaei et al. (2007) stated that there were no significant differences in AST values in the milk of healthy cows compared to cows with subclinical mastitis. According to the determined higher levels of glucose in the blood serum of cows with mastitis, Saleh et al. (2022) stated that a significant increase in blood glucose can be a consequence of higher cortisol levels (stress hyperglycemia). Furthermore, the same authors also indicate a significant decrease in total proteins, albumin and globulin in the serum due to the stressful state of the organism, which was also determined in this study during May and June. Furthermore, Tripathy et al. (2018) indicated a significant ($p<0.05$) significant decrease in glucose and Ca concentration values in cows with mastitis compared to healthy ones. Yildiz & Kaygusuzoğlu (2005) reported that milk Fe levels were significantly ($P<0.01$) elevated in mastitis-positive cows compared to healthy cows. Furthermore, the same authors' state that Ca levels in the milk of cows with mastitis was significantly lower ($P<0.001$) than in healthy cows. In addition, they found significantly higher levels of Ca in the blood serum of healthy cows. Similar results were reported by El Zubeir et al. (2005) who found a significant decrease ($P < 0.01$) of calcium in blood serum samples of clinically infected cows.

Conclusion

Performed statistical analysis of data showed that the effects of parity, stage of lactation and classes of SCC included in the used statistical model statistically significantly ($p < 0.05$) affected the variability of biochemical parameters in blood plasma and milk of selected Holstein cows. Also, variability in all analyzed biochemical parameters in blood plasma and milk due to the month of sampling was observed. Obtained results indicate that, if biochemical parameters in blood serum or milk are used as a bioindicator of occurrence of inflammation of organism (mastitis or some other disorder), a correction needs to be done accordingly to animal-related effects (parity and lactation stage) and the effect of sampling month.

References

1. Antanaitis, R., Juozaitienė, V., Jonike, V., Baumgartner, W. & Paulauskas, A. Milk lactose as a biomarker of subclinical mastitis in dairy cows. Animals 11, 1–11 (2021).
2. Babaei, H., Mansouri-Najand, L., Molaei, M. M., Kheradmand, A. & Sharifan, M. Assessment of lactate dehydrogenase, alkaline phosphatase and aspartate aminotransferase activities in cow's milk as an indicator of subclinical mastitis. Vet. Res. Commun. 31, 419–425 (2007).
3. Batavani, R. A., Mortaz, E., Falahian, K. & Dawoodi, M. A. Study on frequency, etiology and some enzymatic activities of subclinical ovine mastitis in Urmia, Iran. Small Rumin. Res. 50, 45–50 (2003).
4. Djokovic, R. et al. Serum enzyme activities in blood and milk in the different stage of lactation in holstein dairy cows. Biotechnol. Anim. Husb. 33, 193–200 (2017).
5. El Zubeir, I. E. M., Elowni, O. A. O. & Mohamed, G. E. Effect of mastitis on macro-minerals of bovine milk and blood serum in Sudan. J. S. Afr. Vet. Assoc. 76, 22–25 (2005).
6. Gonçalves, J. L. et al. Milk losses associated with somatic cell counts by parity and stage of lactation. J. Dairy Sci. 101, 4357–4366 (2018).
7. Hu, H. et al. Application of Metabolomics in Diagnosis of Cow Mastitis: A Review. Front. Vet. Sci. 8, (2021).
8. ICAR. Guidelines for Dairy Cattle Milk Recording. Guidelines (2017).
9. Liu, P. et al. Bioactivity Evaluation of Certain Hepatic Enzymes in Blood Plasma and Milk of Holstein Cows. Pak. Vet. J. 32, 601–604 (2012).
10. Puppel, K. & Kuczyńska, B. Metabolic profiles of cow's blood; a review. J. Sci. Food Agric. 96, 4321–4328 (2016).
11. Saleh, N., Allam, T., Omran, A. & Abdelfattah, A. Evaluation of Changes in Hemato-Biochemical, Inflammatory, and Oxidative Stress Indices as Reliable Diagnostic Biomarkers for Subclinical Mastitis in Cows. Alexandria J. Vet. Sci. 72, 23–34 (2022).
12. SAS Institute Inc. SAS User's Guide, Version 9.4. (2019).
13. Tripathy, R. K., Rath, P. K., Mishra, B. P., Panda, S. K. & Jena, B. Clinico-Pathological and Compositional Changes in Milk of Mastitis Cows. Int. J. Curr. Microbiol. Appl. Sci. 7, 1680–1687 (2018).
14. Yildiz, H. & Kaygusuzoğlu, E. Investigation of Ca, Zn, Mg, Fe and Cu concentrations in blood and milk of cows with negative and positive CMT results. Bull. Vet. Inst. Pulawy 49, 209–213 (2005).

BASIC CALCULATIONS FOR THE PLANNED LIVESTOCK GRAZING

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Abstract

The forage yield on the pasture should meet the targeted consumption of the livestock (daily and seasonal) in order to successfully meet the nutritional needs of the livestock, as well as to use the pasture resources efficiently. Aim of the work use to present mathematical formulas to livestock farmers, business planners and researchers involved in livestock nutrition, livestock management and forage production and utilization.

Key words: Forage yield, livestock grazing, mathematical formulas

Introduction

Livestock grazing is one of the oldest activities that people have undertaken since the beginning of animal husbandry. Grazing (or browsing) is also one of the most natural activities for herbivorous domestic animals, which enables them to consume nutrients from the herbage mass available on the pasture. During grazing, available forage is consumed as fresh green herbage, which is generally of better quality than stored forages (hay, silage and haylage, DLG, 1997) if cut at the same developmental stages as the pasture is being utilized. The better quality of fresh green forage is the result of a higher content of vitamins and provitamins, and lower losses of nutrients compared to stored forages. Grazing is inevitably associated with other benefits for livestock, such as free movement in clean air and sunbathing, which have a beneficial effect on livestock health and livestock behavior. In modern conditions, animal products can be obtained from pastures with a premium retail price (i.e. grass-fed meat and milk; Lameiras, 2022; Bauman, 2021; Hoop, 2021) compared to products obtained from animals confined in stables and fed with TMR-ratios rich in concentrated feeds. In addition, pasture is often rated as the cheapest forage. Namely, grazing avoids most of the work (i.e. costs) associated with the preparation of stored voluminous fodder, because it avoids mowing, manipulation, collection, transport, storage and delivery to the animals.

Livestock grazing can be done nomadically, or sedentary, with low complexity of grazing management, or high management complexity (i.e. intensive grazing management), with all possible nuances between the mentioned extremes. However, the expected or present herbage mass on the pasture, as well as the forage yield on the pasture should meet the targeted consumption of the livestock (daily and seasonal) in order to successfully meet the nutritional needs of the livestock, as well as to use the pasture resources efficiently. With aim to achieve these goals, the livestock or pasture manager in intensive grazing management can use mathematical formulas that can help in planing the grazing activity and livestock movements. These formulas mainly use the state of the pasture (the present herbage mass per unit area, estimated daily pasture growth rate and the expected seasonal pasture yield) and the expected pasture consumption (daily and seasonaly) of the present livestock as independent variables in order to calculate the required total pasture area, expected occupation period of a paddock (for the rotational grazing/stocking method) and alocated pasture area (for the strip grazing/stocking method).

Aim of the work is to present these mathematical formulas to livestock farmers, business planners and researchers involved in livestock nutrition, livestock management and forage production and utilization.

Terminology

Pasture or **pasture land** is according to Allen et al. (2011) an area of land intended for the production of forage for livestock (or game) grazing, and can also be used by mowing. A pasture can basically be a permanent grassland, a cultivated grassland, or a sown grassland on arable land. The pasture can be divided into **subunits** (so-called **paddocks**) in order to increase the utilziation rate of herbage mass on the occupied parts of the pasture, undisturbed regeneration of the grassland plants on the parts of the pasture that are not currently occupied, and to prevent too early repeated bite-off of the young regrowth of pasture plants. **Defoliation** is a term that denotes the separation of above-ground parts of pasture plants, either by biting off as a result of grazing, or by mowing for the production of hay, silage or haylage. According to Gantner et al. (2021), after defoliation, pasture plants regenerate (rebuild the removed above-ground organs – leaves and stems) and thus create new growth (i.e. regrowth). For their regeneration, pasture plants use the energy reserves stored in the ground part of the sod and in the upper parts of the roots, and the restoration of the same reserves begins only when the pasture plants create a sufficiently large photosynthetically active surface (green leaves and green stems). In order to achieve fast regrowth, a good annual pasture yield and a persistance of grassland, pasture plants should be allowed for a sufficiently long **rest period** before repeated defoliation, as this enables sufficient energy accumulation in the sod and grass roots. For most pasture plants, the optimal average rest period between two defoliations is about 30 days. During the spring, when the grass has a naturally fast and lush growth, the rest period can be shorter, i.e. about 20 days, sometimes even only 15 days (if the grass reaches the suitable height for grazing in thus short period). During the second half of summer, **cool-season grasses** (fescues, ryegrasses and others) need a rest period of more than 30 days, often 40 days, in order to regenerate sufficiently, because their above-ground mass growth is very slow in summer, especially in dry conditions. **Warm-season grasses** (bermudagras, johnsongrass and others) show their maximum growth rate at the beginning of summer, which is still good during the second half of summer. **Perennial legumes** (alfalfa, red clover, white clover, asparagus) have a faster growth in summer than cool-season grasses, so in summer they compensate for the lack of grazing on cool-season grasses. This is why they are highly desirable components within the botanical composition of the pasture. Moreover, legumes fix atmospheric nitrogen into a plant available form, and exchange it with neighboring grasses, thus increasing their yield. In addition, their above-ground mass is richer in proteins than the above-ground mass of grasses during the summer, so they improve the nutritional value of pasture. The **grazing season** is the period of time during which grazing can normally be carried out each year. On the territory of continental Croatia, it lasts from the end of April till the middle of November, and probably the same is in the lowlands of Bosnia and Herzegovinia.

Stocking / Grazing methods

According to Allen et al. (2011), the term „**stocking** or **grazing method**" implies the process of manipulating animals in space and time in order to achieve certain goals (greater use of available forage, unhindered regeneration of pasture plants before the next grazing or mowing, prevention of premature defoliation of repeated plant growth). Here will be presented calculations for the three most popular planned grazing methods:

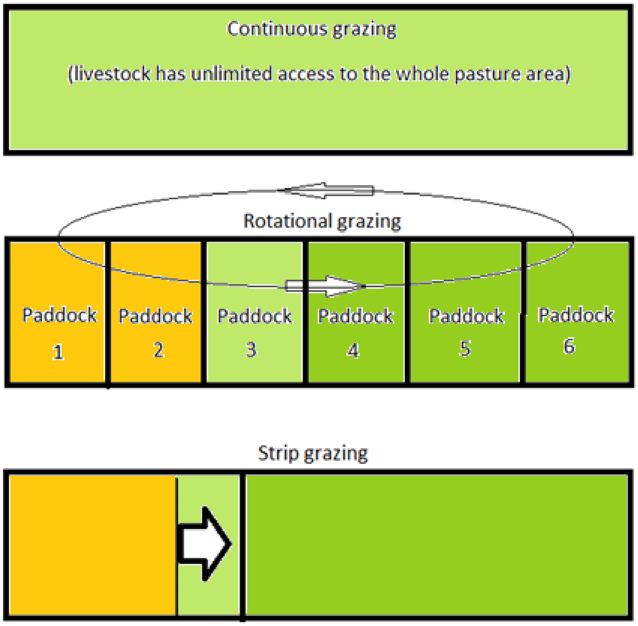
Continuous stocking/grazing is a method of grazing livestock on a specific unit of land where animals have unrestricted and uninterrupted access throughout the time when grazing is allowed. Practically, it is a grazing method in which animals have unlimited and uninterrupted access to grazing on a whole specific pasture.

Rotational stocking is a method that utilizes recurring periods of grazing and rest among three or more paddocks (subunits) in a grazing management unit throughout the time when grazing is allowed. Pracitcally, it implies return periods of grazing and rest on three or more sub-units (paddock) of a particular pasture (or of the total pasture area of a farm) during the grazing season.

Strip stocking/grazing – a method that confines animals to an area of grazing land to be grazed in a relatively short time, where the paddock size is varied to allow access to a specific land area. Practicall, it is a method that lets animals forward onto an ungrazed area by moving a movable fence forward, so that the new area is sufficient for one day's consumption. In addition to moving the front fence, the rear fence is also moved after the animals so that the livestock have free access to the area that was grazed during the two previous grazing days (Gantner et al., 2021a) (Scheme 1).

Herbage mass present on the pasture

Knowing the HM is extremely important because the same variable is used to calculate derived variables important for grazing management, such as the period of occupation of each pasture subunit in rotational grazing and the newly allocated pasture area in strip grazing.



Scheme 1. The most common pasture grazing / stocking methods (Gantner et al., 2021.a)

The herbage mass (HM) present on the pasture represents the currently present herbage mass expressed as pure dry matter (DM) per unit area, and is established on the basis of sample mowing of smaller parts of the pasture (e.g. area 0.5 m × 0.5 m), whereby sampling should be representative. HM can be determined by mowing at the level of the soil surface or by mowing at a certain height from the soil surface. The latter is much more practical because it considers the height of easy biting by grazing animals, which is usually 1.5 cm above the ground level for sheep, and 4 cm above the ground level for cattle. When expressing the variable HM, it should always be specified whether it is HM above the soil surface or HM above the height of easy biting by grazing animals. HM is calculated according to the following expression:

$$HM\ (kg_{DM}/ha) = \frac{weight\ of\ fresh\ herbage\ mass\ (kg)\ \times\ dry\ matter\ content}{mowed\ area\ (ha)}$$

During the period with slow herbage growth (summer or autumn), the HM found at the time of sampling usually enables a satisfactorily precise calculation of the other derived dependent variables. However, during the period of faster herbage growth (spring), the expected herbage growth rate (HGR) during the period of occupation (PO) should be added to the present HM:

$$HM_{ACTUAL}\ (kg_{DM}/ha) = HM_{INITIAL}\ (kg_{DM}/ha) + HGR\ (kg_{ST}/ha/day) \times PO\ (days)$$

The expected HGR usually takes values within the range of 0 to 100 kg_{DM}/ha/day (Gantner et al., 2021), and varies substantialy during the grazing season, with particularities regarding the climate where grassland takes place (Figure 1).

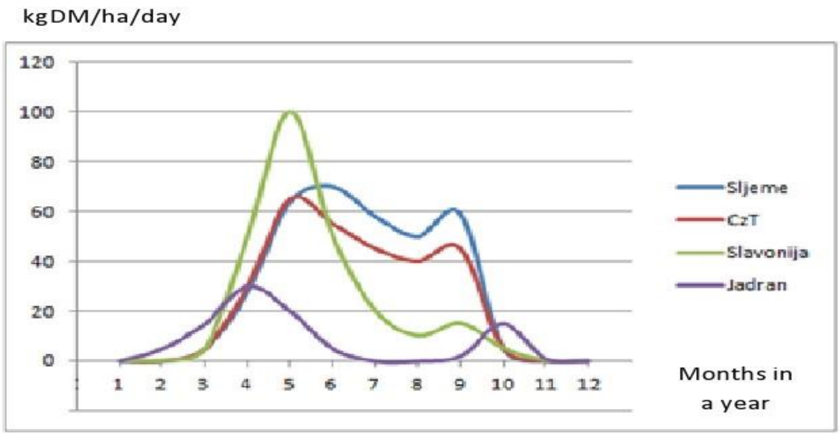


Figure 1. Estimated herbage growth rate (HGR) of natural grasslands of Croatia (Gantner et al., 2021a)

The HM, in addition to being important for planning grazing activities, is also important because it affects the consumption of pasture and the productivity of animals. According to Gantner et al. (2021), if the HM is low (less than 0.5 tST/ha, measured from the ground level), cattle have small bites, which slows down rumen filling, and cattle need to spend more time moving to find ungrazed grass, which it also slows consumption and limits total daily consumption. According to Dougherty and Collins (2013), it can generally be said that plant mass less than 500 to 750 kg_{DM}/ha (measured from ground level) is unavailable for consumption, and plant mass less than 1,000 to 1,500 kg_{DM}/ha (measured from ground level) limits consumption to less than the maximum possible (valid in general for pastures with grasses and cool-season legumes while their plant mass is in the vegetative phase). Excessive HM at the beginning of period of occupation, is often associated with the aging of the plant mass, i.e. with an increase in the proportion of hard stems in the spring growth or with an increase in the proportion of wilted (dead) leaves. Such obsolescence of herbage leads to a significant reduction in the quality or nutritional value of herbage and, consequently, to a drop in animal consumption and productivity. According to Nielsen (1997), a cow that grazes on 24 cm high grass bites off long pieces of leaves and stems that it has to chew for a long time, and therefore has a lower daily consumption than a cow that grazes on grass height 15 cm. According to Čižek (1970), for the beginning of grazing, the most favorable grass height is from 15 to 25 cm, because the grass mass in that range is of the highest quality, and the cattle use it well.

For most grasslands with cool-season grasses, the optimal starting (initial) HM for grazing is between 2,500 and 3,000 kg_{DM}/ha, and the remaining (residual) HM around 1,000 kg_{DM}/ha (all measured from the soil surface, Gantner et al., 2021a). The difference between initial and residual HM (1,500 to 2,000 kgST/ha) represents usable HM for grazing. If the remaining HM after grazing is too low (less than 500 kg_{DM}/ha), this indicates that the cattle were starved towards the end of the period of occupation of the pasture or pasture sub-unit, unless they were supplemented with hay or some other forage.

Annual Pasture Yield (APY)

The annual pasture yield (APY) represents the sum of the measured or utilized plant masses during the entire grazing season, i.e. the total production of pasture dry matter expressed per unit area:

$$APY\ (kg_{DM}/ha/year) = HM_1\ (kg_{DM}/ha) + HM_2\ (kg_{DM}/ha) + HM_3\ (kg_{DM}/ha) + \ldots + HM_n\ (kg_{DM}/ha)$$

Based on yield data collected and presented by Gantner et al. (2021), the annual dry matter yield of pure crops of alfalfa, red clover and clover-grass mixtures on the fertile arable soils of continental Croatia can be roughly estimated at about 10,000 kg_{DM}/ha/year, lowland-valley permanent grasslands about 5,000 kg_{DM}/ha /year, hilly permanent grasslands about 3,000 kg_{DM}/ha/year, mountain grasslands about 1,000 kg_{DM}/ha/year, and karst grasslands about 500 kg_{DM}/ha/year.

Herbage daily dry matter intake (DMI)

According to the reference DLG-tables (1997), the most abundant component of fresh herbage mass on the pasture is water (84 to 54 %, depending on the developmental stage and age of the plants), while the rest is made up of dry matter (DM) of the plant mass (16 to 46 %). The DM of the HM contains nutrients (simple sugars, complex carbohydrates, plant fibers, proteins, fats, minerals) and other physiologically active compounds, but in much lower concentrations (vitamins, tannins, phenolic compounds, essential oils, etc.). Considering that the nutrients are contained in the DM of the HM, and that they make up its largest part, the consumption of DM is an essential variable for livestock farmers. Namely, through the consumption of DM livestock is supplied with nutrients. Numerous studies show that increasing the daily consumption of dry matter (or the dry matter intake – DMI) increases livestock productivity (daily body weight gain or daily milk production). Daily DMI can be expressed in two ways:

1. in absolute amount (DMIa), i.e. in kg per head per day (kg_{DM}/head/day) or in kg per livestock unit per day (kg_{DM}/LU/day), where the LU is the 500 kg live body mass (LBM) equivavalent;
2. in relative amount (DMIr), i.e. in percentage in relation to live body mass (%), calculated by DMIr (%) = DMIa / LBM × 100 %

How important the DMI is can be shown by the research of Beretta et al. (2006) in Uruguay, where the average daily gain of Hereford bulls increased from 0.3 to 0.7 kg/head/day with an increase in daily dry matter consumption of pasture from 2.2 to 3.9 % in relation to LBM of cattle. The experiment was carried out during the summer, on a pasture sown with reed fescue, red clover, white clover and birdsfoot trefoil, with an average initial body weight of calves of 282 kg/head.

However, when feeding beef cattle with TMR-ratios composed of forages and concentrated feeds, the targeted DMI is somewhat lower because TMR-ratios are richer in concentrated forages, i.e. richer in easily digestible nutrients compared to pasture. Lalman and Richards (2014) tabulated the required DMI (3.7 to 10.7 kg_{DM}/head/day), depending on the current body weight of the animal (from 135 to 432 kg/head) and the target daily body weight gain (0.9 to 1.35 kg/head/day), and Gantner et al. (2021.a) based on the same values, calculated the relative DMI between 2.22 and 2.87 % in relation to the LBM of the animal.

In dairy cows on pasture composed mainly of perennial ryegrass, research by Roca-Fernandez et al. (2011) in Ireland showed a positive correlation between higher daily milk production and higher pasture DMI. Daily consumption of pasture dry matter ranged from 14.0 to 16.6 kg_{DM}/head/day, and daily milk production from 17.9 to 20.1 kg/head/day. The cows were of the Holstein-Friesian breed, with the start of the experiment at the 53rd day of lactation on average. Given that in their research the average body weight of cows was 513 kg/head, the estimated relative daily dry matter consumption of pasture was between 2.7 and 3.2 % in relation to LBM.

Kolver and Muller (1998) in Pennsylvania (USA) achieved higher daily consumption of dry matter of pasture and higher milk yield, thanks to high-quality pasture consisting of perennial ryegrass and white clover, and optimal management of grazing, so that the initial HM before the enter of cows onto the pasture subunit was about 2.9 t_{DM}/ha, and the residual HM at the moment when cows left the pasture subunit was about 1.5 t_{DM}/ha (Table 1). For dairy cows fed TMR-rations, according to Wheeler (1996; cited by Gantner et al., 2021), the required daily DMI increases with the increase in daily milk yield of dairy cows (Table 2).

Table 1. DMI and milk yield depend on the type of feeding (pasture vs. TMR) (Kolver and Muller, 1998.)

Parameter	**pasture**	**TMR**
DMIa (kg/head/day)	19.0	23.4
DMIr (% of LBM/day)	3.39	3.93
Milk yield (kg/head/day)	2.,6	44.1
Feed composition	**Perennial ryegrass, White clover**	**Whole-crop maie silage, Legumes silage, concentrates**
DM content in feed (%)	17.0	58.2
Crude protein content in feed (% in DM)	25.1	19.1
NDF (%in DM)	43.2	30.7
ADF (%in DM)	22.8	19.0
NE_L (MJ/kg_{DM})	6.9	6.8

However, the daily dry matter consumption of dairy cows on pasture can rarely reach the high values from Table 2, because the pasture is not shredded as are the components of the TMR-ratio, nor does it contain concentrated feeds whose contnets also enable higher daily consumption.

Table 2. Targeted daily consumption of forage dry matter in cows from the middle to the end of lactation depending on the daily milk secretion (Beth Wheeler, 1996.; cit. Gantner et al., 2021.)

Daily milk yield (kg/day/cow)	**Live body mass (LBM) of cow (kg/head)**					
	450		**550**		**650**	
	Daily DMI					
	% of LBM	**kg**	**% of LBM**	**kg**	**% of LBM**	**kg**
10	2.6	11.7	2.3	12.7	2.1	13.7
20	3.4	15.3	3.0	16.5	2.8	18.2
30	4.2	18.9	3.7	20.4	3.4	22.1
40	5.0	22.5	4.3	23.7	3.8	24.7
50	5.6	25.2	5.0	27.5	4.4	28.6

According to the NRC (1996, cited by Kerley and Lardy, 2007), beef cows need, while giving suck to their calves, a daily DMI of about 2.3% of LBM (the first six months after birth), and after weaning the calves, only about 2.1% of LBM (the remaining 6 months until the new birth).

The required daily consumption of dry matter in sheep mostly depends on the stage in which the animal is during the reproductive cycle (NRC, 1985). Dry ewes that have weaned their lambs have the lowest needs, and lactating ewes have the highest needs, during the first three months of lactation (Table 3). Growing lambs, which have moved mostly to grazing, have even greater needs than sheep. Based on the above presented data, daily DMI for herbivore livestock can generaly be aproximated to about 3 % of the LBM, with some variations due to livestock species, clas and productivity level.

Table 3. Approximate average needs for daily DMI in sheep of LBM = 70 kg and lambs

	Daily DMI	
	kg/ head	**% in relation to LBM**
Sheep dry	1.2	1.7
Sheep gravid	1.4	2.1
Sheep last third of gravidity period	1.8	2.7
Sheep giving suck to lamb	2.6	3.8
Lamb LBM = 20 kg	1.1	5.0
Lamb LBM = 30 kg	1.3	4.5
Lamb LBM = 40 kg	1.5	3.8
Lamb LBM = 50 kg	1.6	3.2
Ram LBM = 100 kg	3.0	3.0

Seasonal pasture dry matter intake

Seasonal pasture dry matter intake (SDMI) per livestock unit depends equals to the sum of DMI for the each day during the grazing season. It can be roughly estimated by multiplying the expected average DMI with number of days of grazing season:

$$SDMI\ (kg_{DM}/LU/season) = DMIa \times days\ of\ grazing\ season$$

For exaple, if the targeted DMI is 3 % of LBM, it equals to 15 kg_{DM}/head/day, and when multiplied with 180 days of grazing season, it equals to 2,700 kg_{DM}/LU/season. Annual DM consumption (ADMI) can similarly be estimated at about 5,500 kg_{DM}/LU/year.

Total pasture area per livestock unit and stocking rate

The total pasture area (TPA/LU) is often intended to supply the sufficient herbage quantity during the grazing season. It can be calculated from the seasonal DMI:

$$TPA/LU(ha/LU) = SDMI(kg_{DM}/LU/season)/APY\ (kg_{DM}/ha/year)/utilization\ rate$$

In such a pasture area sizing, it is very likely that there will come a lack of herbage on pasture during the summer slump of cool-season grasses, or at least during the autumn minimum of pasture growth. In these periods the livestock has to be supplemented with the hay harvsted from usually excessive spring growth of pasture plants. Supplementation can be minimized by maximizing the total pasture area, up to the size when its production meets the annual need for forages:

$$TPA/LU(ha/LU) = ADMI\ (kg_{DM}/LU/year)/APY\ (kg_{DM}/ha/year)/utilization\ rate.$$

The utilization rate (measured above the height of easy biting) in well-managed rotational grazing can be very high, even around 90% (Roca-Fernandez et al., 2011), but according to Nielsen (1997), in practice, it can be much lower, i.e. between 50 and 70 %. The lower utilization rate relates to continous grazing method, while the rotational and strip grazing are expected to have higher utilization rates. Utilization rate of harvested and stored forages (hay, silage, haylage) should be close to 90 %. The reciprocal to the TPA/LU is called stocking rate (SR) and is expressed in LU per unit area:

$$SR(LU/ha) = APY\ APY\ (kg_{DM}/ha/year)/ADMI\ (kg_{DM}/LU/year) \times utilization\ rate$$

Stocking density

The stocking density (SD) represents the ratio of the number of heads or LU and the allocated pasture area:

$$SD\ (heads/ha) = \frac{Number\ of\ heads\ (n)}{Allocated\ pasture\ area\ (ha)}$$

In the case of continuous grazing of the entire pasture area, the SD is equal to the stocking rate (SR). If the total pasture area is divided into sub-units as in rotational grazing, then the stocking density is usually many times higher than the stocking ratio, because livestock are concentrated on the occupied pasture sub-unit. In the case of rotational grazing of pasture, the greater the number of subunits (n_s) into which the pasture is divided, the greater the concentration of livestock, i.e. the stocking density is:

$$SD_{Rotational}\ (LU/ha) = SR\ (LU/ha) \times n_s$$

The stocking density is usually high in strip grazing because livestock is limited to the ungrazed area of pasture sufficient only for the one day's consumption, with addition of the area that was grazed during the previous two days. In strip grazing the SD is inversely proportional to the allocated pasture area (APA):

$$SDStrip\ (LU/ha) = \frac{1}{APA\ (ha/LU)}$$

Daily herbage allowance

The daily herbage allowance (DHA) represents the herbage mass (HM) offered daily to grazing animals during the period of occupation (PO) of the allocated pasture area (APP) (Gantner et al., 2021). The offered herbage mass can be expressed above the soil surface or above the height of easy biting, which is actually more practical because then it represents easily available plant mass (for sheep above 1.5 cm from the soil surface, and for cattle above 4 cm from the soil surface). The DHA is calculated according to the expressions below, depending on whether it is expressed per head, per LU or as a percentage in relation to LBM:

$$DHA\ (kg_{DM}/head/day) = \frac{HM\ (kg_{DM}/ha)}{SD\ (head/ha)\ \times\ PO\ (days)}$$

$$DHA\ (kg_{DM}/LU/day) = \frac{HM\ (kg_{DM}/ha)}{SD\ (LU/ha)\ \times\ PO\ (days)}$$

$$DHA\ (\%\ of\ the\ LBM\ /\ day) = \frac{HM\ (kg_{DM}/ha)}{SD\ (kg_{LBM}/ha)\ \times\ PO\ (days)} \times 100\%$$

For periods of occupation longer than one day, on the initial day of occupation, the ratio of the currently offered herbage mass to the number of head is higher than the targeted DHA, because the offered plant mass is actually equal to the targeted amount for the entire period of occupation. As the occupation period progresses (by consecutive days), the currently offered herbage mass becomes lesser and lesser due to consumption by grazing animals, and on the last day of occupation it should theoretically be equal to the targeted DHA. An exception to this rule occurs when the daily growth of grassland on the allocated area is equal to or greater than the daily consumption (eg during spring). In the expression for calculating the DHA during the period of rapid grasslang growth (spring), especially in the case of longer occupation periods, it is useful to correct the herbage mass (HM) for the expected herbage daily growth rate (HGR) during the period of occupation:

$$DHA\ (kg_{DM}/head/day) = \frac{HM_{INITIAL}\ (kg_{DM}/ha)\ +\ HGR\ (kg_{DM}/ha/day)\ \times\ PO\ (days)}{SD\ (head/ha)\ \times\ PO\ (days)}$$

And after shortening it becomes:

$$DHA\ (kg_{DM}/head/day) = \frac{HM_{INITIAL}\ (kg_{DM}/ha)}{SD\ (head/ha)\ \times\ PO\ (days)} + \frac{HGR\ (kg_{DM}/ha/day)}{SD\ (head/ha)}$$

The offered DHA should be slightly higher than the targeted daily dry matter intake (DMI), by about 10 to 30% more. Namely, the offered DHA equal to the targeted DMI would imply the full utilization of all available herbage mass, ehat only happens when the cattle become hungry. Livestock become hungry only when they consume less than the targeted DMI for high productivity, what is rarely the goal of livestock production, except in cases where unwanted vegetation on pastures is to be suppressed.

Table 4. Performance of grazed dariy cows in Ireland (Roca-Fernandez et al., 2011.)

Initial herbage mass (kg_{DM}/ha) > 4 cm	1,600		2,400	
DHA (kg_{DM}/cow/day) > 4 cm	15	20	15	20
Average milk yield (kg/cow/day)	18.2	20.1	17.9	18.9
Milk yield per hectare (kg/ha/206 days)	15,057	16,983	13,876	15,440
Average daily alocated pasture area (m^2/cow/day)	98	119	66	83
Sward height - initial (cm)	11.9	11.5	14.4	14.3
Sward height - residual (cm)	4.2	4.7	4.2	5.2
Herbage utilization rate (%) > 4 cm	97.7	91.3	98.3	88.4
Pasture DMI (kg_{DM}/cow/day) - summer	15.1	16.6	14.2	16.4
Pasture DMI (kg_{DM}/cow/day) - autumn	14.1	15.8	14.0	15.5
Average herbage growth rate (kg_{DM}//ha/day)	68	77	64	74

A larger DHA usually results in greater DMI (because then there is plenty of herbage), higher animal productivity, but also a lower utilization rate of the available herbage mass (because abundance enables selection, i.e. selective consumption). Roca-Fernandez et al. (2011) have found in Ireland that a higher DHA was associated with higher DMI and higher milk yield of dairy cows (Table 4), but also with lower utilization rate of herbage.

Higher productivity of dairy cows with greater DHA was found by Kennery et al. (2008), also in Ireland (Table 5).

Table 5. Effect of DHA on milk yiled of dairy cows in Ireland (Kennedy et al., 2008.)

DHA, above 4 cm (kg_{DM}/head/day)	14,1		17,0		20,0	
HM, above 4 cm (kg_{DM}/ha)	2,809		2,826		2,776	
Sward height - initial (cm)	16.1		16.1		15.9	
Average daily alocated pasture area (m^2/cow/day)	51		62		72	
Addition of concentrate (kg_{DM}/head/day)	0	4	0	4	0	4
Sward heught - residual (cm)	3.6	4.0	4.3	4.8	5.3	6.0
Daily milk yield (kg/day/cow)	21.4	28.5	23.6	27.7	23.4	30.0

Table 6. Effect of various levels of DHA on the dairy cows performance in Ireland (Maher et al., 2003.)

		Daily herbage allowance (DHA)		
Month	Targeted DHA above 3,5 cm (kg_{DM}/day/cow)	Low 16	Medium 20	High 24
May	Milk yiled (kg/day/cow)	25.1	26.4	26.8
	Initial HM expressed as organic matter (kg_{OM}/ha) >3,5 cm	2,476	2,456	2,608
	Residual HM expressed as organic matter (kg_{OM}/ha) >3,5 cm	196	336	551
	Initial sward height (cm)	20.8	20.2	20.2
	Residual sward height (cm)	4.5	6.0	7.5
	Crude protein (% in DM of herbage)	19.8	21.0	19.0
	Digesitbility of herbage organic matter, %	84.9	85.1	84.5
August	Mliječnost (kg/dan/krava)	16.9	18.9	19.6
	Initial HM expressed as organic matter (kg_{OM}/ha) >3,5 cm	1,560	2,187	2,185
	Residual HM expressed as organic matter (kg_{OM}/ha) >3,5 cm	297	370	375
	Initial sward height (cm)	13.1	13.6	14.3
	Residual sward height (cm)	4.3	5.3	6.5
	Crude protein (% in DM of herbage)	18.1	18.8	17.7
	Digesitbility of herbage organic matter, %	8.6	80.5	80.6

Maher et al. (2003) also found in Ireland that during the summer a higher DHA was associated with increased milk production, while the influence during the spring was less pronounced (Table 6). The research was conducted at three common DHA levels (16, 20 and 24 kg_{DM}/day/cow, i.e. 2.9%, 3.6% and 4.3% in relation to the LBM). Cows were calved mainly in February. Beretta et al. (2006) found in Uruguay in Hereford beef cattle that with an increase in the DHA (from 3 to 9 % in relation to LBM), the DMI of pasture increases (from 2 to 4 % in relation to LBM) and average daily gain (ADG) of live body mass as well (from 0.3 to 0.7 kg/head/day), but the utilization of the offered herbage is being reduced (Table 7).

Table 7. Effects of daily herbage allowance and maize grain supplementation on the performance of hereford steers in Urugway (Beretta et al., 2006.)

Supplementation with maize grain (% of the LBM)	0			1		
Daily herbage allowance (DM, % of the LBM)	3	6	9	3	6	9
ADG of the LBM (kg/head/day)	0.299	0.483	0.667	0.761	0.804	0.733
Daily pasture DMI (DM, % of the LBM)	2.2	2.8	3.9	1.7	2.9	3.3
Maize grain daily DMI (% of the LBM)	0	0	0	0.86	0.87	0.81
Maize grain daily DMI (kg/head/day)	0	0	0	2.71	2.73	2.54
Initial herbage mass (kg_{DM}/ha)	3,928	3,701	3,676	3,379	3,802	3,724
Residual herbage mass (kg_{DM}/ha)	1,045	1,949	2,097	1,392	1,972	2,352
Pasture herbage utilization rate (%)	73.4	47.3	43.2	58.8	48.1	36.8
Initial sward height (cm)	20.9	20.0	19.7	18.6	21.6	20.7
Residual sward height (cm)	4.2	7.9	9.8	5.8	8.9	11.7

In New Zealand, Geenty and Sykes (1986) found that in Dorset sheep, with an increase in daily herbage allowance, pasture consumption and average milk yield of sheep (during the first 6 weeks of lactation) increased (Table 8).

Table 8. Effects of DHA on sheep milk yield in New Zealand (Geenty and Sykes, 1986.)

Targeted daily herbage allowance (kg_{DM}/day/sheep)	2	5
Average milk yield (kg/day/sheep) first 6 weeks	1.99	2.54
Offered average daily herbage allowance (kg_{DM}/day/sheep)	2.2	5.1
Offered average daily herbage allowance (% of LBM/day)	4.4	10.2
Initial herbage mass (kg_{dm}/ha)	2,410	2,410
Residual herbage mass (kg_{dm}/ha)	910	1,630
Average herbage DMI (kg_{DM}/day/sheep)*	1.32	1.63
Relative daily herbage DMI (% of LBM/day)*	2.6	3.3

In France, Prache et al. (1990) found that a higher DHA offered to lactating ewes with twin lambs was associated with higher average daily lamb gain (Table 9). The sheep breed was Ile de France, and the experiment was started with lambs 55 days after lambing, with their initial body weight of about 16 kg.

Table 9. Effects of DHA and maize grain supplementation on gain of lambs in France (Prache et al., 1990.)

DHA expressed in herbage organic matter (% of LBM of sheep + lambs)	3.85		5.70	
Maize grain supplementation (kg_{DM} /lamb/60 days)	0	16.0	0	17.5
ADG of LBM of lambs (kg/day/lamb)	0.226	0.287	0.276	0.277
ADG of LBM of sheep (kg/day/head)	0.040	0.058	0.065	0.019

Based on the data presented above, there can generaly be recommended the DHA about 10 to 30 % greater than the targeted daily DMI for optimum livestock and pasture performance, in the case the pasture is of sufficient quality.

Period of occupation

The period of occupation (PO) refers to the time period from the beginning of the occupation of the pasture or a subdivision of the pasture to the end of the occupation of the pasture or the subdivision of the pasture, expressed in days. The PO is most often adjusted to the available herbage mass on the pasture (or on a pasture sub-unit) and the targeted consumption of herbage by the herd (or flock). Namely, the planned PO should not be longer than the time needed to consume the available herbage mass, because the livostock would starve after consuming all the available pasture. The PO should not be much shorter than the time required to consume the available pasture, as this would result in poor utilization of the available pasture. The PO depends on the method of grazing/stocking of the pasture. In case of continuous grazing, the PO can be very long, e.g. the entire grazing season, because the cattle have unlimited access to the entire surface of the pasture. In rotational grazing, the POs of individual pasture subunits are usually short, in order to avoid that the livestock repeatedly graze the young regrowth of the grasses, before the grasses renew their energy reserves in their roots and sod. The greater the intensity of grazing management, the greater the number of subunits into which the pasture is divided, and the shorter the average PO of individual pasture subunits (Table 10).

Table 10. Effect of number of subdivisions of total pasture area on the average period of occupation of each subunit, with average sward rest period of about 30 days (Gantner et al., 2021.)

Number of subunits (paddocks) (n)	**Average period of occupation of each subunit (days)**	**Average sward rest period (days)**	**Intensity of rotational grazing management**
16	2	30	intensive
11	3	30	
9	4	32	medium
6	6	30	lax
4	10	30	

The average period of occupation depends on the number of pasture subunits according to the following expression:

$$average\ period\ of\ occupation\ (days)\ = \frac{average\ sward\ rest\ period\ (days)}{(number\ of\ subunits - 1)}$$

Actual period of occupation of each pasture unit in rotational grazing largely differs from the average during the grazing season because the present herbage varies substantialy during the grazing season. Therefore, the actual period of occupation (PO) has to be adjusted to the current state of the pasture (present HM) and the prospective growth rate of herbage (HGR).

During the periods of slow herbage growth (summer and autumn), the next expression will give a satisfactory prediction of the period of occupation:

$$PO\ (days) = \frac{HM\ (kg_{DM}/ha)}{SD\ (LU/ha)\ \times\ DHA\ (kg_{DM}/LU/day)}$$

Here the SD is equal to stocking rate (SR) multiplied by the number of subunits (ns):

$$SD\ (LU/ha) = SR\ (LU/ha) \times n_s$$

During the periods of fast herbage growth (spring for cool-season grasses and begin of summer for warm-season grasses), the expression has to be corrected for the expected herbage growth rate (HGR):

$$PO\ (days) = \frac{HM_{INITIAL}\ (kg_{DM}/ha)}{SD\ (LU/ha)\ \times\ DHA\ (kg_{DM}/LU/day) - HGR\ (kg_{DM}/ha/day)}$$

In rotational grazing, grazing season can practically start when the first pasture subunit can offer sufficiently long period of occupation (depending on the number of subdivisions). In the case of strip grazing method, the period of occupation of a new strip is most often planned for one day, what is considered a high intensity of grazing management.

Allocated pasture area

An adequate area of pasture should be allocated to the present herd during the grazing season, whether it is the entire area of the pasture (in the case of continuous grazing) or the area of a subunit of the pasture (in the case of strip or rotational grazing). This calculation is particularly important in the method of strip grazing, because an unutilized area of pasture should be allocated to the livestock daily, in accordance with the targeted consumption and the available herbage mass in the pasture. The following expression includes in the denominator a correction for the expected daily herbage growth rate:

$$APA\ (ha/LU) = \frac{DHA\ (kg_{DM}/LU/day)}{HM_{INITIAL}\ (kg_{DM}/ha)\ +\ HGR\ (kg_{DM}/ha/day)}$$

For the case when newly area is being allocated every two or more days (i.e., PO = two or more days), the calculus changes to:

$$APA\ (ha/LU) = \frac{DHA\ (kg_{DM}/LU/day) \times\ PO\ (days)}{HM_{INITIAL}\ (kg_{DM}/ha)\ +\ HGR\ (kg_{DM}/ha/day)\ \times\ PO\ (days)}$$

In rotational grazing method, alocated pasture area is constant and is equal to the area of each pasture subunit (paddock).

Conslusions

Grazing managers have to meet the needs of their livestock for daily and seasonal herbage (pasture) dry matter intake, and tend to efficiently utilize their pasture area. Carefull sizeing of the total pasture area and planing of the grazing activity according to the chosen grazing method can much help in achieving their goals. Main determinants for planning the grazing activities are the targeted daily herbage dry matter intake (DMI), seasonal herbage dry matter intake (SDMI), targeted daily herbage allowance (DHA), herbage mass (HM) present on the pasture, herbage growth rate (HGR), annual pasture yield (APY), utilization rate of pasture yield, total pasture area (TPA), stocking rate (SR), chosen grazing method, stocking density (SD), period of occupation (PO) of each pasture subunit in rotational grazing method and daily alocated pasture area (APA) in strip grazig method. In this work there are presented mathematical expressions required for calculation of these crucially important variables in planned grazing.

References

1. Allen, V.G, Batello, C., Berretta, E. J., Hodgson, J., Kothmann, M., Li, X., McIvor, J., Milne, J., Morris, C., Peeters, A., Sanderson, M. (2011.): An international terminology for grazing lands and grazing animals. Grass and Forage Science 66:2–28.
2. Bauman, P. (2021.): Grass-Fed Beef: Market Share of Grass-Fed Beef. South Dakota Univerity Extension. https://extension.sdstate.edu/grass-fed-beef-market-share-grass-fed-beef
3. Beretta, V., Simeone, A., Elizalde, J. C., Baldi, F. (2006.): Performance of growing cattle grazing moderate quality legume–grass temperate pastures when offered varying forage allowance with or without grain supplementation. Australian Journal of Experimental Agriculture 46:793–797.
4. Čižek, J. (1970.): Proizvodnja krmnog bilja. Sveučilište u Zagrebu. Zagreb.
5. DLG (1997.): *Futterwerttabellen Wiederkauer*. Universitat Hohenheim Dokumentationsstelle. Frankfurt am Main: DLG - Verlags GmbH
6. Dougherty, C. T., Collins, M. (2013.): Forage Utilization. In: Barnes, R. F., Nelson, C. J., Collin, M., Moore, K. J. (2013.): Forages – an introduction to grassland agriculture. Iowa State Press. Ames. Iowa.
7. Gantner, R., Bukvić, G., Steiner, Z. (2021.): Proizvodnja krmnoga bilja. Sveučilišni udžbenik. Sveučilište J. J. Strossmayera u Osijeku, Fakultet agrobiotehničkih znanosti Osijek. Osijek.
8. Gantner, R., Steiner, Z., Herman, G. (2021.a): Forages production. Faculty manual. Faculty of agrobiotechnicam sciences Osijek, Osijek.
9. Hoop, B. (2021.): etter Milk Price and Low Basic Ration Costs Make Grass-Fed Milk Cost-Efficient. Swiss Agricultural Research (12): 189–195.

10. Geenty, K. G., Sykes, A. R. (1986.): Effect of herbage allowance during pregnancy and lactation on feed intake, milk production, body composition and energy utilization of ewes at pasture. Journal of Agricultural Science Cambridge 106:351-367.

11. Kerley, M. S., Lardy, G. P. (2007.): Grazing Animal Nutrition. In: Barnes, R. F., Nelson, J. C., Moore, K. J., Collins, M. (2007.): Forages – the Science of Grassland Farming. Blackwell Publishing. Ames, Iowa, USA.

12. Kolver, E., S., Muller, L. D. (1998.): Performance and Nutrient Intake of High Producing Holstein Cows Consuming Pasture or a Total Mixed Ration. Journal of Dairy Science 81:14031411.

13. Lalman, D., Richards, C. (2014.): Nutrient Requirements of Beef Cattle. Department of Animal Science, Oklahoma Cooperative Service Division of Agricultural Sciences and Natural Resources, Oklahoma State University. http://pods.dasnr.okstate.edu/docushare/dsweb/ Get/Document-1921/E-974web.pdf

14. Lameiras, M. M. (2022.): Unpacking consumer demand for high-priced, high-quality beef. CAES Newswire. University of Georgia, College of Agricultural & Environmental Sciences, UGA Cooperative Extension. Athens.

15. Nielsen, D. B. (1997.): Observations on Pasture Management and Grazing. Archived Agriculture Publications. Paper 6. ent and Grazing" (1997). Archived Agriculture Publications. Paper 6. https://digitalcommons.usu.edu/extension_histag/6

16. NRC (1985.): Nutrient Requirements for Sheep. National Reseach Council. National Academy Press, Washington, D.C.

17. NRC (1996.): Nutrient Requirements of Beef Cattle, 7th revised ed. National Academy Press. Washington, D.C.

18. Prache, S., Bechet, G., Theriez, M. (1990.): Effects of concentrate supplementation and herbage allowance on the performance of grazing suckling lambs. Grass and Forage Science 45:423-429.

19. Roca-Fernandez, A. I., O’Donovan, M. A., Curran, J., Gonzalez-Rodriguez A. (2011.): Effect of pre-grazing herbage mass and daily herbage allowance on perennial ryegrass swards structure, pasture dry matter intake and milk performance of Holstein-Friesian dairy cows. Spanish Journal of Agricultural Research 9(1):86-99.

20. Wheeler, B. (1996.): Wheeler, B. (1996.): Guidelines for Feeding Dairy Cows. Government of Ontario, Canda, Agricultural and rural division. http://www.fao.org/prods/gap/database/ gap/files/1334_GUIDELINES_FOR_FEEDING_DAIRY_COWS.HTM

STRATEGIC TECHNOLOGY OF PRODUCTION OF CLEAR JUICES

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Abstract

In this paper, we will mostly be based on juices in the technological sense, on the way of proper handling of raw matkkerials for processing and on the way of processing and obtaining the finished product.
We will describe the production process as well as the details that are important for obtaining the correct finished product ready for further placement.
To a lesser extent, we will show the impact of juices on human health.

*Key words***:** *fruit juices, technological procedures.*

Introduction

The production of juices represents a very important and promising industry in our consciousness as well. In Europe, the biggest producers are Germany (with an annual production of 2,800 billion liters), France (1,600 billion liters), Great Britain (1,400 billion liters) and Spain (1,300 billion liters).

Serbia produces about 230 million liters of fruit juice annually, which makes us one of the serious producers in the region (Greece produces 187 million liters per year, Hungary 127 million liters, Romania 111 million liters, Bulgaria 106 million liters, Slovenia 40 million liters) (www.pks.rs pristup 30. 07. 2022.)

Many books talk about the importance of juices in terms of health, various scientists have dealt with it with more or less success.

A man who is considered very important is Dr. Norman W. Walker who even published a book of recipes for the treatment of many ailments with freshly squeezed fruit and vegetable juices. The fact that his life span lasted 116 years also speaks of his success in that field. After him, one of the most famous is Dr. Rudolf Brois (the famous Brois drink), whose recipes have saved many people's lives in recent times.

In addition to health benefits, juices are also a means of refreshment that is particularly beneficial for the body. Thanks to this very fact, today the juice and non-alcoholic beverage production industry is extremely developed.

The importance of fruits, vegetables and their juices

Modern production and processing offer the market many foods that are not the best from a nutritional and health point of view. More and more refined and instant food is being consumed, from which important ingredients (vitamins, plant fibers, minerals) have been removed. Consumption of refined food and increasing use of fat (with trans-fatty acids) and food with little vegetable fiber is a significant factor in the development of diseases in modern civilization. That is why it is advised to consume more fresh fruits and vegetables produced primarily organically or according to the principles of integral production Šumić, (2014). Fruits and vegetables are rich in carbohydrates of various structures, from simple sugars such as glucose and fructose to complex carbohydrates: cellulose, hemicellulose, inulin and others. Carbohydrates are an important source of energy in dietary nutrition, because due to the consistency of fruit, they are resorbed more slowly in the digestive tract, especially compared to most sweet industrially obtained food products. That is why fresh fruit is recommended in diets for various diseases, such as diseases of the blood system, diabetes, high blood pressure, etc.

In this regard, the ingredients of fruits and vegetables, such as raw plant fibers: cellulose, hemicellulose, starch, pectins, gums, mucus, but also substances that have an antioxidant character, etc., play a significant role.

