

Fruit export through the prism of the high-value market and GLOBALG.A.P. certification: an analysis from Serbia

Izvoz voća kroz prizmu tržišta visokih vrednosti i GLOBALG.A.P. sertifikacije: analiza iz Srbije

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Abstract

On the international fresh fruits and vegetables market Serbia is recognized as a valuable and respectable producer and exporter. The Serbian export of these products is determined by the volume and value of fruit and vegetable production, as well as the implementation of the GLOBALG.A.P. voluntary standard in the farm production. On the example of Serbia, the aim of the paper is to test the statistical significance of the impact of GLOBALG.A.P. certification in plant production, as well as the impact of the fruit production value on the fruit export to high-value markets in the period 2010-2021. For this analysis, a multiple linear regression model is used. The β coefficients in this paper are tested using the t-test, and the regression model using the F-test. It finds that the growth in the number of GLOBALG.A.P. certified producers does not affect the value of fruit exports to high-value markets ($p=0.817$), nor does the increase in certified area ($p=0.446$). At the same time, the value of fruit production affects the export value of this sector to high-value markets ($p=0.000$). The obtained results can be explained by the fact that GLOBALG.A.P. certification is still not significantly represented in the agricultural production of Serbia. The implementation of the standard requires significant investments on the farm, it is administratively extremely demanding, and thus it is available mainly to large-scale farms, with greater economic strength, as well as financially strong companies, which purchase and export fresh agricultural products to the world market.

Keywords: GLOBALG.A.P. certificate, fruit export, high-value market

Sažetak

Na međunarodnom tržištu svežeg voća i povrća Srbija je prepoznata kao vredan i respektabilan proizvođač i izvoznik. Izvoz ovih poljoprivrednih proizvoda iz Srbije determinisan je proizvodnjom voća i povrća (obimom i vrednošću), kao i implementacijom GlobalG.A.P. dobrovoljnog standarda u primarnoj poljoprivrednoj proizvodnji. Na primeru Srbije, cilj rada je da se ispita statistička značajnost uticaja GLOBALG.A.P. sertifikacije u biljnoj proizvodnji, kao i ostvarene vrednosti voćarske proizvodnje na vrednost izvoza voća na tržišta visoke vrednosti u periodu 2010-2021. Za potrebe ove analize korišćen je model višestruke linearne regresije. U radu su β koeficijenti testirani pomoću t-testa, a regresioni model F-testom. Utvrđeno je da rast broja GLOBALG.A.P. sertifikovanih proizvođača ne utiče na vrednost izvoza voća na tržišta visoke vrednosti ($p=0.817$), kao ni povećanje sertifikovane površine ($p=0.446$). Istovremeno, vrednost proizvodnje voća utiče na vrednost izvoza ovog sektora na tržišta visoke vrednosti ($p=0,000$). Dobijeni rezultati mogu se objasniti činjenicom da GLOBALG.A.P. sertifikacija još uvek nije značajnije zastupljena u poljoprivrednoj proizvodnji Srbije. Implementacija standarda zahteva značajna investiciona ulaganja na gazdinstvu, administrativno je veoma zahtevna, te je tako dostupna uglavnom velikim farmama veće ekonomske snage, kao i finansijski jakim kompanijama, koje se bave otkupom i izvozom poljoprivrednih proizvoda na svetsko tržište.

Ključne reči: GLOBALG.A.P. sertifikat, proizvodnja voća, visoko razvijene ekonomije

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1. Introduction

Agriculture is an important sector for the Serbian national economy, judging by numerous indicators, such as the share in gross domestic product, employment, exports, revitalization of rural areas (Bogdanov, et al, 2015; Nikolić et al, 2017; Volk, et al., 2019; Zecević et al., 2019; FAO, 2020; Dašić, Stanić & Živković, 2022). As part of agriculture, fruit production is extremely important, and local producers relatively successfully use favorable natural conditions for production and achieve international recognition and competitiveness, especially in the berry sector (Stojanović & Radosavljević, 2013; Grčak et al., 2019; Zecević et al., 2019; Marković & Marjanović, 2021; Dašić, Stanić & Živković, 2022; Paraušić, 2022). The importance of fruit growing for the national economy is reflected in the achieved export value in this sector, its share in the positive balance of foreign trade, the stimulation of employment in rural areas, the smooth supply of fresh and processed fruit to the national market and other positive impacts in the sector of agriculture and rural development (Grčak et al., 2019; Zecević et al., 2019; FAO, 2020; Marković & Marjanović, 2021; Paraušić, 2022).

