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ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ekonomika2304041K
Received: August, 31. 2023.
Accepted: October, 14. 2023.

ECONOMIC ASPECTS OF FRUIT PRODUCTION IN SERBIA ON THE EXAMPLE OF APPLE ORCHARDS⁴

Abstract

Apple is one of the most important fruits in the world and in Europe. In the Republic of Serbia, it is grown on 27,034 ha of agricultural land and, judging by this criterion, is in second place, right behind plum. The paper analyzes the production of Golden Delicious apple cultivar on a family farm in the region of Šumadija and Western Serbia, on an area of 1 ha, with a 3.2 x 0.8 m planting distance. The apple crop is in full bloom, with all agrotechnical measures necessary for proper cultivation applied in production, including irrigation. The recorded production value is from the yield of 45.0 t/ha of apples. Total variable costs amount to RSD 687,445.00/ha or EUR 5,864.83/ha. Ratio of total costs and income from apple production in 2022 gives a contribution margin of RSD 1,337,555.00/ha or €11,411.15/ha, i.e. RSD 29.72/kg or €0.25/kg, at apple selling price of 45 din/kg, i.e. 0.38 €/kg. The efficiency of apple production is 2.95. Results point to the conclusion that apple production can be profitable and that it is a moderately risky production line.

Key words: *apple, production, export/import, prices, costs, contribution margin/profit, cost-effectiveness of production*

JEL classification: *Q14, Q13, R3.*

ЕКОНОМСКИ АСПЕКТИ ВОЋАРСКЕ ПРОИЗВОДЊЕ У СРБИЈИ НА ПРИМЕРУ ЗАСАДА ЈАБУКЕ

Сажетак

Јабуска је једно од најважнијих воћа у свету и Европи. У Републици Србији се гаји на 27.034 ха пољопривредног земљишта и по овом критеријуму је на другом месту, одмах иза шљиве. У раду је анализирана производња сорте јабуке Голден Делишес на породичном газдинству у региону Шумадије и Западне Србије, на површини од 1 ха, са растојањем садње 3,2 x 0,8 м. Род јабуке је у пуном цвету,

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⁴ Paper is a part of research financed by the MSTDI RS and agreed in decision no. 451-03-47/2023-01/200009 from 03.02.2023.

a у производњи се примењују све агротехничке мере неопходне за правилан узгој, укључујући и наводњавање. Евидентирана производна вредност је од приноса од 45,0 т/ха јабуке. Укупни варијабилни трошкови износе 687.445,00 динара/ха или 5.864,83 €/ха. Однос укупних трошкова и прихода од производње јабуке у 2022. години даје маржу доприноса од 1.337.555,00 RSD/ха или 11.411,15€/ха, односно 29,72 RSD/кг или 0,25€/кг, по продајној цени јабуке од 45 дин/кг, односно 0,38 €/ха. /кг. Ефикасност производње јабуке је 2,95. Резултати упућују на закључак да производња јабука може бити исплатива и да је реч о умерено ризичној производној линији.

Кључне речи: јабука, производња, извоз/увоз, цене, трошкови, маржа доприноса/профит, исплативост производње

JEL classification: Q14, Q13, R3.

Introduction

The share of fruit production in the total value of agricultural production in the Republic of Serbia is 11% (Strategy of Agriculture and Rural Development of the Republic of Serbia 2014-2024), which ranks fruit growing as one of the most important branches of agriculture. Fruit growing is the most productive branch of agriculture, which greatly intensifies entire agricultural production (Kljajić et al., 2013). Fruit production, especially for fresh consumption, is very labor-intensive and very profitable (Mamuza and Vaško, 2013). Fruit production has a direct impact, through primary production and agro-industry, on the overall economic development, especially in rural areas, and then on the development of the country's economy as a whole. The indisputable importance of fruit growing implies the following: the irreplaceability of fruit in the nutrition of the population; fruit as a raw material in food industry and other related activities; export of fresh or unprocessed fruit to the foreign market; employment during the year, especially during the harvest season; high profit per unit area; use of natural resources; fight against soil erosion; microclimate change, beekeeping and others (Božić, 2005, Milić et al., 2005a).