Fruits and vegetables have a relatively low content of proteins and lipids (fats), excluding nuts, potatoes and legumes.

That's why fresh fruits and vegetables are considered mainly carbohydrate foods. Carbohydrates are the basic source of energy or "fuel for the human body", and the same from fruits and vegetables have other important biological roles.

Many of them have protective and regulatory functions in the human body, especially when they are in the form of heterosaccharides and complex compounds.

Phytochemicals in fresh fruits and vegetables are products of plant metabolism, and they play a very important role in human nutrition, because they fulfill the functions of protecting the body and strengthening immunity. First of all, these include: minerals, vitamins, enzymes, fruit acids, chlorophylls, carotenoids, flavonoids, polyphenols, betalains, various glycosides, alkaloids, isothiocyanates, capsaicin, terpenes, phytosterols and other microconstituents, all of which are extremely important for health. Some phytochemicals have been proven to be significant antioxidants. The most famous are vitamin C and E, β-carotene, enzymes, minerals (Se and Zn), flavonoids, anthocyanins, polyphenolic compounds and others. Today, very detailed research is being carried out on the antioxidant properties of fruits and vegetables.

Some phytochemicals from fruits and vegetables, which are antioxidants, will be increasingly important in the future due to the possibility of their extraction.

Vitamins, plant pigments and enzymes should be especially highlighted as phytochemicals-antioxidants. Antioxidants in human nutrition fulfill the functions of protecting the body and strengthening immunity, and consuming food rich in antioxidants helps the body defend against various diseases (cancer, cardiovascular diseases, diabetes, etc.).

Phytochemicals also serve as components of functional foods that have a beneficial effect on human health. Certain phytochemicals are used as components for the production of food supplements in the form of various liquid and solid forms: tablets, capsules, drops, etc. Undoubtedly, the simplest and cheapest, and effective form of their introduction into the body is the consumption of fresh fruits and vegetables Jašić, (2010).

In the last five years, some research has revealed a potential link between certain juices and health. For example, kale juice can lower blood cholesterol, thereby lowering one of the risks of heart disease. Carrot juice can reduce cellular oxidative stress (the action of free radicals that damage cells) in women treated for breast cancer. Juices based on southern fruits and carrots can reduce the risk of heart disease. More research is needed to definitively prove the impact of juices on health.

Rudolph Broys is a naturopath who developed a 42-day juice fast and that program is known as "Total Therapy". The Bruce Cancer Diet is a diet based on fruits, vegetables and herbs that a person takes in liquid form for 42 days.

Because cancer cells have a very different metabolism than normal cells, Bryce's diet is designed so that cancer cells do not get any protein from solid foods. But this kind of diet does not damage normal cells. The recipe for making juice according to Rudolf Broys is: 55% beet root, 20% carrot, 20% celery root, 3% raw potato, 2% radish. Bruce's anti-cancer diet is based on the consumption of 3-5 dl of juice made from beetroot which is included in the composition of the juice with about 50%, celery root 20%, carrot 20%, radish 2% and raw potato about 3%. Potatoes are an option, except in the case of liver cancer, where they play an important role in healing Breuss, (1987). Knowing the nutritional properties of fruits and vegetables, as well as their products, is extremely important for every technologist. The processing of fruit into fruit juice results in a reduction of its antioxidant properties, it changes its nutritional properties because canning most often leads to degradation. Processed products generally retain the characteristics of the fruits and vegetables from which they were produced, usually with reduced nutritional and biological value. In processing, it is necessary to establish regimes that will retain the desirable properties of nutrients, texture, aroma, color, vitamins, mineral substances and other phytochemicals, because it is not enough to know how to produce a product, but also how to meet the demands and satisfaction of consumers in terms of the general quality of the product Ranđelović, (2009).

Technological properties of fruits and vegetables

The basic raw material must meet the requirements set with regard to physical and chemical properties, as well as general and specific quality characteristics that the finished product should have. Thus, in the production of juices, the most important properties of the raw material are monitored, such as: juiciness, the ratio of sugar and acid, then color and aroma.

From a technological point of view, the basic elements of the quality of fruits and vegetables as raw materials for processing are:

- mechanical composition (randman),
- chemical composition i
- technological maturity, Vračar, (2001).

Mechanical composition of fruits and vegetables

The mechanical composition of the raw material is a basic condition for profitable production, regardless of the product.

The mechanical composition refers to the weight ratio of individual parts of the fruit, i.e. the productive organs that are processed (skin, stone, petiole, etc.). During processing, from a technological point of view, there are mainly two parts of fruits and vegetables: the one that is used and the one that represents waste. The ratio of the part that is used to that which is removed is actually "randman".

Chemical composition of fruits and vegetables

The chemical composition of fruits and vegetables is important both from the point of view of nutrition and from the point of view of technology. Which technological procedure will be applied, which reactions can be expected during processing, as well as what kind of product and how much product will be obtained are correlated with the chemical composition of the raw materials.

Chemical composition means the content of all ingredients in the product, including water. The components of the chemical composition in quantity, as well as in relation to each other, form the sensory quality characteristics and nutritional properties of the finished product.

The chemical and mechanical composition is specific for each type and variety of fruit and vegetable.

This specificity is characterized by varying within certain limits depending on climatic conditions, agrotechnical measures, as well as the stage of maturity. The content and therefore the ratio of certain chemical compounds and mineral substances of the raw material for processing depends on the stage of maturity.

From a technological point of view, the chemical composition is most simply expressed and most quickly determined as the content of dry matter. This term covers the content of all the compounds that make up fruits and vegetables, except for water.

Based on the dry matter content of individual species and varieties, those varieties with a higher dry matter content are considered high-quality. Given that a higher content of dry matter conditions a higher content of individual ingredients, it can be presented that such raw material has a higher nutritional value and more favorable sensory quality characteristics.

The most important components of the chemical composition of fruits and vegetables are considered to be:

- sugars,
- acids,
- colored substances,
- pectic and
- mineral substances Lovrić, & Piližota, (1995).

Technological maturity

The technological maturity stage of fruits and vegetables represents the ripening stage that provides optimal quality conditions for the canned product. In some species and in some cases this stage coincides with the physiological maturity of the fruits (this is much more common in fruits than in vegetables). Except for compote, fruit is processed for all other products in the stage of full maturity.

In the case of certain types of vegetables in which the cellulose or starch content increases with ripening, the stage of technological maturity is significantly earlier than physiological maturity (peas, green beans and cucumber) Luh, (1988).

Juice production technology

The production of juices represents a special industrial branch, considering their importance and consumption. Recently, this area has been developing very intensively from an industrial-technical and scientific-technological point of view.

Juices are a specific type of product according to their physical characteristics, and according to their chemical composition, they are the closest products to fresh fruit. Any corrections are made only to improve the taste or to achieve refreshing properties.

The first industrial or commercial juice production is considered to have started in the 19th century in Switzerland with apple juice and in the USA with grape juice. A greater increase and development of this production was recorded after 1925.

In addition to apple and grape juices, the production and study of citrus juices soon began due to their vitamin C content. It was only later that other types of fruit were used to obtain juice Samogyi, (1996).

According to the technological process, physical characteristics and chemical composition, several types of juices are distinguished:

- clear, cloudy or opalescent,
- mushy,
- carbonated and
- concentrated juices.

Technological procedure for the production of clear juice

Technological scheme - clear juices are made by mechanical pressing of fruit directly or by diluting concentrated semi-semi-products. The clear juice production technology includes the following main operations: reception and preparation of raw materials, extraction of juice by pressing, clarification, pasteurization and packaging (Figure 1. https://agrosmart.net pristup 30.7.2022).

The most important raw materials in fruit drinks, which are available through international trade, are citrus fruits, apples, pears, quinces, stone fruits, grapes and berries. All cultivated or wild fruits are used for juice production. Some of the raw materials are suitable for the production of juices without correction (eg apple, orange) since their juices are tasty in themselves. On the other hand, juice from some other types of fruit (eg, various types of currants) is only tasty if mixed with sugar syrup.

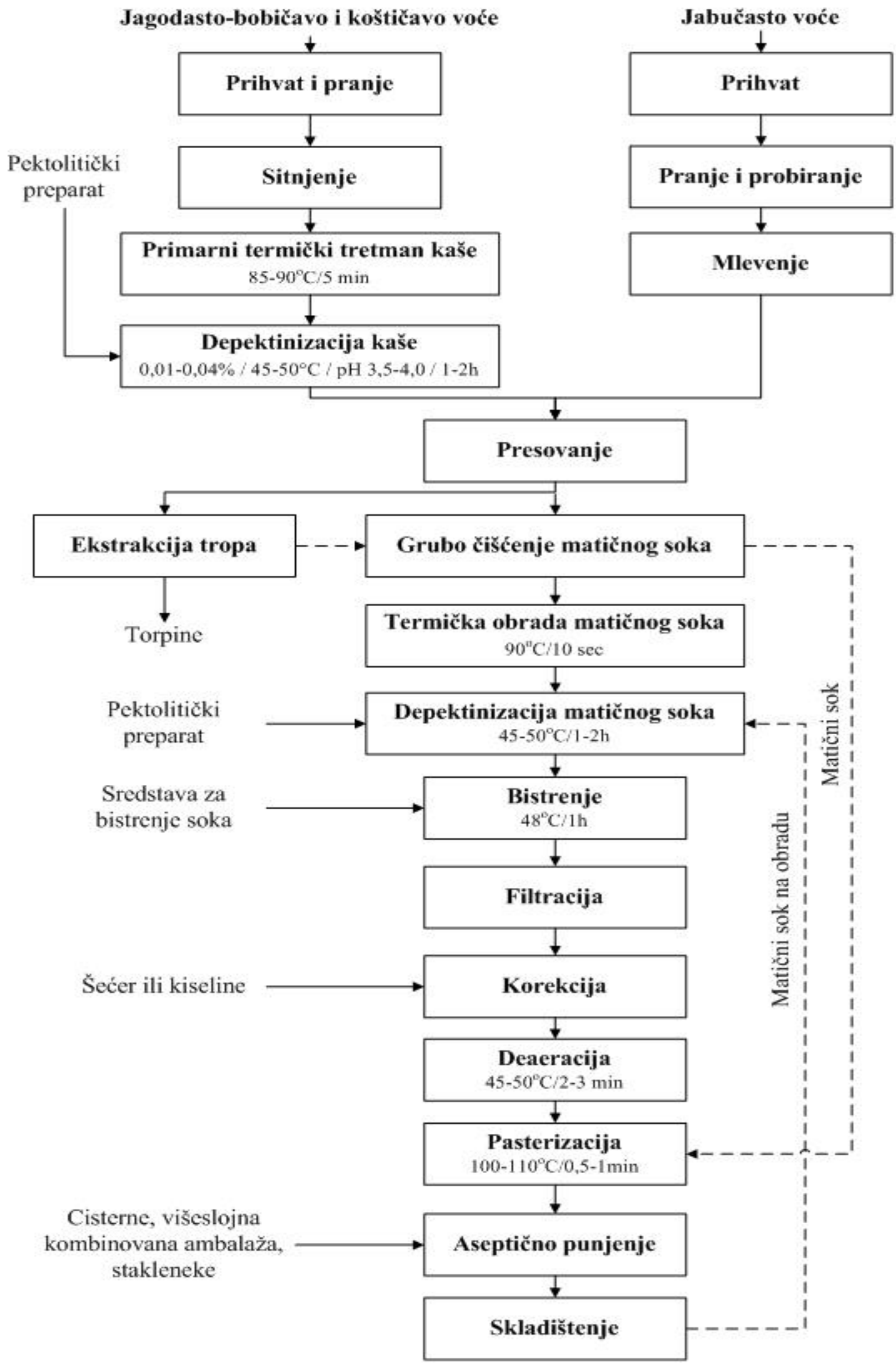

Figure 1. Technological scheme of clear juice production.

Fruit must not be transported for a long time and stored in bad conditions. The factory must have a raw material base as close as possible, so that close professional cooperation with the manufacturer can be established without difficulty. If, in addition to the required quantity, the quality of the fruit is not taken into account, and if the responsibility of both the raw material producer and the processor is not established through mutual obligations, it will not be possible to ensure safe and high-quality fruit production, and thus the basic condition for high-quality and economical juice production. The harvest time also depends on the available storage conditions, Gvozdenović, et al., (2006).

For the production of fruit juices, it is allowed to use only those raw materials that meet the following criteria:

- possess appropriate maturity and taste,
- have no signs of rotting,
- do not contain foreign impurities, pathogenic microorganisms and products of their metabolism.

In addition, raw materials must comply with applicable regulations and standards Pravilnik o tehničkim uslovima za voće za indutrijsku preradu, Službeni glasnik RS 36/09.

Also, compliance with the requirements related to pesticides and heavy metals in raw materials must be checked, Pravilnik o količinama pesticida, metala i metaloida i drugih otrovnih supstancija, hemioterapeutika, anabolika i drugih supstancija koje se mogu nalaziti u namirnicama, Službeni list SRJ 5/92, 11/92, 32/2002).

In recent years, a lot of attention has been paid to the quality of products in Serbia, in accordance with the law and the needs of modern consumers. Several production facilities were opened, some of which function at an extremely high level. Figure 2 and Figure 3 show the flow diagrams of one of our companies engaged in this activity.

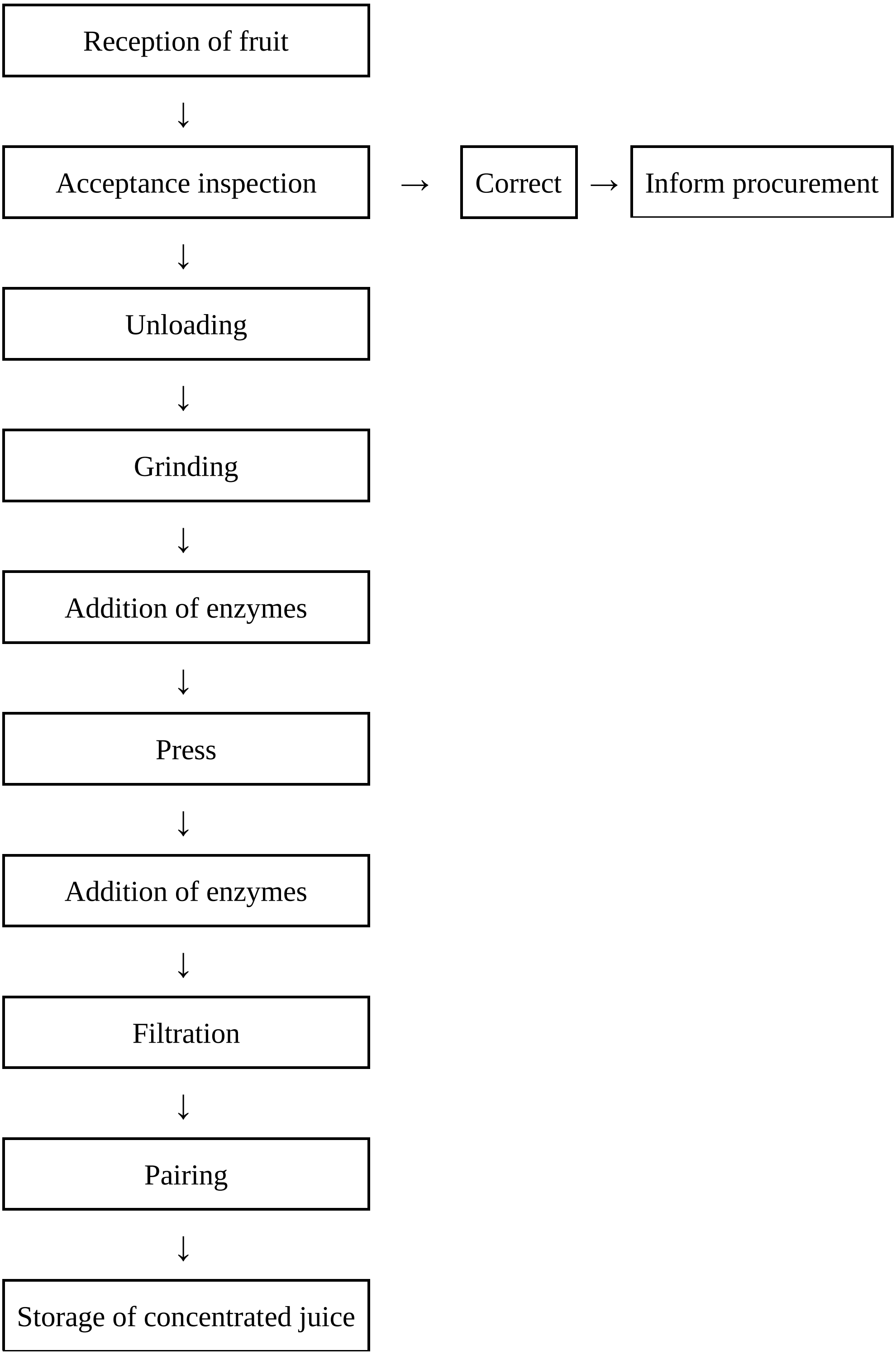

Figure 2. Flow chart of concentrated fruit juice production

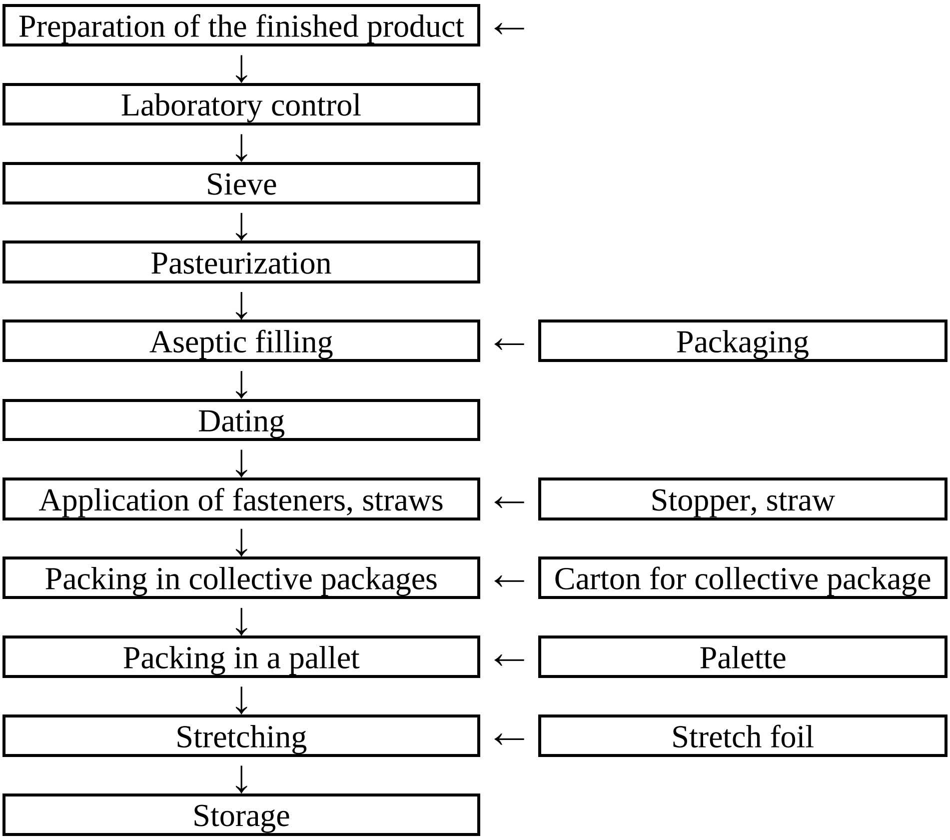

Figure 3. Flow chart of aseptic filling (tetrapak)

In the recent era of production, they must be certified by accredited companies in order to be able to place their products on the market. This certification enables proper handling during production as well as the possibility of eliminating problems from the very start, by prescribing clear and strict rules that refer to each point of the flow diagram individually.

The flow charts are accompanied by certain documentation that defines the rules down to the smallest operations, the handling of raw materials and machines. The hygiene of both internal and external spaces, as well as the hygiene of employees, is very important. Product storage as well as proper handling can also affect the reflection of the quality of the finished product. Any deviation from the rules can cause great losses or, in the worst case, endanger the health of consumers, Lična higijena radnika u prehrambenoj industriji, objavljeno 26.03.2013. http://sanitarnaapv.vojvodina.gov.rs (Pristup 30.07. 2022).

Conclusion

Today, the juice and non-alcoholic beverage production industry is extremely developed. The task of this paper was to describe and explain the juice production process, but also to highlight their importance for the human race.

Due to wrong lifestyle habits, we increasingly encounter various problems that we try to solve in a natural way, so the consumption of healthy "freshly squeezed juices" is of great importance.

Of course, it is recommended to use organically grown fruits and vegetables for this purpose. The paper contains the famous recipe for Brojsko juice, which has been proven to save the lives of many people around the world, as well as information that all problems can be alleviated or even cured by consuming the juices of certain fresh fruits and vegetables. In the technological sense, all types of juices and their production method are listed, regardless of whether they are recommended for health or not, because the paper deals with the topic of technology above all. In order to obtain a completely correct product, ready to be placed on the market, the procedure must be followed from beginning to end, from the import of raw materials into the factory and its reception, to storage and distribution. A good knowledge of the properties of fruits and vegetables is necessary because there are complex biochemical, physiological and microbiological processes that can cause changes in the raw material itself as well as in the flow of technological processes.

Fruit juices are well-known on the market, but vegetable juices have only recently gained attention.

Their production does not take place on such a large scale and they mostly find their place on the shelves of healthy food, which, among other things, indicates their exceptional quality.

Because of all of the above, a lot of knowledge and effort is needed in order to reach the end consumer with a product that satisfies the needs in all respects and justifies the purpose of its existence.

References

1. B. S. Luh, (1988). Commercial Vegetable Processing, New York: AVI book.
2. D. Gvozdenović, L.,Vračar, A. Tepić, (2006). Berba, čuvanje i tehnologija prerade voća, Voćarstvo, 237-244.
3. Dobrila Ranđelović, (2009). Kupina, objavljeno 04.06.2009. godine.
4. L. Samogyi, (1996). Processing fruit Major Processd Product, Lancaster: Technomic.
5. Lična higijena radnika u prehrambenoj industriji, objavljeno 26.03.2013. god. http://sanitarnaapv.vojvodina.gov.rs (Pristup 30.07. 2022).
6. Lj. O.Vračar, (2001). Priručnik za kontrolu kvaliteta svježeg i preradjenog voća, povrća i pečurki i osvježavajućih pića, Novi Sad: Univerzitet u Novom Sadu Tehnološki fakultet.
7. Mithad Jašić, (2010). Značaj voća i povrća u prehrani, objavljeno 17.11.2010.

8. Pravilnik o tehničkim uslovima za voće za indutrijsku preradu, Službeni glasnik RS 36/09.
9. Pravilnik o količinama pesticida, metala i metaloida i drugih otrovnih supstancija,
10. hemioterapeutika, anabolika i drugih supstancija koje se mogu nalaziti u namirnicama, (Službeni list SRJ 5/92, 11/92, 32/2002). (pristup 30. 07. 2022).
11. R. Breuss, (1987). Rak leukemija i druge prividno neizlečive bolesti izlečive prirodnim putem, Beograd: Kosmos, III izdanje.
12. T. Lovrić, V.Piližota, (1995). Konzerviranje i prerada voća i povrća, Zagreb: Globus.
13. Zdravko Šumić, (2014). Tehnologija proizvodnje bistrih voćnih sokova, N. Sad.
14. https://agrosmart.net/2015/05/23/tehnologija-proizvodnje-bistrih-vocnih-sokova/
15. www.pks.rs (pristup 30. 07. 2022).

STRATEGIC SIGNIFICANCE OF FOREST VEGETATION ON PLANTS AND VEGETATION

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Abstract

The goal of this research is to show the extent to which forest vegetation is important for assessing the quality of urban ecosystems, which is of great importance considering that anthropogenic ecosystems have been damaged. In this research, an analysis of the impact of vegetation on the quality of urban ecosystems was carried out. Vegetation of natural and artificial ecosystems is the most effective means of mitigating negative consequences caused by anthropogenic impacts on the environment. The sanitary-aesthetic function of forest vegetation is very important. Within that, it can be established that forest vegetation in urban ecosystems can be viewed as: vegetation as an adsorbent or vegetation as an absorbent.

Key words: Environment; anthropogenic impact; forest vegetation; city center

Introduction

Strategic ecosystem represents the unity of biotope and biocenosis. Therefore, any space inhabited by living beings that are connected by various interactions in order to share resources or reproduce constitutes an ecosystem. The members of this complex ecological level of organization are interconnected by nutritional relationships. The basic and unavoidable component of the ecosystem consists of primary producers - i.e. plant species and other autotrophic organisms whose basic function is the production of nutrients. In addition to producers, consumers and decomposers also play a role in food chains. Urban ecosystems are specific considering the relationship of the mentioned members. In urban ecosystems, plant species - producers, are generally not used as a source of food, nor are there enough of them to feed all heterotrophs, consumers.

The characteristic of other ecosystems is the circulation of matter and the flow of energy. Plants use inorganic matter to make organic matter. The resulting organic compounds are transferred along the food chain. When plant and animal species die, they are broken down by decomposers into inorganic matter that is transported into the environment, i.e. soil, water or air. At all these levels there is a flow of energy. Plants absorb solar energy, convert it through chemical bonds, and then decompose to release heat.

In order for the ecosystem to survive, self-regulation based on nutritional relationships is necessary. There are always the most plants, but their abundance is regulated by herbivores. The abundance of herbivores is regulated by carnivores. The number of herbivores and carnivores is regulated by omnivores, which are the least numerous and if they multiply too much, competition for food occurs and the number decreases.Urban ecosystems have the fewest plants and definitely the most carnivores, but this problem is overcome by exploiting other ecosystems. From all of the above, it follows that the city is an immature ecosystem due to features such as too fast growth, incomplete utilization of available resources and too much waste Lješević, (2002).

Urban flora and vegetation

Urban flora and vegetation represents one of the youngest and most dynamic floristic-vegetation complexes that develops mainly in human settlements, as well as in other anthropogenically formed environments that are occasionally or permanently under the direct or indirect influence of human activity. The presence of anthropogenic influences is certainly of decisive importance for the appearance, development, distribution and dynamics of ruderal flora and vegetation.

In contrast, the influence of climatic, geological, pedological, orographic, historical and other abiotic environmental factors has been changed to a great extent and "uniformized" by human action, which decisively influences the formation of a specific complex of ecological conditions in ecosystems such as human settlements Lješević, (2002).

Flora and vegetation of secondary and tertiary type can be characteristic of anthropogenic environments that are occasionally or permanently under the influence of various forms of human activity. Ruderal flora and vegetation belongs to the weed flora and vegetation in a broader sense and is a relatively autonomous component of the ecosystem of urban and industrial settlements and is an integral component of the most immediate living and working environment.

Unlike weed flora and vegetation in the narrower sense (segetal weeds of agricultural crops), ruderal flora and vegetation (the name ruderal comes from the Latin words "rudus, ruderis" - debris, ruin) develops and is maintained in habitats that are under constant influence man, but not for the purpose of creating agricultural areas. This includes areas next to roads, paths, fences, sidewalks, sidewalks, yards, embankments next to railroad tracks, walls, roofs, riverbanks in urban settlements, various landfills, street entrances, construction sites, ruins, neglected lawns, abandoned lots, economic yards, cemeteries, borders, edges of cultivated areas and park areas, etc.

All these habitat types enable the growth, development, reproduction and spread of anthropophytes, plants linked and adapted to the ecological conditions created and developed by the human population Radosavljević, (2010).

Adapted to these specific, often very unfavorable, habitat conditions both in terms of hygroscopic and thermal regime and character of the substrate, as well as in terms of mechanical influences such as trampling, mowing, grazing, burning, etc., ruderal plants, thanks to their great biological potential and in the absence of competition from species characteristic of primary ecosystems, they very easily "conquer" such habitats, appearing first as pioneer species, and later through various successive phases, more stable coenotic relationships are established, which are conditioned by the type and intensity of various anthropogenic influences.

In general, ruderal flora and vegetation develops on all those surfaces where human activity is present, but not organized, but spontaneous (anarchic) Radosavljević, (2006).

Climate changes have a major impact on the health and survival of forests. According to some authors, an increase in air temperature of about 2°C in winter and about 2-3°C in summer is expected for southern Europe. A 5-15% decrease in precipitation during the summer is also expected Rózsa, (2004).

The Balkan Peninsula is also an area threatened by drought.

All this will result in a decrease in the vitality of forests and their gradual deterioration, mainly for the following reasons: decrease in soil moisture, occurrence of climatic extremes, decrease in the vegetation period, difficult reproduction, decrease in resistance to harmful biotic factors, occurrence of epiphytozoa of pathogenic fungi, infestations of harmful insects, all of which lead to the drying of forests on a larger scale. The harmful impact of increased drought and higher summer temperatures will be especially evident in arid areas, although it will also be manifested in humid continental regions. The complex effects of high temperatures and drought are reflected both on soil and vegetation. As a result of warming, the moisture content in the soil decreases, and this affects the surrounding vegetation. Among forest species of woody plants, coniferous species with shallow plate-like roots, such as spruce, are the first to be attacked.

While the trees are younger, the harmful effect is less pronounced; however, already in middle-aged trees that have a greater need for water, there is a physiological weakening and the appearance of drying. Certainly, the phenomenon of drying is not caused only by drought, but it creates favorable conditions for the appearance of parasitic organisms. For example, when it comes to pure stands of spruce or mixed stands of spruce and fir, physiologically weakened trees due to drought become susceptible to the attack of the fungus Heterobasidion annosum, which leads to drying of the trees.

Forests and other phytocenoses perform a number of polyvalent functions, both through influence on other physical and geographical elements of the environment, and in the domains of ecology, erosion protection, recreation and tourism. Forests and other phytocenoses perform a number of polyvalent functions, both by influencing other physical and geographical elements of the environment, and in the domain of ecology, erosion protection, recreation and tourism.

Forest ecosystems represent the most important biogeographical resource and have an inestimable value. General useful functions of forest ecosystems (production of primary organic matter, production of oxygen, consumption of carbon dioxide, air purification, mitigation of climatic extremes, hydroregulation, ecological balance, etc.) should have priority and greater value than economic functions. However, with the development of the wood industry and construction, priority was given to economic functions.

The use of modern mechanization, the construction of forest roads, the opening of numerous private (registered and unregistered) sawmills, circular sawmills, and carpentry workshops greatly increased the scope of forest exploitation for the purposes of wood processing and construction. The concessionaires, who only clear the forest, and pay almost no attention to the cultivation, restoration and protection of forests, also contribute to forest exploitation taking on unprecedented proportions.

Devastation of forests, due to excessive cutting, clearing, plant diseases and fires, is gaining momentum.

According to the data, the largest volume of forest cutting was in the five-year period from 1972 to 1977, when 120,637 m^3 were cut annually. In the period 1978–1983. year, the average felling was 73,000 m^3 per year, while in the period 1972-2001 year, the volume of all forms of logging (regular, sanitary and illegal) amounted to 69,000 m^3 per year. By year, excessive felling was recorded in 1995, when 101,611 m^3 were cut (which is significantly above natural growth), and the lowest amount of felling was in 1998, when 35,231 m^3 were cut. In 2006, 63,890 m^3 were cut, of which 58,360 m^3 were conifers and 4,530 m^3 hardwoods. Of the total felling in state forests, 60,910 m^3 were cut. Illegal or illegal logging is a serious problem. The volume of that felling was close to 4,000 m^3 in 1992, and 2,500 m^3 in 1993 Pickett, (2008).

Previously, the forest belt was suppressed by clearing in the zone of permanent settlements, but the forest expanded at the expense of clearing and pastures. Today we have the opposite case, meadows and even fields in the zone of permanent settlements turn into forest, because there is no one to cultivate them, while due to excessive exploitation, new clearings are created and forest clearings expand.

Excessive and uncontrolled exploitation of forests gained momentum in the last period of the market economy. By improving the technology of forest exploitation and cutting forest roads, as well as by suspending actions on reforestation, their devastation increased. This is contributed by economic forcing at the expense of general communal functions and neglect of cultivation and protective measures. The consequences of the destructive influence of man on forests are multiple: there are fewer and fewer natural ecosystems and they are replaced by agricultural areas or bare and rocky areas, the number of plant and animal species decreases, the ecological balance and structure of plants is disturbed. communities of change.

Large-scale felling of tall forests has largely turned them into impoverished coppice thickets. Forest fires, diseases, climate change, especially "acid rain", insects and natural disasters also contribute to the devastation of forests.

Environmental awareness, culture and morality among the population should be raised to a higher level, which can be achieved to some extent through various forms of education for school youth, through school programs and local media programs. Through familiarization with ecological conditions and the consequences of environmental pollution and degradation, people's way of thinking can be influenced and the need to change the relationship between man and nature in terms of preserving the natural balance and protecting and improving the environment. Pay special attention to the improvement of ecological culture as a system of knowledge, attitudes and behavior of individuals and society in order to prevent negative impacts on nature, prevent its pollution and degradation and improve its quality.

Plants are of fundamental importance to and in the biosphere for several reasons:

a) Plants are almost the only producers of free oxygen;
b) Plants are the only ones to carry out photosynthesis;
c) Plants convert solar energy (unavailable) into chemical energy (available);
d) Plants are mediators of the C, N, P, K cycle;
e) Plants are the primary producers of organic matter;
f) đ) The main role in the circulation of gases through photosynthesis and respiration (CO_2, NH_3, CH_4, water vapor);
g) Role in the water cycle;
h) Ability to create usable salts of some elements (K, Ca...)
i) Absorption and fixation of nitrogen in the humus layer of the soil;
j) Regulation of the water regime of the substrate (land);
k) Mechanical bonding of the substrate;
l) Regulation of some climatic parameters (air movement, temperature, humidity);
m) Source of substances important for ecosystem functioning and human health - allelopathy (Allelon=mutual, Pathos=influence) Radosavljević, (2009).

Of the total mass of living beings, 95% belong to plants. Plants release the bound oxygen from the compound into the atmosphere, and it, being very reactive, reacts with another element and builds a new compound. A small part of free oxygen is produced by photooxidation of water vapor. The circulation of oxygen through assimilation and dissimilation is closely related to the carbon cycle Washburn, & Cullen, (2006).

Due to the loss or reduction of vegetation, the cessation or reduction of the intensity of photosynthesis inevitably occurs. This is the reason for the decrease in the intensity of oxygen production. In the most extreme situations, this would lead to the suffocation and death of living beings, followed by the decomposition of corpses - a process that leads to an increase in the amount and concentration of CO_2 in the atmosphere (there is no FS to consume it).

Something like this would lead to the emergence of the so-called "dense" atmospheres. The accumulation of CO_2 very quickly leads to the formation of the "greenhouse" effect and the impossibility of uniform cooling on Earth. All of this results in an increase in the average temperature on the Earth's surface, which brings with it consequences of a global character, that is, the melting of "eternal" ice, which is expressed especially at the poles. With the increase in temperature and the melting of glaciers, there is an inevitable increase in the level of the ocean by, perhaps, 50 m Rusong, (2002). In this way, there are frequent and large floods and submergence of coastlines, then to fundamental changes in the global climate and biogeochemical cycles, which would ultimately lead to a cataclysm of life on earth. Forest vegetation is very important because it converts solar - "unusable" energy into chemical - "usable" energy. Through photosynthesis, plants transform part of the sun's energy, which is then available for use by other living beings - consumers and reducers. The energy captured by plants from the sun is used for the formation of organic matter, and because of this characteristic, they are designated as primary producers.

Bearing in mind that plants are the basis of the ecosystem, it is possible to talk about the primary production of the ecosystem. Primary productivity is the rate at which energy (in the process of photosynthesis) is accumulated and bound to newly created organic substances that can be used as nutrients Mičić, et al., (2019).

Ignificance of forest vegetation in urban ecosystems

Higher plants can absorb nitrogen in the form of nitrate (NO_3) and exceptionally in the form of nitrite (NO_2) and ammonium salts (NH_4). Free nitrogen is very inert and can be "forced" to combine with other elements in technological processes at very high temperature (300-400 °C) and pressure (300 atm.) with the presence of a catalyst (Pt). In nature, free nitrogen from the air is converted into an available nitrate form (without high temperatures and pressures) by the action of nitrogen-fixing organisms Rusong, (2002).

Plants with their active substances are an important and irreplaceable, natural, source of medicinal substances that are used for the treatment of people and animals, but also for various other purposes (natural antibiotics, pesticides, enzymes, hormones, etc.).

Although plants represent the basis of the biosphere, the role of animals and microorganisms is equally important and also complementary, because without animals and microorganisms, a whole series of fundamental processes in plants would not be possible (pollination, fertilization, dispersal, fixation of C and N...) which means that life would not be possible on planet Earth in the form it exists today.

Vegetation of natural and artificial ecosystems is the most effective means of mitigating negative consequences caused by anthropogenic impacts on the environment.

The function of mitigating negative impacts is essentially related to the functions of plants and vegetation in the biosphere and primarily refers to the regulation of proper runoff and conservation of water (which is related to the basic role of plants as bioreinforcement and biosponge), protection against erosion (relation to the role of bioreinforcement), mitigating the extreme conditions of the urban environment, sanitary-aesthetic function of vegetation, protection of settlements from air pollution, protection of settlements from noise, etc.

Forest vegetation in urban ecosystems is a real regulator of proper water runoff and storage. However, it is very important to note that the mode of water absorption and runoff in a certain area depends on the amount and type of precipitation, the type and condition of the soil, and the type and condition of the vegetation cover. The center of gravity is towards maximum absorption and minimal surface runoff of water, however, only soil under vegetation satisfies this center of gravity.

Even in ancient times, it was observed that vegetation, especially forest vegetation, plays a significant role in regulating the water regime of a region. "The more a land is cleared, the poorer it is with water" (Buffon, 1739) Radosavljević, (2009). In the structure of the biocenosis (storiedness), a very important reservoir and regulator of movement, i.e. of water runoff is the litter floor. Forest litter is very hygroscopic and retains (absorbs) water sediment of 10-12 mm in one day. By saturating the forest floor, water begins to slowly migrate into the ground, thus enabling the continuous availability of water for other members, structures and processes in the ecosystem Rózsa, (2004).

The influence of vegetation on the water regime of the habitat is important, especially for areas under a slope, but also for areas in the plain.

Vegetation functions as a "biosponge" by receiving water from atmospheric precipitation (rain, downpour, hail, snow) with its above-ground (primarily) and underground parts, distributing it over a larger surface (leaves, twigs, branches, tree) and slowing down its speed. it slowly reaches the surface of the earth, amortizing in this way the negative, mechanical, effects on the surface layer of the soil Davies, (2011); Mičić, et al., (2019).

Apart from this very important function of forest vegetation in urban ecosystems, one of the equally important functions is the anti-erosion function of forest vegetation.

A large number of factors lead to erosion. First of all, it is water, then the slope of the terrain, wind, temperature differences, destructive human action, etc.

However, there is only one factor that counteracts erosion and that is vegetation.

Vegetation affects the reduction and prevention of erosion in two ways:

a) By reducing or canceling the impact force of water and wind

b) By binding the substrate ("bioarmature") and increasing the porosity of the soil, it enables a greater absorption and retention of water in the soil and a reduction of the water that runs off on the surface.

Only by technical measures, without the involvement of plants, ie. vegetation, it is impossible to reduce or prevent the erosion that inevitably occurs.

Another very important function is the climatic function of vegetation. Climatic factors as the most important ecological factor (light, temperature, air, humidity) decisively determine the general character of the living world in a given area.

On the other hand, vegetation acts on a certain modification of the basic type of climate and the formation of special characteristics of the climate within the biocenosis - ecosystem, and on that basis such a climate, modified by plants, is designated as a phytoclimate Tao, & Grimm, (2015).

Light

The greatest modification of light as an ecological factor is realized in the forest biocenosis, i.e. ecosystem.

Different types of forest phytocenoses (composition of species, age structure, cover, assembly, ...) modify the light regime in the habitat in different ways, which has a reflection on the character of the entire biocenosis. Thus, the light forests are primarily the habitat of the species Larix sp. and Betula sp., while the dark forests are composed of the following species: Picea sp., Taxus sp., Carpinus sp. and Quercus sp.

Temperature

Forest vegetation has the greatest influence on the formation of the specific thermal regime of the habitat, but also the relatively close presence of water habitats - rivers, lakes, ponds, swamps.

The temperature regime of a habitat under vegetation, and especially a habitat with high vegetation (forest), differs from the temperature regime of an area that is not or is poorly covered with vegetation in three basic ways:

1. The extremes and fluctuations of T are reduced
2. In winter and at night, it is warmer in the forest than in the open space
3. In the summer and during the day, it is colder in the forest than in the open space.

Air humidity

Due to the intense process of transpiration in interaction with the temperature regime and evaporation of the earth's surface, air humidity is almost always higher in the forest compared to e.g. meadow or bare ground.

The air humidity of green areas is higher by 18-22% compared to bare areas.

Movement of air and water

The most pronounced modification of the environmental factor is the movement of air, where it is observed that in the case of high vegetation, a closed and dense assembly (forest), the speed of air movement is reduced, and there is a greater or lesser change of direction.

Perhaps even the most significant when it comes to urban ecosystems is the sanitary-aesthetic function of forest vegetation. Within that, we note that forest vegetation in urban ecosystems can be viewed in several different ways, namely: vegetation as an adsorbent or vegetation as an absorbent.

Vegetation as an adsorbent - a considerable amount of floating particles (dust, soot, spores, pollen,...) is deposited on the vegetative parts of plants, so depending on the type, size, aspect, degree of development of the vegetation, up to 70% of particles from the air can be adsorbed .

In the park and above the park in the summer months, there is about 22% less dust compared to the area outside the park.

Vegetation as absorbent - plants absorb gaseous substances from the air and thus reduce the amount of negative substances (SO2, NOx, CO2, CO, ...).

Vegetation produces phytoncides - volatile substances from fir bark (Abies sp.) kill diphtheria bacteria, phytoncide substances from poplar leaves (Populus sp.) kill dysentery agents.

One cubic meter (1m3) of air in the forest contains about 200-300 bacteria, and the same volume of air in megalopolises contains up to 250 times the number of bacteria Elmqvist, et al., (2008).

Robinia pseudoacacia and Tilia grandiflora and Tilia cordata have the most active fungicidal effect on Septoria robinea spores on Cerospora microspora.

Pinus silvestris, Larik sp., Abies sibirica and Pinus nigra also have a highly toxic effect on mushroom spores. Quercus pedunculata, Acer monspessulanum, Acer platanoides, Pinus silvestris, Forsitia viridissima and Tamarik sp have high fungicidal activity Radosavljević, (2006).

In the modern living conditions of the inhabitants of big cities, engaging in mountain, sea or rural tourism is a necessity, not a luxury, due to multiple positive effects on the health, physical and psychological status of the individual.

The significance of areas under greenery, in modern urban conditions, is extremely positive and multiple, and the main characteristics are:

1. Conversion of oxygen and carbon dioxide;
2. Microclimate regulation (temperature, humidity, light, ...);
3. Wind protection;
4. Protection from sand and snow drifts;
5. Noise protection (tall trees);
6. Adsorption of floating (sedimentary) particles and absorption of harmful gases - combustion products;
7. It has a positive effect on the current health-physiological state of a person (staying in parks lowers heart rate, blood pressure, cools down on hot days, relieves the psyche);
8. Greenery has sociological significance - especially parks (places of gatherings, meetings, games, gatherings, sports and music events, etc.);
9. Remediation function for degraded areas (draining of wetlands - one of the examples in our country is Chair park, where former garbage dumps were greened)
10. Aesthetic experience.

Picture 1. Chair park in Niš

Conclusion

Urban settlements themselves, as artificial - anthropogenic ecosystems, show a number of specificities in relation to natural ecosystems. The city as an artificial (eco)system survives thanks to the constant supply of the necessary energy by man, and the matter is transformed only to a small extent, while the rest is eliminated from the system. However, the differences between natural and anthropogenic ecosystems are also evident when it comes to the soil itself.

Most often, in urban areas, the soil that is available to plants is mostly covered with artificial materials, and the little free soil has more or less changed characteristics in both the solid and exact and gaseous phases.

It can be concluded from the work that forest vegetation plays a very important role in urban ecosystems. First of all, the production of oxygen and the positive influence on microclimate regulation must be emphasized. Tall trees provide protection from noise, which is of great benefit to residents of large cities. In addition, urbanization has increased the intensity of traffic and the number of household fireplaces, and therefore the amount of sulfur and nitrogen oxides that are released by burning fossil fuels, so today the degree of pollution is a big problem in the city.

Forest vegetation in urban ecosystems has the role of adsorption of these harmful particles. However, in the artificial ecosystems of urban settlements, mutual relations between organisms - members of the biocenosis are very changed and specific as a consequence of the action of modified abiotic factors, primarily in the domain of food availability, shelter, population and biocenotic relations. Due to the unfavorable and "unnatural" conditions in which urban vegetation develops as a whole, but also individual species in it, it is susceptible (more than vegetation in natural habitats) to the negative influence of biological agents, primarily fungi and insects. City administrations of large European cities have seen the importance and all the positive aspects of forest vegetation in urban ecosystems, so at the end of this paper, a proposal can be made to intensify work in this area in the future and increase green areas in urban ecosystems of our country.

References

1. J. Radosavljević, (2006). „Urbana ekologija i prostorno planiranje“, Niš, Fakultet zaštite na radu u Nišu.
2. J. Radosavljević, (2009). „Urbana ekologija“, Niš, Fakultet zaštite na radu u Nišu.
3. J. Radosavljević, (2010). „Prostorno planiranje i zaštita životne sredine“, Niš, Fakultet zaštite na radu u Nišu.
4. L. Tao, N.B. Grimm, (2015). „Comparative study of urban ecology development in the U.S. and China: Opportunity and Challenge“, Urban Ecosystems, 18 (2), p. 599-611.
5. Mičić I., Rajić Z., Mičić I., M., (2019), ECONOMICS OF SUSTAINABLE AGRICULTURAL PRODUCTION AND ANALYSIS MACROINVERTE-BRATES OF WATER SOURCES IN SERBIA, MODERN TRENDS IN LIVESTOCK PRODUCTION 12th INTERNATIONAL SYMPOSIUM 9-11 October, BELGRADE, SERBIA, p. 548-557. ISBN 978-86-82431-76-3

6. M. Lješević, (2002). „Nauka o životnoj sredini – Urbana ekologija“, University of Belgrade, Faculty of Geography, Center for Environmental Study and GIS, Belgrade.
7. P. Rózsa, (2004). „Város és környezet – Bevezetés a települések környezetta nába – Kossuth Egyetemi Kiadó“, Debrecen.
8. S. J. Washburn, T. M. Cullen, (2006). "Epiphytic macrolichens of the greater Cincinnati metropolitan area – part II: distribution, diversity and urban ecology", Bryologist, 109, pp. 516-526.
9. S.T.A. Pickett, (2008). „Urban Ecological Systems: Linking Terrestrial Ecological, Physical, and Socioeconomic Compnents of Metropolitan Areas“, In: Urban Ecology. An International Perspective on the Interacton Be1tween Humans and Nature (Eds.: Marzluff M.J.et all). Springer Verlag.
10. T. Elmqvist, C. Alfsen, J. Colding, (2008). „Urban systems: Encyclopedia of Ecology“, Elsevier B.V., The Netherlands, p. 3665- 3671.
11. Z. G. Davies, (2011). „Mapping an urban ecosystem service:quantifying above-ground carbon storage at a city-wide scale“, Journal of Applied Ecology, 48, p.1125-1134.
12. W. Rusong, (2002). „Five Facets of Ecocity Development. In: Ecoscape Eco-industry, Eco- culture“. The fifth International ECO-CITY Conference. Shenzhen, China. pp. 148-151.

STRATEGY FOR PRODUCTION OF LAMBS FOR SALE AND SHEEP'S WOOL IN FARM CONDITIONS

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Abstract

Surveys were conducted in the Nisava and Toplica districts in Serbia during 2021. The research material comprises the sheep genotype: Pure Breeds: Merino Sheep. The study included a medium-sized private sheep farm (A) in Držanovac in Toplica district and a small private sheep farm (B) for wool production in Orljan, Nišava District. The volume and technology of production of wool genotype for both farms was monitored and economic results analyzed. During the study period, it was found that on farm A there were 150 heads of Merino breed and on farm B 75 heads. Total profit on farm A without incentives in crop production: wheat 1,215.0 EUR, maize 1329.7 EUR, barley 1314.60 EUR, triticale 1561.50 EUR and livestock for 150 heads 16.920 EUR, of which 2.250 EUR in sheep wool production, per head 112.80 EUR. Also, the total profit on farm B in crop production: wheat 2,853.0 EUR, maize 1329.6 EUR and livestock production, by 75 heads, 8,460 EUR, of which in sheep wool production EUR 1,125, per head 112.79 EUR.

Key words: Development, textile industry, sheep breeds, wool, price.