Nevertheless, the potentials for the development of agriculture, including fruit production, are insufficiently used (Volk, Rednak & Erjavec, 2012). Production efficiency is low compared to the EU countries, as a result of low labor productivity, fragmented holdings, low organization of food supply chains and difficulties farmers face in accessing the financial market (Živkov, 2013; Stojanović & Radosavljević, 2013; Bogdanov et al, 2015; Horvat et al., 2020; FAO, 2020). Rural areas are characterized by progressive depopulation, a low level of diversification of economic activities, rural poverty and an underdeveloped labor market (Bogdanov et al, 2015; FAO, 2020). Additionally, Serbia has major problems in the segment of financial consolidation and support to agriculture (Popović & Grujić, 2015). Support to the agricultural sector and rural development is still low, unstable, insufficiently adapted to the needs of small-scale farmers, as well as the EU's common agricultural policy (abbr. CAP), along with internal political pressures (Volk, et al, 2019; FAO, 2020; Erjavec et al, 2021).

Despite all these limitations to the total food export from Serbia, which in the period 2020-2022 averaged 3.4 billion USD (group 0 Food and live animals), the value of fruit exports (fresh, dry, prepared fruit and products, except juices) is 910.6 million USD on average, which accounts for about 27% of the share in the exports value of the entire group 0 (SORS, 2023a). In the mentioned three-year period (2020-2022), berries account for more than 50% of the value of fruit exports from Serbia (SORS, 2023a). Fruit exports in Serbia is dominantly focused on high-income markets. In the period 2010-2021, 62% (2017) to 79% (2021) of total fruit exports from Serbia went to these markets (International Trade Centre, 2023). The two biggest challenges facing national farmers and exporters in the sector of fruit production and fruit export to the high-income markets are (Stojanović & Radosavljević, 2013; Paraušić & Simeunović, 2016;

Manić & Janković, 2019; United States International Trade Commission, 2021; Paraušić, 2022): (a) the need for more efficient market organization, more precisely, food supply and value chains; and (b) the need for implementation and certification of fruit production in accordance with the certification scheme and the GlobalG.A.P. IFA standard.

The first challenge is still “unsolvable”. That is, as the United States International Trade Commission (2021, p. 171) points out, “*the lack of integration between growers and processors prevents growers from receiving the full benefits of increased global market prices for the fresh input, lending to instability at the Serbian grower level, including grower-led protests within Serbia*”. We could make progress in this area with the implementation of the Law on Regulation of the Market of Agricultural Products (National Assembly of the Republic of Serbia, 2021), which foresees, among other things, the establishment and recognition of producer organizations in fruit sector.

Serbia largely manages to “cope” with the second challenge and shows progress in food safety and quality assurance standards. That is, national producers realized that the compliance of fruit production with the strict EU food quality and safety standards is a condition for entering these markets (United States International Trade Commission, 2021), so the number of GlobalG.A.P. certified producers in Serbia is constantly growing (GlobalG.A.P. organization, data obtained at the authors' request).

On the example of Serbian farmers and agriculture, in this paper authors analyze national fruit production, export results in the fruit sector (export value, export markets), as well as the progress of farmers in the GLOBALG.A.P. certification (crop base). After that, authors test the statistical significance of the impact of GLOBALG.A.P. certification, as well as the realized value of fruit production on the Serbian fruit exports values in high-value markets. The period from 2010 to 2021 is analyzed, and descriptive statistics and a multiple linear regression model are used for the analysis. The main goal of the paper is to examine whether the progress in GLOBALG.A.P. certification (crop base) began to contribute to the export value of fruit to high-value markets, or this export was determined by another factor, such as the realized value of fruit production.

2. Fruit production in Serbia: features and trends

Fruit growing represents an important agricultural sector in the Republic of Serbia (Dašić, Stanić & Živković, 2022), and fruit crops show significantly higher competitiveness on the international market and contribute significantly more to the surplus in the exchange of agricultural products, compared to vegetable crops (Zecević et al, 2019; Marković & Marjanović, 2021). Raspberry stands out from the fruit crops, as the most economically important berry, which makes Serbia recognizable on the international market (Paraušić & Simeunović, 2016; Grčak et al., 2019; Thiemann, 2020; United States International Trade Commission, 2021). Raspberry production has a

long tradition in the Republic of Serbia, and research by Wróblewska, Pawlak & Paszko (2019) shows that raspberry cultivation is economically profitable in Serbia. Serbia's success as a global supplier of frozen raspberries is the result of an ideal climate for raspberry production (including conditions for organic raspberry production, which is expanding), as well as low prices for fresh raspberries, which is influenced by low labor costs (United States International Trade Commission, 2021).