In different natural conditions (microclimate and soil characteristics), the possibilities for growing different types of fruit and their varieties also differ. According to fruit representation, in Serbia, stone fruits (peach, apricot, plum, cherry, sour cherry, morello cherry) are in first place, followed by apples (apples, pears, quinces, medlars, sorb apples), berries (raspberries, blackberries, strawberries, currants, gooseberry, blueberry, mulberry), while nuts (walnut, hazelnut, almond, chestnut) are represented to the smallest extent. Apple is one of the most common types of fruit in our country (Lukić and Milošević, 2016). According to the Statistical Office of the Republic of Serbia, Statistical Yearbook 2022, plums are grown on the largest areas (on 72,569 ha of agricultural land), followed by apples (on 27,034 ha of agricultural land).

Apple is one of the most important fruits in the world and in Europe. It can be said that apple production shows the development of the entire fruit production in any country (Subić et al, 2017; Kljajić et al., 2014). Apple originates from Asia Minor and Central Asia, to be transferred to Europe in the Middle Ages, then from Europe to North and South America

and then to Australia. It was used as food since prehistoric times. It belongs to the apple type of fruit, along with pear, quince, medlar and sorb apples, and is a very durable stone fruit that can be preserved and used throughout the year (Milić et al., 2005a, Milić et al., 2014). Apple belongs to the *Rosacea* family. According to Magazin et al., domestic apple (*Malus domestica Borkh*) is the most economically important species out of 33 species within the *Malus* genus. It was created as a hybrid of wild apple (*M. Sieversii* (Lodeb.) Roem.) and European and Asian apple varieties (Brown, 2012).

Owing to its properties, apple is a very healthy fruit that works effectively in the body's fight against viruses and bacteria, improves immunity, controls diabetes, is a good antioxidant, and generally protects the body from various chronic diseases.

Apple contains from 15% to 19% of dry matter, with 9-16% of fruit mass made up of sugars (mainly glucose and fructose), from 0.2% to 1.8% of organic acids, and 0.4% of mineral matter. Of minerals, there is the most potassium (Purić, 2021). Other biologically significant substances apple contains are vitamin C, carotene, anthocyanins, tannins, amino acids, etc. (Mratinić, 2016).

The success of apple growing depends on environmental conditions in which it is grown. Consequently, apple and its production must be adapted to environmental conditions, i.e. the climatic, soil and hydrological conditions of the area where it is grown. Regarding apple cultivars, the leading cultivar in Serbia is still Idared (Milošević et al., 2007). The share of this cultivar in the production structure is 20-25%. It is an American cultivar obtained as a cross between two apple varieties, "Jonathan" and "Wagener" in 1942. It is grown all over the world. It came to Serbia in 1961 (Rakićević et al., 2008). In the last few years, varieties that belong to the group of fall apple varieties with an earlier ripening period have gained primacy. In this way, the apple harvest period is extended. There is a pronounced trend of introducing other varieties depending on market demand. The share of Granny Smith and Golden Delicious and Jonagold is growing. Red Delicious, Gloucester, Mutsu, Gala and others are present to a lesser extent. Club varieties appear in production as well: Pink Lady, Modi, Fuji Kiku (Lukić and Milošević, 2017; (<http://www.minpolj.gov.rs/dokumenti/izvestaji-sa-trzista/>).

Material and method

The aim of the paper work is to demonstrate the economic justification of apple cultivation on the example of the production of one registered agricultural farm in the Šumadija Region and Western Serbia.