Introduction

The importance of sheep production, among other things, consists in enabling agricultural resources to be used more fully and realizing a large part of plant production. In addition, due to the comprehensive production process that has a slight influence of external factors, sheep production significantly affects the overall growth rate of agricultural production. The production of the sheep breed for wool production fell to over one third of the total production in Serbia, while this share in Vojvodina rose to almost half of the total production. Regardless of the natural indicators in the intensive production of Merino sheep, it is very important to provide a detailed insight into the production costs, which is the basis of the economy of the wool production process. In contrast to a rural household that produces sheep for its own needs and the eventual sale of products Mičić et al., (2018*)*. Agricultural holdings or family farms that are permanently oriented towards commodity production must pay close attention to production costs, whereby the products obtained must meet quality standards. Research into the economic parameters of wool production deals with determining the cost price of produced wool and sheep in two phases. The analysis deals with the costs of sheep production in the first stage of the production process, and the determination of the total production costs of individual product categories by applying divisional calculation in the second stage of calculation. The cost correction aims to give the obtained results a wider applicability in relation to the examined farm. In this way, it is possible for the obtained results to have general, and not only local, significance Yuldashbaev, et al., (2018*).* Quantity, as part of the strategic effort to ensure the necessary quantities of wool, milk and meat, still represents an important element of production, although its primacy has long been overcome, Saatchi, et al., (2010*).* In order to increase the production of sheep in the industry, science has made efforts to successfully manage the sheep breeding process. Today, in many countries, including ours, estrus Synchronization methods are used to control the reproductive characteristics of sheep, as well as the realization of several female lambs in the same phase of estrus and ovulation. This method enabled two or three lambs per year for two years, with the aim of increasing wool and meat production Zapletal et al. (2010). point out that the use of appropriate hygiene in sheep reproduction, breeding, environmental conditions, nutrition, prevention and treatment are key factors. Synchronization of estrus successful programs have a key role in lambing and profitability of carrier ewes in semi-intensive production systems, Kukovic, et al. (2013); Cividini, (2012). Serbian sheep breeding is mostly extensive. In Serbia, the sheep population is 80%, of which the following strains are: Pirotska, Svrljiška, Sjenička, while the remaining 20% are: Cigaj, Württemberg sheep, and Australian merino for wool production. Productivity in the population of other breeds is higher, but due to the low participation in the total number of sheep, the effects are insignificant at the state level.

The annual weight of sheep meat in the last decade is below 20,000 t. In Serbia, the consumption of sheep meat is below 3.0 kg per capita, we are among the European countries with the lowest consumption. The basic orientation of farmers in the production of sheep's wool, milk, meat and lamb in Serbia seems to be in the first (F1) generation to achieve better quality production than wool in the textile industry Selionova, et al., (2017); Matsushita, et al., (2010). According to the latest data from the Republic Institute of Statistics, it raises about 1.7 million sheep. The largest number, more than a million, is grown in central and eastern Serbia, but on the other hand, the largest and most organized farms are located in Vojvodina.

Material and methods

The research was carried out in 2021 on the family farm on farm A in Držanovac and farm B in Orljan. Both farms have a closed production cycle. Medium farm (A) has 150 sheep, and small farm (B) 75 sheep per year. 2 people were employed on farm A, and 1 person on farm B. Production costs for both households are based on natural indicators determined on the basis of research conducted and all categories of variable costs in accordance with the production process. Material costs refer to the consumption of nutrients and drugs used in the production process. Depreciation costs in 2021 based on space and equipment standards, we approach investment estimates, estimate depreciation costs based on which fixed cost categories are calculated. When determining production costs, we start from the price of wool, milk and lamb products. Production parameters were monitored: on farms A and B, food consumption on both farms per 1 kg of growth, total growth and food costs on both farms Pešić et al., (2013). The significance of the results in the production of wool, milk and lambs in 2021 was independently monitored on both farms during one year Zaharia, et al., (2013).

Results and discussion

Research on economic parameters of the process of production of lambs for sale and sheep's wool was carried out on a medium-sized sheep farm A and a small sheep farm B. The mentioned farms have a closed production cycle that includes the production of sheep's wool, milk and lambs, on farm A over 200 lambs per year and on farm B about 100 lambs and the production of wool and milk.

Fama A produces the most important nutrients for feeding herds from the cereal group. at 10 a.m. and farm B produces the most important nutrients for feeding the herd from the cereal group, two members work on farm A and one member works on farm B. Based on the recording of production processes on farms A and B, a calculation of material costs was made in 2021, which includes the consumption of foodstuffs, medicines, other materials and water. The largest part of material costs are variable costs Archimede, et al., (2008).

Production of gcereals for farm A

On the researched farm A, the economy of the production of the most important feedstuffs for feeding herds from the cereal group was monitored. The economy of wheat, corn, triticale and barley production was also monitored. The farmer has significant areas and favorable conditions for the aforementioned production. Corn covers 2 ha, triticale 3 ha, wheat 2 ha and barley 3 ha. Annual grain production 50 t on the property cultivated by farm A in 2021.

The paper investigated the medium-sized sheep farm mentioned above as well as crop production due to the provision of nutrients for feeding the herd on farm A. The natural and financial indicators of grain production in 2021 are given in the following tabular representations, namely: calculation of production, corn (table 1); triticale (table 2); wheat (table 3) and barley (table 4).

Table 1: Calculation of realized economic indicators of corn production on 2 ha for farm A

No.	Production year: 2021	Number of repetitions	Quantity	JM	The price	JM	Amount EUR/ha/2
I	Income						
1.	Corn	2	6,5	t/ha	130,0	€ /t	1690,0 €
2.	Corn	2	9	t/ha	17,98	€ /t	323,7 €
A)	Total Income (1 to 2)						2.013,7 €
3.	Costs						
4.	Seeds	1	20	kg	1,50	€	30,0 €
5.	Fertilizer						
6.	Manure	25%	40	t	1,0	€ /kg	40,0 €
7.	CAN (29%N)		400	kg	0,30	€ /kg	120,0 €
8.	Pesticides						
9.	Guardian		6	L	4,0	€ /kg	18,0 €
10.	The thesis		6	L	2,5	€ /L	15,0 €
11.	Irrigation						
12.	Energetic	2	15	L	1,40	€ /L	42,0 €
13.	Diesel fuel		60	L	1,40	€ /L	84,0 €
14.	Maintenance of machinery		2	ha	15,0	€ /ha	30,0 €
15.	Paid on demand. mechanization						
16.	Plowing		2	ha		€ /ha	0 €
17.	Land preparation		2	ha		€ /ha	0 €
18.	Sowing		2	ha	30.50	€ /ha	61,0 €
19.	Harvest		2	ha	65,00	€ /ha	130,0 €
20.	Paid labor		5	r.dan	15,0	€	75,0 €
21.	Other variable costs						
22.	Cost of storage			kg		€ /kg	0 €
23.	Transport to the customer		13	t	3,0	€ /t	39,0 €
B)	Total Costs (3 to 23)						684,0 €
II	PROFIT/LOSS						
24.	Total without incentives (A – B)						**1329,7 €**
25.	Po ha without incentives (24 : 17)						**664,8 €**
26.	Cereal cost price kg (24 : 1)						**0,1 €**
27.	Economy of production (A : B)						**2,94**
28.	Profitability of production (24:B)x100						**194,40 %**

Source: Author's calculation based on data collected in the field

Achieved results: The average corn yield on the tested farm A was 6.5 t/ha, and ranged from 6.0 t/ha to 7.0 t/ha. The total realized profit on 2 ha is EUR 1,329.70, production efficiency 2.94 and production profitability 194.40%.

Table 2: Calculation of achieved economic indicators of triticale production on 3 ha for farm A

No.	**Production year: 2021**	**Number of repetitions**	**Quantity**	**JM**	**The price**	**JM**	**Amount EUR/ha/3**
I	**Income**						
1.	Triticale	3	5,0	t /ha	150,0	€ / t	2.250,0 €
2.	Straw	3	5	t/ha	19,5	€ /t	292,5 €
A)	Total Income (1 to 2)						2.542,5 €
3	Costs						
4.	Seeds	1	750	kg	0,20	€	150,00 €
5.	Fertilizer						
6.	Manure	25%	60,0	kg	1,0	€/kg	60,00 €
7.	Urea		600	kg	0,30	€/kg	180,00 €
8.	Foliar feeding		6	kg	3,0	€/kg	18,00 €
9.	Pesticides						
10.	Meteor		30	G	0,15	€ /L	4,50 €
11.	Irrigation						
12.	Energetic	3	15	Litar	1,40	€ /L	63,00 €
13.	Diesel fuel		90	Litar	1,40	€ /L	126,00 €.
14.	Maintenance of machinery		3	ha	19,0	€ /ha	57,00 €
15.	Paid on demand. mechanization						
16.	Plowing		3	ha		€ /ha	0 €
17.	Land preparation		3	ha		€ /ha	0 €
18.	Sowing		3	ha	30,5	€ /ha	91,50 €
19.	Harvest		3	ha	52,0	€ /ha	156,00 €
20.	Paid season. manpower		20	r. sat	1,50	€	30,00 €
21.	Other variable costs						
22.	Cost of storage			kg		€/kg	0 €
23.	Transport to the customer		15,0	t	3,0	€/kg	45 €
B)	Total Costs (3 to 23)						981,0 €
II	PROFIT/LOSS						
24.	Total without incentives (A – B)						**1561,50 €**
25.	Po ha without incentives (24 : 17)						**520,50 €**
26.	Cereal cost price kg (24 : 1)						**0,10 €**
27.	Economy of production (A : B)						**2,59**
28.	Profitability of production (24 : B) x100						**159,17 %**

Source: Author's calculation based on data collected in the field.

Achieved results: The average yield of triticale on the tested farm A was 5.0 t/ha, and ranged from 4.5 t/ha to 5.5 t/ha.

The total realized profit on 3 ha is EUR 1,561.50, production efficiency 2.59 and production profitability 159.17%.

Table 3: Calculation of realized economic indicators of wheat production on 2 ha for farm A

No.	Production year: 2021	Number of repetitions	Quantity	JM	The price	JM	Amount EUR/ha/2
I	Income						
1.	Wheat	2	5,0	t/ha	170,0	€ / t	1700,0 €
2.	Straw	2	5.0	t/ha	16,9	€ /t	169,0 €
A)	Total Income (1 to 2)						1.869,0 €
3	Costs						
4.	Seeds	1	500	kg	0,20	€	100,00 €
5.	Fertilizer						
6.	Manure	25%	40	t	1,0	€ /kg	40,00 €
7.	Urea		400	kg	0,30	€ /kg	120,00 €
8.	Foliar feeding		4	kg	3,0	€ /kg	12,00 €
9.	Pesticides						
10.	Meteor		20	g	0,15	€ /L	3,0 €
11.	Irrigation						
12.	Energetic	2	15	L	1,40	€ /L	42,00 €
13.	Diesel fuel		60	L	1,40	€ /L	84,00 €
14.	Maintenance of machinery		2	ha	19,0	€ /ha	38,00 €
15.	Paid on demand. mechanization						
16.	Plowing		2	ha		€ /g	0 €
17.	Land preparation		2	ha		€ /ha	0 €
18.	Sowing		2	ha	30,0	€ /ha	60,0 €
19.	Harvest		2	ha	55,00	€ /ha	110,00 €
20.	Paid season. manpower		10	r. sat	1,50	€	15,0 €
21	Other variable costs						
22.	Cost of storage			kg		€ /kg	0 €
23.	Transport to the customer		10	t	0,3	€ /kg	30,0 €
B)	Total Costs (3 to 23)						654,0 €
II	PROFIT/LOSS						
24.	Total without incentives (A – B)						**1.215,0** €
25.	Po ha without results (24 : 17)						**607,50** €
26.	Cereal cost price kg (24 : 1)						**0,12** €
27.	Economy of production (A : B)						**2,86**
28.	Profitability of production (24:B) x 100						**185,78 %**

Source: Author's calculation based on data collected in the field

Achieved results: The average yield of wheat on the tested farm A was 5.0 t/ha, and ranged from 4.5 t/ha to 5.5 t/ha. The total realized profit on 2 ha is EUR 1,215.0, production efficiency 2.86 and production profitability 185.78%.

Table 4: Calculation of realized economic indicators of barley production on 3 ha for farm A

No. I	Production year: 2021 Income	Number of repetitions	Quantity	JM	The price	JM	Amount EUR/ha/3
1.	Barley	3	4,0	t/ha	170,0	€ / t	2.040,0 €
2.	Straw	3	5	t/ha	17,04	€ /t	255,6 €
A)	Total Income (1 to 2)						2.295,6 €
3	Costs						
4.	Seeds	1	750	kg	0,20	€	150,00 €
5.	Fertilizer						
6.	Manure	25%	60,0	t	1,0	€/kg	60,00 €
7.	Urea		600	kg	0,3	€/kg	180,00 €
8.	Foliar feeding		6	kg	3,0	€/kg	18,0 €
9.	Pesticides						
10.	Meteor		30	g	0,15	€ /L	4,50 €
11.	Irrigation						
12.	Energetic	3	15	L	1,40	€ /L	63,0 €
13.	Diesel fuel		90	L	1,40	€ /L	126,00 €
14.	Maintenance of machinery		3	ha	19,0	€/ha	57,0 €
15.	Paid on demand. mechanization						
16.	Plowing			ha		€/ha	0 €
17.	Land preparation		3	ha		€/ha	0 €
18.	Sowing		3	ha	30,5	€/ha	91,50 €
19.	Harvest		3	ha	55,00	€/ha	165,0 €
20.	Paid season. manpower		20	r. sar	1,50	€	30,0 €
21.	Other variable costs						
22.	Cost of storage			kg		€/kg	0 €
23.	Transport to the customer		12	t	3,0	€/kg	36,0 €
B)	Total Costs (3 to 23)						981,0 €
II	PROFIT/LOSS						
24.	Total without incentives (A – B)						**1314,60** €
25.	Po ha without incentives (24 : 17)						**438,20** €
26.	Cereal cost price kg (24 : 1)						**0,11** €
27.	Economy of production (A : B)						**2,34**
28.	Profitability of production (24:B) x 100						**134,00 %**

Source: Author's calculation based on data collected in the field

Achieved results: The average yield of barley on the tested farm A was 4.0 t/ha, and ranged from 3.5 t/ha to 4.5 t/ha. The total realized profit on 3 ha is EUR 1,314.60, production efficiency 2.34 and production profitability 134.0%.

Production of grain for farm B

Also, on sheep farm B, the economy of the production of fodder for feeding herds from the cereal group: corn and wheat was monitored. The farm has the conditions and areas for agricultural production. Corn covers 2 ha and wheat 3 ha. Annual grain production on farm B is 35.5 t in 2021.

Natural and financial indicators are given in a tabular presentation, namely: calculation of realized economic production, corn (table 5) and wheat (table 6).

Table 5: Calculation of realized economic indicators of corn production on 2 ha for farm B

No.	**Production year: 2021**	**Number of repetitions**	**Quantity**	**JM**	**Theprice**	**JM**	**Amount EUR/ha/2**
I	**Income**						
1.	Corn	2	6,5	t/ha	130,0	€ /t	1690,0 €
2.	Corn	2	9	t/ha	17,98	€ /t	323,6 €
A)	Total Income (1 to 2)						2.013,6 €
3.	Costs						
4.	Seeds	1	20	kg	1,50	€	30,0 €
5.	Fertilizer						
6.	Manure	25%	40	t	1,0	€/kg	40,0 €
7.	CAN (29%N)		400	kg	0,30	€ /kg	120,0 €
8.	Pesticides						
9.	Guardian		6	L	4,0	€ /kg	18,0 €
10.	The thesis		6	L	2,5	€ /L	15,0 €
11.	Irrigation						
12.	Energetic	2	15	L	1,40	€ /L	42,0 €
13.	Diesel fuel		60	L	1,40	€ /L	84,0 €
14.	Maintenance of machinery		2	ha	15,0	€ /ha	30,0 €
15.	Paid according to mechanization						
16.	Plowing		2	ha		€ /ha	0 €
17.	Land preparation		2	ha		€ /ha	0 €
18.	Sowing		2	ha	30.5	€ /ha	61,0 €
19.	Harvest		2	ha	65,0	€ /ha	130,0 €
20.	Paid labor		5	r.dan	15,0	€	75,0 €
21.	Other variable costs						
22.	Cost of storage			kg		€ /kg	0 €
23.	Transport to the customer		13	t	3,0	€ /t	39,0 €
B)	Total Costs (3 to 23)						684,0 €
II	PROFIT/LOSS						
24.	Total without incentives (A – B)						**1329,6** €
25.	Po ha without incentives (24 : 17)						**664,8** €
26.	Cereal cost price kg (24 : 1)						**0,1** €
27.	Economy of production (A : B)						**2,94**
28.	Profitability of production (24:B)x100						**194,40 %**

Source: Author's calculation based on data collected in the field

Achieved results: The average corn yield on the tested farm B was 6.5 t/ha, and ranged from 6.0 t/ha to 7.0 t/ha.

The total realized profit on 2 ha is EUR 1,329.70, production efficiency 2.94 and profitability

Table 6: Calculation of realized economic indicators of wheat production on 3 ha for farm B

No.	Production year: 2021	Number of repe-titions	Quantity	JM	The price	JM	Amount EUR/ha/2
I	**Income**						
1.	Simonida wheat of 3 ha	3	7,5	t/ha	170,0	€/ t	3.825,0
2.	Straw of 3 ha	3	4	t/ha	8,75	€/ t	105,0
3	RS incentives for plant production		3	ha	50,00	€/ ha	150,0
A)	Total income (1 to 2) for 3 ha						4.080,0
4	Costs						
5.	Seeds for 3 ha	1	750	kg	0,20	kg	150,0
6.	Fertilizer						
7.	Manure for 3 ha		15	t	4,00	t	60,0
8.	KAN (29%N) 50% + Urea 50%		1500	kg	0,30	kg	450,0
9.	Foliar feeding		6	kg	3,00	kg	18,0
10.	Pesticides						
11.	Meteor		30	g	0,20	€/L	6,0
12.	Irrigation						
13.	Energy for 3 ha	3	15	L	1,20	€/L	54,0
14.	Diesel fuel		90	L	1,20	€/L	108,0
15.	Maintenance of machinery		3	ha	19,00	€/ha	57,0
16.	Paid services			ha			
17.	Plowing		3	ha		€/ha	0
18.	Land preparation		3	ha		€/ha	0
19.	Sowing		3/		30,00	€/ha	90,0
20.	Harvest		3	ha	55,00	€/ha	165,0
21.	Paid seasonal workforce		46	r.sat	1,50	€/h	69,0
22.	Other variable costs						
23.	Cost of storage			€/t		€/t	0
24.	Transport to the customer			t		€/t	0
B)	Total Costs (3 to 24)						**1.227,0**
II	PROFIT/LOSS						
25.	Total with incentive (A – B)						**2.853,0**
26.	According to incentives (25 : 17)						**951,0**
27.	Cost price per kg of cereal grains (B : 1)						**0,0545**
28.	Economy of production (A : B)						**3,33**
29.	Profitability of income (25 : A) x 100						**69,92 %**

Source: Author's calculation based on data collected in the field

Achieved results: The average yield of wheat on farm B was 7.5 t/ha, and ranged from 7.0 t/ha to 8.0 t/ha.

Realized profit on 3 ha is €2853.00, production efficiency 3.33 and income profitability 69.92%.

Based on the presented results for the year 2021, we can conclude that the strategy of wool production on farms A and B is economically justified, financial indicators are given in the tabular presentation of wool production on medium-sized Ovar farm A and small Ovar farm B in Serbia (table 7).

Table 7: Economics of production of lambs for sale and wool on sheep farm A and B in Serbia for 2021.

ELEMENTS	FARM A	FARM B
Number of sheep on the farm	150	75
VOLUME OF PRODUCTION		
Total volume	6.750	3.375
According to the sheep	45	45
INCOME		
1. Sheep's wool	2.250	1125
2. Incentives for milk	0	0
3. Incentives for wraps. young man	3.000	1.500
4. Lambs for sale	13.500	6.750
5. Lambs for the overhaul of the herd (spike)	2.250	1.125
6. This milk	9.000	4.500
7. Manure	3.000	1.500
8. Exiled sheep	6.000	3.000
A. Total income	38.970	19.485
COSTS		
1. Food	12.000	6.000
2. Veterinary services and medicines	750	375
3. They will die	1.500	750
4. Human work	4.500	2.250
5. Energy and fuel	1.500	750
6. Depreciation of buildings and equipment	1.000	500
7. Other	800	400
B. Total costs	22.050	11.025
INCOME/LOSS		
C. On the farm	16.920	8.460
By the throat	112,80	112,79
Economy of production A:B	1,77	1,76
Profitability of production C:Ax100	43,42%	43,41%

Source: Author's calculation based on data collected in the field

Based on the presented result, we can conclude that the strategic production of lambs for sale and wool on farms A and B is economically justified.

Conclusion

Based on the analysis of the situation in our economy in 2021, and especially in the agricultural and livestock sector, specifically lambs for sale and sheep's wool, it is necessary to draw some conclusions when it comes to the approach to this type of production. This primarily refers to the food industry and the textile industry in Serbia.

The following conclusions were reached with this research: a more complex analytical overview of the conditions and results of the development of the food and textile industry of Serbia in the last two decades, a preliminary conceptual (re)definition and systematic classification of the included activities was required, as well as methodological problems of their informative monitoring.

Two branches of industrial production (textiles and agro-livestock), which are based on the processing of primary agricultural products, are connected in the supply chain, i.e. primary production on farms A and B (wheat, corn, barley, triticale and other fodder), and production of lambs Farms A and B are engaged in the sale of wool for the textile industry in Serbia, and around 700,000 agricultural farms bring in around 40% of the gross national product in Serbia. According to PKS data, about 2,700 tons of sheep's wool were produced last year.

The presented data show that the income from the products increased with the incentives covered the production costs and gave the rest of the income on the sheep farms A and B.

The total realized profit in the agricultural and livestock production on the farm A for 150 Merino sheep is EUR 22,340.8.

Production efficiency 1.77 and production profitability 43.42%.

Also on farm B, the total realized profit in the agricultural and livestock production plant for 75 Merino sheep is EUR 12,624.6. Production efficiency 1.76 and production profitability 43.41%.

References

1. Mičić I., Cvijanović D., Pešić V. (2018*)*. Экономика производства ягнятины в сербии, Российский государственный аграрный университет-МСХА имени К.А. Тимирязева Сборник трудов *Международной научно-практической конференции*, p. 126 -130.
2. Yusup A.Yuldashbaev, Maria I. Dongak, Ksenia A. Kulikova, Elena V. Pakhomova, Zhaziraim M. Abenova, Salbak O. Chylbakool, Milan P. Petrovic (2017). The modern state of sheep breeding in russia, Proceedings of the *11th International Symposium Modern Trends in Livestock Production* October 11-13, 201, p. 71- 78.
3. Saatchi, M., Miraei-Astiani, S.R., Zare Shahneh, A. (2010). *Comparison of Growth and feed-lot traits in Kordi crossbred and purebred lambs (crossbreeding between some Iranian fat-tailed breed)* Department of Animal Science Faculty of Agriculture University of Tehran.
4. Zapletal, D., Kuchtik, J., Dobes, I. (2010). The effect of genotype on the chemical and fatty acid composition of the Quadriceps femoris muscle in extensively fattened lambs. *Archiev Tierzucht*, 5, 589-599.
5. Kukovic, S., Németh, T., Lengyel, A., Toldi, G., Jávor, A. (2013). The Effects Of Genotype And Fattening Technology On Meat Producton Characteristics. *Lucrări Ştiinţifice-Seria Zootehnie*, 59, 11-15.

6. Cividini, S., Kompan, D., Ţgur, A. (2012). Carcass and lamb meat quality from improved Jezersko-Solčava flocks in Slovenia. *Europian Federation of Animal Science,* 131, 177-186.

7. Marina I. Selionova, Galina T. Bobryshova (2017). Sheep breeding economic, pluses and minuses Proceedings of the 11th International Symposium Modern Trends in Livestock Production, October 11-13, 8-9

8. Matsushita, M.,Cruz-Martin, Jr A., Marques-Gomes, S.T., de Asis-Fonseca de Macedo, F., Visentainer, J.V., Evalazio de Souza, N. (2010). Influence of slaughter weight on the proximate composition and fatty acid profile of feedlotfattened lamb meat. *Acta Scientiarum Technology,* 32(3) 315-318.

9. Pešić, V., Šaban, M., Vučinoć, S., Bistričev, E., Kadum, (2013): *Ekonomični aspetki na ustočivoto zemedelstvo proizvotstvo*. I.S.L.E. Selskostopanska Akademija, Avangad prima Sofija, p. 112.

10. Zaharia, R., Pascal, C., Zaharia, N., Albu, A., Radu-Rusu, R.M. (2013). The Influence Of The Growth System On Dressing Percentage And The Meat Quality Obtained From Turcana Lambs Bred In Montain Area In North-East Of Romania. *Lucrări Ştiinţifice-Seria Zootehnie,* 59,193-198.

11. Archimede, H., Pellonde, P., Despois, P., Etienne, T., Alexandre, G. (2008). Growth performances and carcass traits of Ovin Martinik lambs fed various ratios of tropical forage to concentrate under intensive conditions. *Small Rumin Res.* 75, 162-70.

INVESTIGATION OF THE EFFECT OF THE "NEW FORMULA" OF ZEOLITE ON THE QUALITY CHARACTERISTICS OF WINE ROOTSTOCK

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Abstract

In agricultural production, and in the specific case in viticulture production, the production of healthy food, that is the production of healthy plants and healthy and quality fruits, and especially the production of virus-free planting material, is still an actual problem. Global pollution has contributed to finding different innovative solutions in the production of healthy food and also in agricultural production and specifically in our trials in viticulture production, it is still very current of healthy and resistant plants and animals. In addition to the application of genetics and the selection of varieties, the choice of nutrition for the plant and the choice of soil improvers (part of the medium where the plant grows) are very significant in the problem.
In particular, our investigations are aimed at improving the properties of the soil during the cultivation of rootstocks (mother plants) in viticulture production. The tests were carried out in the period 2017 - 2019, in the Skopje Vineyard. Grapevine rootstocks introduced in the Republic of North Macedonia were randomly selected. A significant segment in this treatment is that our "new formula" of the mineral zeolite, which is currently being tested in our laboratory, was used. This agent has proven to be very safe for use as a preparation for improving the properties of the soil, and also as an effective agent for protecting and improving the resistance of the grapevine rootstocks to diseases and pests. The treated plants had a better habit and better resistance to external conditions. This preparation is very suitable for use in organic production.

Key words: rootstock, grapevine, zeolite, resistance

Introduction

In viticulture, it is very important to obtain grapes of high quality that will be used for direct consumption in human nutrition (table grapes) or will be used for the production of wine, alcoholic beverages and other grape products. It is also important that the grapevine, in addition to producing a quality crop, must be resistant to diseases, pests, weeds, too much drought, too much moisture, have a good relationship with the soil and be resistant to frost (low temperatures).

Bearing in mind that in European cultivated vines, almost every variety suffers from phylloxera (a condition established since the beginning of the 20th century), grapevine rootstocks from mother plants originating from American grapevine species that are resistant to phylloxera are used in viticulture production. Varieties from the European cultural grapevine are grafted onto them. With the help of genetics and selection, a large number of rootstocks resistant to phylloxera have been obtained, which are used for grafting grapevine varieties. These rootstocks are resistant and strong mother plants that allow the quality characteristics of the "softer" grafts from the varietal plants to come to the fore [1], [2] and [3].

In the global state of pollution, rootstocks are plants that are naturally quite resistant to diseases and do not require extensive application of protection agents that become dangerous under conditions of combined environmental pollution. But these parent plants need to have other quality traits and that; good affinity with varieties, certain lushness, good adaptation to soil and climatic conditions, calcium carbonate resistance, good seeding, resistance to drought and freezing, resistance to viruses, nematodes, etc [4], [5] and [6].

Therefore, the idea in this paper was to use a natural preparation based on zeolite, processed and with improved specific properties, which represents our "new innovative formula". The main goal was to improve the properties of the soil and to improve the quality and resistance (immunity) of the grapevine rootstocks [7], [9]. It will be a significant contribution to the reduction of the use of harmful preparations for plant protection and thus less pollution of the environment.

Material and methods

In this paper, several rootstocks that were introduced and cultivated in the Republic of North Macedonia were examined. The tests were carried out in the period 2017-2019 in the collection and experimental planting of rootstocks at the UKIM Agricultural Institute, Skopje. Two of the rootstocks were tested in an open field in vivo, and the other two were selected from the planted rootstocks grown in vitro in the experimental greenhouse at the institute. Varieties grown in outdoor conditions are Kober 5BB and Rupestris Du Lot, and varieties grown in indoor conditions are Fercal and Richter 110 [2], [3].

The investigation is moving in the direction of grapevine rootstocks grown in outdoor conditions, one part of them is treated with zeolite (T), and another part is not treated (U). Likewise, the grapevine rootstocks that were grown in indoor conditions, one part of them was treated with zeolite (T), and another part was not treated (U).

In particular, the following parameters were examined for the grapevines [3];

- an index of chlorinated salts that is based on the content of active limestone in the soil, which contributes to facilitating the availability of iron (easier assimilation of iron) and its correlation with chlorosis. The formula is as follows:

$$\mathbf{IPC} = \frac{\mathbf{Act.}\, \boldsymbol{C_aCO_3}}{\mathbf{Fe^2}} \times \mathbf{10.000}$$

- the resistance of the grapevines to moisture and drought,
- root strength, tolerance of saline soils,
- resistance to nematodes, etc.

In particular, the solution and the success of our trial are based on the application of the zeolite preparation (soil and foliar) on the grapevine rootstocks and the soil around them, in order to improve the properties of the soil and improve the quality of the seedlings [1], [2] and [3].

This formulation of the zeolite and its binding ability gives better availability of certain elements that are important in the nutrition of the plant (substrates) and together with the foliar treatment (as a supplement) gives the substrates good condition, durability and higher immunity.

Figure 1 Finished product

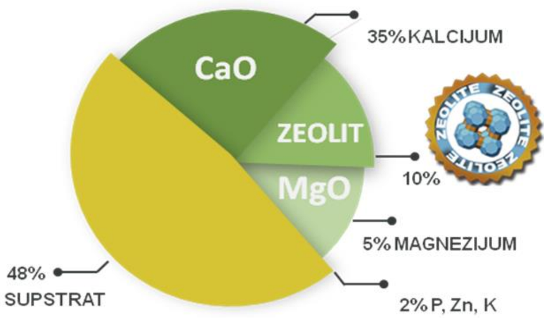

Figure 2 Schematic representation of chemical composition

The examined zeolite originates from the ore deposit near Kopaonik, R. Serbia presents a naturally very high-quality substance in powder, which with additional processing and treatment method is enriched with certain elements that serve to bond with other substances and form complexes (finishing in a plant in Skopje, R.S. Macedonia). The powdery substance is easily converted into agrogel and in a liquid state and is easy to apply. Our innovative formulation has a very favorable structure and good chemical composition, uniform porosity and moderate permeability [12].

The treatment with this zeolite in the given proportions and quantities is completely harmless and has a positive ecological effect on the environment [7], [8].

This innovative formula was examined for the first time in the Department of Pedology of the Faculty of Agricultural Sciences and Food in Skopje, and applications and forms for recognition and approval were submitted to the Ministry of Agriculture, Forestry and Water Management and the Ministry of Environment and Spatial Planning.

This preparation is managed under the proposed name GAIA - Terra Foster, and the laboratory analyzes of its chemical and physical properties are given in the following table;

Tab. 1 Results from characteristics improvement - GAIA –Terra Foster

Item no.	Parameter	Method	Received value	Declared value	Unit measure
Physical parameters					
1.	Moisture	MKC ISO8190:1992	1,12	/	%
2.	Mechanical composition (size in granules)	MKC ISO8397:2009	1 mm 98 min 0,25 mm 80 min	1 mm 98 min 0,25 mm 80 min	%
3.	*Shape	Organoleptic	powder form	Powder form	/
4.	*Color	Organoleptic	white	white	/
5.	*Smell	Organoleptic	no	no	/
6.	*Solubility in water	Organoleptic	very poorly soluble	poorly soluble	%
Chemical parameters					
7.	pH	MKC ISO13037:2011	10,78	/	/
8.	*$CaCO_3$	Volumetric ISO10693	83,31	/	%
9.	* Total CaO	Rulebook on inorganic fertilizers of R.M. no. 96 from 31.06.2009	35,80	35±3	%
10.	* Total MgO	Rulebook on inorganic fertilizers of R.M. no. 96 from 31.06.2009	5,08	5±1,25	%

** Unaccredited method*

The method of treatment is 3-4 treatments during the year on an open plot and the same number of treatments in a greenhouse. In the greenhouse, there can be one additional treatment if necessary. If the treatment is foliar - the first treatment is at the beginning of sprouting (beginning of vegetation), the second is when there is a large green mass in summer, the third is before the end of vegetation (September-October) and the fourth is after the end of vegetation (November-December) [10], [11].

Soil treatment requires a detailed physical-chemical analysis of the soil. Rates of 1 to 3 tons per hectare are commonly practiced.

But in our case, since already planted individual grapevines are treated, the need of zeolite is about 0,100 per seedling *in vitro* conditions to 0,400 kg per seedling outdoors *in vivo*.


3


4


5


6

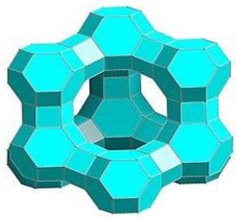
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Figure 3, 4, 5, 6 and 7 Different forms and natural structures of zeolite, our examined zeolite is in the first and fourth group (figures 3 and 6)

Results and discussion

Our innovation consists in the inclusion of highly active clay - zeolite, as a third building component, which is part of the preparation that also contains natural minerals: calcium carbonate (active component CaO) and magnesite (active component MgO). Compared to other available soluble fertilizers from foreign and domestic manufacturers, only this preparation is successfully dissolved in an agrogel variant, with all three active components in liquid form [4], [5] and [7].

The chemical composition of the preparation consists of: calcium carbonate (active component CaO>35%), magnesium carbonate (active component MgO>5%) and highly active clay - zeolite (up to 10%) and trace elements with a share of less than 1% [8].

The preparation is applied for foliar feeding of plants (foliar nutrition) by spraying, or a drop-by-drop system in a dose of 300-400 liters per hectare. This means that 4 kilograms or 2,5 liters of gel preparation is enough to feed plants on an area of 0,5 to 1 hectare. It can be applied to all plants (fruit crops, vegetable crops, cereals, industrial plants, flowers and ornamental plants, lawns and pastures). The time and method of treatment are specific for each plant species [8], [9].

As a soil improver, it is applied from 1 to 5 tons per hectare to the entire surface of the soil, depending on the degree of hardness and mechanical composition of the soil, for the necessary increase in pH value and depth of mixed soil before the basic, deep amelioration plowing which is carried out before planting [6], [11].

The active substances, calcium and magnesium, enter the construction of the porphyrin ring, which is an integral part of chlorophyll. It results in an increase in the transpiration coefficient, which leads to an average yield increase of 20%, depending on the genotype of the plant species. Highly active clay - zeolite, as is known from the literature, improves the physical and chemical composition of the soil and has an active role in binding hygroscopic water in the zone of the root system, which is desirable in conditions of soil moisture deficit. It also corrects soil acidity [6], [11] and [12].

The testing of this zeolite-based product was carried out by treating wild grapevine species that serve as rootstocks for grafting and are required to be of impeccable quality and high immunity to diseases and pests. The treatment was done on four types of rootstocks in outdoor conditions in the collection's mother plant and in indoor conditions in the Agricultural Institute, Skopje (Skopje vineyard) [1], [3].

The treatment included the following parameters in the grapevine rootstocks: index of chlorinated salts, resistance to active calcium, resistance to moisture, resistance to drought and resistance to nematodes [1], [3]. This zeolite formula with chemical reactions based on absorption and substitution contributes to the improvement of the previously mentioned parameters, and thus to the improvement of the chemical-physical properties of the soil and the plant. Zeolite with its constituent elements with a specific formulation – magnesium, calcium, silicon, some microelements and other substances contributes to the availability of iron, binds excessive ions in salts, corrects acidity and pH, cancels the harmful effect of active calcium, etc. All this leads to the reduction of certain negative reactions such as chlorosis, lack of chlorophyll, lack of iron, etc.

Also, the physical properties of the soil are repaired and water and nutrients, Oxygen and CO_2 become available to the plant. In this way, the rootstock has a good root mass, a moderate desired lushness of the leaf mass and becomes resistant to moisture, drought and diseases and pests [2], [3] and [10].

Table 2 shows the results of the examination of the index of chlorinated salts and the resistance to active calcium in untreated zeolite (U) and treated (T) rootstocks *in vitro* conditions. It can be noted that in almost all rootstocks treated with the preparation, there is an increase in the index (an increase in the index is favorable) and an increase in the resistance to active calcium, which is favorable for obtaining well-developed quality seedlings.

Table 3 shows the difference between untreated and treated rootstocks in *in vivo* conditions. In the case of treated grapevine rootstocks with zeolite, in several cases the grade has improved, i.e. the resistance of the rootstocks to excessive moisture, drought and nematodes has increased.

The increased resistance is based on the indirect effect of the preparation on improving the properties of the soil, and thus obtaining quality plants (grapevine rootstocks) with good root and leaf mass and resistant to diseases and pests. Quality, fitness (durability) and immunity are directly and indirectly improved in the treated plants [5], [9].

Table 2 Index of chlorinated salts (IPC) and resistance to active calcium

Rootstocks (2017 – 2019)	**IPC (Index)**		**Active calcium (Ca) resistance %**	
	U	**T**	**U**	**T**
Kober 5BB	40	45	20	24
Rupestris Du Lot	20	22	14	16
Fercal	120	125	40	45
R – 110	25	30	15	17

Table 3 Resistance to moisture, drought and nematodes (rating with a number)

Rootstocks (2017 – 2019)	**Moisture resistance**		**Drought resistance**		**Nematode resistance *(Meloidogyne sp.)***	
	U	**T**	**U**	**T**	**U**	**T**
Kober 5BB	3	4	1	2	1	2
Rupestris Du Lot	2	3	3	3	2	3
Fercal	2	3	2	2	3	3
R – 110	2	3	4	4	1	2

**T = Treated*
**U = Untreated*

Rating with a number: 1-weak, 2-average, 3-good, 4-very good

Figure 8 A large number of untreated rootstocks

Figure 9 Treated rootstocks

Figure 10 Untreated rootstock with chlorosis

Figure 11 Treated rootstock with good growth

Conclusions

The following can be concluded from the tests and the obtained results:

- Our innovation is characterized by the inclusion of highly active clay - zeolite and natural minerals - calcium carbonate (active component CaO) and magnesite (active component MgO). Compared to other available soluble fertilizers, this preparation has a good structure and size and successfully dissolves from a powdery substance into an agrogel variant and further into a liquid form.

- In all grapevine rootstocks *in vitro* treated with the preparation, there is an increase in the index of chlorinated salts and an increase in the resistance to active calcium, and this leads to a favorable utilization of iron and resistance to chlorosis, that is, obtaining well-developed quality and resistant seedlings.

- In *in vivo* conditions, in the grapevine rootstocks treated with zeolite, the grade has improved in several cases, i.e. the resistance of the rootstocks to excessive moisture, drought and nematodes has increased.

- The innovative formulation of zeolite has a very favorable structure and good chemical composition, uniform porosity and moderate permeability.

- The treatment with this zeolite in the given proportions and quantities is completely harmless and has a positive ecological effect on the environment.

References

1. Avramov, L. (1991).Vinogradarstvo. Nolit, Beograd.
2. BOURQUIN J.C, OTTEN L and WALTER B (1995): PCR RFLP analysis of Vitis, Ampelopsis and Parthenocissus and its application to the identification of rootstocks. Vitis 34 (2): 103108.
3. Božinović. Z., (2010). Ampelografija, Agrinet DOO, Skopje.
4. Galabov I, Hristov B, Simeonov K. (1991). Program & Abstracts, Zeolites ’91 (Int. Conf. Center, Havana, Cuba) (abstr.). p 147
5. Kovac G, Bartko P, Vrzgula L, Reichel R, Nistiar F, Mojzis J, Seidel H. (1995) in Natural Zeolites ’93: Occurrence, Properties, Use, eds Ming D W, Mumpton F A(Int. Comm. Nat. Zeolites, Brockport, NY), pp 459–466.
6. Lee, H., Shin, J., Choi, W., Choi, H.J., Yang, T., Zou, X. and Hong, S.B. (2018) "PST-29: a missing member of the RHO family of embedded isoreticular zeolites" *Chem. Mater.* 30, 6619-6623.
7. Morris, A.A., Bignami, G.P.M., Tian, Y., Navarro, M., Firth, D.S., Cejka, J., Wheatley, P.S., Dawson, D.M., Slawinski, W.A., Wragg, D.S., Morris, R.E. and Ashbrook, S.E. (2017). "In situ solid-state NMR and XRD studies of the ADOR process and the unusual structure of zeolite IPC-6" Nature Chem. 9, 1012-1018.
8. Mullins, M.G., Bouquet, A. & Williams, L.E., 2003. Biology of the grapevine. Cambridge University Press, Cambridge.
9. Petrovic A M. (1993). Program & Abstracts: Zeolite ’93: 4th International Conference on Occurrence, Properties & Utilization of Natural Zeolites, Boise, Idaho (Int. Comm. Nat. Zeolites, Brockport, NY) (abstr.). pp 162–164.
10. R Aiello Natural Zeolites ’93, eds D W Ming, F A Mumpton (Int. Comm. on Nat. Zeolites, Brockport, NY), pp. 589–602 (1995).
11. S M Robinson, T E Kent, W D Arnold, (1995) Natural Zeolites ’93: Occurrence, Properties, Use, eds D W Ming, F A Mumpton (Int. Comm. Nat. Zeolites, Brockport, NY), pp. 579–586.
12. Yuhas, B.D., Wilson, K.N., Sylejmani-Rekaliu, M., Mowat, J.P.S., Sinkler, W. (2019). "Crystalline metallophosphates, their method of preparation, and use", US Patent 10,336,622 B1.

- http://www.ecpgr.cgiar.org/Databases/Crops /Vitis.htm
- https://www.ncbi.nlm.nih.gov/books/
- http://www.vivc.de

- International Zeolite Association
- IZA Database of Zeolite Structures
- IZA Structure Commision.
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APPLICATION OF BIOLOGICAL WASTE OF THE FOOD INDUSTRY FOR ANIMAL FEEDING

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Abstract

Worldwide, the production of the food industry is constantly increasing, accompanied by an increase in generated waste. Rising disposal costs, stricter environmental regulations and community awareness have created a need to find sustainable alternatives for waste management. There are various opportunities to convert biological waste from the food industry into value-added products such as compost, fertilizer, biogas, medical products, animal feed, etc. The paper presents the method of applying bio-waste generated during the production of frozen food in food plants to produce concentrated animal feed.

Key words: Biological waste, sustainability, animal nutrition, concentrated nutrients

Introduction

Agro-food waste and by-products are generated in large quantities during plant food processing and represent economic and ecological problems due to the large volume and disposal costs. However, they show a huge potential to be valorized through their reusability in the food chain, (Mateos-Aparicio and Matias, 2019). Food processing operators are characterized by industrial processes that produce significant amounts of biodegradable waste that, according to the EU waste regulation, can be reused or recycled with favorable environmental impacts and an important economic impact.

The Law on Waste Management defines bio-waste as a category of biodegradable waste from gardens, parks, food, kitchen waste from households, restaurants, catering and retail establishments and similar waste from the production of food products, (the list of reference legal regulations, regulations, decrees and laws is given in the literature subsection). Biodegradable waste is biodegradable waste from gardens, parks, food, kitchen waste from households, restaurants, catering and retail establishments and similar waste from the production of food products, as well as the biodegradable part of municipal waste (including separately collected fractions). This waste does not include residues from forestry or agriculture, manure, or other biodegradable waste, such as natural textiles and separately collected paper. That is, biodegradable waste is any waste that can undergo anaerobic digestion or aerobic decomposition, such as food waste and garden waste, paper and cardboard. Biological waste is a part of biodegradable waste that represents biodegradable garden and park waste, food and kitchen waste from households, restaurants, other catering and retail facilities, as well as comparable waste from plant processing plants.

The reuse of bio-waste in the form of by-products in the food industry sector plays a significant role in the circular economy, a new concept of sustainability that aims to retain added value in products as long as possible and that strives to eliminate waste within the framework of the "zero waste" concept. production. The circular economy aims to reduce waste in all phases of the economic cycle and ensure that materials are used as efficiently as possible. Waste prevention is a central concept of the circular economy and challenges us to rethink the existing design, production, distribution and consumption of food products. For the food industry, the circular economy reduces costs, improves the supply chain of raw materials and offers opportunities such as new business models and markets, exploiting the value of materials that could previously be seen as waste, transforming them through better design into valuable new products or raw materials for subsequent production processes, chart 1. For individuals, the circular economy offers a sustainable way of life with a reduced impact on the environment and household savings.

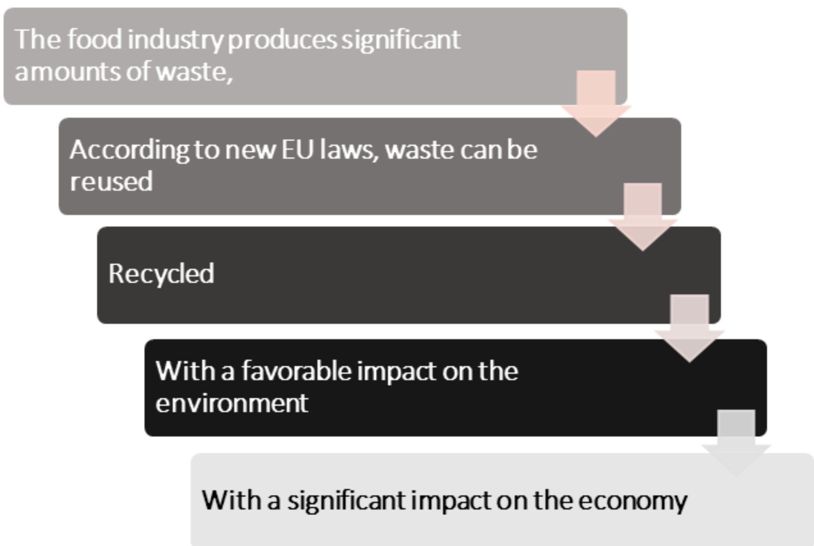

Chart 1 Sustainability of production in the food industry.

Several authors pointed to the valorization of food waste and niche products as a solution for improving the economic and ecological sustainability of the food production chain. Numerous valorization schemes have been proposed for researching the generation of bio-waste and by-products in order to define different bio-products, among them integrated value chains have been identified as one of the most promising ways to achieve the goal of zero waste and speed up the transition of the food industry to a circular bioeconomy, (Ribeiro et al. 2022).

The waste producer is obliged to ensure the application of the principles of the hierarchy of waste management, collect waste separately in accordance with the need for future treatment and store waste in a way that has minimal impact on human health and the environment. Each sub-sector of the food industry produces different types of bio-waste that can be treated or reused in different processes or industries. The presented activities in the paper show the generated bio-waste with the aim of the most convenient or advantageous reuse in accordance with the valid Waste Management Strategy of the Republic of Serbia and best practice.

Material and method

The research carried out for a year in the frozen food production facilities of the company Frikom doo consisted of: collecting data on the amount of bio-waste, its classification, application in practice and determination of various parameters, methods and economic justification of bio-waste processing, as well as the possibility of obtaining newly created value from biowaste in the form of secondary products.

Generated waste is classified into different categories according to the place of origin and composition. Each type of bio-waste is unique, and differs in several segments. The most important difference is in the percentage of SM, that is, the water content, table 1. In order to eliminate moisture from the generated bio-waste in order to include it in concentrate mixtures as a component, thermal treatment was applied.

Thermal processing of bio-waste vegetables was carried out in three ways: drying (Sušara Jevtić Resavica), dehydration ("Eko fungi" doo Padinska Skela) and lyophilization (Z.A. Fruit doo Valjevo, plant in Kosjerić), table 2.

Table 1 Content of SM and moisture in generated bio waste

Type of bio-waste	Moisture%	SM, %
Broccoli cube	94,88	5,12
Broccoli flower	88,74	11,26
String bean	88,98	11,02
A mixture of vegetables	88,14	11,86
Sweet corn, grain	72,00	28,00

Table 2. Experimental treatments of bio-waste

Drying treatments	Bio-material
Lyophilization	Cauliflower
	Broccoli flower
	Broccoli cubes
	Sweet corn
	Peas
	String bean
	Ice cream
Dehydration	Cauliflower
	Broccoli flower
	Broccoli cubes
	Sweet corn
	Peas
Drying	Peas
	Sweet corn
	Broccoli flower
	Broccoli cubes
	Cauliflower
	String bean

Results and discussion

Bio-waste is generated depending on the type of culture before the vegetable raw material enters the food factory, during purification, then in processing depending on the culture and after processing, where the pieces are separated, as well as when the cut product does not match the shape, size and color, while a smaller part of the waste is generated during the packaging process. Sorted "quality waste" can have a wide application, because it consists of vegetables: which do not meet their quality for processing, from processing which does not correspond to the standardization of the finished product, with expired shelf life, or which were converted into waste during manipulation with finished products in warehouse. In the work, the activities were focused on making concentrated mixtures for feeding animals from the generated bio-waste. The initial activities were the removal of water from waste vegetables by drying, dehydrating and lyophilizing. After heat treatment and loss of moisture, this vegetable represents an exceptional raw material as a component for preparing ready-made feed for animals. The use of such heat-treated waste in the preparation of ready-made feed for domestic animals was experimentally carried out at the company Agroprotein doo in Despotovac. A total of 16 different complete and supplementary mixtures for feeding domestic animals in powder and pellet form were produced.

Drying

Vegetable drying can be achieved with small investments and many high-quality products can be obtained, which are not subject to spoilage. Drying is the simplest and most natural way of all food preservation procedures, which preserves the freshness of the product by removing most of the free water from it. A lower level of water content slows down the rate of respiration, enzymatic reactions and the overall rate of decay, making the products more durable for storage as well as much easier and cheaper to store and transport (Babić, 2015).

Drying is the simplest and most natural method of all, which preserves the freshness of the product by removing most of the free water from it. The drying technology is different for each vegetable; from temperature to drying time. Also, the quality of dried vegetables depends on the type. Drying completely and permanently stops the activity of microorganisms.

Seven types of vegetables were experimentally dried: cauliflower cube, cauliflower, broccoli grits, broccoli, sweet corn, green beans, peas, pictures 1-2. After bringing the samples, the weight of all the samples was measured, and then they were distributed into boxes.

