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ECONOMIC ASPECTS OF PLUM PRODUCTION IN THE REPUBLIC OF SERBIA AND WORLDWIDE



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SUMMARY

Plums are the predominant fruit crop in Serbia. In the period under consideration (2012–2021), the Serbian plum area accounted for, on average, 42.52 % of the total fruit area in the country, far surpassing all other fruit crops. The Republic of Serbia is one of the leading plum producers in the world. With an average annual plum production of 440.91 thousand tons, Serbia ranks third in the world (following only China and Romania), contributing 3.77% to the world's total plum production. Nevertheless, the country faces challenges such as low yields per unit area, approximately 5.35 t/ha (FAO, 2023). Presently, the economic significance of plum production is not as high as in previous decades, and cultivation potential remains underutilized. To revitalize plum production in Serbia and reclaim its historical prominence, it is imperative to assess the current state of plum production both globally and regionally and implement appropriate measures to enhance economic performance in this traditional fruit sector.

Key words:

areas under plum orchard, plum production, plum yield, economic indicators

Abbreviations:

FAO - Food and Agriculture Organization of the United Nation; SORS – Statistical Office of the Republic of Serbia

INTRODUCTION

Plums are primarily utilized for fresh consumption and processed into dried plums, juices, jams, and jellies (Nikolić et al., 2012; Mahato et al., 2015). They are adaptable to a wide range of soils and climatic conditions, thus readily cultivable (Mahato et al., 2015). The Republic of Serbia is renowned for its fruit cultivation, encompassing 5.2% of the total cultivated agricultural area in the country in 2021 (SORS, 2022). Among the array of cultivated fruits, plums, apples, raspberries, sour cherries, apricots, pears, blackberries, peaches, and cherries hold prominence. However, the Serbian plum production predominantly occurs on small, fragmented, and neglected parcels, hindering the implementation of efficient cultural measures and mechanization. Approximately 98% of the plum production takes place on small farms, mostly situated in hilly and mountainous regions (Mišić, 2006).

Plum fruits are renowned for their nutritional and health benefits (Ertekina et al., 2006), with historical usage dating back to ancient times for various health issues (Nakatani et al., 2015). The natural conditions of our country, particularly in specific regions, are highly conducive to fruit cultivation. In hilly and mountainous areas, fruit production significantly outperforms the profitability of other crops (Kljaić, 2014). No other agricultural branch can rival fruit production in terms of income generation, especially in hilly and mountainous regions. Fruit cultivation can yield 10–20 times more than wheat and corn production (Keserović et al., 2016). Fruit growing stands out as one of the most lucrative agricultural branches, providing the economic and socio-economic stability for the country. However, the economic viability of fruit production can only be achieved provided such production is organized as an intensive activity.

Fruit production and processing contribute significantly to a country's economic resources (Milić & Lukač Bulatović, 2017). Plum stands as one of Serbia's main symbols and is considered the national fruit, holding utmost importance (Mišić, 2006). Among various fruits, Serbia boasts a significant presence of old indigenous plum varieties, which, however, yield inconsistently and at low rates (Urošević, 2015). Orchards have a finite lifespan, as they gradually lose their biological functions over time, marking the end of their productive cycle (Sredojević, 1996, 1998). Mišić (2006) highlights one of the challenges in plum production, which is the predominant use of fresh plums for brandy production, accounting for about 75% of Serbia's fresh plum output.

To bolster fruit production in the country, revitalizing old orchards and establishing new perennial plantations are imperative, requiring significant investments. This paper focuses on analyzing the production of continental fruits both in Europe and worldwide, as well as the position of Serbia in the overall fruit production. Special attention is given to the country's role in the global plum production and the potential avenues for enhancing this aspect of fruit cultivation.

MATERIAL AND METHODS

During the research, both qualitative and quantitative methods were employed. Descriptive analysis was conducted to elucidate findings and provide a comprehensive description of observed phenomena. Additionally, both inductive and deductive methods, as well as analysis, synthesis, and comparative methods, were utilized.