In addition to the above, the fruit growing sector is characterized by low organization of agricultural producers, as well as weak vertical integration between different stakeholders in fruit production and trade, especially between growers and buyers and processors (coolers). Producers are not sufficiently interconnected, existing associations do not have a great role and importance for farmers (for improving their bargaining

power, market regulation, price formation, etc.), and the entire system of supply and value chains in the fruit sector shows low efficiency (Zivkov, 2013; Stojanović & Radosavljević, 2013; Government of Republic of Serbia, 2014; Paraušić & Simeunović, 2016; Manić & Janković, 2019; Thiemann, 2020; United States International Trade Commission, 2021; Paraušić, et al., 2022). In addition, fruit production in Serbia is largely fragmented, there is a lack of assortment innovation and crop cultivation technology, and the problems of lack of labor force, healthy and high-quality certified planting material, as well as the negative impact of climate change are becoming increasingly pronounced (Vuković, et al., 2018; Thiemann, 2020; United States International Trade Commission, 2021; Paraušić, 2023; SORS, 2023a). All of the above significantly threatens the opportunities offered to Serbian fruit growers by the world market, in terms of high market prices and growing demand for fruit.

Table 1. Descriptive statistics of indicators of fruit production in Serbia in the period 2011-2021

Variables	Orchards, ha	Raspberries		
		Productive area, ha	Production, thous. t	Yield, t/ha
Average	187,863.6	18,000.0	97,357.1	5.4
Min	163,310.0	11,040.0	61,715.0	4.5
Max	240,000.0	24,028.0	127,010.0	6.0
Std. Dev.	26,764.3	5,077.4	23,755.6	0.4
Coefficient of variation, %	14.2	28.2	24.4	8.1
Average annual rate of change, %	-2.7	3.1	2.8	-0.4

Source: Authors' calculation

The SORS data presented in Table 1 shows that in the analyzed time period (2011-2021), the area under orchards in Serbia decreased by 2.7% on average per year, with a weak coefficient of variation of 14.2%. At the same time, if we look at the data on the cultivated area under raspberry, we can see it increasing significantly, with an average annual growth rate of 3.1% and a coefficient of variation of 28.2%. If we take into account the fact that the area under orchards is decreasing, and the fertile area under raspberry is increasing, we can conclude that raspberry is becoming the dominant fruit species in the structure of permanent crops on used agricultural land. The highest quantity of raspberries produced was in 2018, and the lowest in 2014. Although raspberry production has been in constant decline since 2018, it can be concluded that the analyzed time period recorded an average annual growth rate of 2.8% with a coefficient of variation of 24.4%. The analysis of the achieved raspberry yield points to its obvious decrease, given the average annual rate of decrease of 0.4% and a low coefficient of variation of 8.1% (Table 1).

In the coming period, the implementation of the Law on Regulation of the Market of Agricultural Products (National Assembly of the Republic of Serbia, 2021) will certainly contribute to the organization, development and strengthening of the fruit market in Serbia, as this law, among other things, regulates the following issues of interest to producers, traders and consumers in this sector (National Assembly of the Republic of Serbia, 2021):

- Fruit placement on the market (compliance of the product with market standards and other requirements and conditions prescribed by laws governing food safety);

- Establishment and recognition of producer organizations in the fruit sector;
- Contractual relations between agricultural producers and fruit processors or buyers (obligation to conclude sales contracts);
- Operational programs in the fruit sector. The program is brought by a recognized producer organization, with the aim of improving the situation in the production sector and the fruit market or preventing crises.

3. Methodology and data sources

The sources of data for the analysis are data from the Statistical Office of the Republic of Serbia, the International Trade Centre (2023) database, as well as the GlobalGAP organizations on the number of producers and areas under GlobalGAP IFA certification.

The two indicators, as independent variables in the analysis, are producers (number) and certified area (in ha) under GLOBALG.A.P. IFA standard. GLOBALG.A.P. certification in Serbia is dominantly present in crop production (fruit and vegetables production) and is a condition for fruit and vegetables exports from Serbia to the European Union market, i.e., to countries that belong to the group of high-income markets (Paraušić & Grujić Vučkovski, 2023; GlobalG.A.P. organization, data obtained on request). The Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia (abbr. MAFWM) still does not have data on the number of agricultural producers in Serbia that implement and certify production in accordance with GLOBALG.A.P. standard, nor the number of other agricultural producers

supported by the measure “*Increasing competitiveness in terms of adding value through processing, as well as the introduction and certification of food safety and quality systems, organic products and products with geographical origin on farms*” (MAFWM, 2022). Therefore, data of the number of agricultural producers and areas under this standard are provided by GLOBALG.A.P. international organization (GlobalG.A.P. organization, data obtained on request).

The third indicator, also set as an independent variable, is the value of national fruit production. In the SORS database, this value is expressed in local currency (RSD). For research purposes, this value was converted into USD, based on the middle exchange rate of the RSD against a foreign currency published by the National Bank of Serbia for a specific year. The average official middle exchange rate of the RSD against a foreign currency for a particular year is calculated as an arithmetic mean of the official middle exchange rates applicable on working days during that year.

