Analysis of influence of value indicators agricultural production on gross value added in serbian agriculture

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Abstract

The subject of research is the analysis of the influence value of produced agricultural goods and provided services on gross value added (abbr. GVA) in agriculture of Serbia in the period from 2007 until 2020. The aim of writing the paper is to establish which agricultural branch (plant production, livestock production, or agricultural service) has the most contribution to the creation of GVA of agriculture. *The set goal was achieved by using multiple regression methods and in a starting model are given achieved values of plant and livestock production, while the value of agricultural services is excluded due to its low share in the total value of agricultural production (2.5% per average year).* The results of the regression model were shown that the highest contribution to the creation of GVA of agriculture gives plant production, which by its importance stands out from crop production until the value of livestock production contributes creation of GVA of agriculture in significantly lowes share

(value of standardized beta coefficient amounts 0.671 for plant production, ie 0.402 for livestock production). Methods for assessments of the presence of multicollinearity between independent variables (The Tolerance level, VIF value, and Eigen values) have shown that in the frame of plant and livestock production exists a low level of multicollinearity, as a consequence of the influence of livestock production, until in frame of plant production weak multicollinearity as consequences of the influence of fruit-growing and viticulture production.

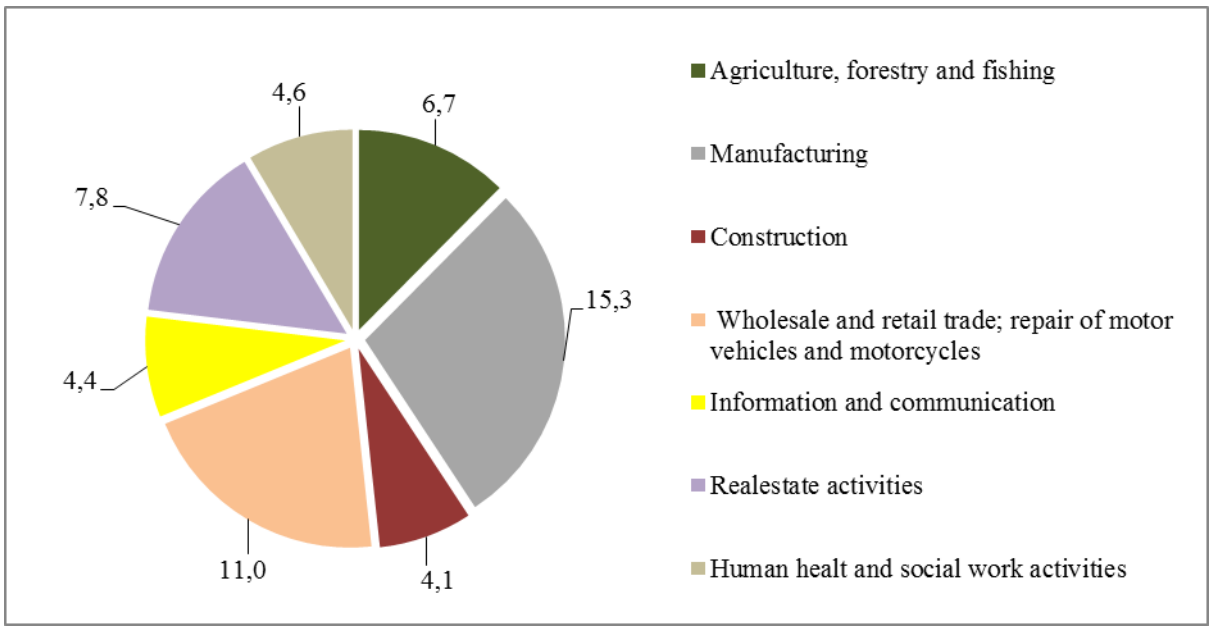
Keywords: GVA. Plant production. Livestock production.