As data sources for this research, specific publications and databases from relevant institutions were accessed, including the Statistical Office of the Republic of Serbia and the Food and Agriculture Organization of the United Nations. All the aforementioned data were utilized for analyzing the movement of areas under plantation, production, and yields of continental fruits over a ten-year period (2012–2021). Initially, the analysis commenced at a global level before narrowing down to the European continent and finally focusing on the Republic of Serbia. The data obtained were interpreted and presented through tables and figures for clarity and visual representation.

RESULTS AND DISCUSSION

Analysis of global fruit production

The global production of continental fruit in 2021 reached 251 million tons, marking an increase of 11.95% compared to the 221 million tons produced in 2012. Notably, Asia stands out as the leading continent in continental fruit production, contributing to over half of the world's total production, as depicted in Fig. 1. The primary conclusion drawn from a decade-long analysis (2012–2021) of global continental fruit production is the consistent upward trend in fruit production.

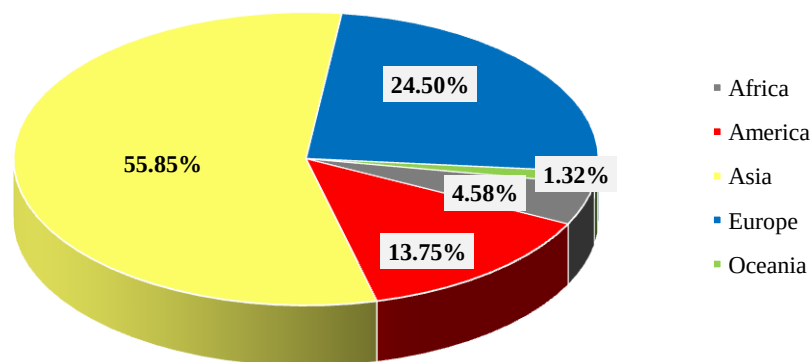


Figure 1. Average fruit production by continent worldwide in the period 2012–2021
(Source: FAO - Food and Agriculture Organization of the United Nation, 2023)

When focusing on global continental fruit and grape production exclusively, apples emerge as the leading product, followed by grapes, pears, peaches, nectarines, and plums (Fig. 2). Consequently, at the global scale, plum production ranks fifth in volume among other varieties of continental fruit.

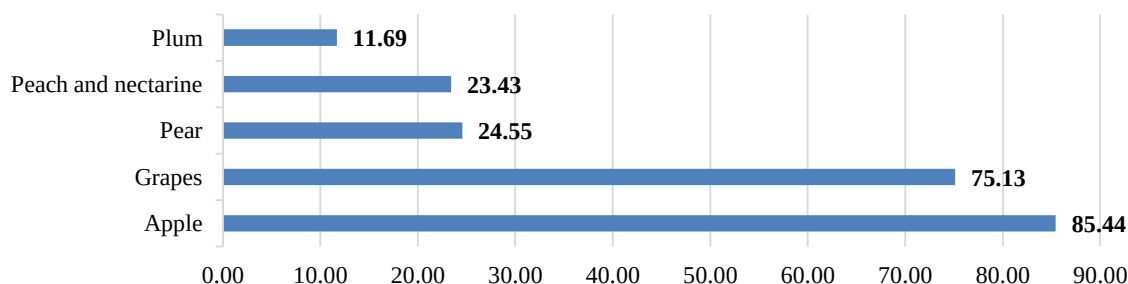


Figure 2. Average production of major continental fruits worldwide in the period 2012–2021*
(* Unit in millions of tons) (Source: Authors' calculations based on the FAO database, 2023)

Analysis of global plum production

According to production, plum is one of the leading continental fruits. Over the past two decades, the global plum production has doubled. Plums are predominantly cultivated in the Northern hemisphere. Asia emerges as the largest producer of plums, followed by Europe and America (Mišić, 2006).