1

2

Pictures 1 and 2 Placement of bio material on drying racks

Drying took 12 hours. At the end of the drying process, it is necessary to turn off the dryer and open the door wide and leave the vegetables to dry slowly for another hour in order to protect them from burning. After drying, the dried samples were measured. The moisture content of dried vegetables was 4.5 - 10%, depending on the type of vegetables, tables 3 and 4. A total of 70 kg of fresh vegetables were dried in the dryer, the weight of which after drying was 8.35 kg, tables 2 and 3. done in a condensing dryer using the convective drying method (hot air drying). The dryer was intended for drying fruits, vegetables and medicinal herbs, with a capacity of up to 450 kg per filling based on raw plums. A 24 kW heat exchanger is used to heat the air in the dryer, in which there is hot water as the heating fluid, which is heated by a pellet boiler.

Table 3 Technical data of the dryer

Working P	The power of the heating element	Installed power	Numbe r of les	Capacity per raw material					
				Plums	Mushro oms	Corn	Broccoli	Cauliflo wer	Peas
m²	kW	kW	Pieces	Kg per filling					
26	24	1	63	450	100	220	220	200	250

Table 4 Drying of vegetable bio-waste from Frikom

Parameters	Bio-material						
	Cauliflower	Cauliflower cube	Broccoli	Broccoli grits	Peas	Sweet corn	String bean
Quantity before drying (kg)	9.300	9,700	6,500	9,600	9,400	9,800	4,500
Quantity after drying (kg)	0,560	0,565	0,585	0,830	2,230	3,190	0,400
Drying temperature (°C)	45-55	45-55	45-55	45-55	45-55	45-55	45-55
Drying time (h)	12	12	12	12	12	12	12
Moisture content of dried biomaterial 4.5 - 10 %							

Dehydration

Dehydration is a type of vegetable drying where vegetables are dried evenly at a temperature of around 45°C while preserving all enzymes and vitamins. Before dehydration, vegetable bio-waste must be thawed. Due to the different content of dry matter, each type of vegetable is dehydrated separately in the dehydrator. A total of 245.4 kg of frozen vegetables were brought for dehydration, the weight of which after thawing was 224 kg. After dehydration, the weight of the vegetables was only 39.18 kg. Dehydrated vegetable bio-waste: sweet corn, peas, cauliflower florets, broccoli cubes and broccoli florets. Figures 3-5 show the preparation of vegetables for dehydration, while table 5 shows the results of vegetable dehydration.



3 4 5

Pictures 3-5 Preparation of vegetables for dehydration and appearance of dehydrated sweet corn grain

Table 5 Results of dehydration of bio-waste vegetables

Vegetables	Frozen/thawed (kg)	After dehydration (kg)	Randman	Product description
Sweet corn	68,80 / 68,10	20,40	3,37	Compact grain, beautiful color, pleasant smell
Peas	50,00 / 46,10	10,70	4,31	Compact grain, beautiful color, pleasant smell
Cauliflower flower	40,30 / 32,20	2,48	12,98	Compact flower, beautiful color, pleasant fragrance
Broccoli cube	50,80 / 44,50	2,65	16,79	Nice color, pleasant smell
Broccoli flower	35,50 /33,10	2,95	11,22	Nice color, pleasant smell

Lyophilization

The lyophilization technique was invented in 1906 by Frenchmen A. d'Arsonval and F. Bordas. This process enables the water contained in the food to be transformed in a short time from a liquid state to a solid state (ice), then directly to a gaseous state (steam) until complete evaporation, without passing through the liquid phase by sublimation. Lyophilization is freeze drying, it is a dehydration process at low temperatures - water is removed from the frozen state by sublimation of ice under vacuum. The result is a product that is almost identical to the fresh product in terms of chemical composition, aroma, color and shape. The main advantage is the significantly extended shelf life of food, preservation of quality, as well as the availability of freeze-dried food throughout the year.

– Stevanović, (2018), states the advantages of lyophilization: It enables the preservation of a large part of the organoleptic qualities of food, and the taste remains very similar to fresh products;

– Maintains the nutritional quality of food: protein losses are less than 5%, and vitamin C losses are around 10%;

– Due to the loss of water, food after lyophilization is up to 10 times lighter than before, which makes transportation much easier, and a refrigerator is not required for their preservation;

Most freeze-dried foods hydrate very quickly thanks to their porous texture. In fact, lyophilization does not cause a significant reduction in volume, water can therefore easily return to its place in the molecular structure of the food.

In our country, the company that produces lyophilizers is "Mikromotors" doo from Belgrade. Their lyophilizer is located in the fruit processing company "Z.A.Fruit" doo Valjevo, whose lyophilization plant is located in Koceljevo. The capacity of the lyophilizer is about 200 kg, depending on the type of vegetables, Figure 8-9.

Vegetables were used for lyophilization: broccoli semolina, sweet corn, peas, green beans, cauliflower cube, small cauliflower and broccoli, Figure 6-9. Also, lyophilized animal cream is bio-waste from ice cream production.


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Pictures 6 -9 Frikom bio-waste lyophilization process

The total amount of vegetables and cattle cream was 82.44 kg, and after the lyophilization process, the weight was 11.3 kg, table 6.

Depending on the type of vegetable, the content of SM after lyophilization in vegetables was about 96%.

Table 6 Results of lyophilization of vegetables

Input raw material	Input quantity (kg)	Amount received (kg)	Randman
Broccoli grits	10,24	0,49	20,90
Sweet corn	12,5	3,54	3,53
Peas	12,5	2,67	4,68
String bean	10,0	0,82	12,20
Cauliflower	8,8	0,58	15,17
Cauliflower cube	10,1	0,48	21,00
Broccoli flower	7,1	0,60	11,80
Livestock cream	11,2	2,15	5,20
TOTAL:	82,44	11,33	

Concentrated food for feeding animals

Animal nutrition technology involves the processing of ingredients and the production of animal feed. It is an integral part of the animal breeding system to provide high-quality and nutritious feed, with the aim of transforming low-quality ingredients into higher-value food components and improving the utilization of nutrients (A.F.B. van der Poel et al., 2020).

Replacing edible crops used for human consumption with inedible biomass in animal nutrition is a potential strategy that could reduce competition for food for humans and mitigate the impacts of animals on the environment (Salami et al., 2019). The costs of many standard animal feeds limit their use in many countries, and producers are turning to alternative feed sources that can meet energy and protein requirements for reproduction and rearing (Blache et al., 2008).

Concentrated nutrients are characterized by a higher content of energy and protein per unit mass. Compared to the group of bulky nutrients, the fiber content is much lower. They also have a low water content. They are particularly important in the diet of non-ruminants, but depending on the production phase, they are necessary for ruminants. The high production of meat and milk in ruminants requires the appropriate addition of concentrate to the bulk basis of the meal. Also, with growing necks whose protein needs have increased, the use of concentrates is inevitable. This group of nutrients includes granular concentrates, by-products of the food industry and ready-made concentrate mixtures.

By-products of the food industry enable the maximum utilization of food resources, where after the production of products for human consumption, the remaining material is used in the nutrition of domestic animals. Among the more important nutrients of this group are by-products of the mill industry (cattle flour, bran, sprouts), by-products of the oil industry (cakes and pellets of various oilseeds), as well as by-products of the sugar industry, alcohol, etc. Figures 10-13 show the concentrated nutrients with bio-waste from Frikom that has been previously treated by drying, dehydration or lyophilization.


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Pictures 10-13 Concentrated nutrients with bio-waste from Frikom

A total of 16 different complete and supplementary mixtures for feeding domestic animals in powder and pellet form were produced. The resulting concentrated nutrients are:

1. Complete mixture for growing and fattening lambs up to 15 kg
2. Complete mixture for growing and fattening lambs II from 15 to 30 kg
3. Complete mixture for growing and fattening lambs III from 30 to 50 kg
4. Complete mixture for cows milking more than 20 liters of milk per day
5. Complementary mixture for dairy cows
6. Complete mixture for fattening cattle I of 250-350 kg
7. Complete mixture for fattening cattle II over 350 kg
8. Complementary mixture for beef fattening

9. Complete mixture for growing and fattening calves III of 100-250 kg
10. Enriched herbal mixture
11. Enriched herbal mixture for roe deer game
12. Complete mixture for piglets I up to 15 kg
13. Complete mixture for piglets II from 15 to 25 kg
14. Complete mixture for growing and fattening pigs from 25-60 kg
15. Complete mixture for growing and fattening pigs II of 60-100 kg
16. Complementary mixture for fattening pigs

The obtained complete, supplementary and enriched mixtures are of exceptional quality, well mixed and combined with other components, with a selling price of the product that is lower compared to products of the same category without waste vegetables. The drying process is the most profitable because the costs of drying are the lowest, while the costs of lyophilization are much higher and it is not economically profitable to lyophilize waste vegetables. Also, it was observed that by mixing lyophilized vegetables with other components for animal feed, the obtained mixture is not completely homogenized because the lyophilization process is performed at low temperatures where the water from the vegetables is removed from the frozen state by ice sublimation under vacuum.

Conclusion

The waste producer is obliged to ensure the application of the principles of waste management hierarchy, collect waste separately in accordance with the need for future treatment and store waste in a way that has minimal impact on human health and the environment. Currently, the food industry is trying to reduce the amount of waste material produced during the production cycle. There is increasing interest in the commercial use of various generated by-products during various production processes.

Animal feed production has a social responsibility to contribute to more sustainable food production systems. Understanding the structures and functional properties of food components, their replacement with different primary and secondary treatments of generated bio-waste in the food industry, is of essential importance for more precisely meeting the nutritional requirements of animals and preserving the environment.

Gratitude

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References

1. A.F.B. van der Poel, M.R. Abdollahi, H. Cheng, R. Colovic, L.A. den Hartog, D. Miladinovic, G. Page, K. Sijssens, J.F. Smillie, M. Thomas, W. Wang, P. Yu, W.H. Hendriks,2020. Future directions of animal feed technology research to meet the challenges of a changing world, Animal Feed Science and Technology, Volume 270,114692,ISSN 0377-8401,
2. Babić, Prof. Dr Ljiljana, 2015. Sušenje i skladistenje biomaterijala. Poljoprivredni fakultet Novi Sad
3. Blache Dominique, Shane K. Maloney, Dean K. Revell,2008. Use and limitations of alternative feed resources to sustain and improve reproductive performance in sheep and goats, Animal Feed Science and Technology,Volume 147, Issues 1–3,Pages 140-157,
4. Ivetić Aleksandra, Bojan Stojanović, Vesna Davidović, Milivoje Ćosić, 2022. The use of biowaste as a silage by-product for sustainable food and feed production. 26th International Eco-Conference, 12th Safe food, Ecological movement of Novi Sad, Matica srpska, Novi Sad, Serbia
5. Mateos-Aparicio I., A. Matias, Chapter 9 - Food industry processing by-products in foods, Editor(s): Charis M. Galanakis,The Role of Alternative and Innovative Food Ingredients and Products in Consumer Wellness,Academic Press,2019,Pages 239-281,ISBN 9780128164532
6. Pravilnik o kategorijama, ispitivanju i klasifikaciji otpada, „Službeni glasnik RS“, broj 56 / 2010
7. Pravilnik o kvalitetu hrane za životinje„„Službeni glasnik RS“, broj 4 / 2010
8. Pravilnik o načinu razvrstavanja i postupanju sa sporednim proizvodima životinjskog, sporednim proizvodima životinjskog porekla, veterinarsko-sanitarnim uslovima za izgradnju objekata za sakupljanje, preradu i uništavanje sporednih proizvoda životinjskog porekla, načinu sprovođenja službene kontrole i samokontrole, kao i uslovima za stočna groblja i jame grobnice, „Službeni glasnik RS”, broj 31/11
9. Pravilnik o uslovima za razvrstavanje i utvrđivanje kvaliteta sredstava za ishranu bilja, odstupanjima sadržaja hranljivih materija i minimalnim i maksimalnim vrednostima dozvoljenog odstupanja sadržaja hranljivih materija i o sadržini deklaracije i načinu obeležavanja sredstava za ishranu bilja (Službeni glasnik RS, broj 30/17, 31/18)
10. Pravilnikom o uslovima za razvrstavanje i utvrđivanje kvaliteta sredstava za ishranu bilja, odstupanjima sadržaja hranljivih materija i minimalnim i maksimalnim vrednostima dozvoljenog odstupanja sadržaja hranljivih materija i o sadržini deklaracije i načinu obeležavanja sredstava za ishranu bilja, „Službeni glasnik RS, broj 30/17, 31/18“
11. Ribeiro Tânia Bragança, Glenise Bierhalz Voss, Marta Correia Coelho, Manuela Estevez Pintado,Chapter 33 - Food waste and by-product

valorization as an integrated approach with zero waste: Future challenges, Editor(s): Rajeev Bhat, Future Foods, Academic Press,2022,Pages 569-596,ISBN 9780323910019

12. Saheed A. Salami, Giuseppe Luciano, Michael N. O'Grady, Luisa Biondi, Charles J. Newbold, Joseph P. Kerry, Alessandro Priolo, 2019.Sustainability of feeding plant by-products: A review of the implications for ruminant meat production,Animal Feed Science and Technology,Volume 251,Pages 37-55,ISSN 0377-8401
13. Stevanović, Snežana. Prednosti liofilizacije kao savremenog načina sušenja. Zbornik Međunarodnog kongresa o procesnoj industriji – Procesing, [S.l.], v. 31, n. 1, p. 141-146, june 2018
14. Strategija upravljanju otpadom za period 2010-2019, "Sl. glasnik RS", br. 29/2010
15. Strategija uvođenja čistije proizvodnje u Republici Srbiji, "Sl. glasnik RS", br. 55/05,71/05, 101/07 i 65/08
16. Zakon o integrisanom sprečavanju i kontroli zagađivanja životne sredine, "Sl. glasnik RS", br. 135/2004 i 25/2015
17. Zakon o sredstvima za ishranu bilja i oplemenjivačima zemljišta, „Službeni glasnik RS, broj. 41/09“
18. Zakon o bezbednosti hrane, "Službeni glasnik RS", broj 41 od 2. juna 2009, 17 od 14. marta 2019

DEBT COLLECTION RISK MANAGEMENT IN DOMESTIC AGRICULTURAL ENTERPRISES

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Abstract

Companies often end up in a situation where they have difficulties with the debt collection, both because of the insolvency of customers and because of their conscious intention to avoid payment. In order to minimize losses, companies manage the risks of debt collection.
The aim of the paper is to find out which methods and strategies are used by domestic agricultural entities to avoid or minimize the risk of crediting customers.
The data were collected using a semi-structured interview method, and were presented through a qualitative content analysis. The sample, which includes 12 companies from the agribusiness sector, was formed by random selection.
The results from the references suggest that it is expedient to check the client's history, define credit limits, monitor the client after the transaction, negotiate payments in difficult conditions, factoring, etc., before executing a purchase transaction. Empirical results revealed that domestic agricultural companies mainly manage the risk of debt collection, and the most common methods are minimizing credit risk, checking the client's history through specialized portals, obtaining information from other farmers, acquaintances, from the bankruptcy register and other sources, before concluding the transaction. Also, the results showed the importance of monitoring the customer's solvency after the transaction.
A key recommendation is for businesses to continue background checks on potential customers, which is especially important among agricultural businesses. Let's note that there are companies that still do not use sufficiently effective strategies for mapping and protection against customer credit risks.

Key words: *management, risk, claim, agricultural enterprises.*

Introduction

A large number of companies go bankrupt or are liquidated every day, because they fail to fulfil their obligations to creditors. Also, insolvency i.e. non-payment of debtor's obligations causes and increases the risk of creditors' bankruptcy. Every company has a unique credit risk profile and it depends on the clients and the business environment (Davydenko, 2013; Sarić, 2019).

Identification of sources of risk is a fundamentally important activity on which the realization of better financial effects depends. Financial risk arises with lending money (Kuzman et al., 2017), but the collection of receivables can also be a risk.

Potential insolvency, as well as the risk of longer illiquidity exists, if customers are given longer payment terms. In this regard, it is very important to have up-to-date information about potential customers. The ability of the customer to pay for the product in accordance with the contract can be assessed in advance. This information allows the management to make a decision on the volume of the clients' loan, define the length of the payment period, as well as the accompanying conditions. Although credit providers and specialized agencies can provide this information, businesses can also conduct background checks on their own, using publicly available data. The collected data can help create a picture of the client's credit profile (Lišanin et al., 2019). Although credit history data is quite easily available today, the occurrence of debt collection problems is still present.

Collecting basic credit information about clients helps creditors avoid potential losses, due to client insolvency or their conscious intention to avoid payments.

In agriculture, the share of business transactions has intensified, which imposes the provision of claims against the business partner, and therefore the risk of collecting claims is greater (Storbacka et al., 2009). Practice shows that companies cannot completely avoid credit risks, which is why it is necessary to map them, objectively evaluate and mitigate them, in order to avoid major losses. Managing receivables today requires more effort than ever before. Despite the importance of long-term business relationships between partners, participants in buying and selling relationships increasingly analyze information about better business opportunities and therefore change business partners more often (Milošević, 2014). The issue of credit risk has mostly been studied only in the context of the credit risk of commercial banks, but relatively little research has been done in the context of the collection of receivables from business entities.

In order for mutual transactions to be successful, it is important to formulate a credit policy, and for the company to have the best possible overview of where its money is at all times. It is extremely important to minimize risks in the credit policy towards customers. Credit risk is a potential situation in which the other contractual party is not able to make a payment, which it is contractually obliged to make.

Credit risk in the context of receivables management

Credit risk arises from the fact that companies sell their products in large quantities and to a large number of intermediaries. Credit risk is the inability of the borrower to settle his obligations, that is, not to settle them on time or after maturity (Andersson et al., 2001; Spasojević, 2013). This paper deals with credit risk in the context of corporate receivables management. Receivables imply an investment from which the company does not generate income, and a change in their level affects the profitability of the company. Longer payment terms and the liberalization of lending conditions increase the turnover of companies, but this situation creates a risk that the debtor company will not be able to settle its obligations to the creditor due to a slow inflow of funds or non-receipt of funds based on its own business (Milošević, 2014; Stančić and Čupić, 2020). Finished goods are sold to customers on credit, which causes a delay in receiving money. Therefore, it is necessary to identify the buyers' ability to settle their obligations, that is, the debtor's risk (Vučičević, 2012).

Credit risk arises because borrowers expect to use future cash flows to repay current debts. It is often a problem to ensure that the borrower has the funds to service the receivables due (Zhao et al., 2008).

Due to the increasing share of business transactions in agriculture, this paper focuses on the risk of non-payment based on purchase-sale business activities.

The risk of customer insolvency is an important factor in overall risk management. The widespread use of trade loans by less creditworthy enterprises was revealed by the study, which focused on risk factors in the choice of trade loans. The study confirmed a positive relationship between the risk-taking incentive and the degree of riskiness of the trade credit, which the company provides to all its clients with a high probability of default. This suggests that the customer default risk represents an important economic source of total risk between suppliers and companies (Cuñat and Garcia, 2012).

Crediting customer meets the needs for goods, which cannot be afforded in the case of sales with immediate payment (Kovačević, 2013). The credit risk that arises between companies most often arises from the sale of goods on credit, which is why the emerging risk is actually a commodity credit risk (Dragosavac, 2014). Commodity credit risk consists, first, of the risk represented by the customer, that is, the intermediary of goods or services, where the creditor has no information about whether the client fulfills his obligations. Another part of the commodity credit risk is the buyer's restrictions, that is, the credit limit, which applies to each buyer. The third is country's risk, which refers to international risks, i.e. credit risks that should be dealt with when trading in international frameworks (Spuchľáková et al., 2015).

In the case of merchandise credit, the terms of payment are sales by installments and sales by fixed-term invoice. If an invoice with a deadline has been issued, the goods will be delivered to the customer upon completion of the sale and payment will be made in a one-time payment on the specified day. In the case of payment in installments, the buyer assumes responsibility for the goods during the purchase transaction and undertakes to pay the installments periodically. The number of installments and payment terms are often agreed between the parties and depend on the quantity of goods and the buyer's ability to pay. A contract for payment in installments may contain a condition for the payment of a mandatory down payment for all types of loans (Kovačević, 2013).

When determining the extent of credit risk, it is important for the company to identify the type of credit risk and to focus on what is involved in granting trade credit and how to prevent, assess and, if necessary, mitigate potential risks (Spasojević, 2013).

The option of eliminating the risk of debt collection would imply not selling on credit. At the same time, it reaches a smaller number of customers, because many companies do not have the resources to pay for goods or services immediately. A more realistic option is to sell goods or services with the approval of a loan. There is a risk that the customer will not pay on time. At the same time, customers are more willing to buy goods or services on credit. Due to business development, the possibility of risk inevitably increases, so it is necessary to thoroughly map and assess credit risk (Gonçalves et al., 2016).

In the management of the risk of debt collection, companies apply different models and strategies. Most models require expertise and data about potential clients (e.g. company reports, financial statements, market prices of securities, payment history, etc.). When assessing credit risk, it is important to have as accurate information as possible about a potential partner. This helps to make a better credit decision.

A key factor in credit risk management is the ability to apply diversification rules. The diversification rule asserts that a base of a client with multiple loans is less risky than a base of a client with one loan. A business with more than one client has less risk, because if one client defaults on their part of the contract, the business has other options to recover from. Credit analysis should focus on the facts and present them as clearly and accurately as possible, and the experience and understanding of the client before the transaction is certainly important. The results of credit analysis are used to make a decision on loan approval (Brown and Moles, 2014).

Most credit risk management tools fall into the category of internal strategy, which is based on five factors (Woods and Dowd, 2008):

- *Background check* is the oldest and basic tool for managing exposure to potential credit risk.
- *Credit limits:* individual credit limits are set for each counterparty. These limits can be "soft" or "hard". The former can sometimes be compromised, while the latter must not be exceeded at any cost.
- *Monitoring:* Companies should always monitor their credit exposure, as well as that of other counterparties. Monitoring systems should send warning signals when the counterparty reaches or exceeds the level of credit exposure.
- *The set-off procedure* ensures that if one party does not comply with the agreement, the amount owed is calculated on a net rather than a gross basis.

- *Credit improvement techniques* include periodic repayment of outstanding debt; adjusting margin and collateral requirements and making arrangements to allow for additional collateral payments if one party suffers a credit loss; obtaining a credit guarantee from third parties; mutual agreement to terminate the contract, when the credit rating of one party reaches a critical level.

In order to manage the risk of debt collection, companies also pay attention to insurance. Some companies "sell" their receivables to third parties (factoring). This has two main drawbacks, namely that the transaction is expensive and that by leaving debt collection to an aggressive third party, companies may risk losing customers (Ivaniš, 2013, Dittman, 2016). When managing credit risk in companies, the application of letters of credit or advances is determined. A letter of credit is an internationally used method of payment, which implies an irrevocable payment obligation and is completely independent of the sales contract (Mastilović, 2019). Unfortunately, these instruments come with limitations, which determine how much customers are willing to buy. Letters of credit are also expensive (the client can spend ~ 3% per transaction) (Dittman, 2016).

Research goal, methodology and sample

The aim of this paper is to find out what methods domestic agricultural entities use to mitigate the risk of crediting customers, that is, how they manage the risks of debt collection, whether they cannot be collected at all or there is a delay in collection, as well as accompanying problems that can threaten the liquidity of creditors.

A qualitative method is used to compile and analyze a semi-structured interview, with which we investigate the risk management of debt collection in domestic agricultural enterprises.

In April 2022, interviews were conducted via e-mail with persons responsible for finances in selected agricultural enterprises, which were included in the sample using the random selection method. Contact was also established through a telephone conversation, and additional information was obtained. The interview consisted of 13 open questions.

The sample, which eventually included 12 agricultural companies (n = 12), was formed by members of the Chamber of Commerce of Vojvodina and the Chamber of Commerce of Belgrade. Although the sample was relatively small, the results suggest the outlines of debt collection risk management strategies in domestic agricultural enterprises.

Research results

The first three questions sought to reveal characteristics of the customer base, such as: the size of customer base, origin of customers, and proportions of private and business customers. The companies in the sample were quite similar in terms of customer base. Eight companies have a customer base ranging from

0-100. Three companies have a customer base ranging from 101-500, with only one company reporting more than 500 customers. There were fewer foreign than domestic buyers. There were companies with only a few foreign customers. Five companies sell goods only to domestic customers. In contrast, one company has a fairly large share of foreign customers. Most of the customers were business clients. At six companies, all customers were business clients. One of them commented that they were all business customers, while in reality there were a few private clients as well. In other companies, the share of business customers is in the range of 75-90%.

All companies from the sample sell their products or services on the basis of an invoice or credit. Payment terms vary from 7, 14, 30 or 60 days depending on the company. The production activities of the companies in the sample are very different. Cereal production, milk production and processing, meat industry, animal feed production, etc. are represented. One company has a customer, who is engaged in agricultural production, who buys seeds and a payment term has been agreed with them, when agricultural subsidies are received. There may even be a 6-month payment period. Also, most buyers get a payment deadline, and new buyers initially pay in advance, as do some who are bad at paying, either from experience or market information. The same is done with companies with bad credit history. There were also companies that never used advance sales or had no such need in recent years.

There was also a company that sold its products under contract. Prices are constantly determined based on stock market prices and products are sold as needed.

All companies were strongly dominated by long-term customers. Three companies had only long-term customers. In the others, the share of long-term customers ranged from 70-90% of the total customer base. There were businesses with several new customers per year. On average, 1 or 2 new business partners are added each year, which are usually one-time deals.

Checking the customer's history, before the transaction, is quite current among the selected companies. As can be seen from graph 1, eight companies or 67%, perform customer verification before making a transaction. One company pointed out that it is engaged in researching information about new customers on the Internet. Since most of their customers are engaged in agriculture, it was possible to get information from other farmers as well. This company has been engaged in agriculture for a long time, and they have a large number of acquaintances in their circle from whom it is possible to obtain additional information. There was also a company that checks the history, but it is unnecessary, because most of their customers are large companies that they have been working with for a long time.

Four companies or 33% do not check customer history. The reason was that the experience of working with customers is so great that they know them, i.e. know their current business situation.

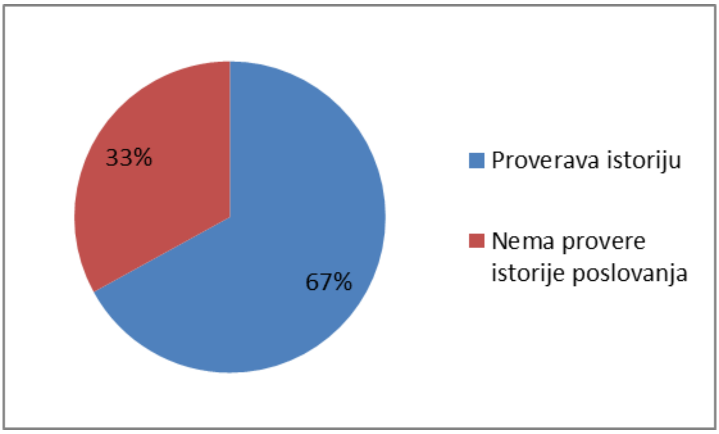

Chart 1. Conducting a customer history check before making a transaction

History checks focus on a company's financial performance and payment behavior. Of the economic indicators, three companies checked the profit, share of own capital, share of liabilities in the balance sheet. One company checked the ratio of current assets and current liabilities, as well as the number and size of real estate.

Four companies also examine debt information before starting a transaction. Tax debts are mostly monitored, but there were also companies that investigated debts owed to other companies. Two companies considered it important to know the background history of the manager or director, which companies the board member was previously associated with, and whether he has any obligations in relation to previous companies.

Chart 2 shows the main sources of information about companies. Six companies are looking for information on company background check portals. Three companies obtained the necessary information from acquaintances. Information is exchanged within the sector and obtained from those who have previously completed transactions or been in contact with the respective client.

Two companies are also constantly checking the information from the bankruptcy register to see whether the companies have debts. Four companies obtain the necessary information from other sources. The necessary information could also be obtained from tax authorities, from annual reports, employee statements and other official announcements. As for private buyers, the main source of information was the Facebook page.

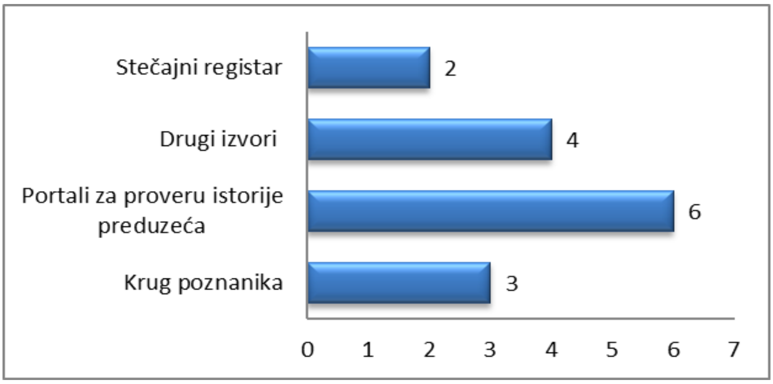

Chart 2. Sources of basic customer information

Most interviewees stated that information about other businesses is relatively easy to access. Three businesses responded that since they do not require a background check, they cannot give an accurate answer about the availability of information. A website could provide such information for a business, but it costs money and they don't want it (it's not worth it). Besides, it was not believed that it would be possible to get valid information from the portal. However, one company felt that it was generally possible to obtain information, but availability was average, as different sources had to be used, although all information could be obtained from one place.

Six companies or 50% (chart 3) follow-up on customers even after the transaction has been completed. Among the monitoring tools, one company noted that it had ordered a monitoring service. Three companies do not follow-up the business situation of their partners after the transaction at all. The reason given was that there were no such large transactions with unknown partners that it would make sense to spend time on them. Also, three companies follow-up customers as needed. They don't follow-up on all customers, but if there is a late payment, they will still investigate the reason for the delay.

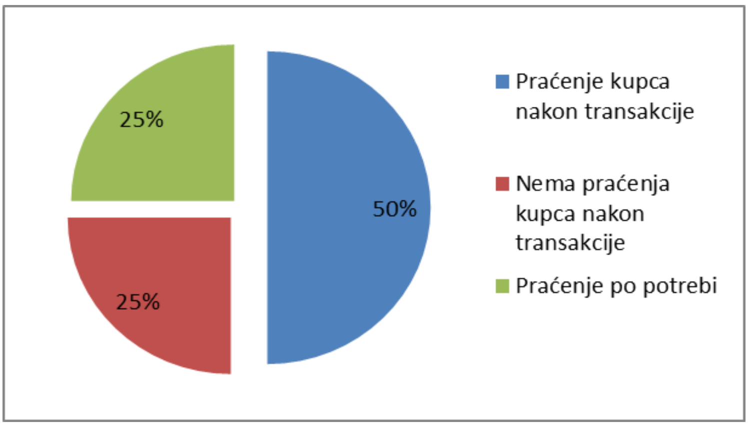

Chart 3. Follow-up of clients after the transaction has been completed

All the interviewed companies have delays in the collection of invoices. As many as seven companies have it regularly and have to constantly deal with it. Three companies have delays, but not to a significant extent. In one of them, several customers do not pay their bills and these claims do not discourage them, because the customers are small and the amounts are insignificant. One company responded that they still have delays, but clients usually notify them before the payment deadline, so they can then take the delays into account. There was also a company, which in 25 years lost money on only one account, and the loss due to the collection of receivables is not significant for other companies either. However, the main problems of debt collection remained in the last century.

Finally, we asked company managers whether they believe that credit risk is higher for private or business clients and what is the reason for this. They provided very different answers. There were managers who thought business clients were riskier. Private clients were considered to be at risk with personal assets and therefore more cautious. Three companies considered that the biggest risk is with smaller business clients. One of them pointed out that there are constantly new clients, traders and restaurants, some of which manage to develop a business, some of which do not. Another noted that some of these small businesses had been liquidated during the year or were in financial difficulties, but had not noticed the malicious non-payment of invoices.

A company representative pointed out that people in rural areas are quite honest, so there are less chances of fraud. One company believed that the risk of debt collection was higher with private customers, because their business was difficult to verify. One interviewee told us there was no risk of debt collection, but thought the issue was certainly important to retailers.

Key finding, discussion and suggestions

Conducting background checks on potential buyers is a fairly common debt collection risk management strategy among domestic agricultural businesses. Most companies check the business of new customers.

It is recommended that companies continue to check the history of potential customers, and those companies that have not yet adopted this method should certainly do so.

When assessing the ability to settle due claims, attention should be paid to the balance sheet, income statement and cash flow statement. It must, of course, be kept in mind that the company's balance sheet characterizes only a certain moment and therefore does not allow to determine with great certainty the current situation and the customer's ability to pay. Therefore, in addition to financial statements, it is very important to take into account other information, such as the age and reputation of the company.

Based on the collected data, the company's ability to properly settle all its obligations and maintain stable operations in the foreseeable future can be assessed, that is, a solvency assessment can be made (Čavlin et al., 2021).

The income statement provides an overview of the company's net profit or loss for a specific period. A cash flow statement shows cash inflows and outflows. As a rule, the cash flows of the business must be positive, i.e. the business must bring money to the company, otherwise the survival of the company, and even its disappearance, may come into question (Čavlin et al., 2021).

Also, the experience of the members of the board of directors and their previous activities is important. It is important to investigate the history of the manager, in order to know if the person has debts in the past or was involved in a failed business. Today, there is a very current happening in the Republic of Serbia, where an entrepreneur shuts down a company or freezes business activity due to debt. This means that it is not active and no annual reports are submitted. However, the company's debts are written off and the malicious company has the opportunity to start the same scheme with a new company.

Farmers emphasize the honesty of people and companies in rural areas, so it seemed that there was less risk of collecting claims from such companies, but we were not given concrete evidence. Comparing private and business clients, it was pointed out that lending to business clients is riskier and that potential risks must be well mapped and carefully managed.

In some situations, although rarely, factoring is used as a means of reducing the risk of debt collection. Among the companies in the sample, only one mentions factoring, but there are other companies that use this service in their daily business.

Careful monitoring of existing clients is certainly a very effective strategy to protect against the risk of debt collection. Monitoring customers after the transaction allows the company to find out in the shortest possible time about the problems that have appeared with the customer, which may affect his ability to settle his obligations to the creditor. In Serbia, tracking existing customers is relatively simple through the company's business verification portal. The portals allow companies to be registered in case of account blocking, and the creditor can request to be notified of changes regarding the customer, either by e-mail or through the appropriate application. However, it can be concluded from the answers that companies with a smaller turnover more efficiently obtain information about the business of customers through business cooperation. For many businesses with lower profits, it is too expensive to invest in portals, which provide customer information.

Asking for advance payment from new clients can also be mentioned, to a small extent, as a strategy to manage the risk of debt collection. This approach provides initial security until the customer is better acquainted with.

Conclusion

One of the cornerstones of successful and efficient business is minimizing the risk of debt collection. The risk of collection of due receivables is present, especially if new clients are included, without first checking their way of doing business.

Most domestic agricultural enterprises manage the risk of debt collection. It was observed that these risks are generally higher for legal entities. Private clients are more responsible for their assets and therefore do not want to take big risks.

As an interesting result, it turned out that a quarter of the respondents do not follow the payment status of their business partners after the transaction. They state that they will collect more detailed information and monitor the customer's payment status only if there are problems with the payment.

The most common method of credit risk management is checking the client before concluding the transaction. The necessary information is usually available on the Internet.

Sources of information are also APR (Commercial Register Agency), tax department, cadastre, various web portals, which have information about companies. Necessary information is also obtained from acquaintances and long-term business partners.

All the interviewed companies have delays in the collection of invoices. There were those where delays occur regularly and rarely, as well as those where occasionally there are longer delays in collection.

The results also revealed the importance of following up with customers after the transaction. Most of them feel that it is important to know how their client is doing after the transaction and how likely they are to receive money from him.

One of the proposals is to deepen the verification of the business history of potential customers. When assessing the ability to pay, you should definitely pay attention to the balance sheet, income statement and cash flow report, etc. However, background research should not be limited to financial statements. It is certainly worth looking at the history of the manager or board member. It may be important to look at the business relationships with current management representatives of potential customers / clients, and also to investigate where they have been engaged before and how they were listed there.

References

1. Andersson, F., Mausser, H., Rosen, D., Uryasev, S. (2001). Credit risk optimization with conditional value-at-risk criterion. *Mathematical programming,* 89 (2), 273-291.

2. Brown, K., Moles, P. (2014). *Credit Risk Management: Part 1 Introduction to Credit Risk Management Process and Techniques*. Edinburgh: Edinburgh Business School.

3. Cuñat, V., Garcia-Appendini, E. (2012). Trade credit and its role in entrepreneurial finance. Oxford handbook of entrepreneurial finance, 526-557. https://www.vicentecunat.com/TC%20Chapter_OUP.pdf (16.04.2022).

4. Čavlin, M., Vapa-Tankosić, J., Miletić, V., Ivaniš, M. (2021). Analysis of the impact of liquidity on the profitability in the medium and large meat

processing enterprises in the Republic of Serbia. *Economics of agriculture*, 68 (3), 789-803. https://doi.org/10.5937/ekoPolj2103789C

5. Davydenko, S. A. (2013). *Insolvency, illiquidity, and the risk of default*. Joseph L. Rotman School of Management, University of Toronto.
6. Dittman, J.P. (2016). Protect against bad debt risk. What companies need to know about trade credit risk and insurance. https://upscapital.com/wp-content/themes/upscapital/assets/uploads/DebtProtectionEbook.pdf (16.04.2022).
7. Dragosavac, M. M. (2014). Teorijski koncept upravljanja kreditnim rizikom. *Škola biznisa*, (1), 108-116.
8. Gonçalves, T. S., Ferreira, F. A., Jalali, M. S., Meidutė-Kavaliauskienė, I. (2016). An idiosyncratic decision support system for credit risk analysis of small and medium-sized enterprises. *Technological and Economic Development of Economy*, 22 (4), 598-616.
9. Ivaniš, M. (2013). Faktoring – savremeni oblik finansiranja preduzeća. *Ekonomija: teorija i praksa*, 6 (1), 55-77.
10. Kovačević, R. (2013). Uticaj trgovinskih i bankarskih kredita na svetski izvoz. *Bankarstvo*, 42, 12-35.
11. Kuzman, B., Prodanović, R., Subić, J. (2017). *Risk and uncertainty management in agricultural holding*, in monograph: Risk in the food economy – theory and practice, The Polish and the EU Agricultures 2020+ Challenges, Chances, Threats, Proposals, pp. 133-147, Eds. dr Justyna Góral, dr Marek Wigier, Institute of Agricultural and Food Economics National Research Institute, Warsaw.
12. Lišanin, T. M., Maglajlić-Kadić, S., Drašković, N. (2019). *Principi prodaje i pregovaranja*. Sveučilište u Zagrebu, Ekonomski fakultet, Zagreb.
13. Mastilović, J. (2019). Značaj dokumentarnog akreditiva i razgraničenje u odnosu na druge poslove međunarodnog bankarskog prava. *Pravo - teorija i praksa*, 36 (1-3), 98-108.
14. Milošević, M. (2014). Upravljanje rizikom likvidnosti, *Bankarstvo,* 1, 12 - 29.
15. Sarić, S. (2019). *Problemi upravljanja rizikom u savremenim uslovima poslovanja*. Doktorska disertacija, Fakultet za ekonomiju i inženjerski menadžment, Novi Sad.
16. Spasojević, J. (2013). Kreditni rizik i kreditni derivati. *Bankarstvo,* 1, 104-137.
17. Spuchľáková, E., Valašková, K., Adamko, P. (2015). The credit risk and its measurement, hedging and monitoring. *Procedia Economics and finance*, 24, 675-681.

18. Stančić, P., Čupić, M. (2020). *Korporativne finansije*. Ekonomski fakultet, Kragujevac.

19. Storbacka, K., Ryals, L., Davies, I. A., Nenonen, S. (2009). The changing role of sales: viewing sales as a strategic, cross-functional process. *European Journal of marketing*, 43 (7/8), 890-906.

20. Vučičević, D. (2012). Teorijski aspekti i osnovne postavke finansijske analize. *Škola biznisa*, 82-96.

21. Zhao, J., Barry, P. J., Katchova, A. L. (2008). Signaling credit risk in agriculture: implications for capital structure analysis. *Journal of Agricultural and Applied Economics*, 40 (3), 805-820.

22. Woods, M., Dowd, K. (2008). Financial risk management for management accountants. http://www.cimaglobal.com/Documents/ImportedDocuments/cid_mag_financial_risk_jan09.pdf (09.05.2022).

SUSTAINABILITY AS THE INITIATOR OF RURAL DEVELOPMENT IN REPUBLIC OF SERBIA

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Abstract

Nowdays, the modern tourist market is characterized by the orientation towards non - standard tourist products. With the changes that have taken place, the demand for alternative forms of tourism is growing, where rural tourism takes significant place. Mass tourism has greatly contributed to the environmental pollution, degradation of natural landscapes, destruction of agricultural lands, and everything that would have negative impact on rural areas. The subject of this paper is an analysis of the base of rural areas development in the Republic of Serbia, role and importance of sustainable development in primary agricultural production and other activities that take central place in rural tourism. In addition, there will be analyzed limiting factors that may discourage rural development of our Republic. The aim of this paper is to point out the importance of applying the sustainability concept as a precondition for the development of rural areas, especially rural tourism as an important initiator of development of these areas.

Key words: Rural areas, sustainable development, sustainable agriculture, limiting factors, Republic of Serbia.

Introduction

Rural areas of Serbia are characterized by a large concentration of natural resources, such as agricultural land, forests, water, with preserved ecosystems and biodiversity. Natural and cultural resources, along with human resources, represent the most significant elements of the rural base of Serbia (Cvijanović et al., 2016). Unfortunately, mass tourism has greatly contributed to environmental pollution, the degradation of natural landscapes, the destruction of natural resources, the reduction of agricultural areas, especially meadows and pasture complexes, and everything that has had a significant negative impact on rural areas. Therefore, numerous efforts are being made to avoid the negative consequences of tourist flows and to raise awareness, as well as responsibility in the protection of rural areas, and the willingness of tourism policy actors to provide a new "chance" to these areas. A special place is occupied by the concept of multifunctionality of resource use and multifunctional agriculture, which start from an integral approach to the entire rural area from one and the definition of several important functions (agricultural - productive, ecological, cohesive, recreational, residential and cultural). (Milanović et al., 2008)

In today's conditions, the modern tourist market is characterized by an orientation towards non-standard tourist products. Namely, mass tourist movements and saturated markets are being replaced by personalization and a focus on the special interests of tourists. With the changes that have occurred, the demand for alternative forms of tourism grows, among which rural tourism occupies an important place.

Rural tourism is not based on encouraging mass arrivals, but is focused on an exclusive target market that needs a vacation that offers something different, distinct and specific (Tyrväinen et al., 2001). Since ancient times, rural areas have attracted people for rest and recreation (Ružić, 2012). At the same time, rural tourism represents a significant factor in the development and revitalization of rural areas (Hrabovski Tomić, 2008). Rural tourism includes staying in rural areas, in such a way that tourists make contact with nature, become familiar with the culture and traditions of the destination where they are staying and participate in the activities of the local population (Njegovan, 2016). Rural tourism is one of the most important components of development, not only tourism, but integral and sustainable development as a whole (Čomić, 2002) and is considered not only a type of tourism, but also a kind of instrument for the development of rural areas (Sorensen, Epps 1996).

The subject of the work is the analysis of the basis of the development of rural areas of the Republic of Serbia, the role and importance of sustainable development within primary agricultural production and other economic and non-economic activities that occupy a central place in rural tourism. In addition, limiting factors that can have a disincentive effect on the development of rural areas of our Republic will be analyzed. The aim of the work is to indicate the importance of applying the concept of sustainability as a prerequisite for the development of rural areas, especially rural tourism as an important driver of the development of these areas.

Overview of the basis for the development of rural areas in the Republic of Serbia

According to the traditional approach in Serbia, rural areas include 70% of the total territory with 43% of the total population (Cvijanović et al., 2009). According to the Organization for Economic Cooperation and Development (OECD), rural areas comprise 85% of the territory of the Republic of Serbia, whereby the OECD defines a threshold of 150 inhabitants per km² when classifying a certain area as a rural area.

The Republic of Serbia has an extremely rich resource base for the development of rural tourism. Favorable geographical position, wealth of natural resources, offer the possibility of affirming Serbia as a rural tourism destination on the tourist map. The wealth of natural resources is an advantage for the development of rural tourism, but there is also a considerable number of potentials that have not been sufficiently utilized. The key products of rural tourism are numerous farms in the area of Vojvodina, ethnic villages, rural and tourist households, while national parks (Fruška gora, Đerdap, Tara and Šar - mountain), rich hydrography and large waterways (Danube, Drina), mountain massifs (Zlatibor, Kopaonik, Zlatar, Valjevske planine, Golija), specific forms of cultural-historical (Old Town Ras) and natural heritage (Diavolja Varoš) represent the main tourist attractions in rural areas.

Serbia represents a country of diverse and preserved nature, with many elements of attractiveness and representativeness, with a development priority in the direction of ecological and rural tourism, which has a great chance on the discerning international market (Petrović, 2014). It is known that the existence of natural and anthropogenic resources in rural areas is not a sufficient condition for the development of rural tourism (Škorić, 2013), they actually constitute a comparative advantage, but what essentially makes competitiveness on the tourism market is the ability to use the available resources in an efficient way in the long term in the function of tourism, i.e. end consumers, i.e. tourists on the one hand and residents on the other (Tasić, 2018).

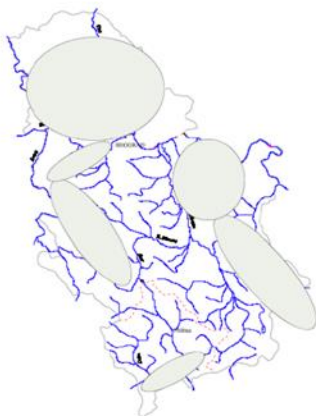

Figure 1. Areas where rural tourism development activities are carried out in Serbia

Source: Cvijanović, D. (2014), Tourist market in the Danube region, Institute of Agricultural Economics, Belgrade, p. 144.

According to the Tourism Development Strategy of the Republic of Serbia for the period 2016 - 2025 ("Official Gazette of RS", No. 98/2016), great geographical diversity (lowlands, hilly and mountainous areas), wealth of natural and anthropogenic resources, multi-ethnic population, indicate that rural areas and more intensive development of tourism could play a key role in the future economic development of the Republic of Serbia, while the Rural Tourism Development Program in the Republic of Serbia ("Official Gazette of RS", no. 85/2011) points out that rural tourism is already developed in some parts of the Republic of Serbia, primarily in Western Serbia, Vojvodina and Central Serbia. These are good examples of how rural tourism can diversify the rural economy and open up new opportunities for employment and income generation for rural households. This shows that rural tourism can empower small farmers and enable them to offer their products directly to tourists.

Sustainable agriculture and limiting factors of the application of the concept of sustainability in rural areas

Agriculture, which is traditionally the most represented activity of the rural economy, has a special role within the concept of sustainable rural development. The concept of sustainable agriculture was extended to sustainable agricultural and rural development (SARD concept) (Stojanović, Manić, 2009). Agriculture and tourism are fundamentally very connected and interdependent. Quantitative changes in tourist traffic (number of tourist arrivals and overnight stays, average length of stay in the destination and similar indicators) determine the dynamics of tourist consumption, and therefore the consumption and production of agricultural and food products included in the tourist offer (Tomić, 2008). Agriculture is one of the oldest human activities, and rural tourism is one of the youngest activities that is developing more and more, both in the world and in Serbia. The importance of the agricultural sector and the analysis of its competitiveness can be understood from the fact that the participation of agriculture in the economy of Serbia is at a relatively high level. As a rule, it ranges between 15 and 20%, depending on the year (Đurić, Njegovan, 2016). The link between agriculture and tourism can provide a basis for solving many problems that characterize rural areas. Agricultural production, preservation of agricultural resources and development of rural tourism as a supplementary activity of people living in the countryside should be one of the most important goals of rural development (Petrović, Grujović, 2015). Benefits based on the integral development of agriculture and tourism, that is, their mutual connection, have been observed all over the world, especially in those types of tourism that include specific agricultural and food products in their offer (Ristić et al., 2019). According to the Agriculture and Rural Development Strategy of the Republic of Serbia for the period 2014 - 2024 ("Official Gazette of RS", No. 85/2014), the Republic of Serbia has 5.06 million hectares of agricultural land, of which 71% is used for intensive way (in the form of arable land, orchards and vineyards), while 29% of agricultural land is made up of natural grasslands (meadows and pastures), and as obstacles to more efficient use of land potential, fragmentation and fragmentation of land holdings, lack of infrastructure, lack of favorable credit conditions, inadequate tax policy, social insecurity of landowners (landowners do not have a secure job, pay a small tax on agricultural land, so they do not want to sell it), unfinished property restitution proceedings and relatively long probate proceedings.

Table 1. Number of farms and areas under different crops and categories according to the size of the agricultural land used in 2018

Variable	**Area/hectare**	**Number of farms/number**
	Total	**Total**
Available agricultural land	5178692	564540
Arable land and gardens	257150	491125
Fallow land	9145	7989
Meadows and pastures	676724	246774
Orchards	182923	270890
Vineyards	20466	60228
Used agricultural land	3475894	559252
Unused agricultural land	289953	109115

Source: Republic Statistical Office (RZS), downloaded on May 27, 2022, from: https://www.stat.gov.rs/

It can be seen from the attached that the Republic of Serbia has appropriate available resources, which refer, first of all, to sufficient agricultural land, meadows, pastures and all other variables that constitute a prerequisite for inclusion in agricultural activities. It is considered that agriculture in rural areas is an important factor in the development of rural tourism. In order to enable the permanent development of agriculture, appropriate assumptions must be met, and they are reflected in the possession of agricultural land, favorable climatic and other factors crucial for the development of agriculture, but the existence of a favorable market and economic environment. In the field of rural tourism development, a very important place is occupied by sustainable agriculture, which is based on ecological principles, and the emphasis is on the production of healthy food.

