

# ECONOMIC EFFECTS OF RASPBERRY PRODUCTION ON THE FAMILY FARM<sup>1</sup>

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**Abstract:** *The paper presents the results of research related to raspberries production in the Republic of Serbia with a focus on the Zlatibor district and selected agricultural holding located in the area of the municipality of Arilje. The research was conducted in accordance with the real data from practice. The pedo-micro-climatic conditions in this area are suitable for raspberries cultivation being within the optimal values for its production. Water resources are also adequate for irrigation applications during the growing season. Research has shown that the total costs of production on the selected (representative) agricultural holding amount to €8,198.5/ha when the irrigation and manual harvesting of raspberries are applied. The annual financial result (profit) is favorable and amounts to €27,649.9/ha. The economic and financial results of the research showed that raspberries production is extremely profitable in this part of Serbia.*

**Keywords:** raspberries, production, economic analysis, costs, profit.

## INTRODUCTION

Fruit growing is a very important branch of agriculture in the Republic of Serbia, as fruit production accounts for about 11% of the value of total agricultural production (*Strategy for the development of agriculture of the Republic of Serbia 2014-2024*).

Considering the climate, land and water resources on the one hand, as well as the vicinity of the market, the existence of cold storage facilities, processing facilities and dryers on the other, in all parts of Serbia there are suitable places for cultivation of some types of fruit. However, some types of fruit are grown in areas with unfavorable agro-ecological conditions, which results in unsuccessful and economically unjustified production. Therefore, it is of utmost importance to be aware of reionization when growing fruit. Certainly, for most fruit species there are several main production regions in Serbia. According to the representation, pome fruits (peach, apricot, plum, cherry, sour cherry, apricot) are in the first place, followed by apple fruits (apple, pear, quince, medlar, gooseberry, hawthorn), berries (raspberries, blackberries, strawberries, currant, gooseberries, blueberries, mulberries), while stone fruits (walnut, hazelnut, almond, chestnut) are the least represented. According to the areas on which they are grown, the dominant fruit species is the *plum* (grown on an area of 72,569 ha), followed by the *apple* (grown on an area of 27,034 ha), which is available in the data of *Statistical Office of the Republic of Serbia, Statistical Yearbook 2022*.

In terms of export value, raspberries are the leading fruit species in Serbia. 1,900.1 t of fresh raspberries valued 6,802.3 thousand USD were exported from our country, in 2001. Most of it was exported to the countries of the European Union (1,878.2 t in the value of 6,753.2 thousand USD), (<https://data.stat.gov.rs/Home/Result/170304?languageCode=sr-Cyrl&displayMode=table&guid=b0462e45-3394-4be4-992c-162751e0a6ea>).

In the same year, in 2021, Serbia exported 97,961.5 t of frozen raspberries (sugar free) worth USD 426,143.1 to all countries of the world, but frozen raspberries from our country are mainly exported to the countries of the European Union (approximately 78% of the total of exports), i.e. 76,275.4 t with an export value of USD

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320,042.4(<https://data.stat.gov.rs/Home/Result/170304?languageCode=sr-Cyrl&displayMode=table&guid=f0c8ff73-6171-4d69-998d-164cfb439633>)

Apart from the export value, raspberries are a special type of fruit with pronounced specificities compared to other fruits. The high content of vitamins, minerals, specific microelements and similar caused that raspberry fruits as well as raspberries' leaves have significant medical characteristics, which is the reason of popularity of these fruit and its in demand both on the domestic and on the world market, and is used for the treatment of many diseases as well as for prevention (Mišić P., et al. 1998, Milivojević J. et al., 2000).

Commercial production of raspberries in our country began in 1920, while its intensive production began in the last twenty years (Mišić P. et al., 2004). High fertility, a long tradition in cultivation, long-term export to the world market and the status of "Serbian raspberry" have significantly contributed to the intensification of raspberries production. Family agricultural holdings were gradually formed into family companies with a rounded production cycle (raspberries plantations and mini-coolers), creating the final product, i.e. frozen raspberries, which are in high demand on the world market (Veljković B., et al., 2006, Petrović S., 2004). Regarding the assortment of raspberries in Serbia, the Vilamet variety dominates (about 95%), followed by miker with 3-4%, and all other varieties with 1-2% (Kljajić, N., 2014).