According to the FAO statistical data, Asia boasts the largest average area devoted to plum cultivation over a ten-year research period. The plum orchards in Asia cover an area of 2,036,121.40 hectares, representing 78.62% of the world's total plum cultivation area. Europe follows with 415,690.70 hectares (16.05%), America (including North and South) with 79,836.10 hectares (3.08%), and Africa with 54,991.30 hectares (2.12%). The smallest plum cultivation area is in Oceania, with just 3,310 hectares (0.13%), as illustrated in Table 1.

Table 1. Distribution of areas devoted to plums worldwide by continent in the period 2012–2021*
(* Unit in hectare) (Source: Authors' calculations based on the FAO database, 2023)

	Africa	America	Asia	Europe	Oceania	World (total)
Average in the period 2012–2021	54,991.30	79,836.10	2,036,121.40	415,690.70	3,310.00	2,589,949.50
Structure (world=100%)	2.12%	3.08%	78.62%	16.05%	0.13%	100.00%

Analyzing the average yearly production of plums in the period 2012–2021, it becomes evident that Asia, besides boasting the largest area under plum cultivation, also dominates the global market as the leading producer of this fruit, commanding a share of 65.86%. However, the proportional distribution of annual production does not align with the average areas dedicated to plum cultivation, suggesting that plum production in Asia is predominantly extensive in nature. Following Asia, Europe accounts for 22.24% of global plum production, whereas America contributes 8.15%, Africa 3.58%, and Oceania mere 0.17%, as shown in Table 2. Unlike Asia, all other continents exhibit a larger share in plum yield volume compared to their respective shares of plum cultivation areas.

Table 2. Average plum production worldwide by continent in the period 2012–2021*
(* Unit in tons) (Source: Authors' Calculations based on the FAO database, 2023)

	Africa	America	Asia	Europe	Oceania	World (total)
Average in the period 2012–2021	418,060.97	952,479.27	7,698,515.50	2,599,583.69	20,438.70	11,689,078.13
Structure (world=100%)	3.58%	8.15%	65.86%	22.24%	0.17%	100.00%

Observing the average yields per unit area over the ten-year research period considered (Tab. 3), it is evident that the global average annual yield stands at 7.12 tons per hectare (t/ha). The highest yields per unit area were achieved in America (12.0 t/ha) and Africa (7.61 t/ha) (surpassing the global average), followed by Europe (6.32 t/ha), Oceania (6.18 t/ha), and Asia (with the lowest yield of 3.78 t/ha, falling below the global average). This reaffirms that plum production in Asia is primarily extensive in nature.

Table 3. Average plum yields worldwide by continent in the period 2012–2021. year* (* Unit in tons/ hectare)
(Source: Authors' calculations based on the FAO database, 2023)

	Africa	America	Asia	Europe	Oceania	World
Average for the period 2012–2021	7.61	12.00	3.78	6.32	6.18	7.12

Based on the average annual production of plums in the period 201–2021, China assumes the top position with a production of 5,879.62 thousand tons, constituting half of the world's production. Following closely, Romania secures the second position with a share of 5.11%, whereas Serbia ranks third with 3.77%. Chile follows with 3.08%, trailed by the USA with 3.02%. Further details regarding other contributing countries can be observed in Figure 3.