Ecological agriculture has great chances of integration into the economy of the rural area, not only because of tourism, but also because that area does not have great opportunities for the development of other economic activities, so it is necessary to give priority to every activity that can be carried out in order to make the rural area as better valued. On the territory of Serbia, the conditions for the development of ecological or health-safe agricultural production are met, and its area is marked by exceptional agroecological differences, that is, the possibilities of different agricultural production and processing (Cvijanović, Ružić, 2017). Although the planning documents of the Republic of Serbia state guidelines for the revitalization of villages and rural ambient units, as well as the fact that the documents of the Ministry of Agriculture, Forestry and Water Management in the Republic of Serbia established a network of 15 regional centers intended to provide support to rural development and agriculture, unfortunately, the Republic Serbia does not have a precisely defined legal framework that defines integral and health-safe agricultural production, while the market for health-safe products has not yet been developed.

Bearing in mind the natural resources, favorable land and climate conditions, biodiversity and relatively healthy agro-ecosystems, it can be said that in the Republic of Serbia there are favorable conditions for the development of integral and organic production. The Republic of Serbia does not have a developed legal framework that defines integral agricultural production, but its great importance and potential is recognized (Strategy of Agriculture and Rural Development of the Republic of Serbia for the period 2014 - 2024 ("Official Gazette of RS", no. 85/2014) In the development of rural tourism, permanent limitations can be observed, such as the departure of young people to the cities, the reduction of agricultural areas, urbanization, the lack of motivation of the local population and service providers to engage in rural activities. The mentioned problems are the result of a lack of knowledge and information. Staff education is from of great importance in creating an authentic product, and providing high-quality service in rural tourism of the Republic of Serbia.

In order to ensure the quality of rural tourism, management must follow three threads in designing a successful strategy: sustainable tourism development, development of exceptional indigenous products and supporting infrastructure, and development of a fund of well-trained and trained people (Baum et al., 2001), it is about concepts of formal and informal education that are complementary and that should not be separated, because their combination achieves better effects in the development of tourism. Training and education are essential in the development of rural tourism, especially in the initial phase of development (Vujović et al., 2012). Agricultural education in the Republic of Serbia is at an unenviable level, and in addition to six faculties and a number of specialized institutions that deal with issues in the field of agriculture, the transfer of knowledge from researchers to agricultural producers is generally at a low level (Strategy of Agriculture and Rural Development of the Municipality of Vrnjačka Banja 2014 - 2024).

It is necessary to strengthen agricultural services, in order to adequately inform farmers about new technologies, which need to be applied in production and processing processes, and especially to do so in a sustainable manner. The development of rural tourism should ultimately lead to an increase in the employment of all members of tourist households, on the one hand, and to provide additional income for those already employed, on the other hand.

Trainings and education take place on several levels. Trainings are necessary for individuals involved in relevant positions at the local level. With appropriate knowledge and skills, these individuals are well positioned to train other individuals at an operational level (Popescu, 2013). It is important to develop awareness among service providers in rural tourism, in order to adequately provide service and meet the expectations of visitors, local residents, but also potential, current and future visitors about the potential of the area, and their activities, respecting the principles of sustainability, during their stay in rural area.

There are many opportunities for quality improvement in rural tourism. They mainly refer to the quality of accommodation, infrastructure and superstructure, the diversity of the tourist offer related to the rural tourism product and the training of all interested parties for the development of rural tourism (Campón - Cerro et al., 2017).

One of the biggest problems of rural tourism development is financing. In order to allocate adequate financial resources in a timely manner, achieve satisfactory results, and ensure the necessary control over the use of these funds, an efficient way of managing the development of rural tourism in the Republic of Serbia is necessary (Radović, 2015).

It is essential to point out the importance of mutual cooperation and coordinated and harmonized action between all the bearers of rural development and other actors interested in the development of rural tourism, from the state, which will pass stimulating laws, economic and agrarian policy measures, educational institutions, national, regional and local tourism organizations, cooperatives, chambers of commerce, local self-governments, associations, local residents and tourists. In that domain, it is important to precisely define the current position and the desired state, and then who, how and in what way will achieve the long-term goals of the development of rural areas in a sustainable way.

Sustainability and its role in the development of rural areas of the Republic of Serbia

The concept of sustainable development is one of the basic concepts of the economics of natural resources and the environment (Milanović et al., 2008). The principles of sustainability refer to the natural, economic and socio-cultural aspects of tourism development, and an appropriate balance must be established between those three dimensions in order to guarantee its long-term sustainability (Jegdić et al., 2013).

The basic principles of sustainable rural development are: environmental principles, which implies respect for the natural diversity of the destination; social principles, that the development of tourism does not destroy the cultural diversity and local natural and anthropogenic wealth of rural destinations, as well as the negative impact on those forms of tourism that negatively affect society as a whole; the cultural principle, which implies the development of authentic forms of tourism with the promotion of the cultural heritage of the area, and the economic principle, which encourages traditional local occupations, local production of products and services and more significant employment in order to prevent the migration of the local population to cities and abroad (Popesku, 2011).

In other words, the sustainable development of rural areas and therefore rural tourism must be economically justified, while the natural, social and cultural characteristics of that rural destination must be preserved.

Comprehensive rural development implies demographic renewal, the use of available resources for the production of healthy and safe food, the development of other economic and non-economic activities that have a comparative advantage in relation to the environment, the development of the overall infrastructure, education, preserving the culture of the area and ecological access to the destination. It is important to develop small agricultural farms, create small and medium-sized enterprises, especially in agricultural and food production, stimulate the transformation of agricultural farms into rural tourist households, encourage other service activities (Veselinović, Ignjatijević, 2013).

Considering the socio-economic problems that a large number of European countries have, it is understandable why rural tourism at the end of the twentieth and the beginning of the twenty-first century became the subject of both experts and businessmen, as well as state administrations (Cvijanović, Ružić, 2017). Rural tourism is an ecological trip to relatively preserved areas for fun, relaxation and enjoyment of nature and is based on the principles of sustainable development and direct contact of tourists with nature and aims to improve life, the environment and create conditions for performing other economic activities (Radović et al., 2018). The World Tourism Organization (UNWTO) defines rural tourism as a form of tourism that includes any tourist activity in rural areas, organized and managed by the local population, relying on local tourist resources and tourist facilities (Đorđević - Milošević, Milovanović, 2012). Rural tourism includes activities in rural areas and implies effective management of the unique resources of rural tourist destinations (Bjeljac, Lović, 2012). Support is also represented by the local population, which increasingly accepts rural tourism as a development opportunity (Mair et al., 2005). Local communities should actively participate in the development process, but also have a control function, i.e., the development of rural tourism should be based on the management process, because this will ensure long-term sustainability (Gajić et al., 2020).

Rural tourism is often associated only with tourism in rural areas and the performance of agricultural activities, however, in the genesis of the concept of rural tourism, it is important to include other activities that complement the stay in rural areas, and are related to staying in nature, participating or enjoying the manifestation and festival in traditional style, production and sale of handicrafts, participation in the activities of the local population and others, making the tourist experience more meaningful and rich.

Rural tourism includes all forms of tourist activities in rural areas, not only those that can be strictly linked to the farm or can be defined as agro-tourism (Thibal, 1988). The term rurality is a specific tourist attraction in itself. Tourists in rural areas are looking for high quality and untouched environment, peace, silence, sometimes solitude, as well as special kindness and contact with the host, which can be provided by agrotourism as the core product of rural tourism (Cawley, Desmond, 2007).

Rural tourism is similar to the concept of sustainable tourism, but it is a narrower concept than sustainable tourism. Rural tourism implies sustainable, ecological, economic and social development, because it represents the preservation of all those values, which are for the benefit of future generations (Janković et al., 2017). Rural tourism is tourism that is based on the principles of sustainable development and direct contact of tourists with nature and aims to improve living conditions, protect the environment as a factor of recreation and rehabilitation, create conditions for performing other economic activities, increase the stability of the working-age population and enable migration in the opposite direction, from urban to rural areas (Loureiro, 2012). Many authors point out that the development of the Rural Tourism Strategy should be based on ecological, economic and social sustainability. (Roberts, Hall, 2003). Diversification of the rural economy in a socially, economically and ecologically sustainable way is necessary in order to improve the quality of life, reduce the level of poverty, and fight against social and ecological degradation. Tourists have increasing demands, and the goal of the tourism industry is to meet their expectations (Master plan for sustainable development of tourism in Serbia).

The development of tourism in the countryside, in an unpolluted natural environment, with a pronounced individualization of tourist demand and its significant focus on non-standard tourist products, represents one of the bases for applying the concept of sustainable tourism development (Cvijanović, 2014).

The sustainable development of rural tourism should be an integral part of the overall strategy for the development of tourism in rural areas, in the way that visitors have a highly developed awareness of the potential of the areas they visit, while at the same time participating in the processes of rural development, with their activities that are in line with the protection and preservation of the natural environment, that is, the management of the destination's resources, controlled and according to the principles of sustainability.

Conclusion

Sustainable development should be an integral part of every economic economy, because this is the only way resources will be used, in such a way as to bequeath to future generations the wealth and beauty of natural landscapes and contribute to the improvement of rural development in already established areas, but also in those with insufficiently discovered areas. and utilized potential. The creation of an authentic rural product is a complex task, and it requires coordinated action at the level of the entire country, because only through such action to increase the quality of the tourist experience and the socio-cultural environment, it is possible to achieve the goals, which will make rural tourism a useful activity for all participants, and to eliminate all the negative influences that the Serbian traditional village is burdened with.

The Republic of Serbia has a rich resource base and a material base for the development of rural tourism, with all its advantages in terms of natural resources, ethnic villages, rural tourist households, cultural and historical settlements, a large number of villages, rich traditions, folk customs, complemented by the warmth and kindness of the hosts. has the potential to develop an authentic product in rural tourism. However, in addition to positive aspects, there are also limiting factors in the affirmation of the Republic of Serbia as a destination for rural tourism, and they relate to inadequate training of the carriers of the tourist offer and all actors in the development of rural areas, lack of financial resources, inadequate management of resources, irrational use natural resources, insufficient information and a precise legal framework on the advantages of carrying out agricultural activities in a sustainable way, but also the lack of qualified labor.

The development of tourism, significantly more than other activities, depends on the quality of the environment and natural landscapes, therefore, its connection to nature is more significant. To a large extent, the development of tourism leaves implications for the natural environment, the degradation of natural landscapes, the reduction of agricultural areas, thus providing resistance to the development of all forms of tourism, and to a large extent rural tourism. The impacts of tourist flows on rural areas are very complex, and relate to ecological as well as socio-cultural and economic components. Only the analysis and consideration of all three components gives a realistic picture of the real impact on rural areas.

References

1. Baum, T., Wahab, S., Cooper, C. (2001), Education for Tourism in a Global Economy, 198-212, in Wahab, S., Cooper, C., *Tourism in the Age of Globalisation*, Rothledge, Taylor and Francis Group, London and New York.
2. Bjelac, Ž., Lović, S. (2012), Ruralni turizam u Banatu, *Prvi stručni skup o ruralnom turizmu i održivom razvoju,* Kragujevac 8-18.
3. Campón - Cerro, A.M., Hernández-Mogollón, J.M., Alves, H. (2017), Sustainable improvement of competitiveness in rural tourism destinations: The quest for tourist loyalty in Spain, *Journal of Destination Marketng & Management*, 6(3), 252-266.
4. Cawley, M., Desmond, A.G. (2007), Integrated Rural tourism: Concepts and Practice, *Annals of Tourism Research*, 35(2), 316-337.
5. Cvijanović, D. (2014), *Turističko tržište u Dunavskom regionu*, Institut za ekonomiku poljoprivrede, Beograd.
6. Cvijanović, D., Katić, B., Kljajić, N. (2009), Rural development in Serbia – regional dissimilarities and problems, *The economic and social conditions of the develepoment of the Polish food economy following Poland's*

accession to the European Union-Multi-Annual Programme 2005, 128, 107-120.

7. Cvijanović, D., Mihailović, V., Vukotić, S. (2016), *Marketing i konsalting u funkciji razvoja turizma Srbije,* Institut za ekonomiku poljoprivrede, Beograd.
8. Cvijanović, D., Ružić, P. (2017), *Ruralni turizam,* Fakultet za hotelijerstvo i turizam u Vrnjačkoj Banji, Univerzitet u Kragujevcu, Vrnjačka Banja.
9. Čomić, Lj. (2002), Ruralni turizam u Srbiji – mogućnosti i perspektive, *Časopis departmana za geografiju, turizam i hotelijerstvo u Novom Sadu,* Novi Sad, 119-120.
10. Đorđević - Milošević, S., Milovanović, J. (2012), *Održivi turizam u funkciji ruralnog razvoja – mala poljoprivredna gazdinstva i ruralni turizam u Srbiji,* Fakultet za primenjenu ekologiju Futora, Univerzitet Singidunum, Beograd.
11. Đurić, K., Njegovan, Z. (2016), *Ekonomika poljoprivrede,* Poljoprivredni fakultet, Novi Sad.
12. Gajić, T., Petrović, M.D., Radovanović, M.M., Tretiakova, T.N., Syromiatnikova, J.A., (2020), Possibilities of turning passive rural areas into tourist attractions through attained service quality, *European Countryside,* 12(2), 179-192.
13. Gašić, M., Perić, G., Ivanović, V. (2015), Razvijenost ruralnog turizma u Republici Srbiji, *BizInfo,* 6(2), 71-81.
14. Hrabovski Tomić, E. (2008), *Selektivni oblici turizma*, Fakultet za uslužni biznis, Sremska Kamenica.
15. Janković, M., Luburić, V., Šofranac, R. (2017), Održivi turizam kao osnova upravljanja nacionalnim parkovima u Crnoj Gori, *Ekonomika,* 63(4), 27-46.
16. Jegdić, V., Škrbić, I., Milošević, S. (2013), Specifičnosti planiranja održivog turizma, *Tims Acta,* 7, 153-162.
17. Loureiro, S.M.C. (2012), *Tourism in ruural areas: foundation, quality and experience. Visions for Global Tourism Industry – Creating and Sustaining Competitive Strategies*, SI, InTech, 441-460.
18. Mair, H., Reid, D., George, W. (2005), Globalisation, Rural Tourism and Community Power, in Hall, D., Roberts, L., Mitchell, M. (eds), *New Directions in Rural Tourism,* Ashgate Publishing Limited, Aldershot, England, 165-179.
19. *Master plan održivog razvoja ruralnog turizma u Srbiji*. https://futurehospitalityleaders.files.wordpress.com/2012/11/master-plan-odrzivog-razvoja-ruralnog-turizma-u-srbiji.pdf

20. Milanović, M., Cvijanović, D., Cvijanović, G. (2008), *Prirodni resursi, ekonomija – ekologija – upravljanje,* Institut za ekonomiku poljoprivrede, Beograd.
21. Njegovan, Z. (2016), *Ekonomika turizma i seoskog turizma,* Poljoprivredni fakultet, Novi Sad.
22. Petrović, G., Grujović, M. (2015), Povezanost i ekonomski značaj ruralnog turizma i poljoprivrede, *Ekonomski signali: poslovni magazin,* 10(1), 56-63.
23. Petrović, M. (2014), *Kvalitet agroturizma Vojvodine i njegov uticaj na stavove lokalnog stanovništva,* Prirodno – matematički fakultet, Novi Sad.
24. Popesku, J. (2011). *Održivi razvoj ruralnog turizma*, TAIEX, Privredna komora Beograda.
25. Popesku, J. (2013), *Marketing u turizmu i hotelijerstvu*, Fakultet za turistički i hotelijerski menadžment, Univerzitet Singidunum, Beograd.
26. *Program razvoja održivog ruralnog turizma u Republici Srbiji*, „Sl. Glasnik RS“, br. 85/2011.
27. Radović, G. (2015), *Modaliteti finansiranja ruralnog turizma u Republici Srbiji,* Doktorska disertacija, Poljoprivredni fakultet, Novi Sad.
28. Radović, G., Košić, K., Demirović, D. (2018), Finansiranje kao ključni segment strategije održivog razvoja ruralnog turizma u Republici Srbiji, *Ekonomika poljoprivrede*, 65(1), 413-426.
29. Republički zavod za statistiku (RZS). https://www.stat.gov.rs/
30. Ristić, L., Bošković, N., Despotović, D. (2019), Održivi i integrali razvoj poljoprivrede i turizma u Repblici Srbiji, *Ekonomski horizonti*, 21(1), 57-74.
31. Roberts, L., Hall, D. (2003), *Rural tourism and recreation: Principles to Practise*, CABI Publishing, Oxon and New York.
32. Ružić, P. (2012), Analiza posebnosti i percepcije ruralnom turizma Istre, *Ekonomska misao i praksa*, 1, 217-238.
33. Sorensen, T., Epps, R. (1996), Leadership and local development: dimensions of leadership in four central Queensland towns, *Journal of Rural Studies,* 12, 113-125.
34. Stojanović, Ž., Manić, E. (2009), Održivi ruralni razvoj i prekogranična saradnja, *Glasnik srpskog geogradskog društva,* 2(2), 43-54.
35. *Strategija poljoprivrede i ruralnog razvoja opštine Vrnjačka Banja 2014-2024.godine.* https://www.vrnjackabanja.gov.rs/images/clanak/633/dokumenta/preuzmite-dokument-strategija-poljoprivrede-i-ruralnog-razvoja-opstine-vrnjacka-banja-2014-2024.pdf

36. *Strategija poljoprivrede i ruralnog razvoja Republike Srbije za period 2014 – 2024. godine,* „Sl. Glasnik RS“, br. 85/2014. https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/sgrs/vlada/strategija/2014/85/1

37. *Strategija razvoja turizma Republike Srbije za period 2016. - 2025. godine,* „Sl.Glasnik“, br. 98/2016.

38. Škorić, D. (2013), *Seoski turizam u Srbiji – preporuke za promene u lokalnim zajednicama prema iskustvima iz prakse*, SANU, Beograd.

39. Tasić, J. (2018), Budući trendovi i pravci razvoja ruralnog turizma u Srbiji i u svetu, *Oditor – časopis za Menadžment, finansije i pravo*, 4(3), 7-19.

40. Thibal, S. (1988), *Rural tourism in Europe,* Council of Europe, Strasburg.

41. Tomić, D. (2008), *Poljoprivreda i selo – ideje i inicijative*, Društvo agrarnih ekonomista Srbije i Institut za ekonomiku poljoprivrede, Beograd.

42. Tyrväinen, L., Silvennoinen, H., Nousiainen, I., Tahvanainen, L. (2001), Rural Tourism in Finland: Tourist’s Expectation of Landscape and Environment, *Scandinavian Journal of Hospitality and Tourism*, 1, 133-149.

43. Veselinović, J., Ignjatijević, S. (2013), *Pravni okvir i ekonomske mere za unapređenje agroturizma*, Planska i normativna zaštita prostora i životne sredine, 04-06. april 2013., Subotica, Palić, Asocijacija prostornih planera Srbije.

44. Vujović, S., Cvijanović, D., Štetić, S. (2012), *Destinacijski koncept razvoja turizma,* Institut za ekonomiku poljoprivrede, Beograd.

RESOURCES IN AGRICULTURE IN THE TERRITORY OF THE DANUBE DISTRICT

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Abstract

Starting from the specificity of agricultural production as an economic activity, above all, high dependence on natural conditions, when analyzing the factors of agricultural production, the starting point is always natural resources. The two key questions that arise are the availability of natural resources and the possibility of efficient exploitation of natural factors. The paper analyzes the three resources necessary for the smooth functioning of agricultural production, land, water and labor. The data used for the conducted analysis refer to the existing resources in the territory of the Danube District, according to the most recently conducted Census of Agriculture in 2012.

Key words: Resource, land, workforce, water, agriculture

Introduction

Soil, water and labour force are the three deciding factors that ensure smooth and high-quality agricultural production. According to the last **Agricultural Census**, there are 631,552 agricultural holdings in Serbia. They cover an area of 3,437,423 hectares of arable land, with an average holding size of 5.44 hectares. We should keep in mind that soil and water are limited and non-renewable resources whose irrational and uneconomical use can have far-reaching consequences in the future. As it is the only active factor in the use of agricultural land and capital, the labour force is the most important input in agricultural production and the key element when combining production factors.

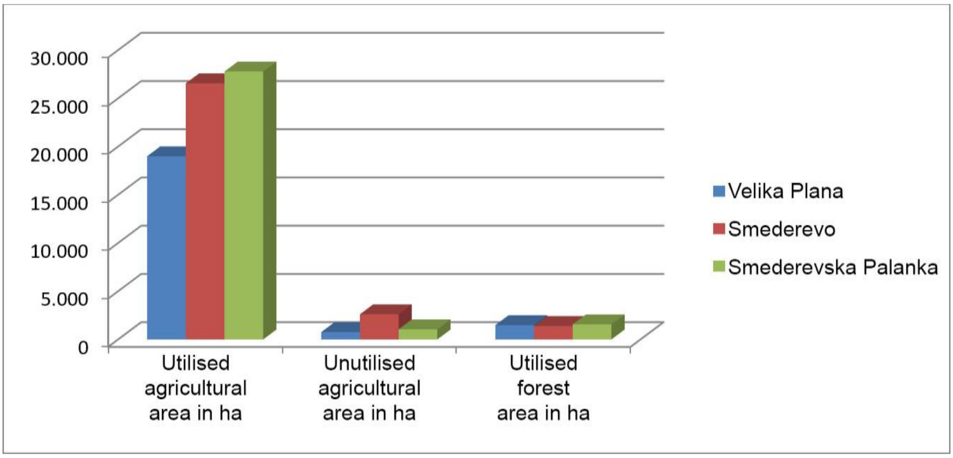
This study deals with the distribution and utilisation of natural resources in the territory of the Podunavlje District, where there are 19,120 agricultural holdings with a total of 73,336 hectares of utilised agricultural area. The study applies the comparative method and the method of descriptive statistics. It is based on the data from the Book of Census Results, Census of Agriculture 2012 in the Republic of Serbia and relevant domestic literature sources.

Soil as an important natural resource and its role in sustainable development

Since agricultural production is a specific economic activity, primarily due to its highly nature-dependent character, the study of agricultural production factors always starts with natural resources. Soil and water are fundamental natural resources and the most important factors of agricultural production. However, considering that all processes that utilise natural resources to produce food are based on human activity, the primary factors of agricultural production include man, i.e. labour force or population (Đurić, 2015).

Soil is a resource whose sustainable use determines the sustainable development of human society. Soil is a natural, non-renewable resource whose formation and renewal take several thousand years while it can disappear in a wink and thus affect other elements of the environment (Petrović et al., 2015). The use of soil as a natural resource in the agricultural production of Serbia entails problems related to the extensive use of soil, land fragmentation, insufficient use of organic matter and degradation processes caused by nature and human activity. These problems decrease the productivity and competitiveness of our agricultural products on the market (Tomić et al., 2005).

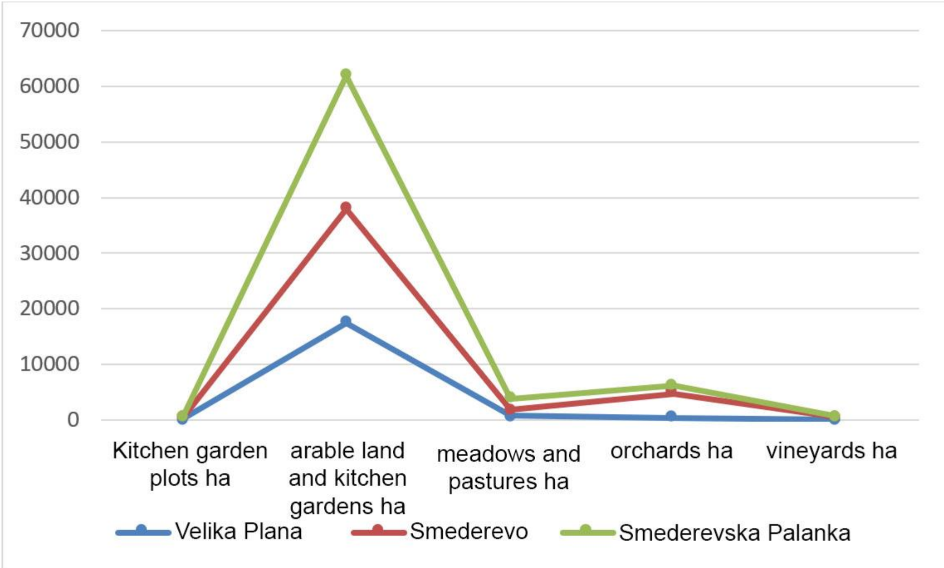
The role of soil in agricultural production is twofold. It is the medium that ensures plant nutrition and the area that is cultivated using mechanisation, irrigation and fertilisation to meet the needs of agricultural production. For the above reasons, the soil is considered a complex production resource of the agricultural economy (Đurić, Njegovan, 2016).



Graph 1. Available land area of agricultural holdings in the territory of the Podunavlje District

Source: Census of Agriculture 2012 – Agriculture in the Republic of Serbia

Data from the 2012 Census of Agriculture for the territory of the Republic of Serbia show that the total area of available land amounts to 5,347,597 ha, where arable land accounts for 437,423 ha. The total area of unutilised agricultural land is 424,054 ha, while the total area of forest land amounts to 337,804 ha. In the territory of the Podunavlje District, the largest area is occupied by the total utilised agricultural land (73,336 ha), which accounts for 2.1% of the land in the Republic of Serbia. It is followed by forest land, which covers an area of 4,458 ha, or 1.3% compared to the Republic of Serbia, and unutilised agricultural land with 4,417 ha, or 1.04%.



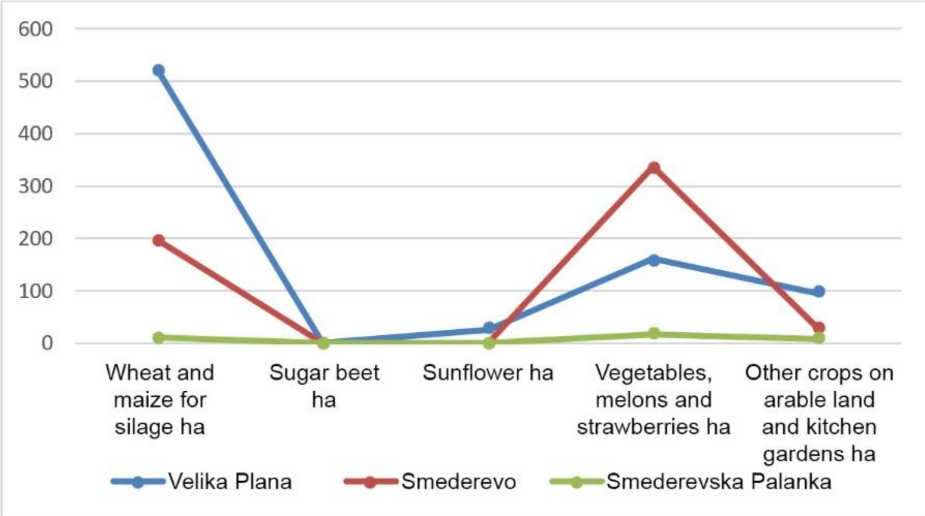
Graph 2. Utilised agricultural land of agricultural holdings by categories in the territory of the Podunavlje District

Source: Census of Agriculture 2012 – Agriculture in the Republic of Serbia

According to the 2012 Census of Agriculture, the largest area of utilised agricultural land is taken up by arable land and kitchen gardens. They spread on 2,513,154 ha in the Republic of Serbia and 61,799 ha in the Podunavlje District, which means that the share oSSf the District in the total area amounts to 2.6%. Orchards account for 6,284 ha of utilised agricultural land in the Podunavlje District, which is 2.1% compared to the average for Serbia which amounts to 295,203 ha. Meadows and pastures cover an area of 3,855 ha, followed by vineyards with an area of 729 ha and kitchen garden plots with 645 ha.

Irrigation and water resources as a factor in agricultural development

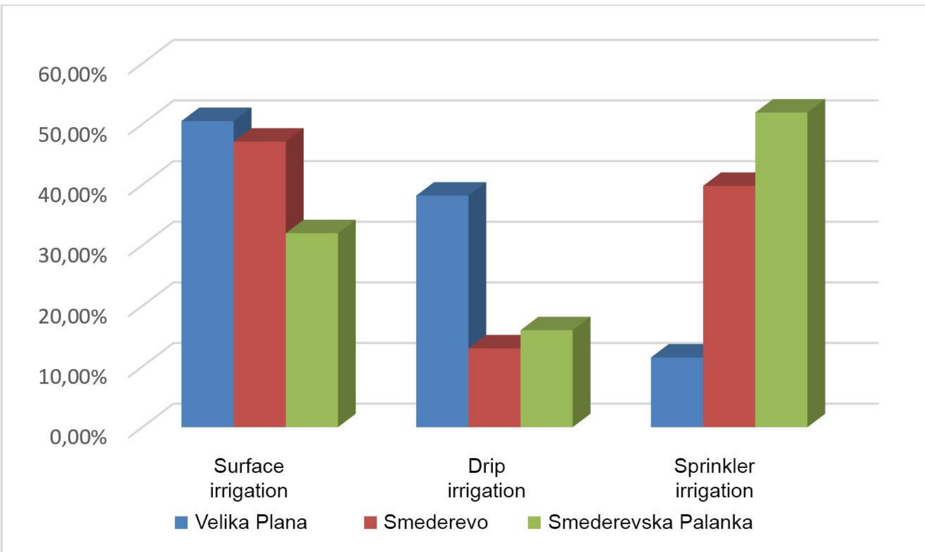
In order to provide enough food for the growing human population, people have been continuously increasing agricultural production, placing thus a heavier strain on the water demand. Although they are the biggest water consumers, people often fail to see that water is not used only for drinking. Water is essential for food production, and the lack of this important input can directly halt food production (Pajčin, 2013). Crop production worldwide relies on irrigation to provide necessary growing conditions. There is a tendency for crop production in irrigated agricultural areas to increase over the next three decades. However, since almost 70% of the total water intended for human use is used in agriculture, the first question which should rightly be asked is whether there is enough water at the global level. Many countries are already facing the problem of insufficient water to meet agricultural needs and this problem is expected to be one of the major concerns in the future as well (Đurić, Njegovan, 2016).



Graph 3. Irrigated area of arable land and kitchen gardens by crop types in the territory of the Podunavlje District

Source: Census of Agriculture 2012 – Agriculture in the Republic of Serbia

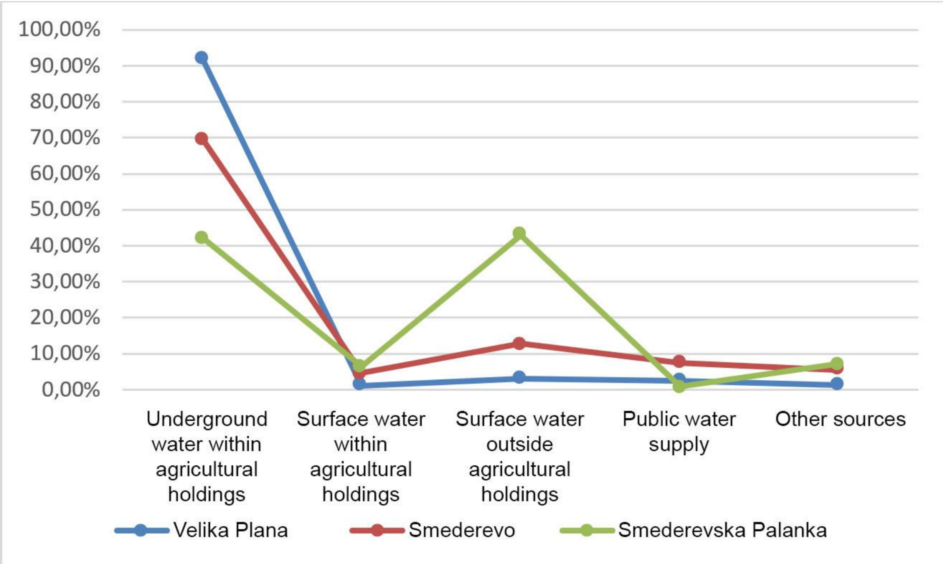
Of the total irrigated area under wheat and maize, which according to the 2012 Census of Agriculture amounts to 36,154 ha, 729 ha are in the territory of the Podunavlje District, which makes a share of 2.01%. It is followed by the area under vegetables, melons and strawberries which in the Podunavlje District amounts to 514 ha and accounts for 2.59% of the total of 19,859 ha in the territory of the Republic of Serbia.



Graph 4. Irrigation methods in the territory of the Podunavlje District in %

Source: Census of Agriculture 2012 – Agriculture in the Republic of Serbia

As can be seen in graph 4, surface irrigation is the predominantly used irrigation method in the territory of the Podunavlje District. It is followed by drip irrigation and sprinkler irrigation. The hydrological conditions in the territory of the Podunavlje District, particularly in the City of Smederevo, are favourable due to the large potential of surface and underground water areas. However, they have been poorly utilised so far.



Graph 5. Main sources of irrigation water in the territory of the Podunavlje District

Source: Census of Agriculture 2012 – Agriculture in the Republic of Serbia

Graph 5 shows that the main sources of irrigation water in the territory of the Podunavlje District are underground water within agricultural holdings, followed by surface water outside the holdings, surface water within holdings and water from the public water supply system.

Labour as a resource in agriculture

Human resources, i.e. labour force, includes all people who are engaged in agricultural production with their physical and intellectual abilities, experience, and professional training. The way they are applied in given socio-economic conditions largely depends on the degree of mechanisation. Besides the labour needed to perform agricultural work, human resources in agriculture include the workforce that provides technical coordination, organisation and management of all resources in agriculture (Subotić, 2005).

According to the results of the 2012 Census of Agriculture, the total number of people working in Serbian agriculture (as members of agricultural holdings or permanently employed) is 1,442,628, which means that an average of 2.28 persons per holding are permanently or occasionally engaged in agricultural work. The high share of holdings with a small number of people working in agriculture is attributed to the decreasing number of household members in Serbia and the increasing mechanisation of agricultural work operations (Bogdanov, Babović, 2014).

Table 1. The number of agricultural holdings by the number of members and permanent employees on a holding in the territory of the Podunavlje District

Podunavlje District	1-2 persons	3-4 people	5-6 people	More than 7 people
Velika Plana	3.825	1.327	104	10
Smederevo	4.894	1.912	274	27
Smederevska Palanka	4.102	2.236	380	29

Source: Census of Agriculture 2012 – Agriculture in the Republic of Serbia

As shown in Table 1, of a total of 631,552 agricultural holdings in Serbia, 19,120 holdings, or 3.03%, are in the territory of the Podunavlje District. Most holdings have one to two members (12,821), while the ones with five or more members are the rarest. This trend has numerous far-reaching consequences, above all, pronounced migration from rural to urban areas.

Table 2. The number of employees on the family holdings and holdings of a legal entity in the territory of the Podunavlje District

Podunavlje District	On the family holding	On the holding of a legal entity
Velika Plana	11.187	87
Smederevo	15.967	92
Smederevska Palan ka	16.448	197

Source: Census of Agriculture 2012 – Agriculture in the Republic of Serbia

According to the results of the 2012 Census of Agriculture in Serbia, a total of 1,416,349 people are employed in family agricultural holdings with a total of 43,597 people, or 3.08%, in the Podunavlje District. On the other hand, a total of 26,279 people are employed with a legal entity in agriculture, while according to the data of the 2012 Census of Agriculture, that number amounts to 376 in the Podunavlje District.

Conclusions

Soil and water are fundamental natural resources and the most important factors in agricultural production. Other primary factors of agricultural production include man, i.e. labour force. The first question that arises when analysing natural resources is their availability. However, we must also distinguish between the distribution of soil and water resources and the possibility of their efficient exploitation.

Soil is an important and irreplaceable resource in agricultural production. In the territory of the Podunavlje District, the total utilised area amounts to 73,336 ha, which is 2.1% of the area at the level of the Republic of Serbia which amounts to 3,437,423 ha. Water is a resource necessary for agricultural irrigation conducted with the aim to increase yields and product quality. In the Podunavlje District, irrigation water is mainly supplied from underground water within agricultural holdings, surface water outside or within the holdings, and the public water supply system.

Labour force is the most important input in agricultural production and a key element when combining production factors because it the active factor of land and capital exploitation in agriculture. Out of the total of 1,416,349 people employed on family agricultural holdings in Serbia, 43,597 people or 3.08% are employed in the territory of the Podunavlje District.

References

1. Bogdanov N., Babović M. (2014): Labour force and activities of agricultural holdings, Census of Agriculture 2012, Republic Institute of Statistics, Belgrade
2. Đurić K. (2015): Agricultural Economics – Practice book, Faculty of Agriculture, University of Novi Sad
3. Đurić K., Njegovan Z. (2016): Agricultural Economics, Faculty of Agriculture, University of Novi Sad
4. Pajčin M. (2013): Water as a resource of the future, Faculty of Technical Sciences in Čačak
5. Petrović G., Grujović M., Karabašević D. (2015): The soil as an important natural resource in the function of sustainable development, International Symposium on Natural Resources Management, Faculty of Management in Zaječar, The Republic of Serbia
6. Subotić J. (2005): Labour force in Serbian agriculture, Institute for Agricultural Economics, Belgrade
7. Tomić D., Gulan B., Umićević B. (2005): Land – a resource of the future, Agricultural Economics 2005, vol. 52, no. 4, pp. 421-428, Regional Chamber of Commerce Novi Sad, Chamber of Commerce of Serbia Belgrade
8. Agriculture Census Book – The Census of Agriculture 2012 – Agriculture in the Republic of Serbia popispoljoprivrede.stat.rs

REGIONAL AND ECONOMIC ASPECTS OF TOURISM DEVELOPMENT IN RURAL AREAS IN THE REPUBLIC OF SERBIA

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Abstract

The subject of the research is the representation of the tourist offer of rural households by region in the Republic of Serbia. The research methodology is based on the application of the inductive-deductive method, the method of analysis and synthesis, and the comparative method. The research uses data from the publications of the Statistical Office of the Republic of Serbia, the Tourist Organization of Serbia, as well as the results of other relevant research. The goal of the research is to give recommendations for the future improvement of the regional development of rural tourism and the economic and other effects of such development based on the observed situation. Based on the results of the research, the regions of Western Serbia, Central Serbia and Vojvodina were singled out as regions where the offer of rural tourist households is concentrated, followed by the region of Eastern Serbia.

Key words: Rural tourist households, rural tourism, rural development, regional development, Republic of Serbia

Introduction

Rural areas of the Republic of Serbia cover 85% of its territory, more than half of the population (55%) live in them and they form 41% of GDP (Bogdanov, 2007). The economy of rural areas depends to the greatest extent on agriculture, in which about 45% of the working rural population of the Republic of Serbia is employed and on the exploitation of natural resources (Bogdanov, 2007). The low degree of diversification of economic activities in rural areas is reflected in low real employment and opportunities for earning income. The insufficient connection of primary production with processing, services, and the market additionally makes the economic position of small agricultural rural households more difficult. Rural tourism can represent an additional source of income for the local community, and the interactive processes it establishes with other activities in the countryside, especially with agriculture, can become the development axis of rural areas (Panić, 2013). Rural tourism was singled out as one of the tourism products with special importance in the previous, as well as in the latest, Strategy for the Development of Tourism in Serbia for the period from 2016 to 2025. Rural tourism includes total tourist activities in rural areas, which includes a wide range of activities and services by the owners of rural tourist farms, but also the entire rural population of rural areas, who are motivated by the creation of additional income from tourism.

Rural areas in Serbia are recognized as areas with significant development limitations and more pronounced poverty, and rural households with modest development potential make up the nominal majority of the total number of households in Serbia (Bogdanov, 2007). In such conditions, the development of some new activities (among which is tourism) is recognized as a necessity, because often existence cannot be secured only by farming (Đekić et al., 2011). Encouraging rural and regional development and reducing depopulation is highlighted as one of the important determinants of the tourism business mission of the Republic of Serbia until 2025 (Tourism Development Strategy of the Republic of Serbia for the period 2016-2025).

The experiences of different countries indicate that changing the economic structure of rural areas can be achieved by encouraging the development of small and medium-sized enterprises in non-agricultural activities, which are intertwined with agriculture, and tourism is one of those activities. This development model gives a strong impetus to the development of these areas and is an important lever in the realization of balanced regional development (Radovanović, 2010). Farmers are aware of the importance of diversification of agricultural activities, as well as the creation of products with added value, and one such activity is agritourism as part of rural tourism (Kovačićek et al., 2021). The wealth of different rural areas that Serbia has is the basis on which its future tourism development can be based and planned, and tourism and its multiplied effect will have a positive impact on the overall economic life of these areas (Vuković et al., 2007). Rural tourism is already developed in western Serbia, Vojvodina, and central Serbia (Master plan for sustainable development of rural tourism in Serbia, 2011). According to the results of the latest research, where, with the application of the Kruskal-Wallis test, the arrivals and overnight stays of tourists were compared, according to the regions of Serbia, the region of Šumadija and Western Serbia stands out as the region with the largest number of rural households (Dimitrijević et al., 2022). The author's conclusions are that it is important to develop rural tourism in other regions as well, as well as to develop rural tourist households in tourist destinations with the highest number of overnight stays.

The subject of research is the representation of the offer of rural tourist households (RTH) according to regions in the Republic of Serbia. The goal of the research is to give recommendations for the future improvement of the regional development of rural tourism and the economic and other effects of such development based on the observed situation.

Material and method of work

The research methodology is based on the application of the inductive-deductive method, the method of analysis and synthesis, and the comparative method. The research uses data from the publications of the Statistical Office of the Republic of Serbia, the Tourist Organization of Serbia (TOS), as well as the results of other relevant research.

Results with discussion

In the Republic of Serbia, there are significant differences in economic development between regions. Thus, for example, based on data on regional GDP from 2014, the Belgrade region and the Vojvodina region are classified as developed regions with a realized value of gross domestic product above the value of the national average, while underdeveloped regions with a value of gross domestic product below the value of the republic average - the region of Šumadija and Western Serbia and the region of Southern and Eastern Serbia (Gašić, 2017). It is considered that the most effective investments in the development of rural areas are through encouraging the development of agriculture and tourism (Petrović et al., 2015).

According to the data of the Republic Institute of Statistics, looking at regions, the most significant results in tourism, as far as overnight stays and tourist arrivals are concerned, are recorded by the region of Šumadija and Western Serbia. According to the latest data, in 2020 the participation of the region of Šumadija and Western Serbia in total overnight stays (6,201,290) was about 48% (2,979,581), while the region of Southern and Eastern Serbia took second place with 25% (1,528,528). The Belgrade region had a share of 15% (928,233), and the Vojvodina region only 12% (764,948).

Domestic tourists dominated the overnight stays in the region of Šumadija and Western Serbia with around 89% participation, while the region recorded a participation of around 54% in total overnight stays by domestic tourists. When talking about rural tourism, it should be pointed out that one of its basic characteristics is the reliance on domestic demand, and that the mentioned region has the longest tradition of rural tourism.

Rural tourist households are the most important type of accommodation in rural tourism and have certain accommodation capacities:

Table 1. RTH accommodation capacities (rooms and beds), Republic of Serbia, 2014-2020.

Year	**Rooms**	**Beds**
2014	109	344
2015	383	997
2016	583	1.540
2017	675	1.723
2018	616	1.680
2019	644	1.732
2020	631	1.500

Source: Republic Statistical Office of Serbia Note: situation on August 31, table created by the author

As can be seen (Table 1), in 2020 the Republic of Serbia had a total of 631 rooms and 1,500 beds in rural tourist households, which is less than in the previous year 2019. In these accommodation facilities, an increasing tourist traffic is realized year after year:

Table 2. Tourist arrivals and overnight stays, RTH, Serbia, 2014-2020.

Year	Arrivals	Nights
2014	164	502
2015	1.523	4.910
2016	4.335	14.497
2017	5.061	16.040
2018	5.584	15.039
2019	8.529	24.677
2020	11.673	38.981

Source: Republic Statistical Office of Serbia Note: table created by the author

From the data (Table 2), the number of arrivals and overnight stays in rural tourist households is increasing from year to year, which indicates an increasing interest in tourist demand for rural areas, which is in line with current trends in the international tourism market. In the following, we will work on the identification of municipalities and villages, according to regions, with the most significant influence in rural tourism of the Republic of Serbia.

According to TOS data, in 2011, the offer of rural tourism was developed in 42 municipalities and 115 villages, where a total of 153 registered households provided tourist services. According to data from the latest published Catalog of Rural Tourist Households (TOS), in 2017 the number of households providing tourist services increased to over 200 households located in the vicinity of fifty towns.

Table 3. RTH, according to regions in Serbia, 2011 and 2017

Regions	2011.		2017.	
	Number	%	Number	%
1. Central Serbia	45	29	87	39
2. Western Serbia	58	38	44	20
3. Vojvodina	26	17	53	24
4. Eastern Serbia	24	16	38	17
Total:	153	100	222	100

Source: TOS Note: table created by the author

In 2011, the region of western Serbia stood out as the region with the most developed offer, ie the largest number of households. In 2017, the total number of households increased from 153 to 222 households, the largest number of which are located in the region of central Serbia.

The region of central Serbia

In the territory of central Serbia, the offer of rural tourism in 2011, according to TOS data, included 11 municipalities with 36 villages in which a total of 45 rural households were registered for the provision of tourist services. In 2017, the offer of the Central Serbia region included 10 municipalities, 51 villages and 87 households:

Table 4. RTH, according to municipalities, central Serbia, 2011 and 2017

Municipality	2011.	2017.
Gornji Milanovac	16	46
Ljig	6	2
Topola	1	6
Knić	8	4
Kragujevac	-	14
Kraljevo	1	11
Ub	-	1
Aleksandrovac	1	1
Kruševac	3	1
Brus	2	1
Aranđelovac	1	-
Lučani	5	-
Čačak	1	-
Total:	45	87

Source: TOS Note: table created by the author

The most intensive development of rural tourism is recorded in the municipality of Gornji Milanovac. It is a municipality that in 2011 had the most significant offer of rural tourism. The number of villages in the municipality that became active in tourism increased from 13 to 22 villages (the following villages joined the offer: Dragolj, Mutanj, Jablanica, Belo Polje, Donja Crnuća, Vraćevišnica, Ozrem, Lozanj, Brđani, Gornji Branetići).

Table 5. RTH, by municipalities and villages, central Serbia, 2017.

Municipality	Villages	2017.
Gornji Milanovac	Trudelj, Dragolj, Rudnik, Mutanj, Grabovica, Jablanica, Belo Polje, Donja Crnuća, Vraćevišnica, Klatičevo, Velereč, Majdan, Ozrem, Lozanj, Koštunići, Gojna Gora, Leušići, Brđani, Drenova, Semedraž, Bogdanica, Gornji Branetići	46
Ljig	Veliševac, Slavkovica	2
Topola	Topola, Lipovac, Vinča, Ovsište,	6
Knić	Žunje, Čestin, Guberevac	4
Kragujevac	Stragari, Vlakča, Veliki Šenj, Mala Vrbica, Kutlovo, Drača, Dragobraća, Grošnica, Velike Pčelice, Gornja Sabanta, Petrovac, Novi Milanovac	14
Kraljevo	Gledić (zaseok Rakija), Bogutovac, Lopatnica, Rudno	11
Ub	Brezovica	1
Aleksandrovac	Latkovac	1
Kruševac	Bela Voda	1
Brus	Kriva Reka	1
	Total:	*87*

Source: TOS Note: table created by the author

In 2017, in second place, according to the number of RTHs, is the municipality of Kragujevac with 14 households distributed in 12 villages, followed by the municipality of Kraljevo with 11 households in 4 villages. In 2011, the municipality of Kragujevac did not have any households, while in the municipality of Kraljevo there was only one household in the village of Lopatnica. Also, in some municipalities, which in 2011 were near the top of the list, such as the municipalities of Knić and Ljig, and which could be expected to increase their offer in the following period, there was a decrease in the number of households active in tourism.

Region of Western Serbia

The region of western Serbia is known as a region with a long tradition of rural tourism, and villages such as Seča Reka, Devići, and Sirogojno are pioneers - originators of rural tourism in our area. In the territory of Western Serbia in 2011, there were 13 municipalities with 42 villages and a total of 58 households included in the tourist offer. In 2017, according to TOS data, the number of households decreased significantly from 58 to 44:

Table 6. Rural tourist households by municipality, Western Serbia, 2011 and 2017

Municipality	2011.	2017.
Ivanjica	8	8
Arilje	-	4
Lučani	-	3
Užice	11	4
Bajina Bašta	-	1
Čajetina	5	5
Kosjerić	6	8
Valjevo	5	5
Loznica	2	2
Ljubovija	3	2
Šabac	1	1
Požega	2	1
Osečina	2	-
Mionica	1	-
Nova Varoš	7	-
Prijepolje	5	-
Total:	58	44

Source: TOS Note: table created by the author

The largest number of households in 2011 (11, or about 19% of the total number) was located in the territory of the municipality of Užice, namely in the villages of Zlakusa, Potpeć, Kačer, Tatinac, Kremna, and Mokra Gora, which are of great tourist importance. This was followed by the municipalities of Ivanjica with 8 and Nova Varoš with 7 households. In 2017, according to the number of households, the municipalities of Ivanjica and Kosjerić stand out:

Table 7. RTH, by municipalities and villages, western Serbia, 2017.