The paper work is designed so that it is divided into two parts. In the first part of the paper work, an analysis of the representation of areas under apple plantations and the total and average yield of apples in the Republic of Serbia, and at the level of the Šumadija Region and Western Serbia, was presented. The analysis covered the period from 2013 to 2022. Relevant changes in the area under apple plantations and total production were analyzed using the average annual rate of change. In addition, the export of apples from Serbia is shown, as well as the import of apples to the Republic of Serbia. These values are expressed in thousands USD. At the end of the first part, the average annual purchase prices of apples in the Republic of Serbia for the period 2013-2022 are shown year.

In the second part of the paper work, the calculation of the apple production of the agricultural farm per 1 ha of surface area, the sensitivity analysis in apple production – the

change in the coverage margin in relation to the drop in yield and the critical value in apple production was done.

For the purposes of the research, data from statistical publications of the Statistical Office of the Republic of Serbia (RZS) for the period 2013-2022 were used. Trade statistics for international business development (TRADEMAP), market reports of the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia, as well as available scientific and professional literature dealing with this topic. The results of previous research on the mentioned issue were also used. Data are presented tabularly and graphically.

Research results and discussion

The average area under apple plantations in the last ten-year period (2013-2022) amounts to 26,298 ha. Table 1 shows that the largest area under apple plantations in the Republic of Serbia is in 2022 (27,253 ha), and the least in 2013 (23,989 ha). The largest production is in 2013 in the value of 516,411 t and the lowest in 2017 in the value of 378,644 t. The average value of total production in the period 2013-2022 is 471,251 t. The highest achieved yield is in 2013 (21.5 t/ha), and the lowest in 2017 (15.1 t/ha), while the average value for the observed ten-year research period is 17.9 t/ha.

Table 1. Average value of area, total production and apple yield in the Republic of Serbia for the period 2013-2022

Research period	Harvested area, ha /fertile area, ha	Li	Total production (t)	Li	Yield, t/ha	Li
2013	23.989	–	516.411	–	21,5	–
2014	24.441	101,88	403.936	78,22	16,5	76,74
2015	24.703	101,07	431.759	106,89	17,5	106,06
2016	24.818	100,47	400.473	92,75	16,1	92,00
2017	25.134	101,27	378.644	94,55	15,1	93,79
2018	25.917	103,12	460.404	121,59	17,8	117,88
2019	26.089	100,66	499.578	108,51	19,1	107,30
2020	26.360	101,04	489.426	97,97	18,6	97,38
2021	27.034	102,56	513.238	104,87	19,0	102,15
2022	27.253	100,81	486.215	94,73	17,8	93,68
<i>Average</i>	26.298		471.251		17,9	
Average annual rate of change (%)	1,43		-0,67		-2,08	

Source: <https://data.stat.gov.rs/Home/Result/130102?languageCode=sr-yrl&displayMode=table&guid=68df3487-0c0a-45ff-a139-2b51f0cfa503>

In the observed period from 2013-2022, the total area under apple plantations increased by 1.43% on average per year. Total apple production decreased by 0.67% on average per year, while the total yield decreased by 2.08% on average per year.

The largest apple production is in the Šumadija Region and Western Serbia. For the period 2013-2022, the average area under apple plantations was 10,117 ha, with an average total production of 139,885 t and an average yield of 13.3 t/ha. This region accounts for 52.9% of the total apple production in the Republic of Serbia (Table 2).

Table 2. Average value of area, total production and apple yield in the Republic of Serbia for the period 2013-2022

Territory	Harvested area, ha/fertile area (ha)	Total production (t)	Yield (t/ha)
Republic of Serbia (total)	26.298	471.251	17,9
Serbia-North	10.017	221.911	22,1
Belgrade region	2.423	31.366	12,9
Vojvodina region	7.594	190.545	25,1
Serbia-South	16.281	249.340	15,4
Region of Šumadija and Western Serbia	10.117	139.885	13,3
Region of Southern and Eastern Serbia	6.164	109.455	17,7