In 2017, SORS conducted a specialized survey on orchards using a sample of agricultural farms engaged in fruit production in Serbia. In this way, the revision of the existing data for the time series 2013-2017 was carried out to the regional level (NSTJ2). This research was carried out within the IPA 2015 program and was in line with EU Regulation no. 1337/2011 (alignment with EUROSTAT statistics and methodology for perennial crops), and was implemented in cooperation with MAFWM. Family farms, legal entities and entrepreneurs engaged in fruit production with at least 0.2 ha of fruit area participated in the research. This sample accounted for 95% of the total

planted areas of observed fruit species on 15,214 agricultural holdings (SORS, 2018).

The fourth indicator is a dependent variable, i.e., the realized exports value of the fruit sector from Serbia to high-value markets (expressed in USD). The data source for this indicator is the International Trade Centre (2023) database, used to analyze group 08 (Edible fruit and nuts; peel of citrus fruit or melons). High income markets, according to the World Bank jesu zemlje “*in which 2021 Gross National Income per capita was more than 13,205 USD*” (World Bank, 2023).

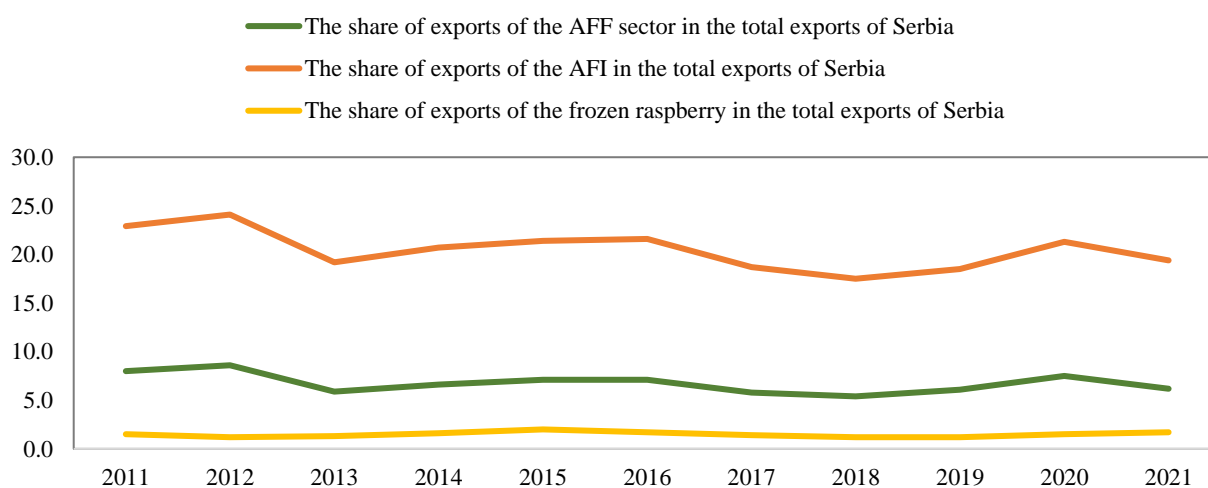
In this paper, the authors used multiple regression model with the aim of showing the influence of independent variables on the dependent variable in the period 2010-2021. The obtained coefficients were tested in the specified model using the t-test and the entire regression analysis model was tested using the F-test. The aim of the test was to check whether certain coefficients and the model are statistically significant at the 0.05 significance level. The data was processed in the R statistical software.

4. Results and discussion

Export markets and Serbian results in fruit export

Agriculture, forestry and fishing (abbr. AFF) sectors and agricultural food industry (abbr. AFI) have a significant share in the value of total commodity exports from Serbia, as well as the value of frozen raspberry exports (subgroup 0583220 – raspberries, frozen, without sugar). The share trend of the mentioned indicators is shown in Graph 1.

Graph 1. The participation of the selected parameters in the value of the total merchandise exports from Serbia, 2011-2021, in %



Note: AFI includes the following product groups: 0. Food and live animals; 1. Beverages and tobacco; 21. Hides, skins and furskins, raw; 22. Oil-seeds and oleaginous fruits; 29. Crude animal and vegetable materials, n.e.s.; 4. Animal and vegetable oils, fats and waxes.

Source: Calculation of the authors based on the SORS data (2023a).

The indicators shown in Graph 1 are processed using descriptive statistics, and the results are shown in Table 2. Analysis of the data in Table 2 indicates the following:

- The average share of exports of the AFF sector in the total export of goods from Serbia was 6.8%, the

minimum share was recorded in 2018 and the maximum in 2012, while the deviation from the arithmetic mean is mild or relatively weak (14.8%);