1. Introduction

The agricultural sector in the Republic of Serbia, as well in all other countries of Western Balkan, has a significant role in economic development, export, employment, and therefore significantly contributes to the value of the gross domestic product (abbr. GDP) (Nikolić et al, 2017; FAO, 2020a; Sanfey & Milatovic 2018; Volk et al, 2019; Grujić et al, 2021). However, competitiveness and further development of this sector are limited by many factors: low rate of technical efficiency of agricultural production; which is a consequence of low labor productivity and fragmented ownership of agricultural funds, then the difficult and inefficient access to financing sources, insufficiently development cooperative sector, low innovatively and production organization, as well marked depopulation and high risks from the poverty of the rural population (FAO, 2020a; FAO, 2020b; Zivkov, 2013; Horvat et al, 2020; Bedrač, et al, 2019; Kotevska, 2015; Milosevic et al., 2021; Paraušić & Domazet, 2018). Although the political goal of Serbia are directed toward EU accession, the agricultural policy is not an adequate measure adapted to CAP, support for agriculture and rural development is still low and unstable, and support measures for small and family farms are not sufficiently developed and implemented (Erjavec et al, 2021; FAO 2020b).

Countries of the world are also different from each other by level of significance of agriculture in the creation of GDP. Thus, at the end of 2018[h] on the level of the EU (28) share of GVA of agriculture in the creation of total GDP was 1.5%, and in Serbia, 6.3%, so can be concluded that this activity is much more important in Serbia than in EU (28) countries (Grujić et. al., 2021). Although Serbia's agriculture is less developed compared to the counties of Europe and the world, this segment certainly scores enviable records (Grujić et. al., 2019), and the potential for further development of agriculture and agribusiness is significant (Sanfey & Milatovic, 2018).

In the continuation of work, in the given graphic are presented the activities with the highest average annual share in the creation of Serbia's GDP in the period 2007-2020 (Graph 1).



Graph 1: Activities with highest average annual share in creation of GDP of Serbia in period 2007-2020

Source: SORS, National accounts, GDP by production approach, GVA, by activities, for annual years, eletronic database

Note: there is no data available for the *activities of extraterritorial organizations and bodies*.

In graph 1. are presented activities that in the observed period achieve the highest average annual participation in GDP with 53.9%. It is evident that the largest contribution to creation of GDP has Manufacturing with 15.3% until agriculture, forestry, and fishing noted average annual participation with 6.7%. The remaining activities make 4,6% of average annual participation in making GDP, and the lowest contribution has activities household as the employer; activities household which produce goods and services for individual needs with 0.2%; while 1.1% makes – water supply, wastewater management, controlling the waste removal processes and similar activities and art, entertainment and recreation. Only 1.4% of the share is the activity of the other service activities.

The following table shows the average annual rate of GVA changes by activities for the period 2007-2020 (Table 1), to see which economic activity achieved the greatest growth in the analyzed period.

Table 1: Average annual rates of GVA changes by activities in period 2007-2020 (in %)

Activity	Average annual rates of change	Activity	Average annual rates of change
Agriculture, forestry and fishing	6.3	Financial activities and insurance activity	10.0
Mining	7.5	Real estate business	3.8
Processing industry	4.3	Professional, scientific and technical activities	7.7
Electricity, gas, steam and air conditioning supply	6.9	Administrative and auxiliary service activities	10.8
Water supply; waste water management, controlling the waste removal process and similar activities	6.3	State administration and defense; compulsory social insurance	7.4
Construction	9.0	Education	8.1
Wholesale and retail trade; repair of motor vehicles and motorcycles	9.0	Human healt and social work activities	6.5
Transport and storage	7.5	Art, entertainment and recreation	7.5
Accommodation and catering services	4.6	Other auxiliary activities	4.0
Information and communication	11.6	Activity of the household as an employer; activity of households that produce goods and services for their own needs	6.6

Source: Author's calculation based on the SORS, National accounts, GDP by production approach, GVA, by activities, for annual years, eletronic database.
Note: is no data available for the *activities of extraterritorial organizations and bodies.*

In the observed period, total GVA is annually increasing by 6.8% until all activities achieved increasing GVA, which are contributed to the increase of total GVA. Observing individual activities, the highest average annual increase is achieved in the following activities: *information and communication (11.6%)* and *administrative and auxiliary service activities (10.8%),* until GVA for activities *agriculture, forestry and fishing* have annually increased by 6.3% (processing industry for 4.3%).