In recent years, the image of areas under raspberries in Serbia has changed. New raspberries plantations with multi-bearing varieties were established in areas where traditionally raspberries were never grown, especially in Vojvodina. On the other hand, raspberries production was abandoned in the regions where raspberries are grown the most, partly due to the unprofitability of production and partly due to the poor price of raspberries several years ago, as well as the lack of seasonal workers. Also, looking back several years, the occurrence of early frosts, stormy rains followed by the appearance of hail, and in 2020, along with all these occurrences, there were also floods that affected particularly Western Serbia and caused great damage and production loss.

Raspberries yields are still relatively low, although some examples from practice show that, with the full application of all necessary agrotechnical measures, the raspberries yields can reach a value of 10-15 t/ha, or even more, in the period of full bearing.

## MATERIAL AND METHODS

The subject of research in this paper are the production and economic indicators of raspberries production on an individual agricultural holding in the Zlatibor district. The goal of the research is to observe the basic indicators of raspberries production and to evaluate the level of profitability of this production. The research should give the answer to the question of how growing raspberries in the Zlatibor district (an example of an agricultural farm) is economically justified.

The concept of this paper is that the first part includes an analysis of the representation of areas under raspberries plantations, the achieved total yield and the achieved average yield in the Republic of Serbia, as well as at the level of the Šumadija Region and Western Serbia in the ten-year research period (from 2012 to 2021). The review of relevant changes in observed phenomena (area under fruit species and total production) was performed using the average annual rate of change. Also, in the first part of the paper is given a description of the world's largest raspberry producing countries and an overview of the export of frozen raspberries from Serbia to the countries of the world as well as to the countries of the European Union, expressed in thousands USD, as well as the average annual purchase prices of raspberries in the Republic of Serbia for the ten-year research period.

The second part of the paper refers to the analysis of the main economic indicators of raspberries production, which was carried out in 2021, where the production and economic results per unit area were obtained based on the data of one agricultural holding in the municipality of Arilje. The economic parameters of production were determined based on the value of raspberries production, production costs, financial results and economic efficiency of production.

For the purposes of research in this paper, data from statistical publications of Statistical Office of the Republic of Serbia (SORS) for the period 2012-2021 and the Food and Agriculture

Organization of the United Nations (FAO) were used, as well as the available scientific and professional literature that deals with this subject. The data are presented in tables and graphs with the application of statistical and calculative methods for solving such tasks and problems in science and practice.

## RESEARCH RESULTS AND DISCUSSIONS

Based on official data of the Statistical Office of the Republic of Serbia, the average area under raspberries plantations in the last ten-year period (2012-2021) amounted to 18,891 ha. The data presented in Table 1 show that the largest areas under raspberries plantations in the Republic of Serbia were in 2020 (20,807 ha), and the least in 2012 (11,996 ha). The average fertile area for the same period was 18,891 ha. The highest total yield of 127,010 t was achieved in 2018, and the lowest of 70,320 t was achieved in 2012. The average value of the total yield for the ten-year period is 102,410 t. Regarding yield expressed in t/ha, the highest achieved yield was in 2015 (6.0 t/ha), and the lowest in 2020 (4.9 t/ha), while the average value for the research period for the observed ten years was 5.5 t/ha.

**Table 1. The average value of areas and yields of raspberries in the Republic of Serbia for the period 2012-2021. year**

Period of research	Harvested area, ha /arable land, ha	Index (2013=100)	Total yield (t)	Index (2013=100)	Yield, t/ha	Index (2013=100)
2012	11.996	100,00	70.320	100,00	5,9	100,00
2013	13.118	109,35	74.682	106,20	5,7	96,61
2014	14.792	123,31	82.683	117,58	5,6	94,92
2015	16.211	135,14	97.165	138,18	6,0	101,69
2016	20.194	168,34	113.172	160,94	5,6	94,92
2017	21.861	182,24	109.742	156,06	5,0	84,75
2018	22.654	188,85	127.010	180,62	5,6	94,92
2019	23.249	193,81	120.058	170,73	5,2	88,14
2020	24.028	200,30	118.674	168,76	4,9	83,05
2021	20.807	173,45	110.589	157,27	5,3	89,83
<b>Average</b>	<b>18.891</b>		<b>102.410</b>		<b>5,5</b>	
<b>Average annual rate of change</b>	<b>6,31</b>		<b>5,16</b>		<b>-1,18</b>	