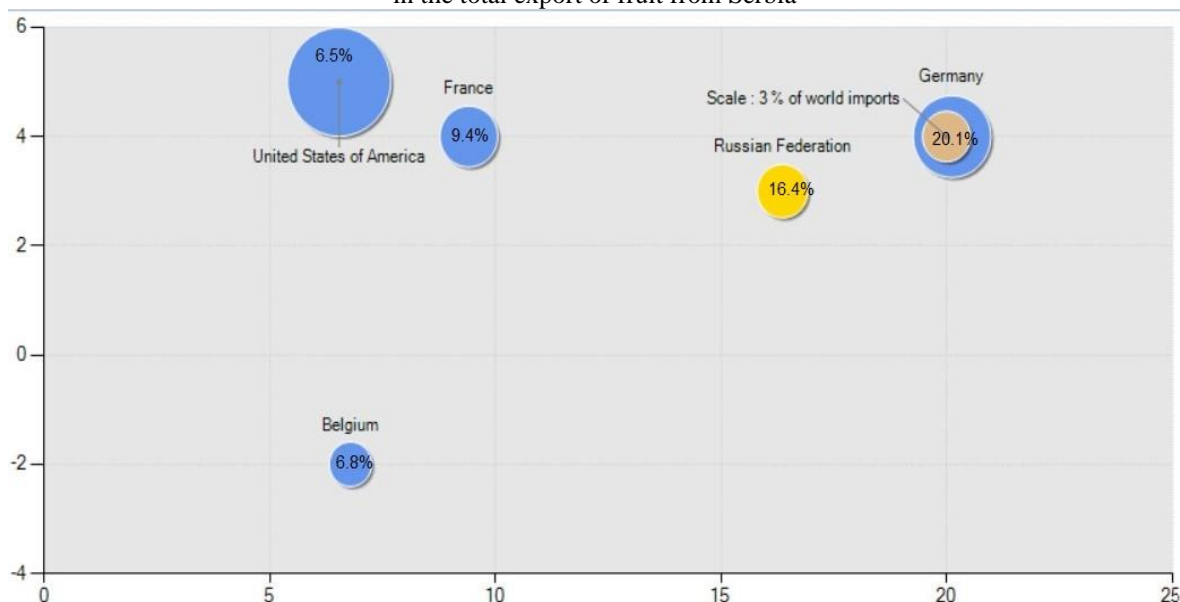
- The share of exports of the AFI sector in the total export of goods from Serbia in the observed period

was an average of 20.5%, the minimum value of share was in 2018 and the maximum in 2012 (as with the share of exports of the AFF sector), and the share in all years was around the average values and with very weak deviations (9.8%);

- The share of frozen raspberry exports in the total export of goods from Serbia in the eleven-year period averaged 1.5%, the minimum share was in 2012, 2018 and 2019, and the maximum in 2015. The value of the coefficient of variation shows a relatively weak deviation from the arithmetic mean (20%);
- The highest average annual growth rate was recorded in the share of the export value of frozen raspberries in the total exports of goods from Serbia (9.2%).

Based on the International Trade Centre data, in 2021, Serbia exported fruit (group 08 *Edible fruit and nuts; peel of citrus fruit or melons*) worth approximately 975 million USD. The leading fruit importing countries from Serbia (according to their share in the total export of fruit from Serbia) in 2021 were: (1) Germany (20.1%); (2) Russian Federation (16.4%); (3) France (9.4%); (4) Belgium (6.8%) and (5) USA (6.5%). See the overview of these countries in Graph 2. To the mentioned world countries, Serbia exported fruit worth approximately 577 million USD, which accounts for about 60% of the total fruit export from Serbia.

Graph 2. Share of leading importing countries of product group 08 (Edible fruit and nuts; peel of citrus fruit or melons) in the total export of fruit from Serbia



Source: International Trade Centre, 2023.

According to the International Trade Centre data in the 2010-2021 period, Serbia exports to high-income markets from 62% (2017) to 79% (2021) of the total value of exports of group 08 (Product: 08 Edible fruit and nuts; peel of citrus fruit or melons), and the number of importing countries belonging to this group of countries increased from 33 in 2010 to 45 in 2021.

The most important export product of Serbia in group 08, according to export value, is subgroup 081120, “*Frozen raspberries, blackberries, mulberries, loganberries, black, white - or red currants and gooseberries, uncooked or cooked by steaming or boiling in water, whether or not sweetened*”, where Serbian exports are dominated by frozen raspberries. Serbia is a respectable and export-oriented supplier of processed raspberry products, which it markets primarily to the European Union, and on the American market it is one of the main suppliers, after Chile and Mexico (United States International Trade Commission, 2021). The dominant export of raspberries from Serbia includes processed raspberry products, i.e., “*individually quick-frozen raspberries*” (abbr. IQF products). This type of freezing technology is predominantly used in Serbia, because it preserves the whole raspberry fruit and so frozen

raspberries have a significantly higher price on the market compared to other types of freezing (United States International Trade Commission, 2021; Paraušić, 2023).

According to the International Trade Centre data, Serbia ranks first in the world in terms of export value of frozen raspberries (product group 081120). Serbia has been in that position for many years, and its biggest competitors are Poland and Chile. In 2021, Serbia’s exports represented 32.3% of world exports for this product (081120), and was ranked first in world exports (International Trade Centre).