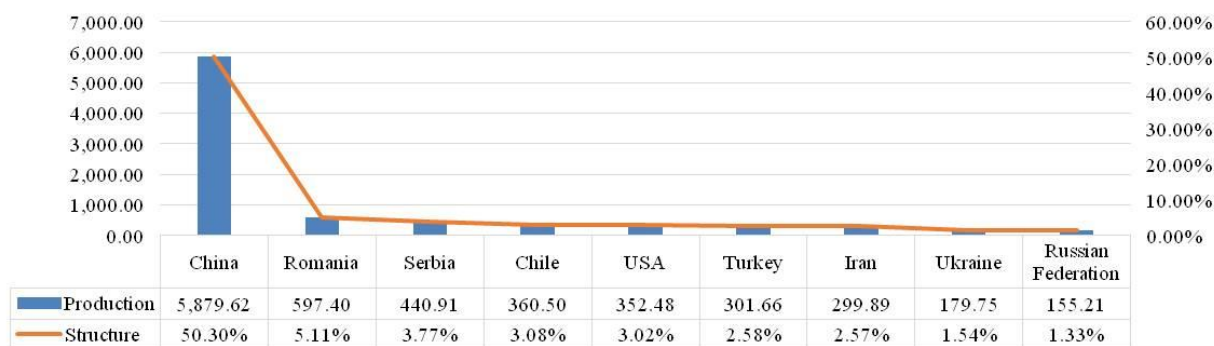


Figure 3. Average production and share of leading plum producers worldwide in the period 2012–2021*
(* Unit in thousands of tons) (Source: Authors' calculations based on the FAO database, 2023)

According to the annual plum yield per unit area, Chile is at the top of the list with a production of 21.21 t/ha, whereas China is at the bottom of the list with a production of 3.08 t/ha (Fig. 4.). These indicators provide valuable information on the implementation of cultural practices in plant care, the representation of highly fertile planting material, the use of irrigation systems, and plant care in the mentioned countries. Better and higher quality fruit treatment guarantees higher yields in production.

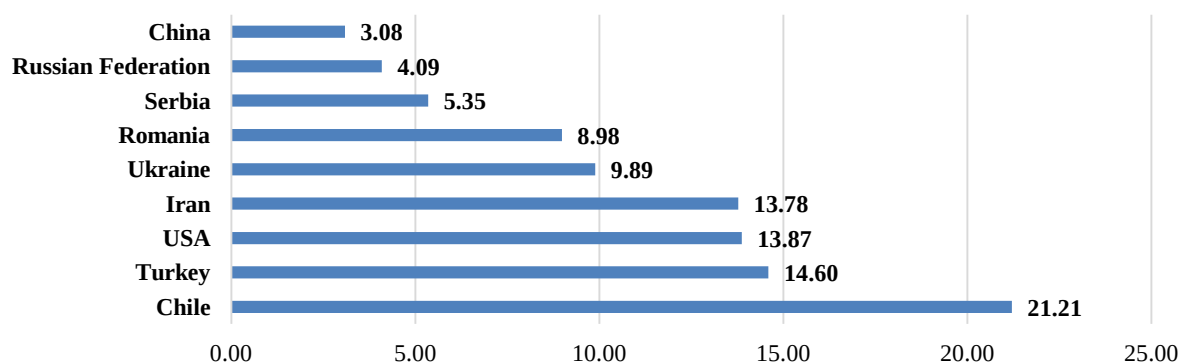


Figure 4. Average actual plum production worldwide by county in the period 2012–2021* (* Unit in tons/hectare) (Source: Authors' calculations based on the FAO database, 2023)

Analysis of plum production in Europe

In the period 2012–2021, the overall production of continental fruit in Europe amounted to 58,930.55 thousands of tons. Grape production claimed the largest share of 46.27%, followed by apples (28.86%), peaches and nectarines (6.69%), pears (4.72%), plums (4.41%), and other minor fruit crops (Fig. 5). Plums ranked seventh in the European fruit production according to the production volume.