Source: <https://data.stat.gov.rs/Home/Result/130102?languageCode=sr-Cyrl&displayMode=table&guid=02d2de7e-c59c-4884-8c29-ac929c23b706>

The data shown in Table 2 present that at the level of the Zlatibor district, the largest areas under raspberry plantations were in 2020 (19,268 ha), and the least in 2012 (10,635 ha). The average fertile area for the same period was 15,466 ha. The highest total yield of 104,894 t was achieved in 2018, and the lowest of 63,506 t in 2012. The average value of the total yield for the ten-year period is 86,328 t. Regarding the yield expressed in t/ha, the highest achieved yield was in 2015 (6.1 t/ha), and the lowest in 2020 (5.3 t/ha), while the average value for the research period for the observed ten years was 5.7 t/ha.

**Table 2. The average value of areas and yields of raspberries in the Šumadija region and Western Serbia for the period 2012-2021. year**

Period of research	Harvested area, ha /arable land, ha	Index (2013=100)	Total yield (t)	Index (2013=100)	Yield, t/ha	Index (2013=100)
2012	10.635	100,00	63.506	100,00	6,2	100,00
2013	11.143	104,78	63.604	100,15	5,7	91,94
2014	11.909	111,98	66.857	105,28	5,6	90,32
2015	13.210	124,21	80.845	127,30	6,1	98,39

Period of research	Harvested area, ha /arable land, ha	Index (2013=100)	Total yield (t)	Index (2013=100)	Yield, t/ha	Index (2013=100)
2016	16.404	154,25	93.076	146,56	5,7	91,94
2017	18.175	170,90	91.273	143,72	5,0	80,65
2018	18.503	173,98	104.894	165,17	5,7	91,94
2019	18.746	176,27	102.653	161,64	5,5	88,71
2020	19.268	181,18	101.824	160,34	5,3	85,48
2021	16.669	156,74	94.749	149,20	5,7	91,94
<b>Average</b>	<b>15.466</b>		<b>86.328</b>		<b>5,7</b>	
<b>Average annual rate of change</b>		<b>5,12</b>		<b>4,54</b>		<b>-0,93</b>

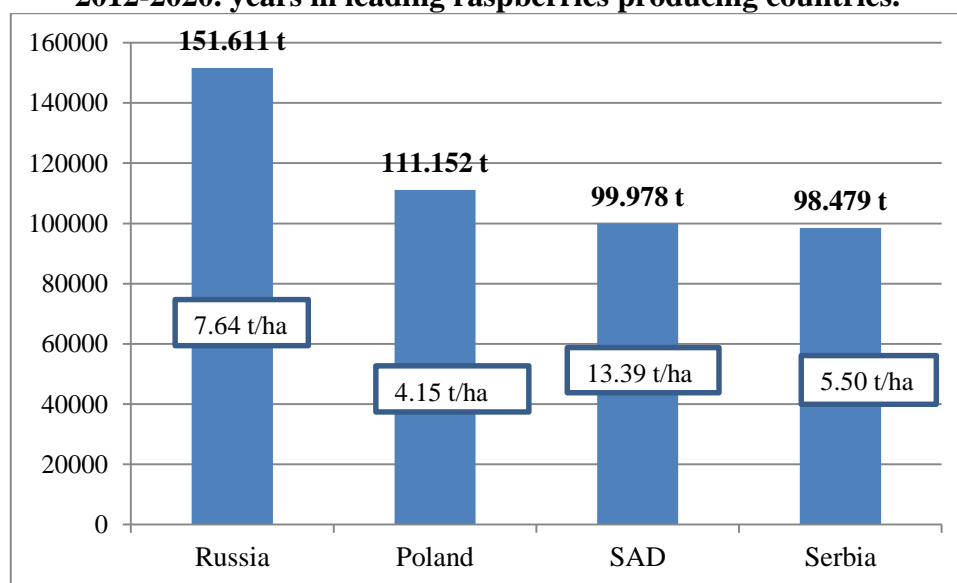
Source: <https://data.stat.gov.rs/Home/Result/130102?languageCode=sr-Cyrl&displayMode=table&guid=02d2de7e-c59c-4884-8c29-ac929c23b706>