Source: Author's calculation based on data from <https://data.stat.gov.rs/Home/Result/130102?languageCode=sr-yr1&displayMode=table&guid=68df3487-0c0a-45ff-a139-2b51f0cfa503>

Modern apple production makes it possible to achieve high and stable yields. It implies the application of all necessary agrotechnical measures, as well as irrigation, hail and frost protection, etc. This reduces the risk of production to the smallest possible extent (Potkonjak i et al., 2011). When modern agricultural techniques are applied in production, it is possible to achieve high yields, satisfying fruit quality and high financial results (Čejvanović et al., 2005). According to Đurović et al. (2023), the fruits of trees under intense irrigation are characterized by uniformity, are larger, better colored, ripen earlier, have a more harmonious taste, and so on. However, the application of irrigation requires moderation, so when irrigating with a non-optimal amount of water, the fruit loses its quality, i.e. fruits become tasteless and their storage length is shorter.

The structure of apple producers has changed significantly in recent years. Ten years ago, the main apple producers in Serbia were individual farmers who grew apples in the traditional way, on 2-5-ha plots. Now they are commercial farms that gradually increase the plantation area to about 10 ha. In addition, these farms apply modern and contemporary technology in apple production. The number of companies with 25-250-ha apple plantations is also growing. They apply the most modern growing technology and, therefore, get high yield (50-70 t/ha).

The export of apples is the basis for increasing the total domestic fruit production, because apples are in second place among all types of fruit in terms of production. To increase exports, the growth of domestic apple production is necessary, on the one hand, as well as the change and adaptation of apple varieties to market requirements, on the other hand (Vlahović et al., 2015).

Tables 3 and 4 show the export and import of apples from and to Serbia for the period 2013-2022 to all world countries as well as to the EU countries.

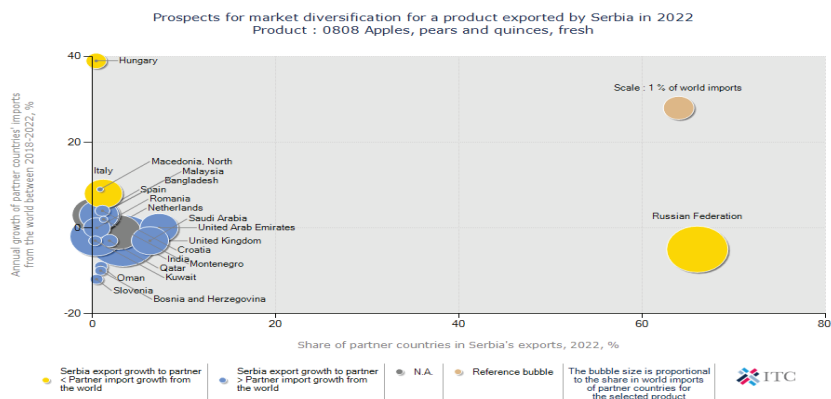
Table 3. Export of fresh apples from the Republic of Serbia for the period 2013-2022.

Year	All countries		EU countries (28)	
	Quantity (t)	Value in thousand USD	Quantity (t)	Value in thousand USD
2013	115.938,2	53.024,8	38.835,7	8.836,3
2014	135.982,2	81.307,5	4.880,2	1.708,8
2015	187.365,6	104.096,7	22.985,0	4.843,3
2016	232.203,8	127.074,6	23.303,1	4.150,9
2017	197.581,8	124.667,5	23.034,9	7.513,6
2018	144.747,0	101.414,5	11.775,5	4.579,1
2019	217.000,2	118.517,4	38.238,6	8.608,4
2020	173.098,4	125.400,7	21.715,6	6.733,4
2021	179.639,9	127.390,3	19.194,2	7.657,4
2022	148.077,4	107.674,7	8.842,6	4.035,8
Average	177.294,7	109.917,9	23.102,8	5.866,7

Source: <https://data.stat.gov.rs/> Last update: 22 February 2023

For the research ten-year period, the largest export of 232,203.8 t was in 2016, worth 127,074.6 thousand USD, while the smallest apple export was in 2013 (115,938.2 t), worth 53,024.8 thousand USD. This data refers to the export of apples to all world countries. The situation is similar when it comes to apple export to EU countries (28). In contrast to exports, apple import into our country is insignificant. According to Trade Statistics for International Business Development, in 2022, apples were mostly exported from the Republic of Serbia to North Macedonia, the Netherlands, Russia, Germany, Italy... (Chart 1).