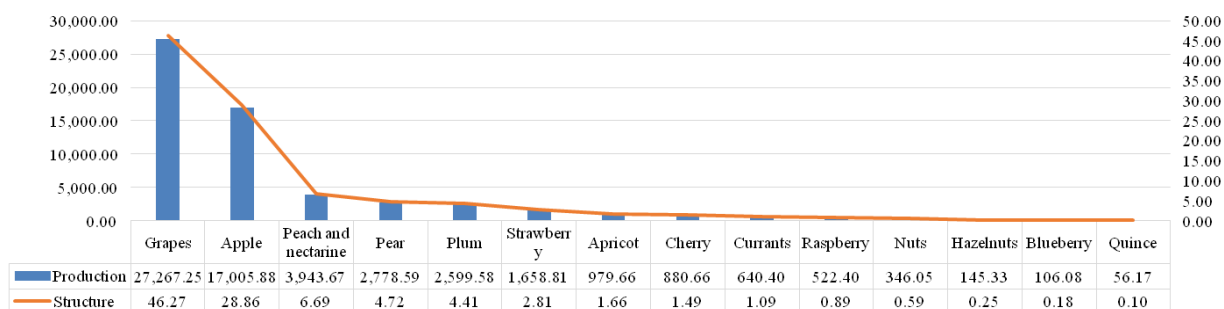


Figure 5. Average production and structure of major continental fruit crops in Europe in the period 2012–2021*
(* Unit in thousands of tons) (Source: Authors' calculation based on the FAO database, 2023)

The average total plum production in Europe amounted to 2,599.58 thousand tons in the period 2012–2021, representing 22.24% of the world's total plum production. The ten leading European countries produce 87% of this fruit in Europe. The biggest plum producer in Europe is Romania, with a production of 597.40 thousand tons and a share of 22.98%, followed by Serbia, with a production of 440.91 thousand tons and a share of 19.96%, and Italy, with a production of 193.20 thousand tons and a share of 7.43% (Fig. 6).

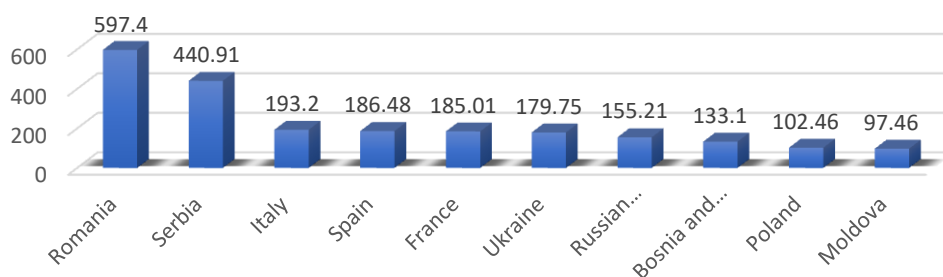


Figure 6. Leading plum producers in Europe in the period 2012–2021*
(* Unit in thousands of tons) (Source: Authors' calculation based on the FAO database, 2023)

Analysis of plum production in the Republic of Serbia

The status and significance of plum production in Serbia are best illustrated in Figure 7, showing the distribution area of the 13 most important fruit crops in Serbia. Plum plantations accounted for 42.52% of the total area devoted to fruit crops in 2012–2021, clearly indicating their dominance over any other fruit crop.

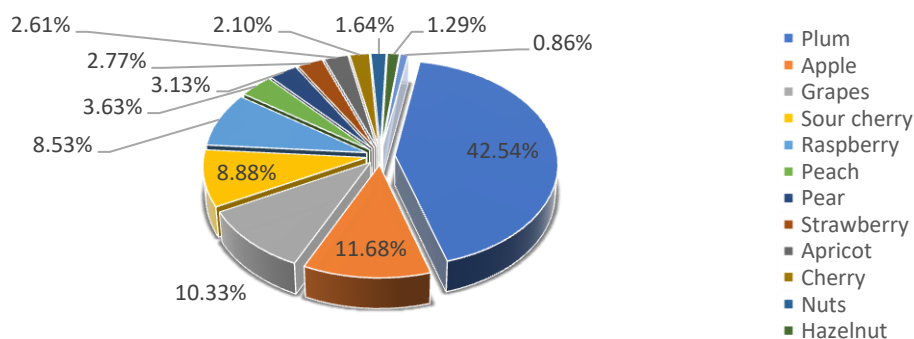


Figure 7. Average distribution and structure of plum orchards in the Republic of Serbia in the period 2012–2021
(Source: Authors' calculation based on the FAO database, 2023)