In the region of Šumadija and Western Serbia, where also the Zlatibor region belongs, the situation is similar to that of the entire territory of Serbia. From 2012 onwards, there is a trend of growth in the area under raspberries plantations, as well as an increase in yield corresponding to the increase in the area under raspberries plantations.

The Zlatibor region belongs to the region of Šumadija and Western Serbia and includes ten municipalities: Užice, Arilje, Bajina Bašta, Kosjerić, Nova Varoš, Požega, Priboj, Prijepolje, Sjenica and Čajetina. The total number of agricultural holdings in this area is 43,829, which have a total of 202,051 ha of agricultural area. One of the most important branches in this area and at the same time the most profitable is fruit growing because it enables the development of less developed parts of this area. Orchards are spread over 23,049 ha of agricultural area, with the largest area under orchards in the municipality of Arilje (3,368 ha), and the smallest area under orchards is in the territory of the municipality of Sjenica (129 ha), (*Municipalities and Regions in the Republic of Serbia, 2021. year*).

Compared with the countries that are considered to be the world's leading producers of raspberries, Serbia occupies a high position in terms of the amount of raspberries produced (Graph 1).

**Graph 1. Average volume of production (t) and yield of raspberries (t/ha) for the period of 2012-2020. years in leading raspberries producing countries.**



Source: The authors' calculation by given data <https://www.fao.org/faostat/en/#data/QCL>

The average raspberries yield in Serbia is 5.5 t/ha, and that average is higher than the average raspberries yield in Poland, which is 4.2 t/ha. It is obvious that data on average yields do not reflect the real state of raspberries production. According to data from the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia, there are two groups of producers among

raspberries producers. One part of the producers applies modern production, introducing and implementing all agrotechnical measures, irrigation systems and similar, thereby raising the yield close to the genetic potential of raspberries, which is about 20 t/ha, while a large number of producers maintain already existing plantations, without introducing new technology and thus it achieves average yields, i.e. around 5 t/ha. In this way, the level of production in Serbia is maintained, but the quality is lost. The solution to increase the yield but not to the detriment of its quality would be in expert testing of varieties and clones, improving the production of certified planting material and improving the production technology, applying innovative technologies in the production itself (Keserović Z., Magazin N., 2014).

Table 3. shows the export of raspberries from Serbia for the period 2012-2021. year to all the countries of the world as well as to the countries of the European Union.