Municipality	Villages	2017.
Ivanjica	Komadine, Kumanica, Katići, Kušići, Raščići, Lisa, Marina Reka	8
Arilje	Visoka, Mirosaljci, Bogojevići	4
Lučani	Gornja Kravarica, Guča, Grab	3
Užice	Zlakusa, Kačer, Kremna	4
Bajina Bašta	Tara	1
Čajetina	Šljivovica, Tripkova, Zlatibor, Rožanstvo	5
Kosjerić	Mionica, Skakavci, Rosići, Stojići, Mušići	8
Valjevo	Petnica, Popučke, Lelić, Struganik, Zarube	5
Loznica	Tršić, Gornja Koviljača, Banja Koviljača	2
Ljubovija	Vrhpolje, Drlače	2
Šabac	Varna	1
Požega	Tometino polje	1
	Total:	*44*

Source: TOS Note: table created by the author

When it comes to the municipality of Užice, the number of STDs instead of the former 11 is now only 4. Based on previous data, it seems that the development of rural tourism in the region of Western Serbia has "slowed down" and that the interest of households is declining.

Region of Eastern Serbia

In the territory of Eastern Serbia, in 2011, rural tourism was developed in 8 municipalities with 21 villages and a total of 24 households registered for providing services in rural tourism. The municipality that stood out in particular with the RTH number (6) is Sokobanja, a well-known spa center.

Table 8. RTH by municipalities, Eastern Serbia, 2011 and 2017

Municipality	**2011.**	**2017.**
Golubac	-	2
Malo Crniće	-	1
Petrovac na Mlavi	1	2
Despotovac	-	1
Žagubica	-	2
Negotin	2	14
Zaječar	2	1
Dimitrovgrad	-	3
Knjaževac	5	6
Niš	-	1
Pirot	4	1
Sokobanja	6	4
Majdanpek	2	-
Bujanovac	*2*	-
Total:	*24*	*38*

Source: TOS Note: table created by the author

In 2017, the number of households increased significantly and amounted to 38, distributed in 12 municipalities and 27 villages, which indicates a certain shift in the development of rural tourism in this part of the Republic of Serbia.

Table 9. Rural tourist households, by municipalities and villages, Eastern Serbia, 2017.

Municipality	Villages	2017.
Golubac	Dobra	2
Malo Crniće	Aljudovo	1
Petrovac na Mlavi	Ždrelo	2
Despotovac	Lipovica	1
Žagubica	Milanovac, Selište	2
Negotin	Šarkamen, Plavna, Rogljevo, Rajac, Bukovo, Vratna, Jabukovac, Kusjak	14
Zaječar	Nikoličevo	1
Dimitrovgrad	Poganovo, Senokos	3
Municipality	**Villages**	**2017.**
Knjaževac	Vrtovac, Jalovik Izvor, Ćuštica, Mezdreja, Crni Vrh	6
Niš	Sečanica	1
Pirot	Zavoj	1
Sokobanja	Šarbanovac, Jošanica, Trubarevac	4
	Total:	*38*

Source: TOS *Note:* table created by the author

The municipality of Negotin stands out with 14 households and participation of about 38%. In this municipality, instead of the former two villages, as many, as there were in 2011, six years later, 8 villages became active for tourism.

Region of Vojvodina

Out of a total of 153 registered households in 2011, 26 households are located in Vojvodina. In this region, in 2011, rural tourism was developed in 10 municipalities with 16 villages and a total of 26 households. In 2017, the number of households included in the rural tourism offer of AP Vojvodina totaled 53 households:

Table 10. RTH by municipalities, AP Vojvodina, 2011 and 2017

Municipality	2011.	2017.
Sremska Mitrovica	-	4
Irig	1	3
Šid	-	1
Inđija	-	2
Novi Sad	2	5
Bačka Palanka	-	2
Bački Petrovac	3	4
Sombor	5	3
Subotica	3	6
Pančevo	-	8
Kovačica	3	7
Zrenjanin	3	1
Kovin	4	6
Senta	1	1
Beočin	1	-
Total:	*26*	*53*

Source: TOS Note: table created by the author

In 2011, the largest number of tourist-active villages and households was located on the territory of Bačka (14, which is about 54% of the total number). The next district in terms of representation was the Banat district (with 11 households, or about 42%), and Srem district stood out as the district with the least developed offer of accommodation facilities, with only one household, which is about 4%. In the period from 2011 to 2017, the number of households increased significantly, which can be favorably assessed:

Table 11. RTH, by municipalities and villages, AP Vojvodina, 2017.

Municipality	Villages	2017.
Sremska Mitrovica	Mačvanska Mitrovica, Zasavica, Manđelos, Ležimir	4
Irig	Irig-Novo Hopovo, Jazak, Rivica	3
Šid	Morović	1
Inđija	Maradik, Čortanovci	2
Novi Sad	Čenej, Stari Ledinci, Begeč	5
Bačka Palanka	Neštin, Bačka Palanka	2
Bački Petrovac	Bački Petrovac	4
Sombor	Gradina, Bački Monoštor	3
Subotica	Kelebija, Bački Vinogradi, Donji Tavankut, Palić, Hajdukovo-Nosa, Subotica	6
Pančevo	Ivanovo, Glogonj, Banatski Brestovac, Dolovo, Starčevo, Kačarevo	8
Kovačica	Crepaja, Kovačica, Padina, Debeljača	7
Zrenjanin	Belo Blato	1
Kovin	Skorenovac	6
Senta	Gornji Breg	1
	Total:	*53*

Source: TOS Note: table created by the author

In 2017, the largest number of RTHs was found in the territory of the Banat district (23), which is different from 2011, when Bačka district led the way. In the region of Vojvodina, the municipalities of Pančevo, Kovačica, Subotica and Kovin stood out with their offer.

Conclusion

The development of rural tourism in the Republic of Serbia is regionally uneven. Based on the analyzed data, the regions of Western Serbia, Central Serbia and Vojvodina have the largest number of rural tourist households. When it comes to municipalities, the most intensive development of rural tourism is recorded in the municipality of Gornji Milanovac. Although in terms of its natural and cultural-historical wealth and potential it does not lag behind the mentioned regions, the region of Eastern Serbia has the least developed tourist offer of rural households. Bearing in mind the possible positive effects of tourism development on the economic, social, demographic, cultural and infrastructural development of rural areas, it is recommended that in the future work on encouraging and improving the tourist offer of all regions, especially those lagging behind in economic development. It is important that each of the regions creates a recognizable, authentic, content-quality tourist offer, as well as to motivate, educate and support rural households in that process. Promotion of the offer should be directed, first of all, to urban domestic demand.

References

1. Berleković, B. K., Bošković, T., Kojčić, I. *SPORTS AND RECREATIONAL PROGRAMMES AS PART OF THE RURAL TOURISM OF VOJVODINA.* (доступно на: http://vpts.edu.rs/sed/fajlovi/eko/13.pdf)
2. Bjeljac, Ž., Brankov, J., Popović, I. B. (2009): *Tourism in undeveloped areas in the Serbia,* Journal of the Geographical Institute" Jovan Cvijic", SASA, 59(2), 95-110. (доступно на: http://www.doiserbia.nb.rs/img/doi/0350-7599/2009/0350-75990902095B.pdf)
3. Bogdanov, N. L. (2007): *MALA RURALNA DOMAĆINSTVA U SRBIJI I RURALNA NEPOLJOPRIVREDNA EKONOMIJA*, Београд, Република Србија, Министарство пољопривреде, шумарства и водопривреде, стр.63, 32, 31
4. Bošković, T. (2013): *Turizam kao razvojna prednost ruralnih područja Vojvodine*, Ekonomski fakultet, Univerzitet u Nišu, Niš, Republika Srbija.
5. Bošković, T., Maksimović, B. (2019): *Tourism development in messuages in Autonomous province of Vojvodina: possibilities and limitations, TEME,* 257-274. (доступно на: http://teme2.junis.ni.ac.rs/index.php/TEME/article/download/902/358)
6. Đekić, S., Jovanović, S. Кrstić, B. (2011): *Neke determinante kreiranja politike i strategije održivog ruralnog razvoja*, Agrarna i ruralna politika u Srbiji-nužnost ubrzanja reformi, 49-63. Društvo agrarnih ekonomista Srbije i Ekonomski fakultet Univerziteta u Subotici.
7. Dimitrijević, M., Ristić, L., Bošković, N. (2022): *Rural tourism as a driver of the economic and rural development in the Republic of Serbia*, Menadžment u hotelijerstvu i turizmu, 10(1), 79-90. (доступно на: https://scindeks-clanci.ceon.rs/data/pdf/2620-0279/2022/2620-02792201079D.pdf).
8. Đurić, D., & Đurić, D. (2017): *CULTURAL–HISTORIC HERITAGE AND CULTURAL TOURISM IN THE FUNCTION OF STRENGTHENING OF THE TOURIST OFFER OF SERBIA.* In Tourism International Scientific Conference Vrnjačka Banja-TISC, Republika Srbija, Vol. 2, No. 1, pp. 362-378.
9. Đurić, K., Vukoje, V., Miljatović, A. (2021): *Diverzifikacija ekonomskih aktivnosti kao faktor održivog ruralnog razvoja Diversification of economic activities as a factor of sustainable rural development,* ECOLOGICA, 28(104), 611-618. (доступно на: https://www.researchgate.net/)
10. Gašić, M. M. (2017): *Turizam u funkciji razvoja ruralnih područja južne i istočne Srbije*, doktorska disertacija, Ekonomski fakultet, Univerzitet u Nišu, Niš, Republika Srbija.

11. Grupa autora: *Master plan održivog razvoja ruralnog turizma Srbije, UN Joint Programme „Sustainable Tourism for Rural Development“* funded by the Spanish MDG Achievement Fund, April 2011.

12. https://mtt.gov.rs/

13. https://www.srbija.travel/

14. Jurdana, D. S., Frleta, D. S., Đedović, L. (2018): *OBILJEŽJA TURIZMA U RURALNOM PROSTORU,* 4. međunarodni kongres o ruralnom turizmu, Zbornik radova, str. 220-229.

15. Kovačićek, T., Mikuš, O., Antolković, P., Grgić, I., Rogelj, M. J. (2021): *Ruralni turizam u revitalizaciji ruralnog prostora Sisačko-moslavačke županije,* Agroeconomia Croatica, 11(1), 115-125.

16. Panić, D. (2013): *Rural Tourism as Key Factor in the Process of Rural Areas Revitalization,* Ekonomika, Journal for Economic Theory and Practice and Social Issues, 59(1350-2019-2713), 186-194. (доступно на: https://ageconsearch.umn.edu/record/290085/files/4-2013%20pages%20186-194.pdf)

17. Pavlović, N., Berleković, B. M. K. (2018): *TURIZAM KAO POKRETAČ RAZVOJA RURALNIH PROSTORA–STUDIJA SLUČAJA JUGOISTOČNE BAČKE,* International Journal of Economic Practice and Policy, (1), 105-122. (доступно на: https://aseestant.ceon.rs/index.php/skolbiz/article/download/19868/7566/)

18. Pavlović, S., Đorđević, T. (2013): *Prognoze razvoja seoskog turizma u opštinama Kosjerić i Gornji Milanovac*, Zbornik radova, 63 (1), 47-65. (dostupno na: http://www.gi.sanu.ac.rs)

19. Petračić, M. (2018): *Poduzetnički projekti u održivom razvoju ruralnog turizma*, Doctoral dissertation, University of Rijeka. Faculty of Tourism and Hospitality Management, Republika Hrvatska.

20. Petrović, G., Grujović, M. (2015): *Povezanost i ekonomski značaj ruralnog turizma i poljoprivrede,* Stručni rad, Kragujevac, Република Србија (доступно на: https://web.archive.org/web/20180719203817id_/http://scindeks-clanci.ceon.rs/data/pdf/1452-4457/2015/1452-44571501056P.pdf)

21. Radovanović, V. (2010): *Integralni ruralni razvoj: ka skladnijem regionalnom razvoju*, Zbornik Matice srpske za društvene nauke, (132), 41-51. (dostupno na: http://www.doiserbia.nb.rs/img/doi/0352-5732/2010/0352-57321032041R.pdf)

22. *Strategija razvoja turizma Republike Srbije za period 2016.-2025.*(2016) Beograd, Republika Srbija, Vlada Republike Srbije.

23. Turistička organizacija Srbije (2017): *Katalog seoskih turističkih domaćinstava*, Beograd, Republika Srbija, (dostupno na: https://www.srbija.travel/)

24. Vesić, M., Bolović, J., Todorović, N., Pavlović, S. (2021): *Uticaj pandemije COVID-19 na održivi razvoj ruralnog turizma u turističkoj regiji Zapadna Srbija The impact of the COVID-19 pandemic on sustainable development of rural tourism in the West Serbia tourist region,* ECOLOGICA, 28(103), 451-458. (доступно на: https://web.archive.org/web/20220227091116id_/http://doi.fil.bg.ac.rs/pdf/journals/ecologica/2021-103/ecologica-2021-28-103-16.pdf)

25. Vuković, P., Cecić, N., Cvijanović, D. (2007): *Održivi turistički razvoj ruralnih područja Srbije*, časopis Ekonomika poljoprivrede, Beograd, God./Vol. *LIV, br N, 2.,* Beograd, Republika Srbija (dostupno na: https://ea.bg.ac.rs/index.php/EA/article/download/1284/1127

26. www.stat.gov.rs

ECONOMIC CHARACTERISTICS AND SPECIFICITIES OF BIOMASS AS A RENEWABLE ENERGY SOURCES

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Abstract

Today's high energy dependence on non-renewable energy sources, primarily oil and oil derivatives, whose reserves are estimated for the next 20 years, has imposed the need for greater use of renewable energy sources (RES). Bearing in mind the availability, available quantities, characteristics and advantages of biomass in energy production, it can be expected in the coming period to have a more significant participation in the production of energy from RES. From the point of view of biological diversity and distribution, Serbia has a significant biomass potential (estimated at 3,448 Mtoe per year), of which 48% is agricultural and 44% wood biomass. Wood biomass is most represented in the mountainous area of Serbia covered with forest, while agricultural biomass is most represented in the plain areas in the north of Serbia. Despite its wide distribution, biomass is used in a symbolic percentage, less than 2%. As an incentive for the production of energy from renewable sources, the EU adopted a series of Regulations and Directives on the mandatory use of RES in the total production and consumption of energy. A large number of European countries, including Serbia, have prescribed incentives for kW of electricity produced from RES.

Key words: Renewable energy sources, biomass, agricultural biomass, energy production.

Introduction

The rapid growth of production and consumption of products and services in the world, which occurred in the second half of the 20th and the beginning of the 21st century, resulted in a significant increase in the demand and consumption of all forms of energy. Today, the provision of energy resources and the availability of their use are the priorities of the governments of many countries in the world. We live in a world of energy and practically everything that surrounds us is based on the use of some kind of energy. It is known that the ever-increasing growth of humanity's energy needs, and the diminishing reserves of fossil fuels, as well as the uncontrolled pollution of the environment, are some of the biggest problems today. By reducing supplies, non-renewable energy sources will become "luxury goods", and consequently we will be forced to look for other, cheaper RES, such as solar, wind, biomass, geothermal energy, etc. This is energy whose sources are constantly or cyclically renewed, and which is consumed at a rate that is less than or equal to the rate at which it is created in nature.

The problems of lack of energy, as well as its high prices, which humanity is facing, have accelerated research aimed at greater and more economical use of RES. In the latest research on new alternative sources of energy, biomass is one of the sources that is receiving more and more attention.

From the point of view of greenhouse gas emissions, biomass energy represents a new, significant, mostly free and clean source of energy.

Even though Serbia has enviable amounts of RES, they are insufficiently represented in comparison with their representation in the structure of total energy consumption in developed countries.

The aim of this paper is to point out the potential and importance of RES for humanity, with an emphasis on biomass energy, because non-renewable energy sources are relatively limited, and their exploitation increases the emission of gases with the greenhouse effect, which leads to serious climate changes on planet Earth.

Both national and international publications on energy production from renewable sources with a focus on energy from biomass were used in the research. In addition, appropriate scientific and professional literature, data from the Internet, as well as the results of previous research on this issue were used. In accordance with the sources and characteristics of the data, appropriate quantitative and qualitative research methods are also applied in this study.

Definition, technical and economic features of biomass

Biomass refers to living or until recently living matter, plant or of animal origin, which can be used as fuel or for industrial production. Biomass refers to living or until recently living matter that can be of plant or animal origin and can be used as fuel or for industrial production. It is most often used for heating, cooking or heating hot water, but it can also be used to produce electricity and heat, which is why it has recently been increasingly used to produce biofuels. It can also be used in the fiber and chemical industry. Biomass can be divided into woody biomass, non-woody biomass and animal waste (Volk and synthetic aperture radar (SAR) 2000).

Some of the types of biomass are:

1. Cereals (corn, wheat, industrial potatoes, sugar beet)
2. Food waste (in food production and processing)
3. Forestry (residues from felling, thinning and forest maintenance)
4. Agricultural residues (straw, fodder, rice straw, fertilizers, residues from pruning, etc.)
5. Urban waste (sludge, urban wood waste, remains after disasters, etc.)

6. Energy crops (algae, hybrid grasses, hybrid tree species)[3]

In the creation of biomass, photosynthesis plays an important role, because it converts solar energy into glucose. Thermal energy is released when biomass is burned. The production of bioenergy starts from the fact that living biomass takes CO_2 from the air, and releases it when being burned (CO_2 balance is approximately equal to 0). Taking into account the issue of the greenhouse effect, this is quite acceptable because there is no increase in gases in the atmosphere.

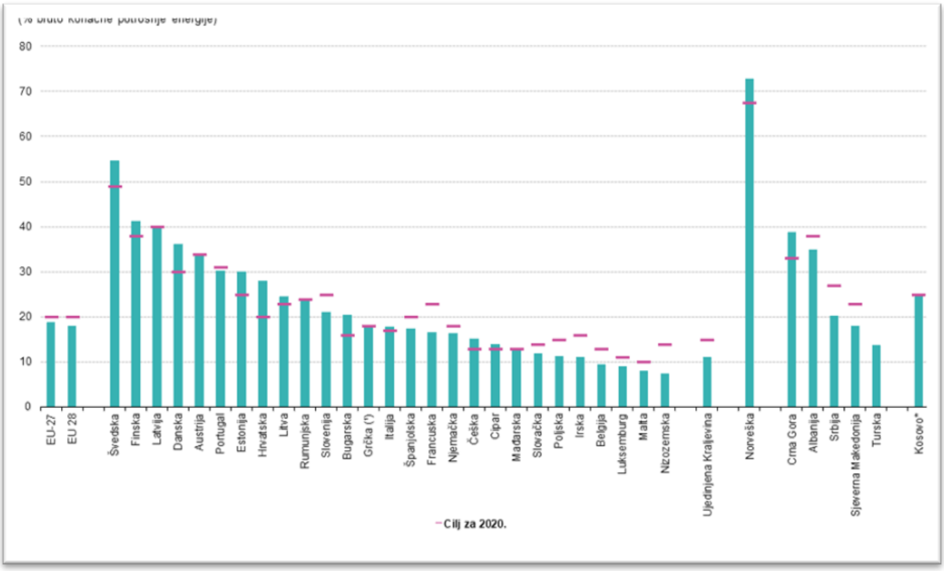

Chart 1. Share of renewable energy sources in total energy consumption in EU member states in 2018 and goals for 2020 defined by Directive 2009/28/EC

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

Analysis of biomass from residues and waste is more complicated due to the complexity of the materials being handled and the diversity of the sectors from which they originate (varies from agriculture to the utility sector). Firstly, EU directive 2008/98/EC defines the difference between by-product and waste: "A by-product is any material that can be reused, while waste is defined as material that is obtained at the end of the production cycle and cannot be recycled".

Biomass from the wood industry

Biomass from the wood industry is used to produce briquettes for energy production. Biomass from the wood industry also includes waste generated during wood processing. Waste from the wood industry is much cheaper and more economical for energy production than production from fossil fuels.

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[3] Upotreba biomase iz poljoprivrednog otpada kao obnovljivog izvora energije, pg. 614

The characteristics of wood biomass depend on its composition, thermal power, ignition temperature and combustion. The heat value depends on moisture, chemical composition, density and type of wood. The aforementioned differences in the proportion of individual ingredients and substances used as fuel significantly affect the energy value of wood biomass.

Agricultural biomass

In order to obtain agricultural biomass, residues from the following plant crops are used: straw, corn stalks, stalks, husks, stones, fruit and vine prunings, etc. Experience has shown that after the harvest of corn, corn stover, stalk with leaves, corncob and husk. Since the average grain-to-mass ratio (the so-called harvest ratio) is 53:47, it follows that there is approximately as much biomass as grain. If corn stovers and husks are separated, then their ratio is 82:18, i.e. for every ton of corn grain produced, 0.88 t of corn kernels and husks biomass is obtained.

Energy plants

Fast-growing cane and sugarcane (such as Arundo Donax, tall grasses) are examples of grasses that can serve as a good element to increase biomass productivity. At the same time, some other agronomic characteristics represent only disadvantages such as the depletion of nutrients from the soil, the high cost of planting, relatively weak harvest mechanization, high humidity during harvest and high ash content. Artichoke and miscanthus are energy crops with Mediterranean characteristics of cultivation with little water: for this reason, great interest and research in the field of agronomy and genetics with improvement programs has been devoted to them (Riva, 2011). Plants rich in oil or sugar in large quantities, such as fast-growing trees and Chinese reeds with an annual yield of 17 t/ha, eucalyptus with a yield of 35 tons of dry matter per hectare, green algae with a yield of 50 t/ha are significant sources for production biomass. The properties of such energy plants are: rapid reproduction, lush green mass and high yields per hectare. The heat capacity of non-woody biomass is equally affected by moisture and ash content. The share of ash in non-wood plant residues can be up to 20%, which significantly affects the thermal power. In Serbia, the highest yields are achieved with poplars, willows and cottonwoods[4] . The development of energy plantations, primarily fast-growing tree species, for the production of energy from renewable sources is a new sector that has significant expansion and offers a number of benefits for producers, consumers, local communities and the environment. This method of biomass production is recognized in EU countries and supported through energy policy. In this sense, the current and upcoming activities within the UNDP (United Nations Development Program) project should stimulate the development of Serbia's institutional capacities, additionally contribute and facilitate the

[4] https://agroinfonet.com/poljoprivreda/ratarstvo/energija-biomase-moze-zagrejati/

adoption of plans and methods of encouragement for the establishment of such plantations and the production of biomass within them[5].

Biomass from animal farms

Biogas is a mixture of methane (40 - 75%), carbon dioxide (25 - 60%) and about 2% of other gases (hydrogen, hydrogen sulfide, carbon monoxide). Biogas is about 20% lighter than air and is odorless and colorless. Its ignition temperature is between 650-750°C, and it burns with a pure blue flame.[6]

Biomass from livestock production (liquid manure) also represents an exceptional energy source. The energy obtained from liquid manure during exploitation does not emit harmful gases that are created during the burning of classic fossil fuels and thus contributes to greater environmental protection. For example, about 10-12 kg of liquid manure with 4-10% dry matter is needed to obtain 1 m^3 of biogas (Furman et al., 2007). Domestic animals whose liquid manure can be economically used for biogas production are dairy cows, cattle, fattening pigs and laying hens. Research shows that 110 tons of manure and 250 tons of corn silage per year is enough to produce about 8 GWh of electricity without producing ash. This is equivalent to burning about 16,000 t of lignite.

One hectare of corn silage is sufficient for the production of 10,000 m^3 of biogas, which generates over 20 MWh of electricity, which represents the average annual consumption of about 5 households. Estimates are that around 500,000 hectares under various plants for biomass production could provide around 10 GW, which is equivalent to the production of one small power plant.[7]

Biofuels

Ethanol is produced by enzyme hydrolysis of starch molecules in sugar that is fermented in alcohol. The following are used for the production of ethanol: sugar beet, corn stover, wood, agricultural residues, etc. Biodiesel is obtained by esterification of alcohol and vegetable oils such as rapeseed oil, sunflower oil, soybean oil, palm oil, etc., as well as from waste oils and fats from households. It can be used independently or in a mixture with diesel obtained by refining crude oil. Depending on the proportion of biofuel in the mixture, biodiesel is called B100 (pure, 100% biodiesel), B20 (20% biodiesel and 80% fossil diesel), B5 (5% biodiesel and 95% fossil diesel), etc. In Serbia, the consumption of about 1.4 million tons of diesel fuel was recorded. There is no data on the amount of biodiesel production, and there is no data on biodiesel consumption

[5] http://biomasa.undp.org.rs/?p=2792
[6] 1.5 m^3 of biogas is equivalent to 1 m^3 of natural gas.
[7] http://www.parlament.gov.rs/upload/archive/files/lat/pdf/akta_procedura/2014/113-14Lat.pdf.

either. It is estimated that biodiesel[8] consumption is less than 0.5% of diesel consumption in Serbia.[9]

During the production of biodiesel from rapeseed, several by-products (oilcakes, pellets) are created, which can be used as protein supplements for animal feed, as well as raw materials (glycerol, etc.) that can be used in the cosmetic and pharmaceutical industry. At the end of the technological process, oily sludge remains, which is used as a high-quality organic fertilizer in ecological agriculture. Without the use of biodiesel (or any other biofuel), a certificate of organic agricultural production cannot be obtained in the EU today.

Municipal waste

The green part of recycled waste, biomass from gardens and parks, as well as sludge from waste water represent city waste with a high calorific value, but its disposal by landfilling and biological decomposition is harmful. The technology of burning waste on grates (grate firing) is currently the most dominant technology for the thermal treatment of waste, and it has been used for decades. The main obstacles are precisely in environmental protection, but on the other hand there are also advantages in waste burning technology. By burning waste, the volume and mass of waste is reduced, and harmful substances from that waste are destroyed (Kovačević, 2018).[10]

Economic and ecological aspects of using biomass

Biomass represents the "storage" of CO_2 and solar energy in the process of photosynthesis during its creation. Biomass represents the "storage" of CO_2 and solar energy in the process of photosynthesis during its creation. Using biomass for biofuel, bioenergy, chemical and other products does not increase the CO_2 content in the atmosphere. By transforming biomass into energy (electrical or thermal energy, fuel for engines or raw material for the chemical industry), CO_2 is released, but in a significantly smaller amount compared to the burning of other energy sources. Incineration of agricultural and forest residues, as well as municipal solid waste for energy production is doubly beneficial because it represents an efficient use of waste products, and at the same time it solves the problem of waste disposal. Due to its combustion characteristics, the production and use of biomass protects the environment, promotes economic growth and provides additional energy security. The potential of biomass for bioenergy is very large and very widespread throughout the world. Today, biomass is the main source of the world's energy resources, providing 13% of total energy. In developing countries, 35% of energy is provided from biomass. European countries such as Austria, Sweden and Finland already produce around 20% of

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[8] Data from 2008

[9] http://www.mre.gov.rs/doc/efikasnostizvori/02%20Nacionalni%20akcioni%20plan%20za%20koriscenje%20 obnovljivih%20izvora%20energije%20u%20Republici%20Srbiji.pdf.

[10] Biomasa – Korišćenje poljoprivredne biomase u Republici Srbiji, str. 28.

commercial energy from biomass. It is estimated that by 2050 biomass could meet approximately 38% of the world's fuel needs and 17% of its electricity needs.

Unlike solar energy and wind energy, whose production is significantly dependent on weather factors, biomass is used throughout the year for energy production. If the energy produced from biomass is used in cogeneration[11] for the production of electricity and heat, then the heat output is 70-80%.In the case when biomass is used only for the production of electricity, the performance ranges from 10-25%.

The advantages of using biomass compared to other sources of energy are the following: prevention of erosion, reduction of the risk of fire, protection of flora and fauna and other components of their diversity, lower emissions of harmful substances from electricity generators that use biomass as fuel (compared to similar technologies that use fossil fuels), reduction of gases that produce the greenhouse effect, creation of new jobs, economic benefits in rural areas, etc.

Despite the many advantages of biomass exploitation as a renewable energy source, there are also certain disadvantages. Despite the many advantages of biomass exploitation as a renewable energy source, there are also certain disadvantages. Some of them are: manipulation and economic problems with the collection, packaging and storage of biomass, periodicity of biomass generation, low thermal power of biomass reduced to a volume unit, sparseness in space which causes high collection costs; unfavorable shape and high humidity of biomass, high investments for plants for processing, preparation, combustion of biomass, etc. (Kosanović, 2015).

In addition to the economic ones, the ecological effects of using biomass as RES should also be emphasized. These are: that the biodegradability of biomass in the soil is high because almost 95% of biomass matter is decomposed in 28 days, biofuels contain small amounts of sulfur, so there is no sulfur dioxide in the products, during the biomass burning process, so-called clean ash is obtained, there is no hydrocarbon emissions and after all, biomass already exists on Earth and it is not necessary to create it, but only to use it in a planned way, and help it regenerate (Europe 2020). For these reasons, biomass, in addition to other sources of energy (wind, water and solar energy), is considered a valuable resource for obtaining clean energy.

Biomass potential in the Republic of Serbia

The Republic of Serbia belongs to the countries that, from the aspect of biological diversity and distribution, have a significant biomass potential. Studies and analyzes show that biomass is the most significant potential of

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[11] The process of simultaneous production of heat and electricity is called cogeneration (Combined Heat and Power or CHP). In this procedure, the thermal energy generated by the production of electricity in thermal energy plants is used for district heating of buildings or settlements.

renewable energy sources in Serbia. It is estimated at 3,448 Mtoe per year (table 1), of which 48% is agricultural and 44% wood biomass (SRERS 2025-2030). Wood biomass is most abundant in the mountainous regions of Central Serbia. The estimated potential of agricultural biomass from residues of agricultural crops, residues in fruit growing, viticulture and fruit processing is 1.67 Mtoe per year. Agricultural biomass is the most represented in the north of Serbia. Despite the large distribution, the potential of biomass is used in a symbolic percentage (less than 2%).

Table 1: Structure of biomass potential in Serbia

Biomass	**Available technical potential in use (Mtoe)**	**Untapped Available Technical Potential (Mtoe)**	**Total Available Technical Potential (Mtoe)**
Agricultural biomass	0,033	1,637	1,67
Remains of agricultural crops	0,033	0,99	1,023
Residues in fruit growing, viticulture and fruit processing	-	0,605	0,605
Liquid manure	-	0,042	0,042
Wood (forest) biomass	1,021	0,509	1,53
Energy plants	-	-	not available
Biodegradable waste	0	0,248	0,248
Biodegradable municipal waste	0	0,205	0,205
Biodegradable waste (except municipal)	0	0,043	0,043
In total:	1,054	2,394	3,448

Source: Energy Development Strategy of the Republic of Serbia until 2025 with projections until 2030
http://www.zelenaenergija.pks.rs/ZelenaEnergija.aspx?id=3&p=0&amp

In the period 2010-2012, biomass participated with 63% in the total production of energy from renewable sources in Serbia. In Serbia, biomass is predominantly used in the traditional way for heating, cooking or heating water. In addition to its traditional use, biomass has recently been used for the production of pellets, the production of heat energy through combustion in boilers, in specialized plants for the production of electricity and heat energy, but also as a special raw material for the production of biofuels. Biomass production in Serbia, in addition to the Energy Development Strategy of the Republic of Serbia until 2025 with projections until 2030 (Official Gazette, No. 101/2015) and the Agriculture and Rural Development Strategy of the Republic of Serbia for the period 2014-2024 (Official Gazette, No. 85/2014), is also treated in the National Action Plan for the use of renewable energy sources (Official Gazette, No. 53/2013).

According to the National Action Plan for Renewable Energy Sources, OIE with a technically usable potential of about 5.6 Mtoe per year can significantly contribute to a lower use of fossil fuels and the fulfillment of defined goals on the share of renewable sources in the total final energy consumption, as well as environmental improvement. Biomass potential is about 3.4 Mtoe per year, 0.2 Mtoe per year in geothermal energy, 0.1 Mtoe per year in wind energy, 0.2 Mtoe per year in solar energy and 0.04 Mtoe per year in the biodegradable part of waste. Serbia uses about 35% of the total available technical potential of RES. According to the Energy Balance for 2011, the share of RES in BFPE in 2009 was 21.2%. By 2020, Serbia should increase the share of RES to 27.0% (Stevanović, Stevanović, 2022).

Heat generators are most dominantly used for burning agricultural biomass. These are simple furnaces and boilers, and the use of wheat and soybean straw dominates. In recent years, the production of agro briquettes and pellets from wheat and soybean straw has increased significantly. The price of agro briquettes and pellets per ton is approximately 2.5 times higher than that of whole baled straw. This method has its advantage in terms of using automated firing. The storage space required is significantly smaller (the density is six to eight times higher), so it can be used even in houses that do not have storage space. Agro pellets, the price of which is in the range of 60-70% of the price of wood, can be used in suburban settlements.

In 2001, the EU adopted the Declaration on Renewable Sources (2001/77/EC), which represents an obligation for the legislation of EU member states, in terms of increasing the share of renewable energy sources in electricity production. In 2001, the EU adopted the Declaration on Renewable Sources (2001/77/EC), which represents an obligation for the legislation of EU member states, in terms of increasing the share of renewable energy sources in electricity production. The EU has set itself the goal of increasing the share of renewable energy sources in total energy production from 15% in 2002 to 22.1% by 2010.

In Germany, the number of biogas production plants has doubled in a very short period of time. With the dynamic development of biogas production, an increase in employment in the RES sector is expected. It is predicted that in Germany by 2020, 400,000 new jobs will be created in the energy sector. In Denmark, which is twice the size of Serbia, but one of the leading pig breeders in the world, biomass has been used for energy purposes for years. In 2000, 20 plants were built for the production of biogas from liquid pig manure and waste water from the food industry. After burning, biogas is used for the production of electricity and heat, and by processing the substrate, a very high-quality organic fertilizer is obtained. The fertilizer obtained in this way, without unpleasant odors, is returned to the farmers who use it on their fields. After the world economic crisis of the 1970s, by adopting several plans as part of its energy policy, Denmark showed how it is possible to use the potential in biomass for the production of electricity and heat. Today, it produces a sufficient amount of energy for its own needs, and 5% of energy is exported to other countries (Jordanović-Vasić, 2009).

In Sweden, there are plants for the production of thermal energy by burning straw. The collected straw from 120 ha is enough to heat 130 houses. This investment cost 520 thousand euros and will pay off in 6.7 years. Only one company already has 30 such existences, which indicates the determination of the state to seriously invest in RES, but also the profitability of such projects. Of course, in addition to this, environmental protection is also being worked on (Brkić, 2002).

Conclusion

In conditions of constant growth in the demand and consumption of energy in the world, and at the same time the increasing limitation of the amount of all types of non-renewable energy sources, as well as potentially suitable land areas on which it could be produced, biomass is emerging as a respectable alternative for energy production from RES. In addition to reduced CO2 emissions, the use of biomass through the employment of labor encourages the growth of the economy and ensures greater energy security of the country. The production of energy by recycling municipal waste achieves double effects. On the one hand, the amount of waste disposed of in landfills is reduced and thus pollutes the environment less, and on the other, the foreign currency necessary for importing energy is saved.

Today, 13% of total energy is provided from biomass. Developed countries such as Austria, Sweden and Finland produce about 20% of energy from biomass. It is estimated that by 2050 biomass will meet approximately 38% of the world's fuel needs and 17% for electricity.

Considering the respectable potential for energy production from biomass in Serbia, it is necessary to develop own technologies for its even greater use in energy production. It is estimated that around 25% of Serbia's energy needs could be met from this source. In order to make significant progress in increasing the use of biomass as RES, it is necessary to conduct a well-designed and coordinated energy policy of the country.

In order to encourage the production of energy from RES, as well as increasingly strict regulations on environmental protection, the EU introduced incentives for "kW of green energy" produced and delivered to electricity distribution operators. Serbia applies similar regulations in the area of energy production from RES. The aforementioned regulations encourage the construction of new capacities for the production of energy from RES.

The experience of developed countries has shown that the transition to the production of energy from RES must be based on the determination of the state to subsidize producers for each kW of delivered "green energy".

References

1. Brkić, M. (2002): Dostignuća u korišćenju biomase u Danskoj i Švedskoj, Traktori i pogonske mašine, 7, Beograd, str. 50-55.

2. Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.

3. Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, L 140/16, Official Journal of the European Union 5.6.2009. http://data.europa.eu/eli/dir/2008/98/oj

4. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, European Council. 5 June 2009. Retrieved 19 September 2016.

5. Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity, Official Journal of the European Communities, No L 27/20, 30.01.1997.

6. Energetski bilans Republike Srbije za 2020. godinu, Službeni glasnik RS, 94/2019.

7. Jordanović-Vasić, M. (2009): Upotreba biomase iz poljoprivrednog otpada kao obnovljivog izvora energije, Nauka+praksa, Niš, 12.1/2009.

8. Kosanović, V. (2015): Snabdevanje grada Novog Sada električnom i toplotnom energijom iz raspoloživih obnovljivih izvora energije, diplomski – master rad, fakultet tehničkih nauka, Novi Sad.

9. Kovačević, V. (2018): Korišćenje poljoprivredne biomase za energetske potrebe u Srbiji, UNDP, Ministarstvo energetike Republike Srbije, Beograd. http://biomasa.undp.org.rs/wp-content/uploads/2019/01/Agricultural-Biomass_12_01_2019_1_srpski.pdf

10. Nacionalna strategija održivog korišćenja prirodnih resursa i dobara, Službeni glasnik RS, Beograd, br. 33, 15. April 2012. http://www.zzps.rs/novo/kontent/stranicy /propisi_strategije/S_prirodnih%20resursa.pdf

11. Nacionalna strategija održivog razvoja, Službeni glasnik RS, br. 101/2007.

12. Nacionalni akcioni plan za korišćenje obnovljivih izvora energije (NAPOIE), Službeni glasnik RS, broj 53/2013.

13. Nacionalni akcioni plan za korišćenje obnovljivih izvora energije Republike Srbije (U skladu sa obrascem predviđenim Direktivom 2009/28/ EZ-Odluka 2009/548/EZ).

14. Riva, G., Foppapedretti, E., Carolis, C., Priručnik o obnovljvim izvorima energije, 2011.

15. Stevanović, S., Stevanović, Snežana (2022): Biomass as a Renewable Energy Source, Economics of Agriculture, 69(1), 195-209, Belgrade.
16. Šljivac, D. (2008): Obnovljivi izvori energije, Osijek.
17. Strategija poljoprivrede i ruralnog razvoja Republike Srbije za period 2014-2024 godine (Službeni glasnik, br. 85/2014).
18. Vodič kroz Strategiju „Evropa 2020“, Evropski pokret u Srbiji, Fond za otvoreno društvo, Srbija, Beograd. http://www.mpn.gov.rs/wp-content/uploads/2015/08/EU-2020.pdf
19. Volk, T.A., Abrahamson, L.P., White, E.H., Neuhauser, E., Gray, E., Demeter, C., Lindsey, C., Jarnefeld, J., Aneshansley, D.J., Pellerin, R., Edick, S. (2000): Developing a Willow Biomass Crop Enterprise for Bioenergy and Bioproducts in the United States, Proceedings of Bioenergy 2000. Adam's Mark Hotel, Buffalo, New York, USA: North East Regional Biomass Program.
20. Zakon o energetici, "Službeni glasnik RS", br. 145/2014, 95/2018 - dr. zakon i 40/2021). https://www.paragraf.rs/propisi/zakon_o_energetici.html
21. http://www.zelenaenergija.pks.rs/ZelenaEnergija.aspx?id=3&p=0&
22. https://agroinfonet.com/poljoprivreda/ratarstvo/energija-biomase-moze-zagrejati/
23. http://biomasa.undp.org.rs/?p=2792
24. http://www.parlament.gov.rs/upload/archive/files/lat/pdf/akta_procedura/2014/113-14Lat.pdf.
25. http://www.mre.gov.rs/doc/efikasnostizvori/02%20Nacionalni%20akcioni%20plan%20za%20koriscenje%20obnovljivih%20izvora%20energije%20u%20Republici%20Sr
26. https://ec.europa.eu/eurostat
27. http://www.mre.gov.rs/doc/efikasnost-izvori/02%20Nacionalni%20akcioni%20plan%20za%20koriscenje%20obnovljivih%20izvora%20energije%20u%20Republici%20Srbiji.pdf

ECONOMIC ASPECTS OF AGRICULTURE AND ITS IMPORTANCE FOR THE ECONOMY AND PEOPLE'S HEALTH - THE CASE OF SERBIA

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Abstract

Agriculture is an economic branch that has been known since ancient times. All countries that are developed today were agricultural countries at the beginning of their development. Agriculture provides primary products, the processing of which provides food for the entire humanity and ensures the survival of people on planet earth. The importance of agricultural production and food production is particularly visible during economic crises or war situations in any country in the world. The aim of this work is to point out the importance of agricultural production for the survival of both humans and animals, as well as the importance of healthy food production. During the writing of the paper, several methods will be used, such as the method of induction, deduction, analysis and synthesis, comparison and descriptive analysis, and in addition to these methods, field research was carried out through a telephone survey. From the content of the work, it is unequivocally concluded that agriculture is an economic branch very important for the survival of life on planet Earth, that the production of healthy food significantly affects people's health, but that producers of healthy food need the support of the state in the form of various subsidies, as well as education and use new technologies.

Key words: Agriculture, processing industry, food safety, human health.

Introduction

The number of people on earth is experiencing constant growth. Thus, in the period from 1315 to 1317 and the Black Death in 1350, there were about 370,000,000 inhabitants on earth (Biraben, Jean-Noël, 1980). Since then, the population has continued to grow. What statistics have recorded is that the highest growth in world population was between 1965 and 1975 when the growth was 2.06% per year (UN, 2022). After 2015, there is a decrease in population growth so that the growth rate is 1.18%. According to existing estimates, the number of inhabitants on planet earth in 2050 will amount to over 9 billion inhabitants. In fact, this means that we need to produce healthy food for 9 and more billion inhabitants. However, according to FAO data (FAO, 2022), the number of hungry people in the world increased by 828 million in 2021 compared to 2020. The United Nations estimates that by 2030 there will be no reduction in hunger in the world, but that there may be a further increase. In addition to the lack of food in the world, the UN points out the problem of the lack of healthy food as well as the methods by which the costs of producing healthy food can be reduced and thus reduce the impact of food on human mortality.

The joint report on the state of hunger in the world was submitted by: the Food and Agriculture Organization of the United Nations (FAO), the International Fund for Agricultural Development (IFAD), the United Nations Children's Fund (UNICEF), the UN World Food Program (WFP) and the World Health Organization (WHO).

Their joint data is very bleak considering that they concluded the following:

1. 828 million people were affected by hunger in 2021,
2. billion people in the world were affected by food insecurity, so they were not hungry, but their diet was insecure, i.e. on the verge of starvation[12].
3. Women's food insecurity is increasing compared to men's. Thus, in 2021, the gap between the food insecurity of women and men is about 4%, while in 2020 it was 3%.
4. Around 3.1 billion people in the world could not use healthy food in 2020, which is a consequence of the increase in food prices and the measures taken in the fight against Covid-19.
5. It was estimated that 149,000,000 children under the age of 5 had stunted growth and development due to a lack of basic nutritious food, and at the same time 39,000,000 children of the same age were obese, which speaks of the inequality between the rich and the poor. on the one hand, and the way of eating, on the other hand[13].
6. It is predicted that 670,000,000 people will face hunger in 2030 regardless of the possible recovery of the world economy.

To this gloomy picture of the prospects of hunger in the world should be added the ongoing conflict in Ukraine involving two of the world's largest producers of basic life grains, artificial fertilizers, energy sources, etc., which further disrupts the already broken supply chains caused by the Covid-19 pandemic. Such a negative perspective will most affect the poor and the poorest countries in the world, which at the same time means that the goals of the UN that there will be no hunger in the world by 2030 will most likely not be realized, and at the same time inequalities in the world will increase. Many international organizations are concerned about this situation. It is important to point out that UNICEF is concerned about the huge number of malnourished people, especially children. That is why this organization emphasizes that all possible measures must be

[12] Author’s note.
[13] Author’s note.

taken to ensure that the most exhausted children have enough healthy food, as well as to provide treatment for malnutrition. A large number of children in the world suffer from lack of food and any prolongation of measures to reduce the number of children suffering from lack of healthy food can be fatal for their lives. The World Health Organization points out that around 11,000,000 people die annually in the world because of unhealthy food. Bearing in mind that the supply chains have been disrupted and broken due to the Covid-19 pandemic for more than two years, that these supply chains are deteriorating due to the war conflict in Ukraine, resulting in an increase in the prices of all necessities of life, especially healthy food, the situation in the world, especially in poor countries, is even more difficult.

That is why the World Health Organization strives for its goals to fight hunger and malnutrition in the world to be met by 2030, but with complete uncertainty about achieving those goals.[14].

Agricultural production and new technologies

The data from the previous chapter unequivocally show that on planet Earth, which is abundant with numerous resources, there are a large number of people who are either hungry or on the verge of starvation. Also, it is not unknown that the development of new technologies contributed to the organization of scientific research on the moon and other planets, to the organization of tourist trips into space (Beslac, Coric, 2017;), then the question arises why in the 21st century there is a large number of people who are hungry or on the verge of starvation or, even worse, dying of hunger and malnutrition. The authors of this paper believe that the existing resources on the planet earth and the technology that the inhabitants of the planet earth have at their disposal today cannot possibly be the cause of a large number of people being hungry, or on the verge of starvation, or dying of hunger.

The resources of individual countries cannot be the cause of food shortages and hunger, because there would have to be human solidarity and empathy. Also, if it is taken into account that certain countries such as Israel or the Netherlands (Beslac, 2013) do not have enough of their natural resources for food production, but still with their active measures they produce enough food for their population and for export. The Netherlands "steals" the land from the sea and thus provides agricultural land, while Israel provides the production of agricultural products in the desert. If only these two countries are compared with Serbia, which has enormous agricultural potential for all branches of agricultural production, then it should not have any worries about feeding its population with healthy food, and also providing large quantities of healthy food for export. It is not unknown that agricultural production is a specific production that has a

[14]The authors of the paper believe that these proclaimed goals of the WHO will not be achieved because it is not in the interest of the most developed countries in the world and multinational companies.

relatively long time cycle and that it largely depends on numerous natural factors such as the size and quality of the land, relief and configuration of the land, climate, etc. (Frohber, K. 2005), but also it is also a factor that directly depends on the agricultural policy. It depends on the agricultural policy (Sevarlic, Tomic, 2010) how much will be allocated to the agricultural budget from the budget of each individual state and why these funds will be used. Any agricultural policy should bear in mind that the functions of agriculture are multiple and multi-dimensional, that they bind other economic branches such as processing industry, trade, tourism, catering, etc. and that at the end of the day, agriculture provides life for both humans and animals (agriculture provides food for people, and without food for people there is no life). There are a large number of countries in the world that produce agricultural products beyond the needs of their population, which would mean that all produced surpluses can be exported. Today's trade exchange is based on the principle that for a certain market it is necessary to produce products at the time when the market is looking for those products, in the quality that the market is looking for and at prices that the market can bear (Beslac, 2017). Developed countries support agricultural production with significant subsidies, which makes them more competitive in other markets, which at the same time motivates agricultural producers to engage in agricultural production.. Кад је ријеч о земљи Србији онда се недвосмислено закључује да последњих деценија опада број људи који се бави пољопривредом. Namely, in 1948, 73% of the population was engaged in agriculture, and in 1981, 19% of the population (Beslac, 2013). Such a sudden reduction of the population engaged in agriculture has not been recorded in any country, which results in the import of finished agricultural products despite the huge own agricultural resources.

Agricultural potentials of the Republic of Serbia

The Republic of Serbia has extremely favorable natural potentials for agriculture. In addition to the autonomous province of Vojvodina, which represents part of the Pannonian Plain and the granary of Europe, there are areas in Central and Southern Serbia that are very suitable for fruit growing, viticulture, vegetable growing, beekeeping, fruit growing, etc. Also, three large European rivers flow through Serbia (Danube, Sava, Tisza), then there are three Morava, Ibar, etc. The climate is continental in the north, moderate-continental in the south and mountainous in the high mountains. So, these are all favorable conditions for the development of agriculture.

The autonomous province of Vojvodina is objectively the largest and most significant agricultural potential of the Republic of Serbia, because this territory is suitable for the cultivation of all types of agricultural products (fruit growing, vegetable growing, fruit growing, beekeeping, viticulture, etc.). It is important to point out that the Danube-Tisa-Danube (DTD) canal was built through the territory of Vojvodina back in 1977. It should be used to irrigate agricultural areas during the season when there is not enough natural precipitation and to drain internal waters. Also, this canal is planned for navigation, flood defense, tourism and fishing. The DTD canal is 960 km long, of which 600 km is navigable. It was built according to the principle of connected vessels, which means that it has the same water level, while there is water in the Danube and Tisza, and these two rivers have never dried up. This canal is expected to be able to irrigate a total of 510,000 ha, but unfortunately it currently irrigates only 30,000 ha.

Agricultural production in the Republic of Serbia and its impact on the overall economy and GDP

In economic theory, and especially in politics, the opinion that agricultural countries are poor and underdeveloped is often represented. Developed countries are those countries that have developed industry, new technologies, etc. However, the proponents of such attitudes forget that agriculture, that is, food provides people's lives, that if a country does not have enough food either from its own sources or from the sources of other countries, it faces hunger. As has been said so far, the Republic of Serbia has great potential for agricultural production, that is, food production. That is why agriculture has a higher share in GDP, if compared to developed countries.

Table 1. Overview of the share of agriculture in the GDP of the Republic of Serbia in selected years.

Description	Share in GDP in %				
Years	**2016**	**2017**	**2018**	**2019**	**2020**
A - Agriculture, forestry and fishing	6,8	6,0	6,3	6,0	6,3
01. Agricultural production, hunting and related service activities	6,5	5,7	6,0	5,7	6,0
02. Forestry and tree felling	0,3	0,3	0,3	0,3	0,3
03. Fisheries and aquaculture	0,0	0,0	0,0	0,0	0,0

Source: Republic Institute for Statistics of Serbia, accessed on 19.07.2022. years.