In addition to plum plantations, apple plantations are also very dominant (with a share of 11.68%), followed by grapes (10.33%), sour cherries (8.88%), raspberries (8.53%), and other fruits with less significant shares. According to the data obtained from SORS (Tab. 4), the average plum plantation area was 70,974 hectares in the period 2012–

2021. The smallest area was recorded in 2012 (40,428 hectares), whereas the largest was in 2013 (77,950 hectares). Excluding the data for 2012 (due to some inconsistency between SORS and FAOSTAT), the area devoted to plums in Serbia has shown a slight decrease. A distinct downward trend in plum plantations is observed when analyzing the base index over the research period (with the base year of 2013 = 100).

Table 4. Annual changes in areas devoted to plums in Serbia by region in the period 2012–2021*
(* Unit in hectare) (Source: SORS – the Statistical Office of the Republic of Serbia, Statistical yearbooks, 2013–2022)

Years of research	Belgrade region	Region of Vojvodina	Šumadija region and West Serbia	Region South and East Serbia	Total	Base index (2013=100)
2012	1,534	2,664	24,053	12,177	40,428	
2013	2,439	5,340	46,146	24,025	77,950	100
2014	2,507	2,974	53,306	19,161	77,948	100
2015	2,507	2,974	53,306	19,161	77,948	100
2016	3,194	2,207	50,593	17,325	73,319	94
2017	3,182	2,181	49,773	16,888	72,024	92
2018	3,229	2,192	49,863	16,940	72,224	93
2019	3,313	2,168	49,908	16,927	72,316	93
2020	3,483	2,080	50,401	17,046	73,010	94
2021	3,372	2,046	50,188	16,963	72,569	93
Arithmetic mean	2,876	2,683	47,754	17,661	70,974	
Coefficient of variation	21%	37%	18%	17%	16%	
Participation structure	4%	4%	67%	25%	100%	

The regions of Šumadija and Western Serbia, traditionally well-known for plum cultivation, contribute the largest share of plum plantations (67%), followed by the regions of South and Eastern Serbia (25%). Finally, the Belgrade region and the Vojvodina region each hold a uniform share of 4%. The plum production in the period 2012–2021 exhibited uneven volume and significant annual fluctuations. This is evident when examining the examples of maximum and minimum production years, showing considerable oscillations in the yield and a high coefficient of variation ranging from 20% to 30% across the Serbian regions considered (Tab. 5). The highest production was recorded in 2013, totaling 568,840 tons, whereas the lowest production occurred in 2017 with 330,582 tons. The average plum yield during this period was 449,238.40 tons. The fluctuating trend in plum production in Serbia is further highlighted by analyzing the movement of the base index of plum production (with the base year set as 2012 = 100). The plum production fluctuates significantly on an annual basis, rendering it unpredictable and uneven.

Table 5. Statistical indicators of plum production in Serbia by region in the period 2012–2021*
(* Unit in tons) (Source: Authors' calculations based on the SORS database, Statistical yearbooks, 2013–2022)

Years of research	Belgrade region	Region of Vojvodina	Šumadija region and West Serbia	Region South and East Serbia	Total	Base index (2012=100)
2012	15,953	34,632	208,000	134,000	391,000	100
2013	26,349	59,131	326,712	156,648	568,840	145
2014	18,595	41,731	230,573	110,552	401,451	103
2015	16,610	28,094	203,043	96,866	344,613	88
2016	30,161	33,776	278,464	129,041	471,442	121
2017	22,945	30,352	198,047	79,238	330,582	85
2018	25,829	32,816	267,665	103,890	430,200	110
2019	27,695	32,865	363,380	134,991	558,931	143
2020	28,254	28,619	388,894	136,780	582,547	149
2021	20,644	20,219	275,532	96,383	412,778	106
Arithmetic mean	23,304	34,224	274,031	117,839	449,238	
Coefficient of variation	22%	30%	25%	20%	21%	
Participation structure	5%	8%	61%	26%	100%	