Chart 1. Prospects for market diversification for a product exported by Serbia in 2022.
Product: 0808 Apples, pears and quinces, fresh



Source: https://www.trademap.org/Country_SelProductCountry_Graph.aspx?nvpm=%7c688%7c%7c%7c%7c0808%7c%7c%7c4%7c1%7c1%7c2%7c1%7c1%7c2%7c1%7c%7c2

Regarding apple imports, it was 40,749 t on average with a value of 12,678 USD. Of that, 59.8% was imported from the EU countries.

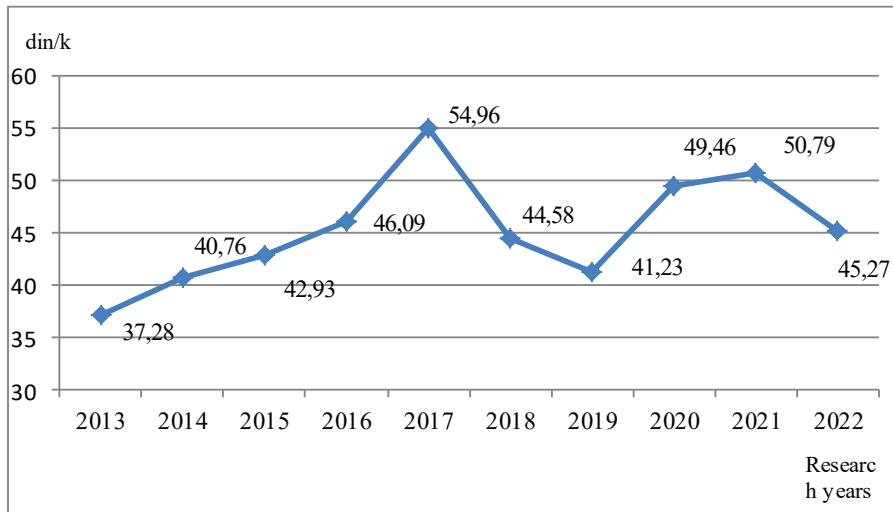
Table 4. Import of fresh apples to the Republic of Serbia for the period 2013-2022

Year	All countries		EU countries (28)	
	Quantity (t)	Value in thousand USD	Quantity (t)	Value in thousand USD
2013	28.753,2	10.429,0	5.622,9	4.276,3
2014	24.543,8	8.352,8	12.313,0	5.387,7
2015	58.223,1	17.258,1	32.260,4	12.381,8
2016	75.570,0	23.101,1	63.038,7	21.014,1
2017	66.439,7	20.637,0	56.032,3	18.061,7
2018	35.992,7	12.741,0	22.151,8	10.782,4
2019	33.209,9	8.518,7	24.105,7	7.422,8
2020	26.565,4	11.208,6	12.839,2	8.392,4
2021	20.713,1	6.714,5	8.988,9	4.920,5
2022	37.483,3	7.822,0	6.274,3	3.509,6
Average	40.749,4	12.678,3	24.362,7	9.750,8

Source: <https://data.stat.gov.rs/> Last update: 22 February 2023

The average purchase price of apples, obtained from the values for the analyzed period (Chart 2), is 45.33 dinars/kg.

Chart 2. Average annual purchase prices of apples in the Republic of Serbia for the period 2013-2022.



Source: <https://data.stat.gov.rs/Home/Result/0302010302?languageCode=sr-Cyrl&displayMode=table&guid=1c4f54bc-4373-4ac4-a8b9-6349cd8a6f97>, Last update: 27th June 2023.