According to Eurostat data, the average share of EU countries' agriculture in the total EU GDP is 1.3%. This means that agriculture in Serbia contributes several times more to its GDP than the EU countries do to the total GDP of the EU. Therefore, it could be concluded that Serbia belongs to underdeveloped and poor countries. However, it should be borne in mind that Serbia's agriculture would have a larger share of GDP if it had a developed processing industry and possessed the latest technologies in agricultural production. Serbia produces surpluses of primary agricultural products, which it exports without further stages of processing, and in that way, in fact, enables importers of primary agricultural products to earn more than producers in Serbia. It should also always be borne in mind that agricultural products are a condition for the nutrition of people and animals that ensure life. And only living and healthy people can develop new technologies in all areas of human life. Likewise, we are witnessing that in 2022, due to the war in one part of the European continent (Russia and Ukraine), the fear of hunger prevailed almost all over the world, especially in countries that do not have natural resources for agricultural production. Therefore, regardless of the fact that high technology brings high incomes, agricultural production, that is, food, will always remain as a condition for the survival of life, growth and development in all areas on planet earth.

Production of healthy food

In the race for ever-increasing returns, new technologies are of immense importance. New technologies enable better and faster processing and cultivation of all agricultural products, higher yields in fruit growing, viticulture, beekeeping, etc. In this sense, the chemical industry has developed a large number of different pesticides and other chemical agents in order to protect plant crops from various diseases, as well as animal feed. Previous experience has shown that agricultural products, and thus food for both humans and animals, are safer than products that have been produced through genetic engineering or the use of high doses of various pesticides. Such agricultural products reach humans through the food chain and contribute to the development of various types of diseases or intensify them. For the purposes of this work, a survey was conducted to determine how much farmers in Serbia are aware of the harmfulness of excessive use of various protective agents in order to achieve higher yields and less work.

Description of the sample:

Sample: 126 farmers from the Network of Young Farmers and the Association of Small Farmers[15].

Geographical location: The entire territory of the Republic of Serbia.
Area of land to be cultivated: 1 ha to 10 ha
Production: vegetable crops, fruit, meat products, fruit and vegetable products.
Form and method of the survey: By telephone - direct telephone conversation

Research results:

Table 2. Production of healthy food

Are you producing completely healthy food?	**Yes**	**No**	**I believe it is healthy**
	96 %	0%	4%

[15] Due to the busyness of small producers and their lack of zthe desire to answer questions, the sample could not be larger, but based on this sample, valid conclusions can be drawn, according to the authors.

The results of the answers to the question show that small producers, who have a license to produce healthy food, predominantly claim to produce healthy food. Only 4% have little doubt that their products are not completely healthy.

Table 3. Use of protective equipment

Do you only use preservatives prescribed for ecologically healthy food?	**Yes**	**No**
	100 %	0%

The results of the answers to the question show that small producers use protective means that are prescribed for ecologically healthy food. The authors of this paper are not completely convinced whether it is exactly so**.**

Table 4. Is the harvesting done within the prescribed time from the day of use of the protective means?

Do you know what a grace period is?	**Yes**	**No**
	87 %	13%

The answers to this question show that a small percentage of healthy food producers do not know what the withdrawal period is, which can immediately have the effect that picking and production can take place during the time when protective agents are still in effect, which can also have an effect on their products they are not completely ecologically safe

Conclusion

There are a large number of economists' opinions that agriculture as a branch of economic activity has a high share in GDP only in less developed and underdeveloped countries. At first glance, there is nothing to complain about such attitudes, especially if you consider the statistical data that the most developed countries have a low share of agricultural production in GDP. However, very often the reasons why agriculture in less developed and underdeveloped countries has a high share of agricultural production in GDP are not analyzed. The reason for this is quite simple. Less developed and underdeveloped countries lack high technology so that they produce primary agricultural products that they use for their own needs as well as for export. Developed countries possess high technology (they do not share it with less developed and underdeveloped countries in order not to allow them additional stages of processing) so they process imported primary agricultural products into finished products and thus achieve greater added value and a high participation of the processing industry in GDP. As for Serbia, it has very high potential for agricultural production, produces primary agricultural products, but does not have a sufficiently developed processing industry, which is why the share of agricultural production in GDP is significantly higher than the share of developed countries. The Republic of Serbia has very significant potential for the production of healthy food, but for its further development, in addition to the support of the state through various subsidies, education and training of young producers, who have the desire to engage in the production of healthy food, are needed. Agricultural production and the production of healthy food encourage not only agricultural production, but it also has a positive impact on other economic branches, such as trade, tourism, catering, etc.

References

1. Babovic J. (2010.), Reunification - a condition for agrarian development and organic agriculture in Serbia, International Symposium, Center for Strategic National Security Research, Belgrade, Sijariska Banja.
2. Beslac M. (2022.): International Economics, College of Business Economics and Entrepreneurship, Belgrade, International Economics, College of Business Economics and Entrepreneurship, Belgrade, p. 51
3. Beslac M., Jovancevic D, (2013.), Serbia as anagricultural country, the second international conference Emoloyment, Educationand Entrepreneurship, October Belgrade Serbia, p. 256-266.
4. Biraben, Jean-Noël (1980.). An Essay Concerning Mankind's Evolution. **4**. Population, Selected Paper 1—13.
5. Frohber, K. (2005.): Special Issue Plenary Paper from XI EAAE Congress, Kopenhagen, Vol. 32. No.3. p. 229-300.
6. Miladin S., Danilo T. (2010.): Agricultural industry of Serbia and European integration: (not) adaptation to the mutual application of the transitional trade agreement: thematic collection, Association of Agrarian Economists of Serbia, p. 133.
7. Milan B. (2013.): Serbia - factory without a roof – why not, in The Monograph: Moral effects of economy and economic effects ofmorality, Belgrad, ISBN 978-86-86707-58-1 str.19-29, COBISS.SR-ID 1990022348. available on: http://www.nomos-elibrary.de/ 10.5771/1435-2869-2013-2-221/ serbia-a-factory-without-a-roof-jahrgang-16-2013-heft-2
8. Milan B., Goran Coric (2017.): Financial and production aspects of genetically modified organisms, Economics of Agriculture, p. 1583-1595, ISSN 0352-3462, UDC 338.43:63, available on: http: //www.bsaae.bg.ac.rs/ images/Ekonomika%20kompletna/2017/ EP%204%202017lq.pdf
9. Milan J., Adrijana J. B., Aleksandra G., Ljubomir M. (2022.): Organic economy and climate change, Ekologica No. 106, COBISS.SR-ID802631175, p.193-200.
10. Van der Wert, H., Knudsen M., Cederberg C., (2020): Towards better representation of organic agriculture in life cycle assessment. Nat. Sustain. 3 no 419-425.

Internet sources

1. World population prospekts – Population Divizion – United Nations, access 18.07.2022.
2. https://www.fao.org/newsroom/detail/un-report-global-hunger-SOFI-2022-FAO/en accessed 18.07.2022
3. https://www.fao.org/newsroom/detail/un-report-global-hunger-SOFI-2022-FAO/en.
4. World population prospekts – Population Divizion – United Nations, accessed 18.07.2022. godine
5. https://www.fao.org/newsroom/detail/un-report-global-hunger-SOFI-2022-FAO/en accessed 18.07.2022.
6. https://www.fao.org/newsroom/detail/un-report-global-hunger-SOFI-2022-FAO/en.

THE ROLE OF THE QUALITY OF AGRICULTURAL PRODUCTS ON THE DEVELOPMENT OF AGRICULTURAL FARMS

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Abstract

Product quality in modern business conditions is a condition for the survival of all organizations. Providing quality agricultural products has become the goal of all agricultural producers in the world because customers in today's markets demand products that are healthy, unique and that match their quality value systems. The strategy of agriculture and rural development of the Republic of Serbia for the period from 2014 - 2024 points to the fact that, "the market of agricultural and food products is one of the most competitive markets, where producers, especially those who export food to the market of member countries, are often EU, set additional requirements for the application of certain standards, initiated, first of all, by large retail chains, but also by consumers". The purpose of this work is to indicate the role of the quality of agricultural products in the development of agricultural farms in the Republic of Serbia through the conducted research.

Key words: Quality, agricultural products, agricultural holdings, farms

Introduction

Today, quality is the basis for achieving competitiveness on the market. Maximum product quality with minimum production costs is the goal of all today's organizations. If we start from the definition of a product as the result of a business activity, we could say that a product represents the way in which each company harmonizes its capabilities, available resources with the needs and demands of the customer in an effort to satisfy them (Vujicic, Vukadinovic, Nikolic, 2011). As a term, quality is often used in everyday life, and everyone has a good idea of what is good and what is bad quality (Marinković, Senić, 2012). In their works, many authors have dealt with issues of quality and the factors that affect it (Milanović, Nikitović, Vujičić, 2020; Stikić, Nestić, Marković,2011; Auriol, Schilizzi ,2015; Dana, Fong,2011; Kranton, 2003). Today there are many definitions of quality that differ because they were created in different contexts and time periods. Juran believes that quality is primarily a business, not a technical matter, and that the survival of organizations depends on their ability to satisfy social needs for quality (Kilibarda, Zečević, 2016). Users believe that the quality of the product can be: superior, average and inferior. Superior quality implies a product of high quality, high prices, but easier conditions when negotiating the sale, while Inferior product quality gives us low prices, and in order to make a profit, a large turnover must be achieved[6]. Depending on what customers are looking for and how they view the relationship between quality and price, the company can make a plan of what quality products to produce.

Product quality in agriculture

It could be said that the improvement of quality in agriculture is the key to Serbia's successful cooperation with the world, primarily with the countries of the European Union. In the last decade, one of the central market trends is the increase in quality requirements, whereby appearance, taste, nutrition, production process, fair trade etc. come into focus. Customers want products that are healthier, fresher, unique and that match their value systems (SEEDEV, 2017). This attitude of customers requires price competitiveness or competitive quality from manufacturers who want to survive on the market.

The strategy of agriculture and rural development of the Republic of Serbia for the period from 2014 to 2024 (Official Gazette of the RS", no. 85/2014) points to the fact that, "the market for agricultural and food products is one of the most competitive markets, where very often , producers, especially those who export food to the market of EU member states, place additional requirements for the application of certain standards, initiated, first of all, by large retail chains, but also by consumers. As today's customers demand products that guarantee a better taste and a higher level of quality, there has been a "turn towards quality" in the agri-food sector in Europe, where there is an increasing movement from the industrial world (with a large number of standardized quality conventions and the logic of mass production) towards "domestic production" where quality rules embedded in trust and tradition, and products and forms of economic organization diverse, localized and ecological (Goodman, 2013).

Empirical research

In order to investigate the quality of agricultural products on the development of agricultural farms in the Republic of Serbia, empirical research was conducted through a survey questionnaire on a sample of 363 respondents in the period from April to June 2022. Questionnaires were distributed in written and electronic form to respondents. On the basis of the above, the system model shown in Figure 1 was created, which consists of the following variables:

Variable 1 - Product Quality (QP)

Variable 2-promotional activities (PA)

Variable 3 - development of agricultural holdings (RPG)

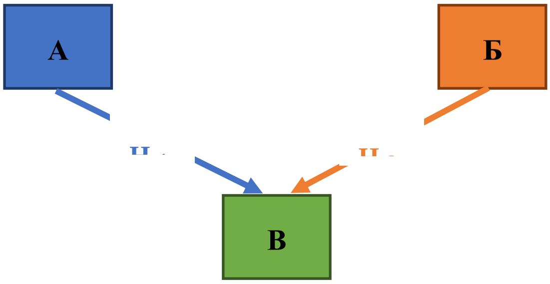

Figure 1. Theoretical system model of research

Surce: Authors

Correlation analysis

Figure 2 shows the Pearson correlation values. The highest correlation coefficient is the connection between the independent variable product quality and the dependent variable development of agricultural holdings, which is 0.7854 and it is strong. The smallest correlation coefficient is the association between the independent variables product quality and promotional activity, which is 0.2799 and it is relatively weak.

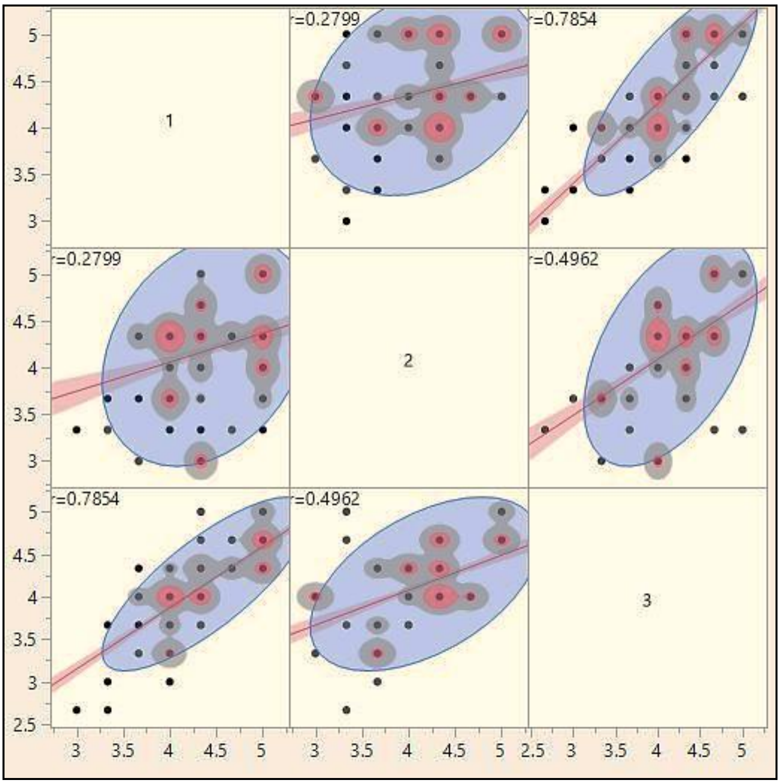

Figure 2. Correlation of the formed model

Surce: Authors

Regression analysis of product quality variables and promotional activities

Table 1 shows the basic evaluation of the model. The coefficient of determination is 0.618905, which means that with 61.89% of the variability, the dependent variable, the development of agricultural holdings (RPG), can be explained by the independent variable, product quality (QP). The correlation between the variables is strong.

Table 1. Evaluation of the model for the RPG and QP variables

Rsquare	0.618905
RSquare Adj	0.617849
Root Mean Square Error	0.267172
Mean of Response	4.158861
Observations (or Sum Wgts)	363

Surce: Authors

The assessment of statistical significance is given in table 2, and it amounts to [F(1,361)=586,2705, p<0,0001].

Table 2. ANOVA for QP and RPG variables

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	41.848364	41.8484	586.2705
Error	361	25.768410	0.0714	Prob > F
C. Total	362	67.616774		<.0001

Surce: Authors

Table 3 shows the size of the contribution of the independent variable product quality to the dependent variable development of agricultural holdings, and it amounts to 0.786705. Based on these data, the alternative hypothesis H_{a1} can be confirmed: The level of product quality affects the level of development of agricultural holdings.

Table 3. Contribution coefficients for QP and RPG variables

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	0.8817577	0.136069	6.48	<.0001	0	.
A	0.7419472	0.030642	24.21	<.0001	0.786705	1

Surce: Authors

Based on the data from the previous table, a regression equation (formula 1 and 2) can be formed, which reads:

$$y = 0{,}8817577 + 0{,}7419472 \cdot x_1 \tag{1}$$

or

$$V = 0{,}8817577 + 0{,}7419472 \cdot A \tag{2}$$

Regression analysis of variables of promotional activity (PA) and development of agricultural holdings (RPG)

Table 4 shows the basic evaluation of the model. The coefficient of determination is 0.260551, which means that with 26.05% of the variability, the dependent variable, the development of agricultural holdings, can be explained by the independent variable of promotional activity. The connection between the variables is medium strong.

Table 4. Evaluation of the model for the variables PA and RPG

Rsquare	0.260551
RSquare Adj	0.258502
Root Mean Square Error	0.372158
Mean of Response	4.158861
Observations (or Sum Wgts)	363

Surce: Authors

The assessment of statistical significance is given in table 5, and it amounts to [F(1,361)=127,2010, p<0,0001].

Table 5. ANOVA for variables B and V

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Model	1	17.617587	17.6176	127.2010
Error	361	49.999187	0.1385	Prob > F
C. Total	362	67.616774		<.0001

Surce: Authors

Table 6 shows the size of the contribution of the independent variable PA to the dependent variable RPG and it amounts to 0.510442. Based on these data, the alternative hypothesis H_{a2} can be confirmed: The level of promotional activities affects the level of development of agricultural holdings.

Table 6. Contribution coefficients for PA and RPG variables

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	2.406535	0.156594	15.37	<.0001	0	.
B	0.4209758	0.037326	11.28	<.0001	0.510442	1

Surce: Authors

Based on the data from the previous table, a regression equation can be formed (formula 3 and 4), which reads:

$$y = 2.406535 + 0,4209758 \cdot\cdot x_2 \quad (3)$$

or

$$V = 2.406535 + 0,4209758 \cdot B \quad (4)$$

Multiple regression analysis for variables product quality, promotional activities and development of agricultural holdings

Table 7 shows the basic evaluation of the model. The coefficient of multiple determination is 0.696425, which means that with 69.64% of the variability, the dependent variable, the development of agricultural holdings, can be explained by the independent variables: product quality and promotional activities. The connection between the variables is strong.

Table 7. Evaluation of the model for the variables QP, PA, RPG

Rsquare	0.696425
RSquare Adj	0.694739
Root Mean Square Error	0.238786
Mean of Response	4.158861
Observations (or Sum Wgts)	363

Surce: Authors

The assessment of statistical significance is given in Table 8, and it amounts to [F(2,360)= 412.9347, p<0,0001].

Table 8. ANOVA for variables A, B and V

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	47.090028	23.5450	412.9347
Error	360	20.526746	0.0570	Prob > F
C. Total	362	67.616774		<.0001

Surce: Authors

Table 9 shows the size of the contribution of the independent variables to the dependent variable RPG. The higher contribution has the independent variable QP and it amounts to 69.50%, and the smaller contribution has the independent variable PA and it amounts to 29.31%. The multiple correlation coefficient is 0, 0.83452 and it is strong. Based on these data, the alternative hypothesis Ha can be confirmed: The levels of product quality and promotional activities affect the level of development of agricultural holdings.

Table 9. Contribution coefficients for the variables QP, PA and RPG

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	0.2572594	0.137957	1.86	0.0630	0	.
A	0.6555123	0.028832	22.74	<.0001	0.695056	1.1083531
B	0.241745	0.025213	9.59	<.0001	0.293121	1.1083531

Surce: Authors

Based on the data from the previous table, a multiple regression equation (formula 5 and 6) can be formed, which reads:

$$y = 0{,}2572594 + 0{,}6555123 \cdot x_1 + 0{,}241745 \cdot x_2 \tag{5}$$

or

$$V = 0{,}2572594 + 0{,}6555123 \cdot A + 0{,}241745 \cdot B \tag{6}$$

Conclusion

In today's business conditions, product quality should be focused on the current and future needs of users. We can say that quality represents a set of activities on the basis of which the product's suitability for use is achieved. Product quality plays a very important role in the survival of agricultural farms because today's market for agricultural products requires high-quality agricultural products with affordable prices.

Research on the impact of product quality and promotional activities on the development of agricultural farms showed that as the level of product quality increases, so does the level of development of agricultural farms. As the level of promotional activities increases, so does the level of development of agricultural holdings. As the levels of product quality and promotional activities grow, so does the level of development of agricultural holdings.

References

1. Auriol, E.,. Schilizzi S. (2015),*„Quality signaling through certification in developing countries”* Journal of Development Economics, 116, 105-121.
2. Dana, J., Y.-F. Fong (2011)*„Product quality, reputation and market structure„* International Economic Review, 52(4), 1059–1076.
3. Gudman, D. (2013) *„The quality ‘turn’ and alternative food practices: reflections and agenda„* Journal of Rural Studies, 19(2013), str. 1-7.
4. Kilibarda, M., Zečević S., (2016) *Upravljanje kvalitetom u logistici*, Univerzitet U beogradu, Saobraćajni fakultet, Beograd
5. Kranton, R. (2003)*„Competition and the incentive to produce high quality„* Economica, 70, 385–404
6. Marinković V., Senić V.(2012)*„ Analiza elemenata kvalitetat usluga u korporativnom bankarstvu* „ Ekonomski horizonti, godište 14, Sveska 1, 13-22, Ekonomski fakultet Kragujevac
7. Milanović M., Nikitović Z., Vujičić S. (2020) T*he importance of the quality of the agricultural product for sustainable success of agricultural holding*, International Review, ISSN 2217-9739 br. 3-4, str. 105-112
8. SEEDEV(2017*) Konkurentnost privrede Srbije*.
9. Stikić, D., Nestić,S., a Marković, d. (2011) „*Kvalitet proizvoda-temelj konkurentnosti*„ Festival kvaliteta 2007, 34.Nacionalna konferencija o kvalitetu, Kragujevac
10. Vujicic, S., Vukadinovic, S., Nikolic, I. (2011) *Kvalitet kao faktor konkurentske prednosti*, Svarog, 3/2011.

WOMEN'S ENTREPRENEURSHIP IN AGRICULTURE

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Abstract

The restructuring of the economy and the transition process in Serbia have resulted in a high level of unemployment, and women are particularly vulnerable social groups. The agricultural sector in the Republic of Serbia is recognized as an important sector for the employment of women because women are more and more the owners of agricultural farms and through various associations they use the incentives that are given for the development of agriculture. Within the National Program for Agriculture and Rural Development of the Republic of Serbia for the period 2015−2020 within the measures foreseen in the selection criteria, priority is given to entrepreneurs, i.e. women owners of agricultural holdings, given the data that indicate the manifestation of gender inequality through an imbalance in the performance of managerial and executive tasks on the farm (the share of female owners of holdings, whose name is runs the farm, is only around 17%, while their participation is in the capacity of decision-makers regarding the organization of agricultural production on the farm (16%) and the permanent workforce on the farm (14.8%). The purpose of the work is to examine the possibilities for the development of female entrepreneurship in agriculture and to point out the obstacles that threaten that development.

Key words: Female entrepreneurship, agriculture, associations

Introduction

Unemployment has been a very important topic in many countries in recent years. In their works, many authors have dealt with issues of unemployment and the factors that affect it (Kovačević, Vujičić, Nikitović, 2015; Radović Marković, Salamzadeh, Vujičić, 2019; Cvijanović, Pantić, Ignjatijević, 2019; Anić, Mladenović, 2020; Radovic-Markovic, Vujičić, Medić, 2021). According to the Report of the Statistical office of the Republic of Serbia (Labor Force Survey in the Republic of Serbia, 2021), the number of employees in the Republic of Serbia in 2021 was 2.848.800. This is 72.100 (or 2.6%) more compared to 2020. year, while the number of unemployed in 2022 was 352.400 and compared to 2020, it is higher by 53.200 (or 17.8). Kirszner's theory emphasizes that entrepreneurship improves the rate of self-employment and thus employment in the country. Economists and policy makers consider this theory the most because a decline in the rate of entrepreneurship tends to increase the rate of unemployment. Improvements in entrepreneurial activities lead countries to poverty reduction, unemployment reduction and rapid economic development. The process of equalizing men's and women's rights as well as the democratization of the entire society in recent years have led to the emergence and development of female entrepreneurship. As the main motive for starting a private business among women in Serbia, we can cite the need to provide means for existence, both for themselves and for their family (Nikitović, Vujičić, 2021). Also, some of the most frequently mentioned motives of women for establishing their own business are: the desire to use and apply the experience and knowledge gained from previous jobs in their own business, the opportunity for higher earnings as a measure of success in business, the desire to actively participate in social life and a sense of belonging and utility in society, the pursuit of employment and income for life (Vukmirovic, 2005). Special attention should be paid to female entrepreneurship today, because its development creates preconditions for opening new jobs, both for female entrepreneurs and for others, which also enables economic development and the development of society as a whole (Nikitović, Vujičić, 2021).

Women's entrepreneurship in Serbia

That the development of female entrepreneurship is a trend of the 21st century is also shown by the fact that there is an increasing number of companies headed by women in the world (Vujičić et. al.2012). In Serbia, only 26% of companies are owned by women, i.e. only every fourth woman owns a small business. Starting and maintaining one's own business is one of the strategies for the economic development of women oriented towards entrepreneurship (Nziku,2012). At the top of the ownership (management) hierarchy of every fourth company is a woman, mostly in smaller companies whose activities are health services and salons for care and recreation.

Within the strategic, institutional and regulatory framework in the Republic of Serbia, entrepreneurship is recognized as a way to improve the economic participation of women and achieve gender equality (Government of the Republic of Serbia, 2015; 2021a; 2021b).

According to the Report of the Agency for Economic Registers, the percentage of women entrepreneurs has recorded an increase in the period of the last three years (Figure 1).

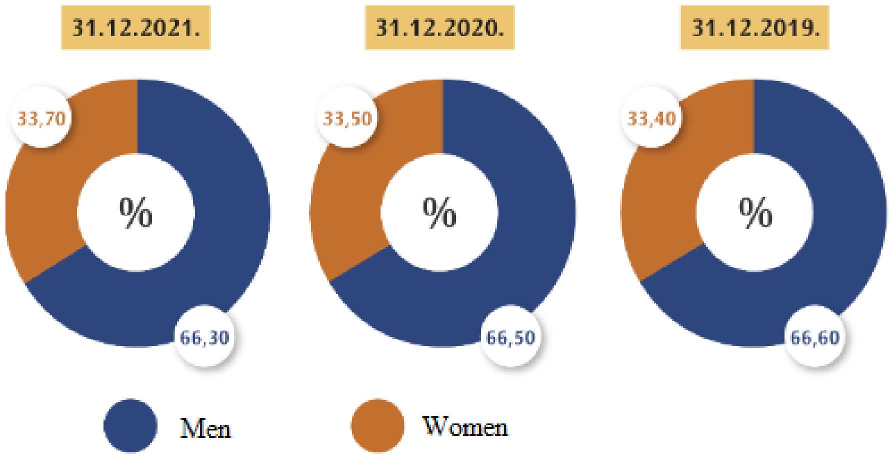

Figure 1: Percentage of registered entrepreneurs, women-men

Source: Agency for Economic Registers https://www.apr.gov.rs/%D0%B8%D0%BD%D1%84%D0%BE%D0%B3%D1%80%D0%B0%D1%84%D0%B8%D0%BA%D0%B5.4318.html?infoId=132

Table 1. shows the number of active companies, entrepreneurs and domestic associations as of December 31, 2021. The number of representative companies in which the representatives are women is almost three times smaller than the number of companies in which the representatives are men, which can be seen in the previous picture.

Table 1: Number of active non-profit organizations and entrepreneurs

ACTIVE ON 12/31/2021. Years		
Representatives of commercial companies	**Number of companies**	**Number of representatives**
Women	124.260	31.978
Men		94.858
Company founders	**Number of companies**	**Number of founders**
Women	124.260	43024
Men		125225
Founder entrepreneurs	**Number of entrepreneurs**	**Number of founders**
Women	290.445	96.149
Men		189.425
Local associations and unions	**Association number**	**Number of representatives**
Women	35.731	12.539
Men		26.763

As for the companies in which the founders are women, it can be noted that also much smaller than companies founded by men.

Women's entrepreneurship in agriculture

In our country, agriculture is positioned as a very important potential in overall social and economic development, taking into account the quality and quantity of available resources, rich tradition and favorable geographical position (Marković, 2010, p. 273). In table 2. we can see employment by sector of activity, gender and region. It is noticeable that the number of women employed in the field of agriculture, forestry and water management is much smaller than the number of men employed in this activity (Table 2).

Table 2: Employees by sector of activity, gender and region, 2021 (in thousands)

Employees by sector of activity, gender and region, 2021 (in thousands)								
	Republik of Serbia							
Staff (15-89)	Total	**Gender**		**Serbia- north**		**Serbia- south**		
		male	female	Belgrade region	Vojvodina region	Region of Sumadia and Western Serbia	Region of Southern and Eastern Serbia	Region Kosovo and Metohija
	2848,8	1595,4	1253,4	755,2	774,5	786,4	532,7	—
No answer	—	—	—	—	—	—	—	—
Agriculture, forestry and fishing	426,3	260,8	165,5	22,5	112,6	203.9	87,3	—
Mining	36,1	32,2	3,9	12,8	5,4	9,1	8,8	—
Manufacturing industry	563,8	335,6	228,2	87,4	190,3	168,6	117,4	—
Supply of electricity, gas and steam	37,0	29,6	7,4	12,8	7,7	6,4	10,1	—
Water supply and waste water management	39,1	30,9	8,2	7,6	9,8	13,5	8,2	—

The survey on the structure of agricultural farms - Labor force and work on agricultural farms - state and trend (2018) showed that women are only 19.4% of family farm owners, which is significantly lower than their participation in the total farm workforce of 42.3 % and indicates unequal access to a position that is associated with greater power and responsibility on the farm. If we look at the period from 2012-2018, the participation of women among the owners of farms has increased, in all regions (Figure 2).

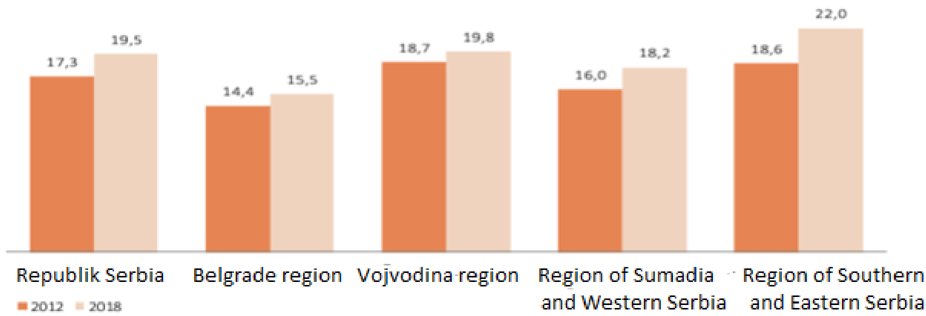

Figure 2: Share of women among heads of family farms, 2012 and 2019 (%)

Research by individual authors has shown that women entrepreneurs in agriculture have a number of specific obstacles to successful business, such as inadequate infrastructure, distance from the market, lack of professional and motivated staff that could be employed, inadequate state support and discrimination against women in business, especially young women and especially in rural areas.

Empirical Research

In order to investigate the factors that influence the development of female entrepreneurship in agriculture in the Republic of Serbia, an empirical research was conducted through a survey questionnaire on a sample of 396 respondents in the period from May to June 2022. Questionnaires were distributed in written and electronic form to respondents. On the basis of the above, the system model shown in Figure 5 was created, which consists of the following variables:

Variable 1-State incentives-SI

Variable 2-Incentives of banks-IB

Variable 3-Women's entrepreneurship in agriculture-WEA

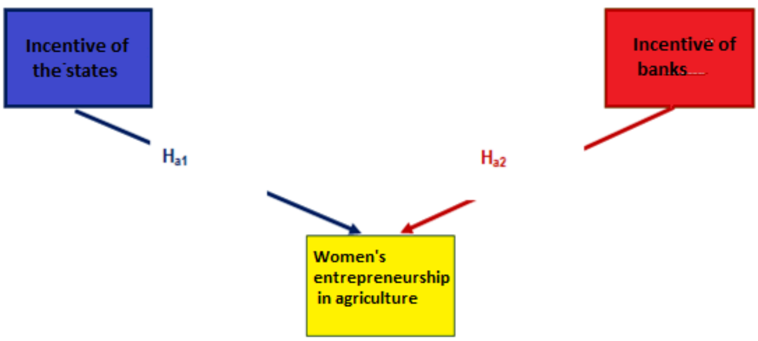

Figure 3: Theoretical system research model

Correlation analysis

Figure 4 shows the Pearson correlation values. The highest correlation coefficient is the connection between independent variable 1 and dependent variable 3, it is 0.7854 and it is strong. The smallest correlation coefficient is the connection between independent variables 1 and 2, it is 0.2799 and it is relatively weak.

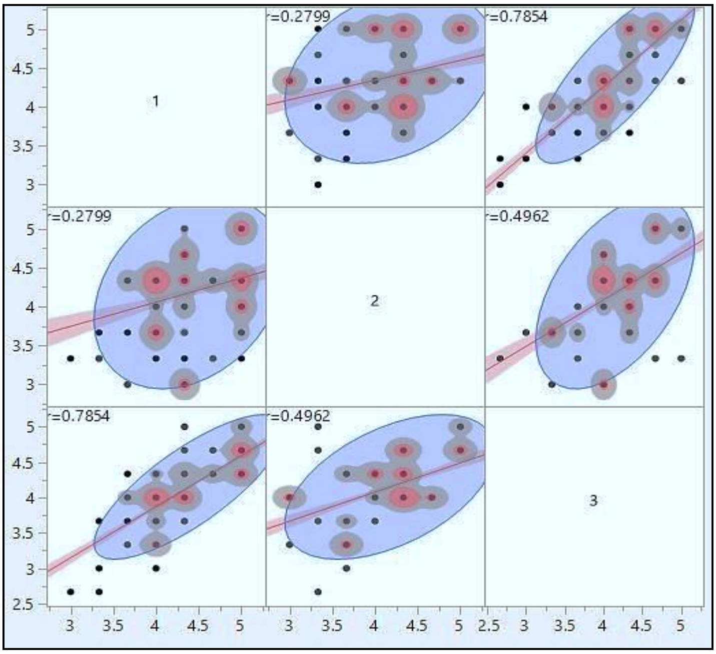

Figure 4. Correlation of the formed model

Source: Author

Regression analysis of variables 1 and 3

Table 3 shows the basic evaluation of the model. The coefficient of determination is 0.616893, which means that with 61.68% of the variability, dependent variable 3 can be explained by independent variable 1. The connection between the variables is strong.

Table 3. Model evaluation for variables 1 and 3

Rsquare	0.616893
RSquare Adj	0.615921
Root Mean Square Error	0.25879
Mean of Response	4.14899
Observations (or Sum Wgts)	396

Source: Authors

The assessment of statistical significance is given in table 4, and it amounts to [$F(1,394)=634{,}4336$, $p<0{,}0001$].

Table 4. ANOVA for variables 1 and 3

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	42.489291	42.4893	634.4336
Error	394	26.386972	0.0670	**Prob > F**
C. Total	395	68.876263		<0.0001

Source: Authors

Table 5. shows the size of the contribution of independent variable 1 to dependent variable 3 and it amounts to 0.785425. Based on these data, the alternative hypothesis Ha1 can be confirmed: State incentives influence the development of female entrepreneurship in agriculture.

Table 5. Contribution coefficients for variables 1 and 3

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	0.985901	0.126251	7.81	<.0001	0	.
1	0.7209804	0.028624	25.19	<.0001	0.785425	1

Source: Authors

Based on the data from the previous table, a regression equation (formula 1 and 2) can be formed, which reads:

$$y = 0{,}985901 + 0{,}7209804 \cdot x_1 \tag{1}$$

or

$$\mathbf{3} = 0{,}985901 + 0{,}7209804 \cdot \mathbf{1} \tag{2}$$

Figure 5 shows the diagram of the regression equation for 1 and 3.

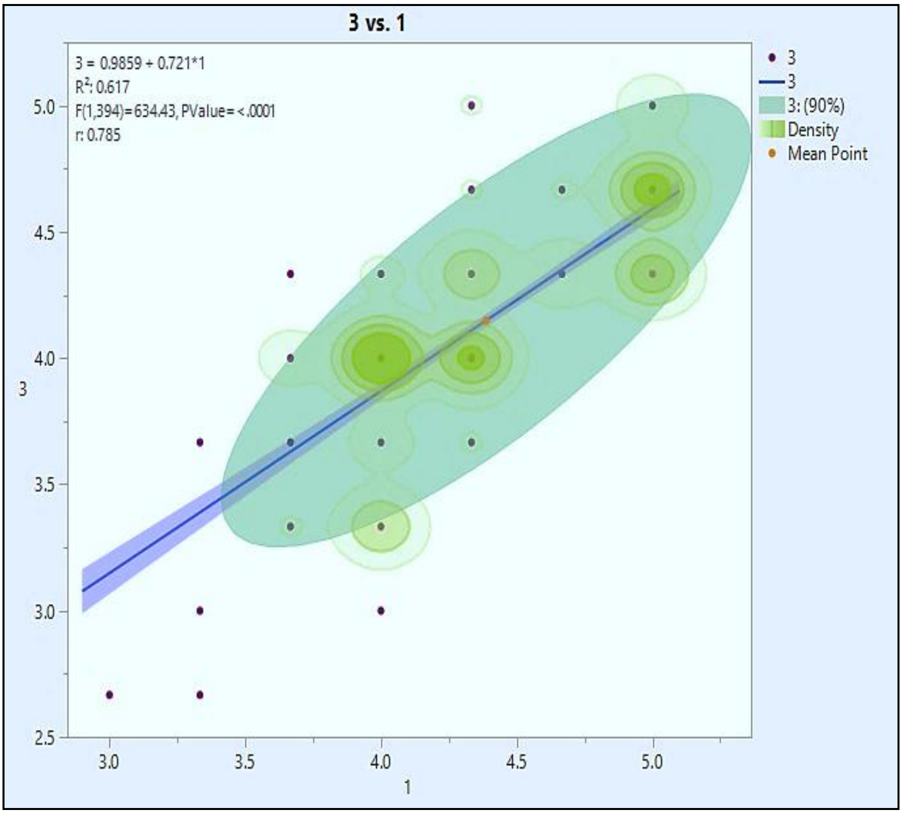

Figure 5. Diagram of the regression equation for variables 1 and 3

Source: Authors

Regression analysis of variables 2 and 3

Table 6 shows the basic evaluation of the model. The coefficient of determination is 0.246174, which means that with 24.61% of the variability, dependent variable 3 can be explained by independent variable 2. The connection between the variables is relatively weak.

Table 6. Model evaluation for variables 2 and 3

Rsquare	0.246174
RSquare Adj	0.244261
Root Mean Square Error	0.363013
Mean of Response	4.14899
Observations (or Sum Wgts)	396

Source: Authors

The assessment of statistical significance is given in table 7, and it amounts to [$F(1,394)=128,6670$, $p<0,0001$].

Table 7. ANOVA for variables 2 and 3

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	16.955542	16.9555	128.6670
Error	394	51.920720	0.1318	**Prob > F**
C. Total	395	68.876263		<0.0001

Source: Authors

Table 8 shows the size of the contribution of independent variable 2 to dependent variable 3 and it is 0.496159. Based on these data, the alternative hypothesis Ha2 can be confirmed: Bank incentives influence the development of female entrepreneurship in agriculture.

Table 8. Contribution coefficients for variables 2 and 3

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	2.4316312	0.152496	15.95	<.0001	0	.
2	0.4111693	0.036248	11.34	<.0001	0.496159	1

Source: Authors

Based on the data from the previous table, a regression equation can be formed (formula 3 and 4), which reads:

$$y = 2.4316312 + 0,4111693 \cdot x_2 \tag{3}$$

or

$$\mathbf{3} = 2.4316312 + 0,4111693 \cdot \mathbf{2} \tag{4}$$

Figure 6 shows the diagram of the regression equation for variables 2 and 3.

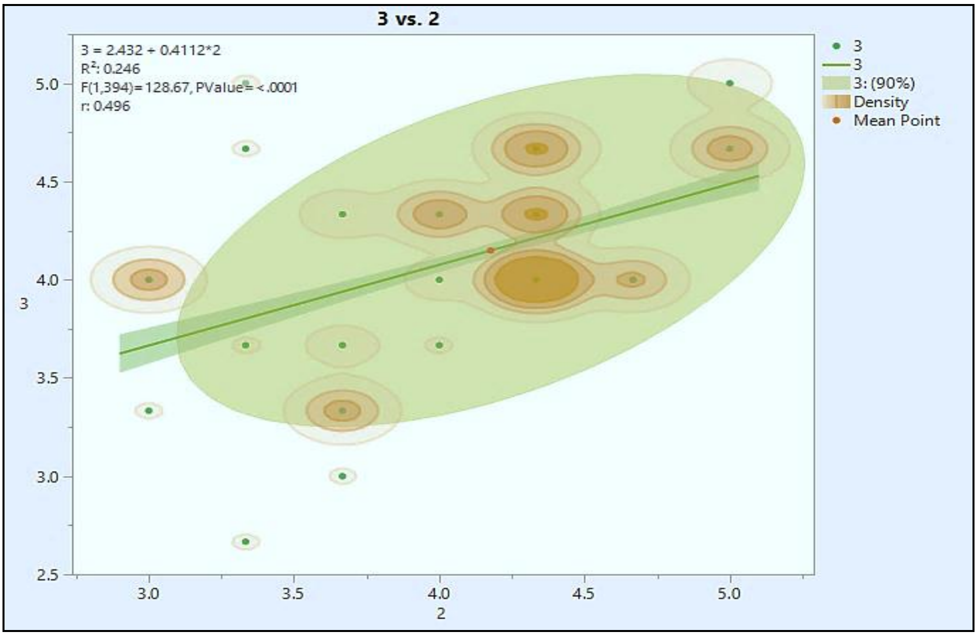

Figure 6. Diagram of the regression equation for variables 2 and 3

Source: Authors

Multiple regression analysis for variables 1, 2 and 3

Table 9 shows the basic evaluation of the model. The coefficient of multiple determination is 0.699748, which means that with 69.97% of the variability, the dependent variable 3 can be explained by the independent variables: 1 and 2. The connection between the variables is strong.

Table 9. Evaluation of the model for variables 1, 2 and 3

Rsquare	0.699748
RSquare Adj	0.69822
Root Mean Square Error	0.229394
Mean of Response	4.14899
Observations (or Sum Wgts)	396

Source: Authors

The assessment of statistical significance is given in Table 10, and it amounts to [F(2,393)= 457.9500, p<0,0001].

Table 10. ANOVA for variables 1, 2 and 3

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	48.196020	24.0980	457.9500
Error	393	20.680243	0.0526	**Prob > F**
C. Total	395	68.876263		<0.0001

Source: Authors

Table 11 shows the size of the contribution of independent variables to dependent variable 3. Independent variable 1 has a higher contribution and it amounts to 70.15%, and independent variable 2 has a smaller contribution and it amounts to 29.98%. The multiple correlation coefficient is 0.83653 and it is strong. Based on these data, the alternative hypothesis Ha can be confirmed: State incentives and bank incentives influence the development of female entrepreneurship in agriculture.

Table 11. Contribution coefficients for variables 1, 2 and 3

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	0.2860438	0.130539	2.19	0.0290	0	.
1	0.643953	0.026429	24.37	<.0001	0.701513	1.0849837
2	0.2484678	0.023859	10.41	<.0001	0.299827	1.0849837

Source: Authors

Based on the data from the previous table, a multiple regression equation (formula 5 and 6) can be formed, which reads:

$$y = 0{,}2860438 + 0{,}643953 \cdot x_1 + 0{,}2484678 \cdot x_2 \quad (5)$$

or

$$\mathbf{3} = 0{,}2860438 + 0{,}643953 \cdot 1 + 0{,}2484678 \cdot \mathbf{2} \quad (6)$$

Figure 7 shows the diagram of the multiple regression equation for variables 1, 2 and 3.

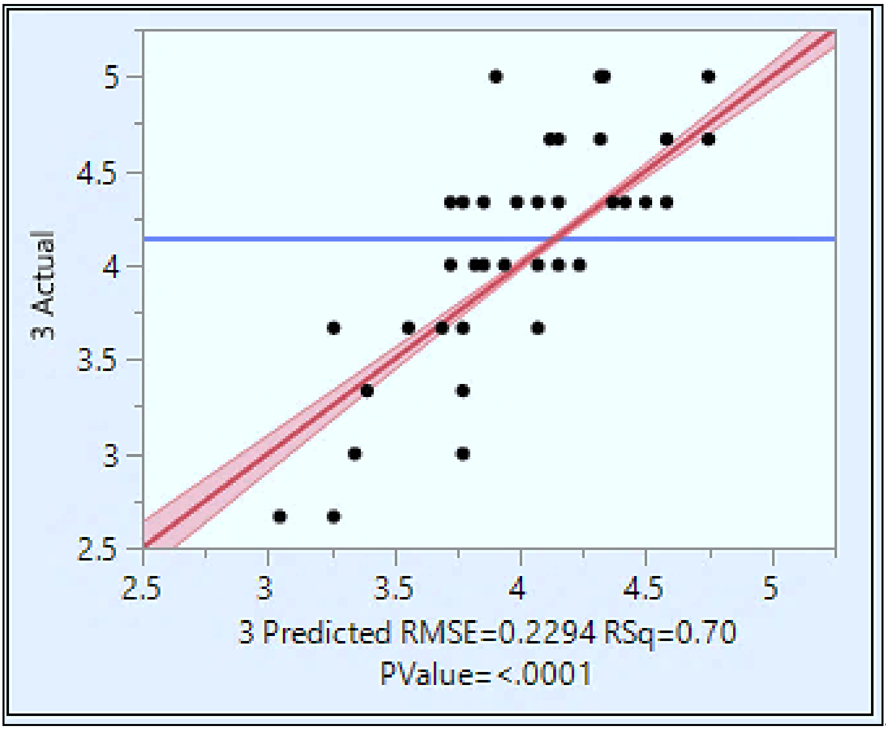

Figure 7. Plot of the multiple regression equation for variables 1, 2 and 3

Source: Authors

Conclusion

The restructuring of the economy and the transition process in Serbia have resulted in a high level of unemployment, and women are particularly vulnerable social groups. Political and economic changes in the previous period created the possibility for women to establish and manage companies. They use this opportunity more and more, and today in countries with a developed market economy, women manage more than 25% of the total number of companies.

The participation of women in agricultural entrepreneurship is becoming more and more significant every day. Research on the influence of certain factors on the development of female entrepreneurship in agriculture has shown that as the incentives of the state grow, so does the entrepreneurship of women in agriculture. As the incentives of the banks increase, so does the entrepreneurship of women in agriculture. The analysis showed that as the incentives of the state and the incentives of the banks increase, the level of entrepreneurship of women in agriculture increases.

References

1. Anić A., Mladenović Z.(2019) *Unemployment rate dynamics in small open economy: The case of Serbia*, Industrija, vol. 48, iss. 4, pp. 7-22

2. Cvijanović D., Pantić N., Ignjatijević S. (2019) *Ekonomska analiza zaposlenosti BDP-a u zemljama Evropske unije*,Ekonomija, teorija i praksa, vol.12,br.4,str.11-23
3. Kovačević I., VujičićS.,Nikitović Z. (2015),,*The influence of tourism on the unemployment in the Republic Serbia,,* The Second International Conference "Higher Education in Function of Development of Tourism in Serbia and Western Balkans", that will be held within the SED 2015 Conference, is one of the results of the TEMPUS project No. 544543-TEMPUS-1-2013-1- RS-TEMPUS-JPCR entitled "Modernization and Harmonization of Tourism Study Programs in Serbia" (MHTSPS).
4. Marković, I. (2010). *Improvement of Serbian export competitiveness.* Facta universitatis, Series: Economics and Organization, 7(3), 271–278.
5. Mirjana Radovic-Markovic,Slađana Vujicic, Zorica Medic (2021) *,,Strategic employee motivation and creating productive work.,,* Tenth international scientific conference Employment, education and entrepreneurship, Belgrade,Serbia, October 21-23, 2021, p.126-130
6. Nikitović,Vujičić (2021) *Preduzetništvo,* Visoka škola za poslovnu ekonomiju i preduzetnoštvo, Beograd
7. Nziku, M. D.(2012) "*Tanzanian Education and Entrepreneurial Influence among Females*" Journal of Female Entrepreneurship and Education (JWE), no. 1- 2/2012: 52
8. Radović-Marković M., Salamzadeh A., Vujičić S.(2019) *Selection of organization models and creation of competences of the employed people for the sake of competitiveness growth in global business environment*, International Review, No.1-2,p. 64-71
9. Radovic-Markovic M., Vujicic S.,Medic Z.(2021) *Strategic employee motivation and creating productive work*, Tenth international scientific conference Employment, education and entrepreneurship, Belgrade,Serbia, October 21-23, 2021, p.126-130
10. Statistical office of the republic of serbia (2021)*Labor Force Survey in the Republic of Serbia*
11. Vujicic, S., Kvrgic G., Ivkovic, D., Vujadin, R., Vujadin N.,(2012) *"The Development of Female Entrepreneurship in the Function of Overcoming Unemployment of Women in Serbia*" Journal of Female Entrepreneurship and Education (JWE), no. 3-4/2012: 1-16.
12. Vukmirović N.(2005) *Women entrepreneurship development models,* Industrija, vol. 33, iss. 4, pp. 1-18

INTRAPRENEURSHIP AS A PROXY FOR THE IMPROVEMENT OF EXISTING AND INTRODUCTION OF NEW TECHNOLOGIES

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Abstract

Intrapreneurship is based on Pinchot s perspective which implies principles of a conservation ethic guided by several simple slogans, like: "get the farmers out of the mud", "greatest good for the greatest number in the long run", and "the art of producing from the forest whatever it can yield for the service of man". Intrapreneurship is based on a commitment to public goods, nature and the environment and disagreement with the concentration of wealth and power. It is rather consistent for over one century with the main aim to introduce innovations. In this research, we used a systematic literature review as a methodological framework. It provides us analyze of the intrapreneurial topic within scientific papers published in open access written in the English language. In this research we found that 40% of papers with intrapreneurial thematic belong to a scientific area of Business and Management, 15% to Social Sciences, 12% to Economics, Econometrics and Finance and 0,2% to Agricultural and Biological Sciences. Results reveal the long tradition of the intrapreneurial concept which can be traced from the beginning of the XX century. This first concept was based on the aspiration to improve the prosperity of the nation from natural resources. It includes better management of the farms, conservation of nature, problems of waterways and business issues. Big companies and corporations recognize this specific concept and now Intrapreneurship is better known as Corporate Entrepreneurship. It was found that a favorable intrapreneurial climate influences the innovativeness of employees. There are several intrapreneurial models the application of which creates a suitable intrapreneurial climate. Intrapreneurial models mainly consist of management support, work autonomy, professional training of employees, business environment, rewarding system, and entrepreneurial attitudes The application of the intrapreneurial model can contribute to the improvement of existing and introduction of new technologies, processes and services. Besides the big companies and corporations, it applies to small and middle enterprises too in all business fields.