Analyzing the average plum production in Serbia by region in the period 2012–2021, it can be concluded that, in proportion to the participation of certain regions in the areas devoted to plums, the same regions, with minor deviations, also contribute to the total production of plums in Serbia. The regions of Šumadija and Western Serbia

exhibit a negative deviation of share in the total plum production at 61%, compared to their participation in the total area devoted to plums, which stands at -6%. Conversely, all other regions show a positive relationship between their participation in production volume and total area devoted to plums. The regions of South and Eastern Serbia contribute 26%, whereas the Belgrade region contributes 5% to the total plum production in Serbia. The region of Vojvodina achieves the best result in plum production at 8%, doubling its production in relation to its participation in areas devoted to plums.

According to the data obtained from SORS (Tab. 6), the average yield of plums per unit area in Serbia in the period 2012–2021 is 6.49 tons per hectare, significantly below the potential and expectations of our country in plum production. Weaknesses in plum production are also evident through annual fluctuations in plum yields, with the coefficient of variation across regions of Serbia ranging from 17% to 28%. The plum production yields show a decreasing trend, as demonstrated by the example of the base yield index per unit area in the period under consideration (with the base year set as 2012 = 100).

Table 6. Statistical indicators of plum yields in Serbia by region in the period 2012–2021*
(* Unit in tons/ hectare) (Source: Authors' calculations based on the SORS database, Statistical yearbooks, 2013–2022)

Years of research	Belgrade region	Region of Vojvodina	Šumadija region and West Serbia	Region South and East Serbia	Total	Base index (2012=100)
2012	10.4	13.0	8.6	11.0	9.7	100
2013	10.8	11.1	7.1	6.5	7.3	75
2014	7.4	14.0	4.3	5.8	5.2	53
2015	6.6	9.4	3.8	5.1	4.4	46
2016	9.4	15.3	5.5	7.4	6.4	66
2017	7.2	13.9	4.0	4.7	4.6	47
2018	8.0	15.0	5.4	6.1	6.0	62
2019	8.4	15.2	7.3	8.0	7.7	80
2020	8.1	13.8	7.7	8.0	8.0	83
2021	6.1	9.9	5.5	5.7	5.7	59
Arithmetic mean	8.25	13.05	5.92	6.83	6.49	
Coefficient of variation	19%	17%	28%	27%	26%	

The smallest yields per unit area are observed in the Šumadija and Western Serbia region, with 5.92 t/ha, whereas the highest results in plum production are reported in the region of Vojvodina, with an average yield of 13.05 t/ha. In regions where plum production is more intensive, such as in Vojvodina, yields are higher. Conversely, in the Šumadija and Western Serbia region, plum production is mostly extensive, occurring in old and neglected plantations, resulting in lower yields. Keserović et al. (2014) assert that Serbia is characterized by extensive plum production, placing it among countries with low yields per unit area. It is necessary to explore solutions to improve plum production and restore it to the prominence it once held in Serbia centuries ago.