Fruit market is free and there are no guaranteed purchase prices. The price of apples, as well as other agricultural products, is defined according to “supply and demand” market principle.

Economic results of apple production on a family farm

When marketing apples (as well as other fruit and other agricultural products) on the domestic and foreign markets, quality and continuity in delivery are necessary, so such market requirements impose the need for economically profitable and environmentally acceptable production (Jeločnik et al., 2011.; Maksimović et al., 2015;).

Table 2 shows the analytical calculation of apple production on an individual farm in the region of Šumadija and Western Serbia. The farm produces apples on a 5-ha-production area. It sells apples to well-known customers on the farm and on local green markets. It applies all agrotechnical measures in production, including irrigation. Without irrigation in apple production, the financial result after harvest would be somewhat uncertain. Therefore, irrigation in apple orchards is a mandatory measure for production safety and good financial result. A drip irrigation system has been installed in the garden. Costs related to system operation refer to energy costs for pump operation, water costs and maintenance of the irrigation system parts. All the necessary materials for plant care are purchased at the local market.

Table 2. Calculation of apple production of an agricultural farm on 1-ha area with a planting distance of 3.5 x 0.8 m (2022 in RSD/EUR/ha)

Element	Quantity	Unit of measure	Price (RSD/UM)	Total value (RSD)	Total value (EUR)*
I INCOME					
Apple production (kg)	45.000	kg	45,0	2.025.000,00	17.275,99
Total income				2.025.000,00	17.275,99
II EXPENSES					
<i>1. Cost of material</i>					
1.1. Seedlings for replacement	25	piece	175,0	4.375,00	37,32
1.2. Binder	12	kg	410	4.920,00	41,97
1.3. Mineral fertilizer				32.500,00	277,27
1.4. Stable manure				28.500,00	243,14
1.5. Pesticides				94.700,00	807,92
1.6. Packaging (wooden crates)	1.900	piece	75	142.500,00	1.215,72
1.7. Irrigation				23.250,00	198,35
1.8. Other cost of material				19.500,00	166,36
Total				350.245,00	2.988,06
<i>2. Costs of depreciation and use of machinery</i>					

2.1. Transportation and spreading of mineral fertilizers	1	ha	4.250,0	4.250,00	36,26
2.2. Transport and spreading of manure	1	ha	6.500,0	6.500,00	55,45
2.3. Treatment with protection agents	12	ha	5.350,0	5.350,00	45,64
2.4. Inter-row processing and grass cutting	2	ha	7.850,0	7.850,00	66,97
2.5. Transport	15	tour	1.050,0	15.750,00	134,37
Total				39.700,00	338,69
3. Labour costs					
3.1. Pruning	400	hour	350	140.000,00	1.194,39
3.2. Harvesting and packaging	450	hour	350	157.500,00	1.343,69
Total				297.500,00	2.538,08
Total expenses				687.445,00	5.864,83
III Contribution margin (I-II)				1.337.555,00	11.411,15

Source: Author's research conducted in 2022

*1 EUR = 117,2147 RSD (average NBS exchange rate on 1 October 2022)

Total costs, market value of production and profit were obtained based on data on costs in the production process and yield. Costing includes total costs, where costs of material are calculated based on market prices. 95% of the produced apples belong to the first class, and only 5% are in the second class, so when selling and buying a single apple price of RSD 45.0/kg is applied.

In the structure of variable costs, costs of material have the largest share (50.95%). Within the cost of materials, packaging costs have the largest share (40.69%). Packaging includes wooden crates with a capacity of 25 kg. In addition to these costs, the costs for the procurement and application of pesticides (27.04%) have a significant share in the total costs of materials (Table 3).

Within the costs of depreciation and use of machinery, the costs are approximately equally distributed between the transportation and spreading of mineral fertilizers and manure, treatment with protection agents, inter-row processing and transport. The share of these costs in total costs is only 5.77%.