**Table 3. Export of sugar free frozen raspberries for the period 2012-2021. year**

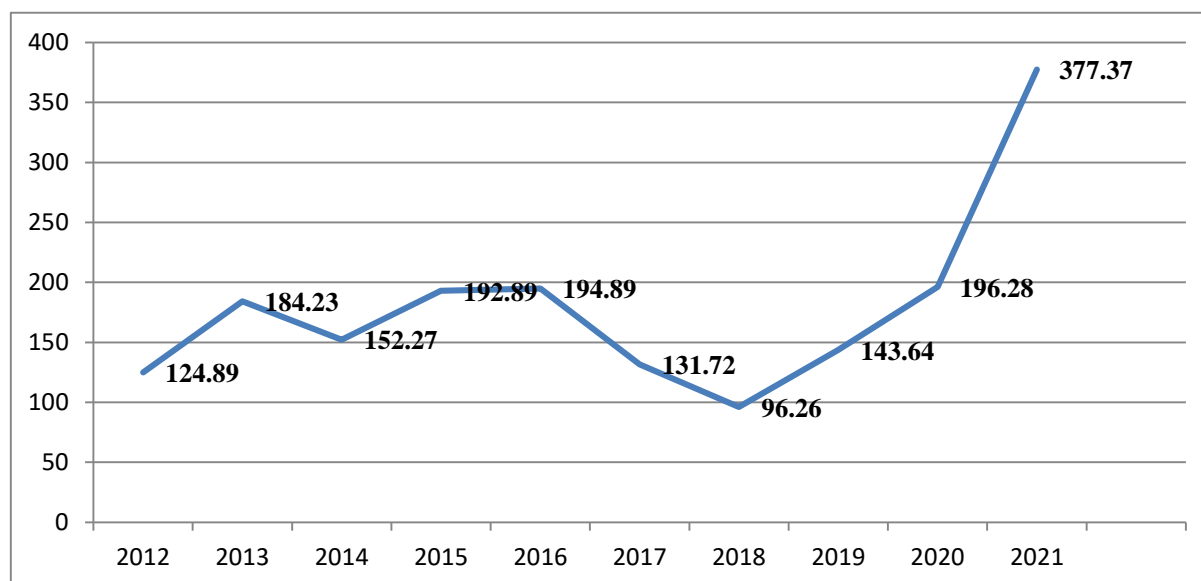
Years	All countries		The European Union countries (28)	
	Quantity (t)	Value in thousands of USD	Quantity (t)	Value in thousands of USD
2012	64.268,1	135.648,1	60.201,1	126.216,0
2013	61.416,9	187.357,7	56.821,0	171.539,8
2014	73.252,6	236.517,6	64.933,4	207.713,4
2015	93.731,6	267.566,4	83.400,1	234.569,4
2016	85.956,9	247.883,5	77.009,8	219.853,6
2017	94.000,2	233.233,4	81.689,1	201.121,6
2018	103.275,8	225.763,8	87.884,2	190.062,9
2019	114.354,2	234.343,9	99.145,6	199.705,1
2020	107.745,2	295.896,5	82.582,6	217.716,0
2021	97.961,5	426.143,1	76.275,4	320.042,4
<b>Average</b>	<b>89.596,3</b>	<b>249.035,4</b>	<b>76.994,2</b>	<b>208.854,0</b>

Source: <https://data.stat.gov.rs/Home/Result/170304?languageCode=sr-Cyrl&displayMode=table&guid=f0c8ff73-6171-4d69-998d-164cfb439633>

The largest amount of exports was achieved in 2019 (114,354.2) with a value of 234,343.9 thousands USD, while the smallest amount of raspberries was exported in 2013 (61,416.8 t) worth 187,357.7 thousands USD. These data refer to the export of raspberries to all countries of the world. Unlike exports, the import of raspberries into our country is insignificant. Raspberries are mainly exported in frozen state (about 98%), mainly to the countries of the European Union (Germany, France, Belgium, Great Britain, Sweden, Holland, Poland; Austria). In recent years, the production of processed raspberry products (juices, jams, etc.) has been on the rise (*Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia, market report, 2020*).

The average purchase price of raspberries, obtained from the values for the analyzed period (Graph 2), is 179.38 dinars/kg.

**Graph 2. Average annual purchase prices of raspberries in the Republic of Serbia for the period 2012-2021. year**



Source: <https://data.stat.gov.rs/Home/Result/0302010302?languageCode=sr-Cyrl&displayMode=table&guid=979941fa-6bf1-4025-a55c-f5d362ff4b4e>

The price of raspberries is defined by the principle of supply and demand on the market, so accordingly, the purchase prices of raspberries varied significantly by year of production (Kljajić N. et al., 2022). Until 2016, there was a trend of price growth followed by a drop in the price of raspberries. During the COVID pandemic, the demand for raspberries increased proportionally to the decrease in raspberries stocks on the world market, which led to a significant increase in prices.