Export of subgroup 081120 from Serbia in the five-year period 2017-2021 was on average 333 mil. USD and from 265 million USD (2017) exports increased to 528 million USD (2021), i.e., by approximately 100% (International Trade Centre, 2023). The share of the export value of subgroup 081120 in the export value of group 08 in the five-year period (2017-2021) ranged from 40% (2017) to 54.1% (2021).

In 2021, Serbia exported products from the group 081120 mostly to Germany with a share of 20.1% of Serbia’s total

exports for this product group, followed by the Russian Federation (16.4%), France (9.4%), Belgium (6.8%), and the USA (6.5%). In general, the most important trade partners of Serbia for this product group are high-income countries, and in 2021, 78% of the total export value of product group 081120, worth 764 million USD, was exported to these markets.

If we look at the quantity of exported products from group 081120, we see that the largest import partner of Serbia is Germany, which during 2021 imported as much as 36,450 tons, which is 27.9% of the total export of Serbia in the world. Apart from Germany, the top five countries in the world according to the quantity imported are: France with 20,457 t or 15.6%; Belgium with 11,332 t or 8.7%; USA with 10,453 t or 8%; Poland 7,877 t or 6%. In general, Serbia exported 66.2% of the total export of products of group 081120 to the first five countries of the world, and

all countries are also in the group of high-income countries.

Regarding export prices for product group 081120, in 2021 Serbia was in the top ten world countries in terms of the quantity of imported products from this group to achieve an average export price of 4,121 USD/t, which is higher than the average export price achieved on the world market (4,035 USD/t).

The remaining part of the paper offers a tabular presentation of descriptive statistics of the achieved export value of product group 081120 from Serbia in the period 2011-2021. The analysis includes indicators at the world level and the first three largest importing countries, according to the value of imports (Germany, France and Belgium).

Table 3. Descriptive statistics of the value of exports of product group 081120 from Serbia to the world and leading importing countries, 2011 - 2021 (in thous. USD)

Variables	World	Germany	France	Belgium
Average	286577.1	88489.7	51680.4	25927.4
Min	180188.0	63501.0	35315.0	17784.0
Max	527704.0	139500.0	80344.0	47305.0
Std. Dev.	91295.9	20455.4	12324.8	8324.0
Coefficient of variation, in %	31.9	23.1	23.8	32.1
Average annual rate of change (AARC), in %	9.7	6.4	7.0	7.1

Source: Calculation of the authors based on the International Trade Centre data (2023).

The results shown in Table 3 show that Germany stands out as the leading importing country according to all observed characteristics: the average import value of 88,489.7 thousand USD, with a relatively weak coefficient of variation of 23.1%, with the min export value recorded in 2012 and the max in 2021 (63,501 thousand USD and 139,500 thousand USD). In the observed period (Table 3), the total export of the product group 081120 from Serbia increased annually on average, both in the world (by 9.7%), and in the analyzed countries, mostly in Belgium (7.1%) and France (7.0%). Based on the previous comments, we conclude that the demand for fruit from Serbia in group 081120, more precisely for frozen raspberry as the most important representative of this group of products, is growing, and we can expect an increase in the export of this product in the coming years as well.

Assessment of the impact of the realized value of fruit production and GLOBALG.A.P. certification on Serbia's fruit export results to high-income markets

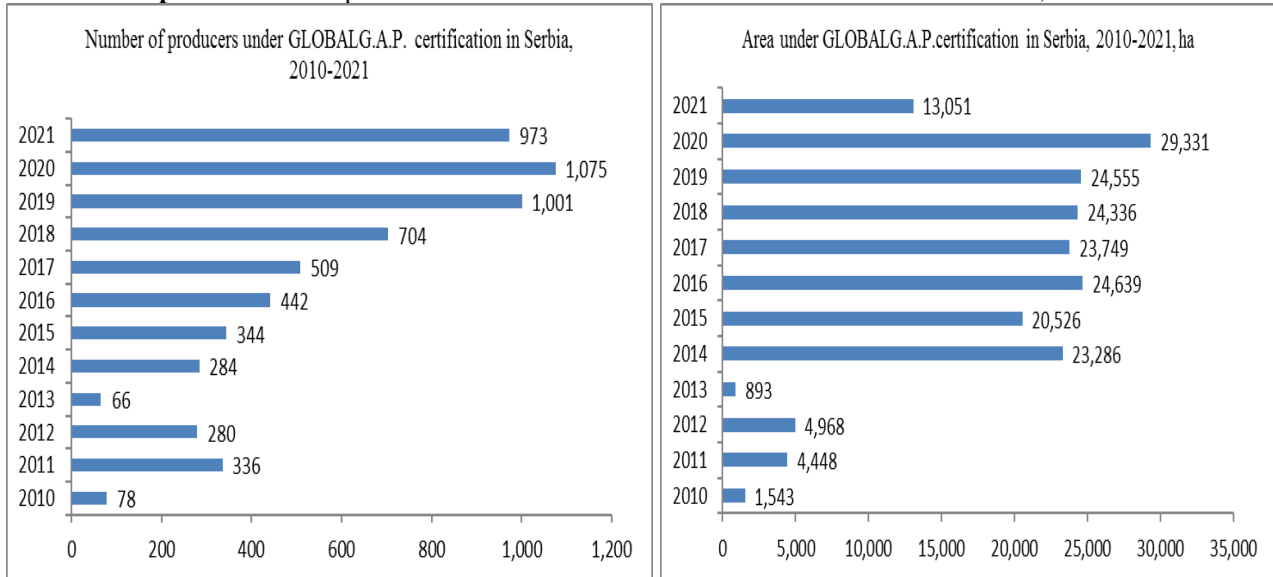
By applying the multiple linear regression model, the authors try to examine the influence of two independent variables on the value of fruit exports from Serbia to high-income markets, which represents the dependent variable.