The possibilities for improving the plum production in the Republic of Serbia

In recent years, plum production has lost much of its once significant economic importance, despite the underutilization of the potential offered by this fruit. Plum production should transition to semi-intensive and intensive cultivation methods, incorporating all necessary cultural, melioration, and protection practices. In well-managed local plum plantations, yields are regular and high, ranging between 20 and 30 t/ha (Mišić, 2006), which is currently four times higher than the average yield in Serbia (6.49 t/ha). To enhance plum production in Serbia, the following measures are necessary:

- implementing the micro-regionalization of fruit production to identify favorable areas for plum cultivation, establishing designated plum regions (Keserović et al., 2013, cited in Prodanović et al., 2017),
- utilizing scientific advancements and professional services to improve and establish plum plantations (Careful consideration must be given to assortment selection, cultivation methods, form, and purpose of production before planting plum trees, as mistakes made in the initial phase cannot be rectified by subsequent cultural practices (Milić & Lukač Bulatović, 2017; Milovanović et al., 2018),
- promoting the use of new and more resilient plum varieties in new plantings, shifting away from the current reliance on indigenous brandy varieties,
- facilitating stronger collaboration among producers through cooperatives, purchasing stations, and other business networks (Keserović et al., 2013, cited in Prodanović et al., 2017),

- diversifying the assortment of plum products and employing effective marketing strategies to ensure profitability and meet consumer demands (Babović & Prodanović, 2012), and
- providing producers with improved access to financial resources under more favorable conditions (Keserović et al., 2013, cited in Prodanović et al., 2017).

Serbia possesses considerable potential for plum production and processing, which should be utilized more effectively. The designation of Serbian plum brandy production as part of UNESCO's intangible cultural heritage in 2022 offers an opportunity for greater European promotion and access to European markets. The revenue generated from plum brandy production has served as a catalyst for producers to revive and uphold the longstanding tradition of plum cultivation in these regions.

CONCLUSION

The production of and demand for fruit are constantly increasing. Asia boasts half of the global fruit production. The plum is a fruit of the Northern Hemisphere. The world's largest areas devoted to plums are in Asia (78.62%), followed by Europe (16.05%), America (3.08%), Africa (2.12%), and Oceania (0.13%). Understandably, due to the large areas devoted to plums, Asia as a continent has the largest share in the world plum production, accounting for 65.86%, followed by Europe (22.24%), America (8.15%), Africa (3.58%), and Oceania (0.17%). The leading country in plum production is China, with a production of 5,879.62 thousand tons, representing half of the world's production. A significant contributor to global plum production is Serbia, which ranks third with a ten-year average production of 440.91 thousand tons, representing 3.77% of the world production. However, there is still room for improvement, particularly in increasing yields per unit area. During the period under consideration (2012–2021), Serbia had a yield of 5.35 t/ha, which is significantly lower than the leading plum producers such as Chile with a yield of 21.21 t/ha, or Turkey with 14.60 t/ha.

According to the volume production, the plum ranks seventh in Europe as a continental fruit crop, accounting for 4.41% of the total European fruit production. Serbia holds the second position in Europe in plum production, contributing 19.96% to the European plum production.

In the period under consideration (2012–2021), the Serbian plum area accounted for, on average, 42.52 % of the total fruit area in the country, far surpassing all other fruit crops. The results obtained indicate a noticeable trend of decreasing areas devoted to plums. The region of Šumadija and Western Serbia accounts for the largest share of plum areas (67%), followed by the region of Southern and Eastern Serbia (25%), and finally, the Belgrade region and the Vojvodina region with a uniform share of 4% each.

Throughout the period under consideration, the average plum production and yields per unit area display annual fluctuations and a downward trend, with a coefficient of variation by region ranging from 17% to 28%. The lowest yield per unit area was recorded in the region of Šumadija and Western Serbia (5.92 t/ha), whereas the region of Vojvodina achieved the best results in plum production with an average yield of 13.05 t/ha.

To enhance plum production in Serbia, several measures are necessary: conducting micro-regionalization of plum production to define favorable areas; utilizing scientific advancements and engaging professional services in raising and establishing plum plantations; implementing proper assortment selection; conducting plum production through semi-intensive and intensive cultivation methods; organizing better associations of producers; facilitating producers' access to financial resources under more favorable conditions; developing a diverse assortment of plum products; and enhancing the competitiveness of plums and plum products in domestic and foreign markets through effective marketing strategies.

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