Based on representation in Graph 1 and Table 1 can be concluded that activity Agriculture, forestry, and fishing don't achieve high participation in the creation of GDP, but it has a high annual average rate of growth, highest than Processing activities, which indicates on the significant potential which this activity have to do Republic Serbia's economy.

The paper analyzed achieved values of plant and livestock production with products of animal husbandry on the total GVA of Serbia's agriculture for the period 2007-2020. Analyzing participation, the values of individual lines of agricultural production in the total value of agricultural production it was noticed that agricultural services achieved the lowest share in the

period 2007-2020 (only 2.5% average annual), and because of that they were excluded from the analysis. In order to determine which branch of agriculture contributes the most to the creation of GVA of agriculture (plant or livestock production), the researchers used the coefficient of correlation, determination, and regression standard errors, while the presence of multicollinearity and the degree of connection between lines of plant and livestock production was evaluated using the Tolerance level, *VIF and Eigen values.*

2. Literature Review

In the Republic of Serbia and other countries of Western Balkan (North Macedonia, Bosnia and Herzegovina, Croatia, Montenegro) sectors of agriculture, forestry and fishing have a significant role in economic structure and highest share in the creation of GDP, right after industry, and the sector contributes to income from export, total employment, food security of countries, etc. (Nikolić et al., 2017; FAO, 2020a; Volk et al., 2019). At the same time, research by a group of authors (Volk et al., 2019) indicates that although in all countries of the western Balkan agriculture is an important sector of the national economy, there is an evident tendency of declining in agricultural production and consequently the contribution to GDP.

Dominant characteristics of the agricultural sector in the Republic of Serbia are high instability of production, the dominance of plant production, the concentration of agricultural fonds on small-scale family farms, and the dual structure of farms, as well and low technical efficiency of agricultural production (FAO, 2020a; Paraušić, Subić & Roljević Nikolić, 2021; Horvat et al. 2020).

Užar and Radojević (2019) explore the influence and contribution of accomplished values of agricultural production, as well as individual branches of this production in Serbia on forming GVA, that is economical development of a country in the period 2008-2017. With the application of the method simple linear regression indicates that changes in GVA in agriculture have statistically important to the movement of total GVA. Also, the authors indicates that in a frame of plant production dominant participation in crop production, with 51.5%, until the realized value in cattle production has the highest contribution to total value of livestock production, with 12.6%

Giannakis & Bruggeman (2015) were using the logistic regression model, as well as ward's, k-means, and two-step clustering methods based on the three indicators (gross-value-added farm, land, and labor productivity), so that they can explain the differences in state and results from European agriculture. Uddin (2015) question contributes to the agricultural sector,

industries, and services to economic growth in Bangladesh using data from time series from 1980-2013. The author indicates that the time series data are stationary at the first difference, that cointegration analysis indicates that each economic sector has a strong, positive, and significant linear relationship with economic growth, while Granger causality test revealed bidirectional causality between agriculture and GDP, as well as industry and agriculture.

The authors of Petrea et al. (2020) using a linear model proved that 43% of the GVA of agriculture in Moldova originates from crop agricultural production.

At the beginning of the 21st century, agriculture in Bulgaria became the most represented sector of the economy, and agricultural production is realized in several major sectors. During 2015. cereal production accounted for about 30% of GVA, and field crops as much as 58% of GVA of agriculture (Ivanov and Sokolova, 2017).