The first independent variable is the number of GLOBALG.A.P. IFA standard-certified producers within the crops base, as well as the certified area in plant production. According to the GlobalGAP data, the number of certified producers in Serbia increased from 78 (2010) to 973 (2021),

and the certified areas increased from 1,543 ha in 2010 to 13,051 ha in 2021 (Graph 3).

According to GlobalGAP organization, the GLOBALG.A.P. IFA standard emphasizes responsible and sustainable agricultural practices, among other things, through the following production control points: "food safety; environmental sustainability and biodiversity; workers' health, safety, and welfare; animal health and welfare; legal, management, and traceability; integrated crop management and integrated pest control" (GlobalG.A.P. organization, official site). Although this standard is voluntary, in practice it is a condition for the placement of agricultural products on the EU market, and this standard is increasingly becoming a condition for the entry of domestic producers into the supplier base of trade chains in Serbia as well (Masood & Brümmer, 2014; Paraušić & Grujić Vučkovski, 2023). For the past few years, in addition to the GlobalGAP standard, foreign buyers also request the GRASP certificate, as an addition related to the social aspects of production (Paraušić & Grujić Vučkovski, 2023). Serbia has the most requests for the implementation of GlobalG.A.P. standards in the production of blueberries and raspberries, and cherry, sour cherry, plum, apple stand out from other fruit species for which there is interest in certification (Paraušić & Grujić Vučkovski, 2023). The largest export-oriented cold stores in the berry sector in Serbia have the necessary standards (HACCP, BRC, IFS) and are mostly holders of the group GlobalGAP certificate for their producers (Paraušić & Grujić Vučkovski, 2023).

Graph 3. Number of producers and area under GLOBALG.A.P. certification in Serbia, 2010-2021



Source: Authors' presentation based on GlobalG.A.P. organization. Data obtained at the authors' request.

The second independent variable is the value of fruit production in Serbia. According to SORS (2023a), from 528 mill. USD in 2010, the value of fruit production increased to 1.1 billion USD in 2021, which is more than double, with an average annual growth rate of 7%.

The authors set up a multiple linear regression model of the following form (equation 1):

$$\beta_1 B + \beta_2 E + \beta_3 J + \beta_0 = N \quad (1)$$

where N – is the value of fruit exports to the markets of high-income countries (dependent variable, in thousand USD), B – number of producers under GLOBALG.A.P. certification (IFA standard, crops base, independent variable), E - area under GLOBALG.A.P. certification, (IFA standard, crops base, in ha, independent variable), J – value of production in fruit sector (in thousand USD, independent variable), while $\beta_1, \beta_2, \beta_3$ and β_0 are model coefficients.

In order for the set regression model to be adequate and evaluated, initial hypotheses were formulated:

- H_0 : Model is not statistically significant;
- H_1 : Model is statistically significant.

The authors formed a matrix form of data values (equation 2):

$$Y^* = X^* \beta^* \varepsilon^* \quad (2)$$

where Y^* - is the vector of the dependent variable, X^* - is the matrix of independent variables, β^* - is the vector of coefficients, ε^* - is the model error.

What follows is the evaluation of the β coefficients ($\beta_0, \beta_1, \beta_2$ and β_3) using the least squares method (equations 3 and 4):

$$\beta^* = (X^{*'} X^*)^{-1} X^{*'} Y^* \quad (3)$$

$$b_0 = \bar{Y}_n - b_1 \bar{x}_{1n} - \dots - b_k \bar{x}_{kn} \quad (4)$$

where $\bar{Y}_n, \bar{x}_{1n}, \dots, \bar{x}_{kn}$ are the arithmetic means of the corresponding data.