Key words: Intrapreneurship, entrepreneurship, new technologies, models

Introduction

Intrapreneurship is considered a subdiscipline of entrepreneurship (Antoncic, Hisrich, 2003). Terminologically, it was first introduced by Pincho (1985), by modifying the term intra-corporate entrepreneurship (Pinchot, Pinchot, 1978). Pinchot's perspective has been rather consistent for several generations, building a new class of employee entrepreneurs who were initially called intracorporate entrepreneurs or “intrapreneurs” (Pinchot III and Pinchot,1978). The main idea around the conceptualization of intrapreneurs assumes that the employee does not have to leave the enterprise to become an entrepreneur (Pinchot, 1985). The characteristics of such employees are: they have a risk minimization strategy, they make decisions related to analysis, they are not guided only by money as a driving force, and they have integrity; as such, by proposing new ideas, they will be dedicated to their job, use available resources to increase productivity, be motivated by success, and be loyal to long-term business goals (Pinchot, 1985). In 1992, the term intrapreneurship[16] was introduced into the dictionary of American heritage and tradition. Intrapreneurship is defined as entrepreneurship in existing companies (Pinchot, 1985). This is the basic definition of intrapreneurship. It is widely accepted despite its simplicity, because it indicates that the employee does not have to leave the existing company in order to realize his business ideas and/or to realize himself as an entrepreneur (Pinchot, 1985). A more comprehensive definition of intrapreneurship indicates that it is a process that takes place within an existing company, regardless of size, and affects not only the emergence of new business activities and activities, but also the improvement of existing products and services, technologies and organizational processes and administrative procedures, as well as business strategies and competitive position of companies within the economic branch (Antoncic, 2001). This definition reveals the essence of intrapreneurship, which is no longer only related to individuals (small business owners), but concerns the company as a whole. The definition of intrapreneurship also contains contradictions because it seems that entrepreneurs and large companies do not go together, but that they need each other (Pinchot, 1985). The reasons for this are that entrepreneurs need resources owned by large companies, and large companies need their business ideas, but still the entrepreneur seeks freedom in work, which is in contrast to the organization of large companies that usually give little room to work autonomy (Pinchot, 1985). It has been established that employees can individually contribute to the development and prestige of the company, to increase earnings even though they are not in management positions (Audretsch, 2003). From the perspective of theory, intrapreneurship is based on the protection of nature and the provision of public goods for the whole society. This principle is contained in the utilitarian theory. Utilitarian theory is a family of normative ethical theories that prescribe actions that maximize happiness and

[16] A person within a large corporation who takes direct responsibility for turning an idea into a profitable finished product through assertive risk taking and innovation (https://ahdictionary.com/word/search.html?q=intrapreneur, accessed 02.06.2019

well-being for all affected individuals. According to Pinchot, conservation ethics is the art of producing from the forest whatever it can yield for the service of man. If the utilitarian theory is applied to companies, it implies that every employee has a certain creativity, which needs to be encouraged in order for the company to benefit from new business activities (2016). Similar perspective can be found in conceptualizing the intrapreneurship in companies. From that strategic perspective intrapreneurship is an innovative strategy determining the orientation of the enterprise, and the expected result is the offering of new or improved existing products and services, administrative procedures and organizational methods (Ireland et al., 2009).

Intrapreneurship depends on organizational elements, and takes place in a favorable organizational climate. The following organizational elements were analyzed in intrapreneurial studies (Hornsby *et al.*, 1999);

- Managerial support;
- Work autonomy;
- Rewards system;
- Working time availability;
- Flow of information;
- Professional training;
- Entrepreneurial attitudes and motives/ Risk taking;
- Business environment;
- Organizational structure and boundaries.

Management support is critical to intrapreneurship (Hornsby et al., 1999). Traditional hierarchical organizational structures are unsuitable for the development of intrapreneurship, because entrepreneurial ventures are started by individuals (employees). By establishing a management support system, it is possible for employees to independently recognize prospective business opportunities, which would otherwise be missed (Hornsby et al., 2002).

Working autonomy establishes a relationship between management's willingness to tolerate failure, show flexibility and free employees from excessive control, and delegate authority and responsibility to lower managers and employees (Hornsby et al., 1999).

Reward system is a motivation for employees to take an extra step and make an additional effort at work. Employee satisfaction is an indicator of the functioning of the motivation and reward system. Rewarding reinforces productive behavior, because employees become aware that behavior has consequences. If entrepreneurial behavior results in an appropriate reward, it means that it is desirable (Hornsby et al., 1999).

Working time availability represents the design of work tasks so that employees have enough time to express their own ideas, and develop new or improve existing business activities in order to achieve the business strategy (Hornsby et al., 1999). Time is a necessary resource for generating and manifesting your own ideas. More available time has a positive effect on the intrapreneurship of employees (Hornsby et al, 2002).

Flow of information is significant in business environment characterized by instant information and the advancement of technology. The primary role of management, but also of employees, is access, systematization and use of information (Kuratko, 2009). The exchange of information through the hierarchical structure of the company is important for decision-making (Hornsby et al., 2002).

Professional training belongs to domain of personal knowledge and education. It is related with the probability of becoming an intrapreneur. Martiarena (2013) found that employees with intrapreneurial characteristics have a higher educational level in comparison to other employees. Similar to that intrapreneurial characteristics have been recognized if employee have participated in training activities (Urbano, Turro 2013).

Entrepreneurial attitudes or risk tacking is willingness to participate in new jobs and projects. It is also willingness to assume the calculated business risk and the ability to recognize business opportunities. The possession and ability to express such traits is considered a positive intrapreneurial characteristic (Covin, Slevin, 1991; Morris, Sexton, 1996; Hisrich *et al.*, 2011)

Influence from the business environment can be summarized in several factors (Sathe, 2003; Schmithüsen *et al.*, 2006). Such influencing factors are:

- consumer requirements;
- subsidies;
- competition;
- legislative and regulatory influences.

Miller, Friesen (1978) indicated that companies with the strongest entrepreneurial orientation are adaptable companies operating in a business environment with moderate changes.

The organizational structure dimension refers to the flexibility of the organization and the centralization of the decision-making. Organizational structure includes supportive organizational structure and organizational boundaries (Knight, 1989; Jones, Butler, 1992).

In addition to intrapreneurship, terms such as: intra-corporate entrepreneurship (Pinchot, Pinchot, 1978), internal corporate entrepreneurship (Jones, Butler, 1992), as well as corporate entrepreneurship have been used (Burgelman, 1983; Guth, Ginsberg, 1990; Hornsby *et al.*, 1999).

This paper aims to analyze academic, empirical literature about perspective of intrapreneurship as a proxy for new technologies with specific attention to subject area of Agriculture and Biology.

Method

In this research we used systematic literature review as a methodological framework. The systematic literature review provides us analyze of the intrapreneurial topic within scientific papers published in open access written in the English language. From SCOPUS data base we search for term "intrapreneurship" in title, abstract and key words. The logic of research is presented in Figure 1. The search results present according to county of origin of the document, type of document, subject area. The results are present in tables and graphs and analyzed form perspective of Agricultural and Biological Sciences subject area.

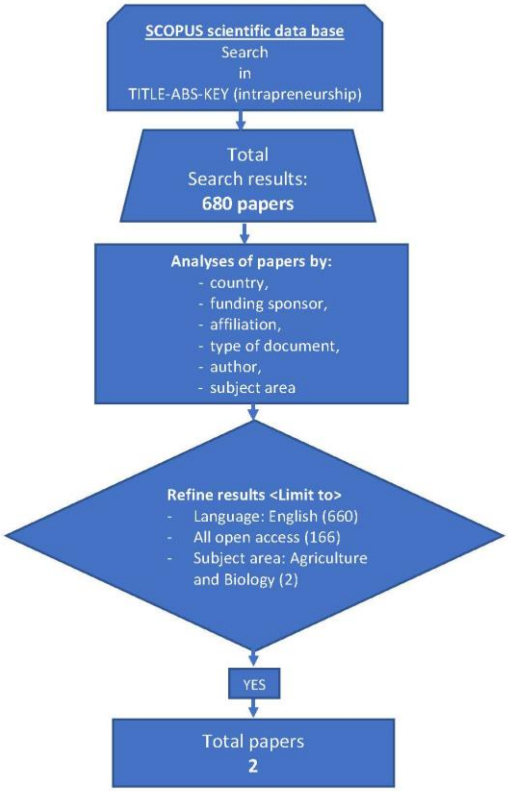

Figure 1. Systematic literature review

Results

The results are presented based on a search of the SCOPUS scientific database. Documents with the topic of intrapreneurship according is shown by territorial distribution, by funding sponsor, by affiliation, by type of document and by subject area. Figure 2 shows Intrapreneurship documents by country.

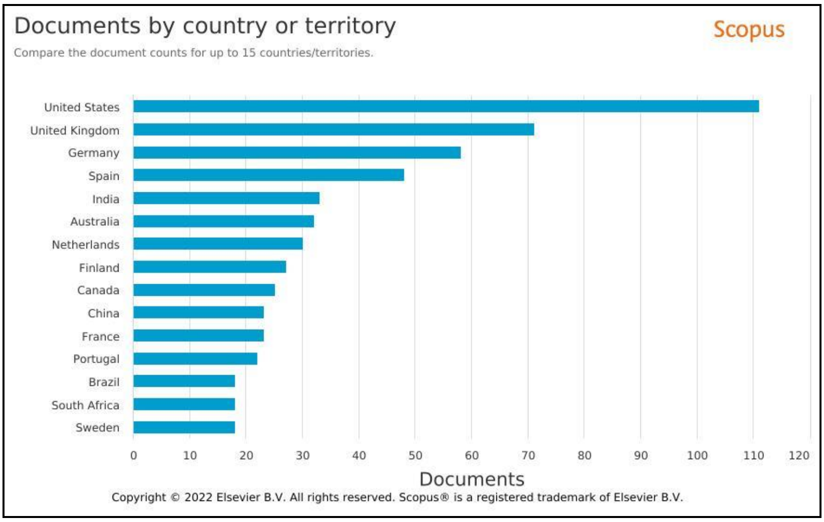

Figure 2. Intrapreneurship in scientific papers by country

The largest number of documents with intrapreneurial topic were published on the territory of the US. This is expected because the phenomenon of intrapreneurship has its origins in the US. They are followed by the UK, Germany, and Spain. The results indicate a wide distribution of research on intrapreneurship.

Funding sponsors indicate the need for research intrapreneurship from a scientific aspect. Funds from Portugal, European Commission and China are leading in this. "Fundação para a Ciência e a Tecnologia" is the Portuguese public agency that supports science, technology and innovation, in all scientific domains, under the responsibility of the Ministry for Science, Technology and Higher Education[17]. European Commission European Social Fund is Europe's main instrument for supporting jobs, helping people get better jobs and ensuring fairer job opportunities for all EU citizens[18]. National Natural Science Foundation of China established in the early 1980s, in order to promote science and technology system reform in our country, the transformation of scientific research[19]. Figure 3 shows documents with intrapreneurial thematic by funding sponsor.

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[17] https://www.fct.pt/ fct
[18] https://ec.europa.eu/esf/main.jsp?catId=35&langId = en
[19] https://www.nsfc.gov.cn/english/site_1/index.html

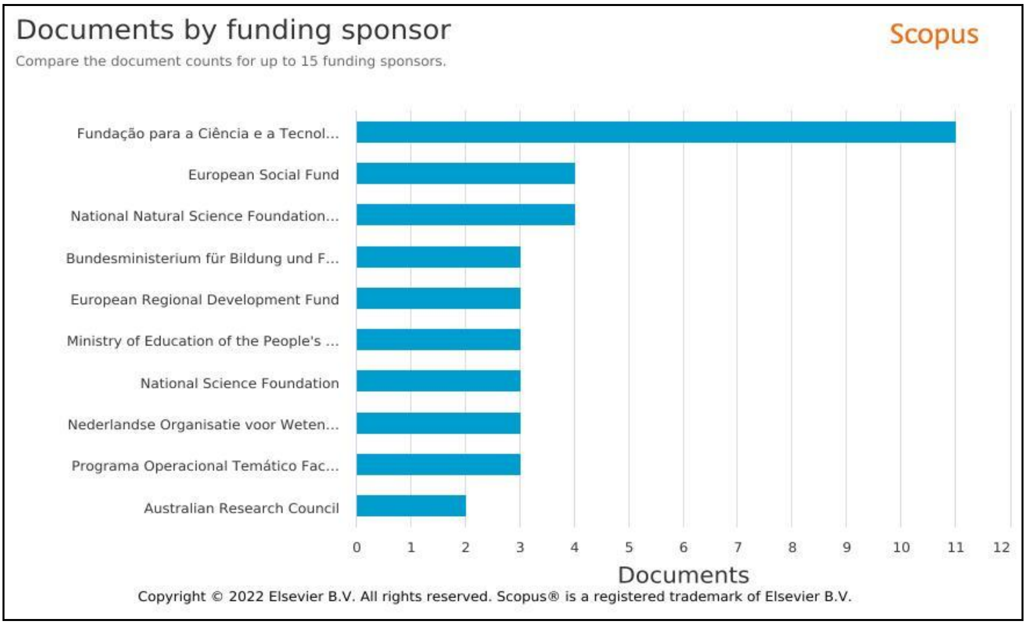

Figure 3. Intrapreneurship in scientific papers by funding sponsor

Regarding documents by affiliation, it is clear that leading institutions from the Spanish-speaking region. The University of Sydney is in 7th place. Among universities from the Balkans, the University of Ljubljana takes a high place. The phenomenon of intrapreneurship is being researched on all continents.

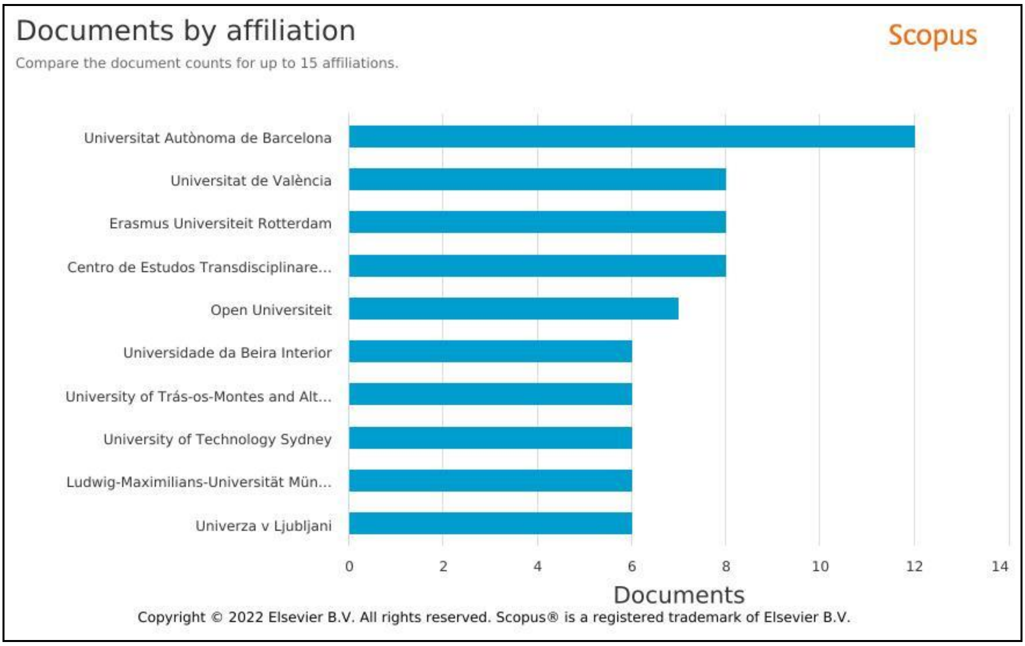

Figure 4. Intrapreneurship in documents by affiliation

Search results of documents by type is presented in Figure 5.

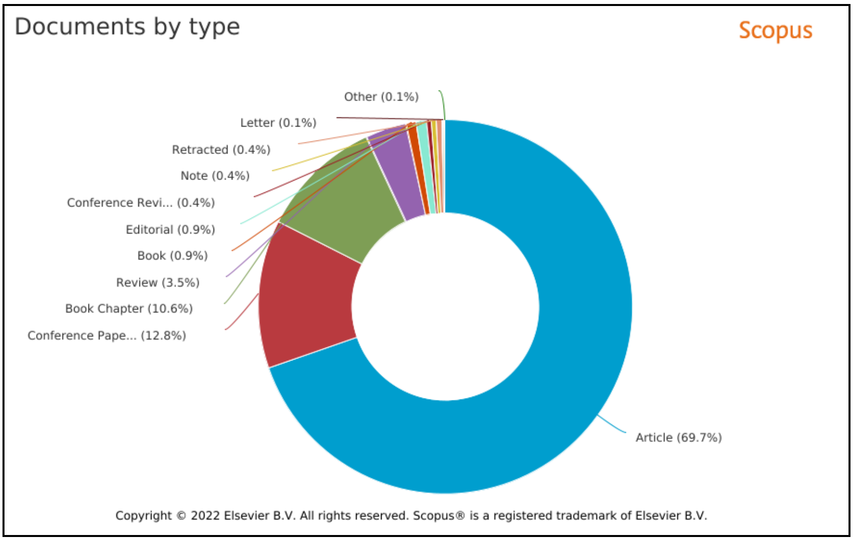

Figure 5. Intrapreneurship in scientific papers by type

Articles in scientific journals have the largest share (69.7%). This is followed by conference proceedings (12.8%) and book chapters (10.6%).

In line with the methodological approach, we started the analysis of the results related to the subject area of Agriculture and Biology.

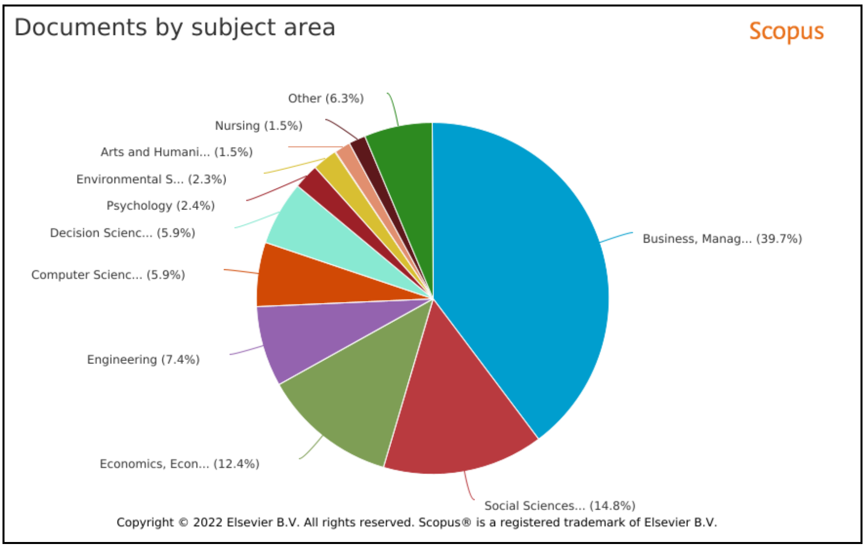

Figure 6. Intrapreneurship in scientific papers by subject area

We have provided this with the command: <Limit to subject area Agriculture and Biology>. We found that there are two documents in the SCOPUS database that meet the search requirements. Analysis of the articles are shown in Table 1 and Table 2.

Table 1. Intrapreneurship in document by subject area Agriculture and Biology

Nº	Type of Document	Year	Country	Affiliation	Nº of References	Nº of Citation	Journal Impact factor
1	Research article	2011	Iran	● Agricultural Extension and Education Department, College of Agricultural Economics and Development, Agricultural and Natural Resources Campus of Tehran University, Karaj, Emamzadeh Hasan Avenue, Iran, ● University College of Entrepreneurship, University of Tehran, Tehran, Iran	26	2	0.517
2	Research article	2020	Serbia	● Institute of Forestry, Belgrade, Serbia ● University of Belgrade, Faculty of Forestry, Belgrade, Serbia ● Institute of Forest, Environmental and Natural Resource Policy, University of Natural Resources and Life Sciences, Vienna (BOKU) and European Forest Institute, Forest Policy Research Network, Vienna, Austria	90	7	3.673

Table 2. Main factors influencing intrapreneurship found in documents by subject area Agriculture and Biology

Nº	Year	Country	Main factors influencing intrapreneurship	Reference
1	2011	Iran	Organizational factor, Behavioral factor and Environmental factor	Karimi *et al.* 2011
2	2020	Serbia	Managerial support, Reward system and Work autonomy	Poduška *et al.* 2020

According to the results, organizational factor, behavioral factor and environmental factor that are the most important antecedents positively and significantly influence intrapreneurship in the Iranian agricultural extension organizations.

In Serbian State-Owned Forestry Enterprises Managerial support, Reward system and Work autonomy are most influential factors to employee innovativeness.

Discussion and Conclusion

Intrapreneurship present specific approach with "initiative from below" where employees undertake something innovative. This concept implies involvement of workers e.g employees in the process of creation and adoption of innovations. In scientific article belonging to subject areas Agriculture and biology, was found organizational factors that support employee's effort for entrepreneurial activity and business improvement and innovativeness. In Iranian extension organization those factors are organizational factor, behavioral factor and environmental factor (Karimi *et al.* 2011). In Serbian State-Owned Forest Enterprises those factors are Managerial support, Reward system and Work autonomy (Poduška *et al*. 2020).

According to these results it can be concluded that the role of employees who can express their innovative ideas is becoming more and more important. This proved that entrepreneurship based on the ideas and creativity of individuals is not only related to high tech sectors, but also occurs in agriculture and forestry. Intrapreneurship requires a specific organizational climate that favors the expression of entrepreneurial attitudes and as a result has improved or new products and services. This research confirms strategic importance of intrapreneurship in fostering innovations.

It can be concluded that intrapreneurial climate in agricultural extension organizations and state-owned forest enterprises is defined with different factors. This differentiation could be explained by different business environment. But the main explanation can be found in motives of employees in state-owned forest enterprises. Those employees develop new and improve existing products, services or business processes that do not have a market perspective, which in most cases are offered free of charge in locations where access is free (e.g., nature based recreation, tourism and education, etc.) and the provision of which relies on revenue from wood or state subsidies.

References

1. Antoncic, B (2001). Organizational processes in intrapreneurship: a conceptual integration. Journal of Enterprising Culture. 9 (2). 221-235.
2. Audretsch D. B. (2003). Entrepreneurship: A survey of the literature. Enterprise Papers No 14. Enterprise Directorate-General European Commission.

3. Antoncic B., Hisrich D. R. (2003). Clarifying the intrapreneurship concept. *Journal of Small Business Enteprisess Developement* 10:7-24.
4. Burgelman, A., R. (1983). Corporate Entrepreneurship and Strategic Management: Insights from a Process Study. Management Science. 29 (12) 1349-1364
5. (2016). Intra-corporate enterpreneurship (Some Thoughts Stirred Up by Attending. accesed 10.2.2016. from intrapreneur. com: http:// www.intrapreneur.com/ MainPages/ History/ IntraCorp. html.
6. Ireland D., R., Covin, G., J., Kuratko f., D., (2009). Conceptualizing corporate entrepreneurship strategy. Entrepreneurship Theory and Practice. 33 (1) 19-46. Hornsby J. S., Kuratko D. F., Montagno R. V., (1999). Perception of Internal Factors for Corporate Entrepreneurship: A Comparison of Canadian and U.S. Managers. *Entrepreneurship: Theory & Practice* , 24 (2), 11-26.
7. Guth W., Ginsberg A., (1990). Guest Editors' Introduction: Corporate Entrepreneurship. *Strategic Management Journal,* 11, 5-15.
8. Hornsby J. S., Kuratko D. F., Zahra S. A., (2002). Middle managers' perception of the internal environment for corporate entrepreneurship: Assessing a measurement scale. *Journal of Business Venturing* , 17, 253-273.
9. Jones, G R; Buttler, J E (1992). Managing internal corporate entrepreneurship: An agency theory perspective. Journal of Management. 18 (4). 733-749.
10. Karimi A., Malakmohamadi I., Daryani M. A., Rezvanfar A. (2011). An empirical look at the intrapreneurship dimension and its antecedents: The case of Iranian agricultural extension organizations, Journal of Food, Agriculture and Environment, Issue 1, Pages 634-641. DOI:10.1234/4.2011.2024.
11. Knight, R. M. (1989). Technological innovation in Canada: a comparison of independent entrepreneurs and corporate innovators. Journal of Business Venturing, 4, 281–288.
12. Kuratko F. D. (2009). The entrepreneurial imperative of the 21st century. B*usiness Horizons* 52, 421—428.
13. Martiarena, A. (2013). What's so entrepreneurial about intrapreneurs? Small Business Economics, 40(1), 27– 39.
14. Pinchot G. I. (1985). Intrapreneuring: Why You Don t Leave Corporation to Become an Entrepreneur. New York: Harper & Row Publisher.
15. Pinchot III G., Pinchot E. S. (1978). Intra-corporate enterpreneurship (Some Thoughts Stirred Up by Attending Robert Schwartz's School for Entrepreneurs). accessed 10.2.2016. http :// www.intrapreneur.com/ MainPages/ IntraCorp. html.

16. Poduška Z, Nedeljković J, Nonić D, Ratknić T, Ratknić M, Živojinović I. (2020). Intrapreneurial climate as momentum for fostering employee innovativeness in public forest enterprises, Forest Policy and Economics, Volume 119,ISSN 1389-9341, https://doi.org/10.1016/j.forpol.2020.102281.

17. Urbano, D., Turro, A. (2013). Conditioning factors for corporate entrepreneurship: an in(ex)ternal approach. International Entrepreneurship and Management Journal, 9(3), 379–396.

SOCIO-DEMOGRAPHIC CHARACTERISTICS OF YOUNG PEOPLE IN SERBIA AND SURROUNDING COUNTRIES

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Abstract

The paper points out some socio-demographic features of young people in Serbia and surrounding countries, their role and importance in the development of society. The share of the young of the population in Serbia from the age of 15 to the age of 30 to the total population, according to the 2011 Census, is 18,40%. The subject of analysis is the period from 2017 to 2021. Young people aged 15 to 24 make up about 10% of the total population in almost all surrounding countries. Young people from these countries, especially educated ones, migrate to other countries in the world, which affects the tendency of the decline of this population and the total population. It is necessary to pay special attention to young people, because they are the core of the future of a nation, resource innovation and driving force of society. That is why it is necessary continuous and systematic investment in youth development.

Key words: Socio-demographic features, youth, Serbia, surrounding countries.

Introduction

The stage of life between childhood and adulthood is youth, and during that period there are expectations from young people to develop skills and abilities to be able to take over social roles in all areas of human activity.

Young people are the present and future of society, the resource of innovation and the driving force of society development. That is why continuous and systematic investment in youth development is necessary and establishing a partnership between youth and the state in order to increase active participation in society, encouraging social integration and ensuring the involvement of young people in youth policiesdevelopment (National Youth Strategy, 2020).

Definitions of youth have constantly changed depending on the changing political, economic and sociocultural environment. It is difficult to define and determine the age limit for youth, and that is why definitions differ between the institutions of the United Nations, European Union and national institutions.

When talking about young people in Serbia, numerous situations that young people face such as poverty in society, low percentage of youth employment and many more challenges of transitioning from the world of children to the world adults require a different approach, which is why the boundaries of youth are being pushed up to thirty years. It is possible to single out several subgroups of young people depending on the context and needs, young people from 15 to 19 years, from 20 to 24 years and from 25 to 30 years.

Based on the Law on Youth, young people are persons from the age of 15 to over 30 years (Law on Youth, 2011). General Assembly of the United Nations defined "youth" as those between 15 and 24 years of age. This one the definition was conducted for the International Year of Youth, which was held around the world 1985 (United Nations, 2010).

Education has significant role for young people, which is reflected in their work, political action, and making plans. Knowledge acquired through education is the most important resource which no one can take away, and a strong educated system makes the society of a state stronger and gives a better chance in the life of the young population and guarantees lifetime income.

The aim of the work is to present and analyze some socio-demographic characteristics of young people in Serbia and surrounding countries, their role and importance in the development of society.

Research material and methods

The paper discusses some socio-demographic characteristics of young people in Serbia aged 15-29, according to different characteristics such as age, gender and schooling with reference to young population of neighboring countries. Data used in the research are from 2011 Census, official publication of the Republic Institute of Statistics of Serbia, Eurostat database and available literature. The selected indicators in the paper are presented using tables and graphics, for better visibility of the analyzed phenomena. Also, by comparative analysis, some indicators in the Serbia were compared with countries in environment.

Research results and discussion

Young people in Serbia

A significant characteristic of each country is the gender and age structure of the population, and special emphasis is placed on the young population, which represents the future of a country's development. The total number of young people in the Republic of Serbia, according to the 2011 Census, is 1,322,021 persons, that is, the share of young people in the total population is about 18%, and compared to the 2002 Census, it has decreased by 190,625 persons. The young male population is more numerous and constitutes 51.22% of the total population (graph 1).

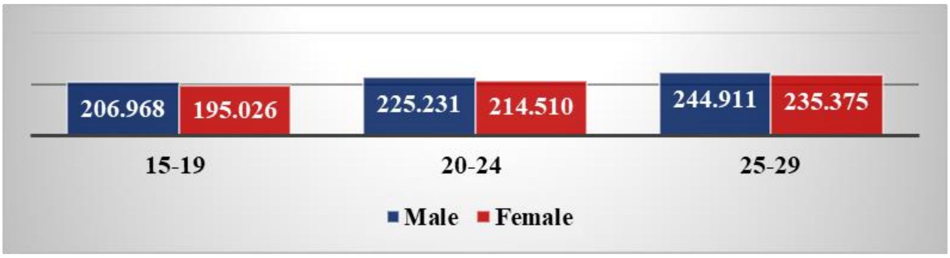


Chart 1: Number of young population by five-year age groups and sex, 2011 Census

Source: Author's illustration based on the 2011 Census, www.popis2011.stat.rs

Due to the negative natural increase, the total population in Serbia is decreasing, especially the share of young people in relation to the total population of the country, while the share of the elderly is increasing. Based on the above data, our country is not a country of young people, and therefore special attention should be paid to them (Jelić, 2017).

Looking at the young population in the Republic of Serbia, we see by regions that the percentage of urban young population in all regions is higher than the percentage in rural population. According to the 2011 Census, the Belgrade region had the most of young people who lived in urban areas, about 80%, and the least in Šumadija and Zapadna Region of Serbia, about 50%. There is a higher percentage of young female population in urban areas, while rural areas have a higher percentage of the young male population in all regions of Serbia (table 1). The decrease in the number of young people results in a further decline in the birth rate, increasing creation elderly and single households and the gradual disappearance of certain settlements.

Table 1: Young population of the Republic of Serbia by region, type of settlement and gender, Census 2011

Type of area	Gender	Belgrade region		Region of Vojvodina		Region of Šumadija and Western Serbia		Region of Southern and Eastern Serbia	
		number	%	number	%	number	%	number	%
Urban settlements	male	122.763	80	109.391	58,5	94.815	49,3	80.663	55,8
	female	125.729	81,5	107.362	60,8	91.962	51,1	76.928	57,3
Other	male	30.719	20	77.472	41,5	97.372	50,7	63.915	44,2
	female	28.487	18,5	69.097	39,2	87.910	48,9	57.436	42,7

Source: Author's calculation based on the 2011 Census, www.popis2011.stat.rs

Young people, as the most important bearers of society, by acquiring knowledge through the education system, make the society of a country stronger and that knowledge increase their chance to succeed in life by guaranteeing them lifetime income.

Awareness of the importance of education in Serbia reached the required level at the end of the 19th century, when the state introduced compulsory primary education for all children in 1883. The law introduced mandatory six-year education in primary schools for all children in Serbia was introduced. Beside that, the state planned to send young men to study abroad every year. When they finished their education, they represented the bearers of social change (Matijević, 2011). Individuals who possess knowledge represent a valuable resource for the development of society, therefore it is necessary to bring the educated rural population back to the countryside in order to contribute to development of rural area. Education is the foundation of economic growth in modern society. Rural development affects the faster development of the country, and rural development is affected by education (Jelić and Popović, 2020).

Young people with acquired secondary education are an absolute majority at the republican level, and as well as in all regions of Serbia. Most pupils and students are in the Šumadija Region and Western Serbia, and the fewest are in the Region of Southern and Eastern Serbia (table 2).

Table 2: Young population aged 15-29 according to schooling, by region, Census from 2011

Region	Total	Without educational attainment	Incomplete primary education	Primary education	Secondary education	High and higher education	Unknown
Republic of Serbia	1.322.021	15.326	22.594	375.459	747.847	157.154	3.641
Belgrade region	307.698	3.000	2.217	71.862	173.836	55.718	1.065
Region of Vojvodina	363.322	5.041	9.157	104.329	204.091	40.236	468
Region of Southern and Eastern Serbia	278.942	4.139	6.912	84.488	156.299	25.968	1.136
Region of Šumadija and Western Serbia	372.059	3.146	4.308	114.780	213.621	35.232	972

Source: Author's calculation based on the 2011 Census, www.popis2011.stat.rs

The share of young economically active population of the Republic of Serbia is 44.4% of young people population. The active population consists of all employed and unemployed persons. The most of the young working population is in the Vojvodina Region, 28.5%, and the least is in the region of South and East Serbia, 20.8%. Also, the Region of Southern and Eastern Serbia contains the least number of young inactive population, 21.3%, while there are most of them in the Region Šumadija and Western Serbia, 28.8% (table 3).

Table 3: Youth according to economic activities by region in the Republic of Serbia, Census from 2011

Region	Age groups	Employed	Unemployed	Inactive population
Belgrade region	**15-19**	2.543	4.090	77.895
	20-24	25.002	14.154	59.083
	25-29	71.023	20.411	33.497
Region of Vojvodina	**15-19**	5.087	8.299	96.446
	20-24	34.898	22.717	63.551
	25-29	71.482	24.756	36.086
Region of Southern and Eastern Serbia	**15-19**	5.205	7.945	104.170
	20-24	33.077	23.761	69.964
	25-29	63.461	26.640	37.836
Region of Šumadija and Western Serbia	**15-19**	3.397	7.548	79.369
	20-24	21.750	21.627	50.157
	25-29	43.981	23.643	27.470

Source: Author's calculation based on the 2011 Census, www.popis2011.stat.rs

According to available data from the National Employment Service, the number of unemployed of young people in April 2021 is 115,533 persons, what makes 21.04% of the total number of the unemployed and make up more than one fifth of the total unemployment in the Republic of Serbia aged 15 to 30 (table 4).

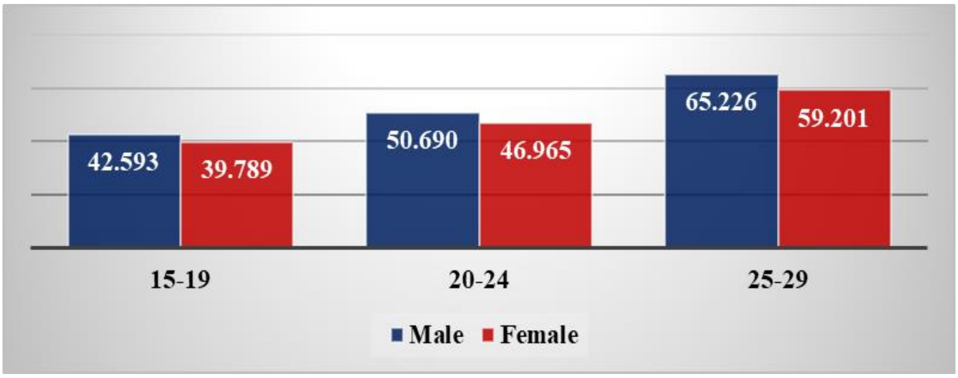
Table 4: Number of unemployed youth from 2017 to 2021 in the Republic of Serbia according to age structure

Year	number of young unemployed	15-19	20-24	25-29
2017.	146.843	14.472	56.569	75.802
2018.	123.686	12.934	46.654	64.098
2019.	114.679	10.979	43.690	60.010
2020.	104.702	10.711	38.902	55.702
2021.	115.533	13.844	44.295	57.394

Source: National Employment Service, Monthly Statistical Bulletin - April 2021, https://www.nsz.gov.rs/live/digitalAssets/15/15962_nsz_bilten_april_2021.pdf

In recent decades, Serbia has been seriously faced with the problem of the outflow of educated youth people. In addition to the change in the demographic structure of the population, the damage from this phenomenon is that the state is at a loss due to investment in the education of personnel who later pass on their knowledge to others country and participate in its reproduction. As a result, Serbia is increasingly left without qualified personnel. The most common reason for migration is unemployment (Nikolić, 2019).

Young people with completed higher education in developed Western countries of Europe and developed overseas countries have significantly higher salaries. These are all the elements that led and still lead to the outflow of both young people and others population contingents, from Serbia (Bubalo-Živković and Lukić, 2015). When it comes to the young population in the Republic of Serbia, their average net salaries are not at a satisfactory level, where the young female population is at an even worse disadvantage position (graph 2).



Graph 2: Average net wages of employed youth in the Republic of Serbia, September in 2021

Source: Author's illustration based on the Republic Institute for Statistics of Serbia database, www.stat.gov.rs

The outflow of young people occurs as a consequence of the labor market action in a way that employers in more economically stable economies can offer far better working conditions and higher earnings for highly educated people, than they have available in the home country. Factors that motivate individuals to stay in their home countries are family, fear of the new, resolved housing issue or some personal reasons. On the opposite, a greater opportunity for career development and a higher standard of living outside the border of the home country are the key factors that brought to the escalation of the brain drain. In recent years, differences in development at the global level are increasingly present, where we have a division into developed and underdeveloped countries, more precisely, to economically developed ones that know how to retain a creative and educated part of the population, and on the underdeveloped countries that cannot implement it. Present differences in economic development among countries contributed to the process of the outflow of a highly educated part of the population from underdeveloped countries to developed countries (Petrović-Randjelović and Miletić, 2016).

Young people in neighboring countries

The young population records a downward trend both in the Republic of Serbia and in all surrounding countries. Young people from 15 to 24 years comprise on average about 10% of the total population in almost all neighboring countries, in the period from 2017 to 2021 (graph 3).

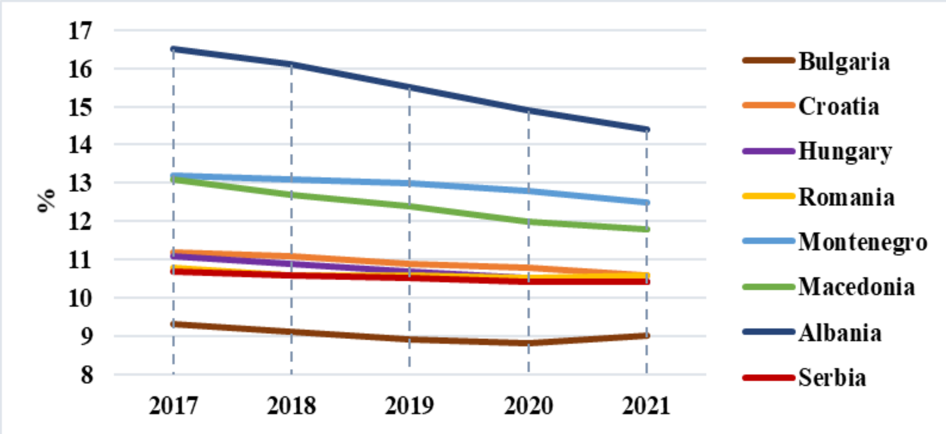


Chart 3: Percentage of the population aged 15-24 in relation to the total population in The Republic of Serbia and neighboring countries, in the period from 2017 to 2021

Source: Author's illustration based on Eurostat database, ec.europa.eu/Eurostat

The unemployment rate is the highest for the age group of 15 to 24 years. Based on the Eurostat's database, unemployment percentage of the young population aged 15 to 24 looking at the period from 2017 to 2021, the highest rate of unemployment has surrounding countries, Macedonia and Montenegro. Also, we can see a downward trend in all countries from year to year. The Republic of Serbia together with neighboring countries in 2020 has the problem of unemployment growth, caused by the permanent consequences of the COVID-19 pandemic 19. However, already in the following year, there is a downward trend in youth unemployment population (chart 5).

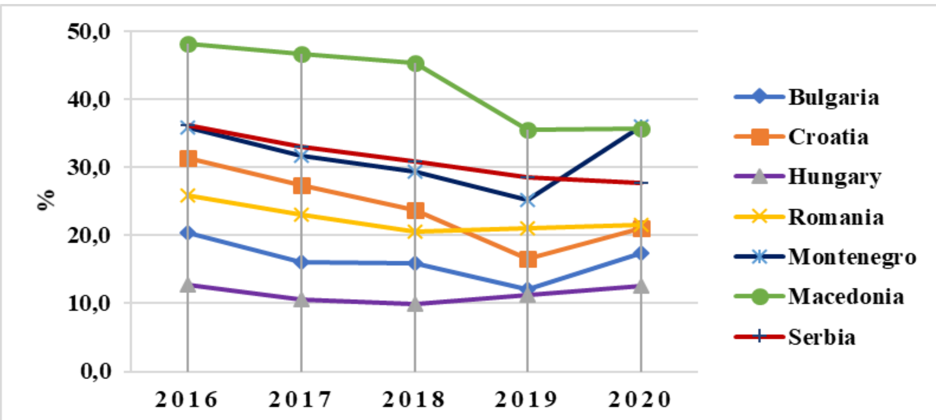


Chart 4: Structure of unemployed persons (% of population aged 15 to 24) in the Republic of Serbia and neighboring countries, in the period from 2017 to 2021

Source: Author's illustration based on Eurostat database, ec.europa.eu/eurostat

When it comes to education, the European Union has set five goals in the European strategy 2020, where one of the goals is to reduce the number of people who have abandoned education to 10% and increase in the share of the highly educated in the population of the age of 30 to 34 years to at least 40% (European Commission, 2010). When it comes rate of school dropouts Serbia met the goal given in the Europe 2020 Strategy, which refers to reducing the rate of early school leaving to below 10%, since that rate in Serbia is around 6 %.

Based on indicators of early leaving education and training according to Eurostat data for Republic of Serbia and surrounding countries are shown the status in these states. This one the indicator measures the share of the population aged 18 to 24 with the most secondary school education which was not involved in any education or training during the four weeks preceding the research. The percentage of those who early education leaving and training between the ages of eighteen and twenty-four should be below 10%. Percentage of early leavers from education and training of the population aged 18 to 24, in the period from 2016 to 2020 in the Republic of Serbia is below 10%, and in the last few years it has been around 6%. Observing some surrounging countries like Bulgaria, Croatia, Hungary, Romania, Montenegro and Macedonia we can notice that Croatia has the lowest percentage of early dropout population from education and trainings, which in the last year of observation is 2.2%, then follows Montenegro with a percentage of 3.6%. The most critical countries in our environment are Romania, Bulgaria and Hungary where the percentage is above 10%. (graph 5).

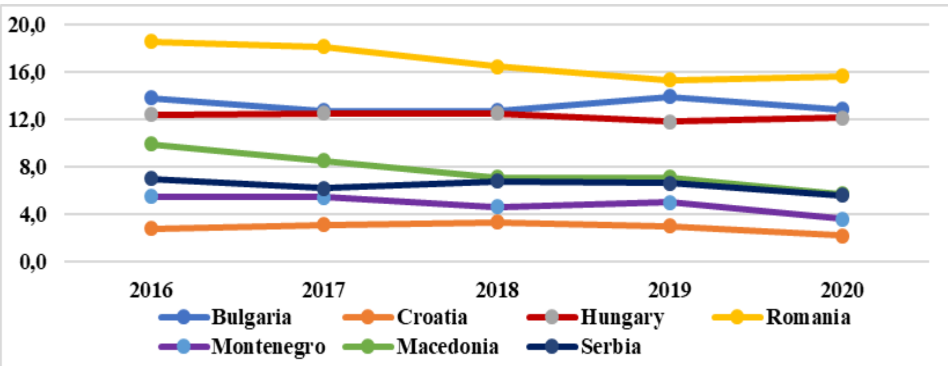


Chart 5: Early leaving education and training (% of the population aged 18 to 24 year) in the Republic of Serbia and neighboring countries, 2016 – 2020

Source: Author's illustration based on Eurostat database, ec.europa.eu/eurostat.

In many countries in transition, education is characterized by multiple patterns. One of them is the existence of a significant difference in learning and achievement, where these differences are related to factors such as geographical location, race, ethnicity, language, social class and gender (Brown and Kanjee, 2006). Also, young women receive less education, compared to young men in almost all developing countries. To expand training opportunities for women, as a key step of the Millennium Development Goals, it is economically desirable to increase women's education, because it increases theirs farm or factory productivity, and more educated mothers improve health and child nutrition (Todaro and Smith, 2011).

The employment rate of younger people is considered as a key indicator for analyzing trends in labor market and depends on the level of their education. The higher the level of education, the lower is the risk of unemployment, which is clearly shown both in Serbia and in all countries in environment (chart 6).

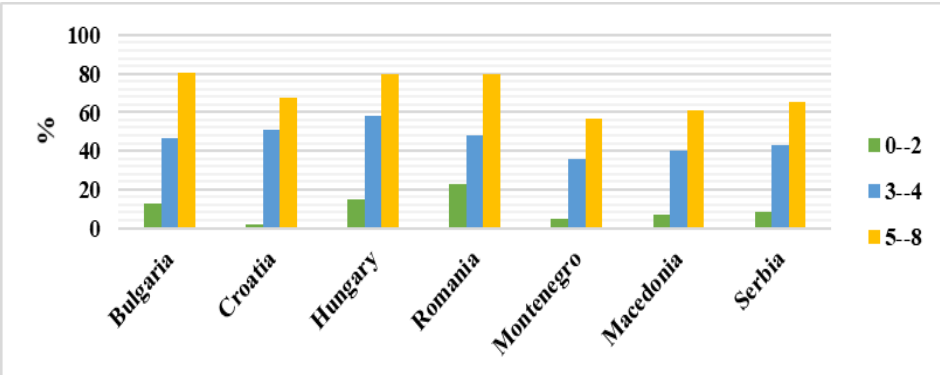


Chart 6: Rate of employed persons aged 15-29 by level of education in 2020. of the Republic of Serbia with neighboring countries

Source: Author's illustration based on Eurostat database, ec.europa.eu/Eurostat

Conclusion

Young people in all countries are the main human resource for development and key actors for social changes, economic development and technological innovation. Their imagination, ideals, significant energy and vision are essential for continued development of society in which they live. They will affect current social and economic conditions, welfare and livelihoods of future generations.

Serbia is not a country of young people, from the total number of inhabitants according to the 2011 Census, young people aged 15 to 30 make up 18% of the total population, that's why they need a special attention, because they are the core of a nation's future. Youth unemployment is one of the big problems in Serbia and in the surrounding countries. The sensitivity of young people is bigger in the labor market compared to other age groups and the unemployment rate significantly decreases with age. Improvement of the educational system and training is necessary to prevent obsolescence of knowledge and skills. Often young people in Serbia and surrounding countries express their dissatisfaction with the environment by going to another country in search for a better living conditions.

References

1. Bubalo-Živković, M, Lukić, T. (2015). *Mladi u Srbiji početkom 21. veka*, Republički zavod za statistiku.
2. Braun, H., Kanjee, A. (2006). Using Assessment to Improve Education in Developing nations, *improving education through assessment, innovation, and evaluation*.
3. European Commission. (2010). *Europe 2020: A strategy for smart, sustainable and inclusive growth: Communication from the commission*. European Union, Brussels.
4. Eurostat, *ec.europa.eu/eurostat* (11.09.2022.)
5. Jelić, S.(2017). Socio-demografska obeležja mladih u Srbiji s osvrtom na Braničevsku oblast. *Savetovanje Kostolac, Održivi razvoj Braničevskog okruga i energetskog kompleksa Kostolac,* Rad po pozivu, Zbornik radova, str. 93-102. https://sites.google.com/site/savetovanjeukostolcu/ .
6. Jelić, S. M., Popović, M. D. (2020) Education and cultural institutions in the context of development of Serbian villages. *Culture and identities,* Belgrade, Srpsko sociološko društvo.
7. Matijević, N. (2011) Žene–obrazovanjem do elite: Situacija u Srbiji u XIX veku (osvrt na knjigu Lj. Trgovčević „Planirana elita “) 2010., *Godišnjak* br. 5.
8. Nikolić, N. (2019). *Nulti izveštaj o ljudskim pravima mladih u Republici Srbiji 2019. godine*. Beogradski centar za ljudska prava, Beograd.
9. Nacionalna služba za zapošljavanje, mesečni statistički bilten – april 2021, *https://www.nsz.gov.rs/live/digitalAssets/15/15962_nsz_bilten_april_2021.pdf* .
10. Petrović-Ranđelović M., Miletić, D. (2016). Odliv mozgova kao ograničavajući faktor privrdnog razvoja Republike Srbije, tekst u zborniku, *Institucionalne promene kao determinanta privrednog razvoja* (ur. Leković, V.), Ekonomski fakultet Univerziteta u Kragujevcu.
11. Popis 2011. *www.popis2011.stat.rs* (10.09.2022.).
12. Todaro, M., Smith, S. (2011). *Economic Development,* Addison-Wesley, Harlow.
13. United Nations (2010). *World Programme for Action for Youth*, New York, United Nations.
14. Vlada Republike Srbije (2020). *Nacionalna strategija za mlade za period od 2015. do 2025. godine*.
15. Zakon o mladima, *Službeni glasnik RS*, br. 50/2011, čl. 3.

BOOK OF PROCEEDINGS