#### **Economic results of raspberry production on a family holding**

The economic analysis of the results of raspberries production on a selected family holding in the Zlatibor district is based on the calculation of raspberries production on 1.0 ha of land. The cultivation of the raspberries variety "Willamette" on this family holding takes place in a vertical trellis formed by wooden posts and wire supports. The Raspberry field is in the period of full fertility and there is a drip irrigation system installed on it. The raspberries planting distance is 2.5 m x 0.25 m, that is, the row spacing is 0.25 m and the row spacing is 2.5 m. In the raspberry field, during the year, on several occasions, the space between the rows is maintained with a motor cultivator, as well as around the rows, i.e. the seedlings, the soil is hoed by hand. The agricultural holding has all the necessary machinery and equipment for carrying out work in the raspberry field.

Harvesting is done manually, in the period from the second half of June to the second half of July. After harvesting, the fresh raspberry fruits are classified into two categories and the largest percentage are handed over to the local buyer, i.e. the cold storer. The remaining part is sold on the market or on the farm itself to well-known customers from the surrounding area.

In the analyzed year, the realized raspberry yield was 11.1 t/ha. When calculating, the purchase price that was realized in 2021 and which amounted to 378 din/kg, i.e. €3.21/kg, is used.

Considering that in our country raspberries are mostly grown on areas smaller than 1 ha, the research results and economic indicators are calculated per 1 ha. An area of 1 ha represents one of the adequate sizes of plantations on which raspberries can be grown in the relevant production areas of our country, and at the same time it is practical for presenting the achieved production and economic results.

The total costs of production include **the costs of materials** (raspberries seedlings, pillars and wires for supports, mineral fertilizers, manure, protective agents-pesticides, packaging, which includes plastic crates for packing 3 kg of raspberries, irrigation equipment and other material costs), **costs of depreciation and use of machinery** (transportation and spreading of mineral fertilizers, spreading of manure, treatment with protective agents, inter-row processing, transport), **costs of labor**

(pruning, manual hoeing around seedlings, harvesting with packaging of raspberry fruits), **and costs of applying irrigation**, which is shown in Table 4.

**Table 4. Raspberries production calculation (P=1,0 ha)**

Element	Quantity	Unit of measure	Price (€/unit of measure)	Total value (RSD)	Total value (EUR)	Structure (%)
<b>I INCOMES</b>						
Raspberries production (kg)	11,150		378,0		<b>35,848.4</b>	
<b>Total income</b>				<b>4,214,700</b>	<b>35,848.4</b>	
<b>II COSTS</b>						<b>100,0</b>
<b>1. Material costs</b>				<b>337,107.0</b>	<b>2,867.3</b>	<b>34,97</b>
1.1. Replacement seedlings	117	pcs	30,0	3,510.0	29,9	0,36
1.2. Poles and wires for replacement	20	pcs	150,0	3,000.0	25,5	0,31
1.3. Mineral fertilizer				43,270.0	368,0	4,49
1.4. Stable manure				44,340.0	377,1	4,60
1.5. Pesticides				63,250.0	538,0	6,56
1.6. Packaging	5,000	pcs		150,345.0	1,278.8	15,60
1.7. Irrigation system				13,520.0	115,0	1,40
1.8. Other material costs				15,872.0	135,0	1,65
<b>2. Costs of depreciation and use of machinery</b>				<b>54,570.0</b>	<b>464,1</b>	<b>5,66</b>
2.1. Transportation and spreading of mineral fertilizers	1	ha		4,820.0	41,0	0,50
2.2. Spreading of stable manure		ha		3,760.0	32,0	0,39
2.3. Protective treatment		ha		33,625.0	286,0	3,49
2.4. Inter-row processing	2	ha		5,785.0	49,2	0,60
2.5. Transport	10	by tour		6,580.0	56,0	0,68
<b>3. Labor costs</b>				<b>572,220.0</b>	<b>4,867.1</b>	<b>59,37</b>
3.1. Pruning	2	working day		58,200.0	495,0	6,04
3.2. Manual harvesting around seedlings	6	working day		11,520.0	98,0	1,20
3.3. Harvesting and packaging	22	working day		488,400.0	4,154.1	50,67
<b>4. Irrigation costs</b>				<b>14,100.0</b>	<b>119,9</b>	<b>1,46</b>
<b>Total costs</b>				<b>963,897.0</b>	<b>8,198.5</b>	
<b>III PROFIT</b>					<b>27,649.9</b>	

Source: The authors' calculation has been made through field research (2021)

\* Exchange rate of National Bank of Serbia on day 31/07/2021 (1 RSD= 117,57 €)

Total costs, market value of production and realized profit were obtained based on collected data on costs in the production process and the amount of yield. Calculation includes total costs, where material costs are calculated based on market prices.