Table 3. Cost structure in apple production expressed in RSD and in %

Type of costs	Value (RSD)	Share (%)
Costs of material	350.245,00	50,95
Costs of depreciation and use of machinery	39.700,00	5,77
Labour costs	297.500,00	43,28
Total costs	687.445,00	100,0

Source: Author's calculation based on research conducted in 2022

Within the labor costs in apple production, pruning costs account for 47.06%, and apple harvesting and packaging costs for 52.94% of total labor costs.

The total variable costs in apple production on the family farm included in this research amount to RSD 687,445.00/ha or EUR 5,864.83/ha. When translated into a value per kg, this cost amounts to RSD 15.08/ha or 0.13€/kg, which, compared to the apple selling price, is a significantly lower value and represents an exceptional benefit for apple producers. By comparing the total costs and realized income in apple production in 2022, we get a contribution margin of RSD 1,337,555.00/ha or 11,411.15€/ha, i.e. RSD 29.72/kg or 0.25€/kg, at the selling price of apples of 45 din/kg, i.e. 0.38 €/kg. The efficiency of apple production is 2.95.

Every investment in production brings a certain degree of risk due to unforeseen circumstances during the production itself and crop life, so evaluating the efficiency of future crops under risk and uncertainty is very important. The goal is to meet producers' expectations under potentially changing production conditions (Maksimović et al., 2015.; Jeločnik et al., 2021).

The analysis of sensitivity of contribution margin to a fall in yield or a fall in the selling price of apples is given in Table 4, which shows that the value of apple production and the price of apples on the market can fall by over 60%, while the farm still has a positive contribution margin in its production.

Table 4. Sensitivity analysis in apple production – change in contribution margin in relation to yield decline.

Fall in yield or fall in selling price of apples (%)	Contribution margin (RSD)
10,00	1.135.055,00
20,00	932.555,00
30,00	730.055,00
40,00	527.555,00
50,00	325.055,00
60,00	122.555,00
70,00	Negative

Source: Author's calculation based on data in Table 2.

Table 5 shows the critical values in apple production where contribution margin equals zero. The critical price of apples is 15.28 dinars/kg, the critical yield is 15,276.56 kg, and the critical variable costs are 2,025,000.00 dinars.

Table 5. Critical values in apple production, expressed in kg/ha, RSD

Description	RSD (kg/ha)
Expected yield (OP)	45.000,00
Expected (average) price (OC)	45,00
Subsidies (S)	0,00
Variable costs (VT)	687.445,00

Critical price: $KC = (VT - S) / OP$	15,28
Critical yield: $KP = (VT - S) / OC$	15.276,56
Critical variable costs: $KVT = (OP \times OC) + S$	2.025.000,00

Source: Author's calculation based on research conducted in 2022.

The results obtained based on the analysis of apple production on the family farm lead to the conclusion that apple production is a profitable production line. This implies respect for the apple requirements as a fruit species in terms of its soil, water and climate needs, and the application of all necessary measures for its care and protection in production.

Conclusion

The results obtained during the analysis of apple production point to the following conclusion:

- Total variable costs amount to 687.445,00 RSD/ha or 5.864,83 EUR/ha;
- Cost of materials have the largest share in the structure of variable costs, first of all the costs of packaging when harvesting and packing apples, and then the costs of purchasing pesticides for the care and protection of plantations;
- Production achieved a positive contribution margin of RSD 1,337,555.00/ha or 11,411.15€/ha, to cover production costs and get a positive financial result;
- Critical production values at which the contribution margin equals zero have the following values: critical apple price is RSD 15.28/kg, critical yield is around 45.0 t/ha and critical variable costs are RSD 2,025,000.00/ha;
- The value of apple production and the market price of apples can fall by over 60%, while the farm still has a positive margin in its production;
- The efficiency of apple production is 2.95.

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