Using the statistical software R, we obtained the results of the β coefficients, so the set regression model now has the following form (equation 5):

$$15.566 * B + 1.341 * E + 0.824 * J - 209198.86 = N \quad (5)$$

Based on the results of the set regression model, the sum of squared errors was calculated, the random error variance was evaluated and the coefficient of determination (R^2) was determined. Finally, the testing of the coefficients and the model itself started.

The value of the coefficient of determination ($R^2 = 0.9413$) shows us a good connection between the dependent variable and the independent variables and a strong mutual correlation.

The β coefficients were tested using the t-test, and the obtained values are shown in Table 4. The t-statistic was distributed according to student's distribution, under the condition that the null hypothesis is correct, with 7 degrees of freedom, and its theoretical value is $t(0.05; 7) = 2,3646$.

Table 4. T-test values for coefficients of regression

Coefficients	Estimate	t value	p
(Intercept)	-209198.8605	-2.816	0.025911
β_1	15.5655	0.240	0.817440
β_2	1.3410	0.808	0.445645
β_3	0.8239	6.916	0.000228

Source: Calculation of the authors. Output from the R program.

We start testing β coefficients proceeding from the null hypothesis, where H_0 : coefficient $\beta_i=0$ (coefficients are not statistically significant) and alternative hypotheses, where H_1 : coefficient $\beta_i \neq 0$ (coefficients are statistically significant), and index i has values 1 to 3.

The results of the t-test show that the coefficients β_1 and β_2 are not statistically significant at the significance level of 0.05 ($t_{\beta_1} = 0.240$ and $t_{\beta_2} = 0.808$). However, the t-value for the coefficient β_3 is in the critical area, because $t_{\beta_3} = 6.916$ and we conclude that this coefficient is statistically significant at the significance level of 0.05.

The established regression model was tested using the obtained F-test values. We start testing the model proceeding from the null hypothesis, where H_0 : the model is not statistically significant because $p=0$, and the alternative hypothesis, where H_1 : the model is statistically significant because $p \neq 0$. The results of the F-test are given in Table 5.

Table 5. The results of the F-test for the assessment of the set regression model

F	F (0.05, 3, 7)	p
37.45	4.3468	0.0001112

Source: Calculation of the author. Output from the R program.

According to the results of the F-test, we can conclude that the set model is statistically significant at the significance level of 0.05 ($F = 37.45$ and $p = 0.0001112$).

By analysing the period 2010-2021 we can conclude that value of production in the fruit sector has an impact on the export value in this sector to high-impact markets ($p=0.000228$), while the number of producers and certified area have no significant impact on the value of fruit exports on high-impact markets. The obtained results can be explained by the fact that GLOBALG.A.P. certification is still not significantly represented in the agricultural production of Serbia. The implementation of the standard requires significant investments on the farm, it is administratively demanding, and thus it is available mainly to large-scale farms, with greater economic strength, as well as financially strong companies that deal with the purchase and export of agricultural products to the world market (Paraušić and Roljević Nikolić, 2020; Paraušić & Grujić Vučkovski, 2023).

5. Conclusion

Serbia is a significant and recognizable exporter of fruit, especially berries, which are mostly exported to EU countries, i.e., high-income economies. According to the International Trade Centre data in the period 2010-2021, Serbia exported from 62% (2017) to 79% (2021) of its total world export value of group 08 (Product: 08 Edible fruit and nuts; peel of citrus fruit or melons) to high-income markets. At the same time, national producers and exporters are making progress in the implementation of the GlobalG.A.P. standard in fruit and vegetables production, which is a condition for Serbia's entry into the EU markets. According to GlobalGAP organization data, the number of producers in Serbia under this certification scheme increased from 78 (2010) to 973 (2021), and the certified areas increased from 1,543 ha in 2010 to 13,051 ha in 2021.

Authors' have found that the growth in the number of GLOBALG.A.P.-certified producers does not affect the value of fruit exports to high-value markets ($p=0.817$), nor

does the increase in certified area ($p=0.446$). At the same time, the value of fruit production affects the exports value of this sector to high-value markets ($p=0.000$). The obtained results can be explained by the fact that GLOBALG.A.P. certification is still not significantly represented in the agricultural production of Serbia. The implementation of the standard requires significant investments on the farm, it is administratively extremely demanding, and thus it is available mainly to large-scale farms, with greater economic strength, as well as financially strong companies, which purchase and export fresh agricultural products to the world market.

For greater progress of local farmers in the process of farm certification, financial support from the state will be required in the form of a larger volume of funds allocated to support producers in the certification. Certainly, greater educational and logistical support from the agricultural advisory service will be needed. Scientific educational institutions, banks, regional development agencies, associations of farmers and exporters can certainly provide additional assistance to farmers in order to bring certification processes closer to farmers, both in terms of understanding their necessity, as well as facilitating administrative procedures and overcoming financial barriers.

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