The total costs of regular raspberries production on the family holding in Arilje amount to €8,198.5/ha. This cost showed into a value per kg is €0.61/kg, which compared to the selling price of raspberries is a significantly lower value and represents an exceptional benefit for raspberries producers. By comparing the calculated costs and realized income in raspberries production in 2021, a profit of €27,649.9/ha, or €2.48/kg, was realized, at the sale price of raspberries in 2021, the year of approximately 378 din/kg, or €3,21/kg.

The economic efficiency of raspberries production shown in this research is 3.37 and is represented by the ratio of the realized value of production and the total costs in the production process. This value is an indicator of how many euros of production value were realized per euro of total production costs (Kljajić N., et al., 2017, Jelocnik M., et al., 2021).

Table 5 shows critical values in raspberries production. If the yield and price values of raspberries are taken into consideration, its production can be characterized as low to moderate risk.

**Table 5. Critical values in production**

Description	RSD (kg/ha)
Expected yield (EY)	11,150.00
Expected price (EP)	378,00
Subventions (S)	0,00
Variable costs (VC)	963,897.00
<b>Critical price: <math>CP = (VC - S) / EY</math></b>	<b>86,45</b>
<b>Critical yield: <math>CY = (VT - S) / EP</math></b>	<b>2,549.99</b>
<b>Critical variable costs <math>CVC = (EY \times EP) + S</math></b>	<b>4,214,700.00</b>

Source: The authors' calculation has been made through field research (2021)

Production on family holding can be completed and thereby strengthen on the market through the association of several producers into specialized cooperatives and associations of raspberries producers, then by processing and packaging a quantity of produced raspberries into juices, jams, etc., as well as by improving production through the introduction of innovations and new scientific knowledge in practice.

## CONCLUSION

Raspberries are extremely profitable fruit species, especially from the area of Serbia, where raspberries have been traditionally grown for years, achieving high yields of extremely high-quality fruits. Regardless of the fact that agricultural producers have found interest in growing raspberries in all parts of Serbia, the area of Western Serbia, especially Valjevo, Arilje, Požega, Ivanjica, is still the center of its production. This is supported by the results from the family holdings of raspberries producers in this region.

The economic indicators determined in this paper confirmed that raspberries production in the Zlatibor district of our country is extremely economically profitable. The financial result on the surface of 1 ha of a representative agricultural holding is positive and amounts to €27,649.9/ha. The total value of production costs is €8,198.5/ha. Total production costs include material costs, depreciation and use of machinery, labor costs and irrigation costs. Labor costs have the largest share in the structure of total costs, and within them, the costs of picking and packing raspberries. Those costs amount to €4,154.1/ha or 59.67% of the total costs.

The purchase price of raspberries was 378 din/kg or €3.21/kg in 2021. This price of raspberries per kilogram is significantly higher compared to the cost per kg of raspberries (€0.61/kg), so the realized profit is €2.48/kg of raspberries.

The raspberry sector is loaded with numerous problems. Some of the problems producers dealing with are purchase at a single price, poor organization of smaller producers with the aim of association, absence of raspberries classification during purchase, absence of quality and health safety control of raspberries, etc. On the other hand, cold storers themselves as buyers of products also face numerous problems, such as the inability to predict the future selling price at the time of purchase, the use of unfavorable loans for purchase, and similar.

In order to maintain the competitiveness of „Serbian raspberries“ on the world and European markets, which significantly contributes to the agricultural sector of Serbia, it is important to ensure the minimum purchase price of raspberries in all areas of our country where they are grown. In order to further encourage farmers' interest in its production, it is necessary to maintain a controlled difference between the purchase price of fresh raspberries and the export price.



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