Adeboye et al. (2014) explaining the results of multicollinearity (The Tolerance level, VIF influence factor, and Eigen value) determined that the GDP of Nigeria is most affected by the value of crop production, and least by the value of livestock production, forestry and fishing.

3. Matherial and Work Method

The analysis is started with the structure of total GVA in Serbia, and then by showing average annual rates of changes in all activities. This indicator shows the movement of GVA of agriculture in the period 2007-2020, that is, it shows the trend of the movement in the analyzed period. The average annual rate of change was calculated according to the following formula (Fay et. al., 2006):

$$\gamma = \left(\left[\frac{\delta_n}{\delta_1} \right]^{\frac{1}{n-1}} - 1 \right) * 100 ,$$

and in our case γ - average annual rate of change, δ_n – absolute value of a latest member of time series, δ_1 – absolute value of the first member of time series, n – number of members in series (i.e. number of years).

In the continuation of the paper is implemented research about analysis of the influence on GVA of agriculture in Serbia, and is started with realized about achieved values of agricultural goods and services (plant production, livestock production with products of animal husbandry and agricultural services). The precise analysis of values and participations of the agriculture in total GVA of Serbia gives Statistical Office of Republic Serbia (SORS) which continuously published the worksheet entitled "Economic accounts for agriculture in the Republic of Serbia“. This publication serves for supervising and valuation of effects of

agricultural policy, and the methodology frame is synchronized with the European System of National and Regional Accounts (ESA 2010). This document, as well as indicators of national accounts in agriculture, represents the basic source of data for the implementation of statistical methods for the period 2007-2020.

In the research first was implemented the analysis of descriptive statistics on total GVA of the agriculture, and then on basic parameters of total value of agricultural production (plant production, livestoc production, and agricultural sevices). Based on their structure, from further analysis is turned down the parameter that achieved the lowest participation in realized value of agricultural production (agricultural services), in order to set up a valid regression model. The goal of creating of the regression model is to determine which branch of agriculture (plant or livestock production with products of animal husbandry) makes the greatest contribution to the total GVA of agriculture. In the appointed regression model the GVA of agriculture represents a dependent variable until independent variable represented values of plant and livestock production. With further analysis value of plant production will be divided into crop production, fruit-growing and viticulture production; until value of livestock production ammounts values of livestock increase (cattle, pigs, horses, sheep and goats, and poultry) and livestock products (milk, eggs and other products of husbandry). For the subject analysis, GVA is expressed in current prices and the value of agricultural production in producers prices of the current year in EUR mln. The SORS database has the values of agricultural production only in domestic currency (RSD), and for the sake of easier understanding of the obtained results, the value of production in domestic currency, using the average annual exchange rate, was calculated and shown in EUR.

The regression model set has the following form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_n + \varepsilon_n,$$

and in our case Y – the value of the dependent variable, X_1, X_2, ..., X_n – the value of the independent variables, β_0, β_1, β_2, ..., β_n – the regression parameters, ε_n – random error.

In order to determine whether there is a strong positive correlation between variables and whether the set regression model is validated, correlation and determination coefficients and standard error of the regression were used. After this analysis, using the correlation between independent variables in the set model will be determined the fulfillment of the initial assumption in terms of whether there is a certain degree of correlation between predictors (independent variables), as well as whether their correlation affects the achieved regression results (i.e. the regression standard error coefficients). The presence of

multicollinearity between independent variables will be held in a three-way, and mathematical formulas are best presented by authors Adeboye et. al. (2014). Thus, the presence of multicollinearity on coefficient of standard regression error will be checked by using the following methods:

- *The Tolerance level,*
- *VIF (Variance Inflation Factors) value,*
- *Eigen values.*

The Tolerance level is calculated by following formula:

$$1 - R^2,$$

and in our case, R^2 is the coefficient of determination and represents the result of regression analysis. The tolerance level can be explained as well as the influence of one independent variable of the second independent variable in a set regression model. It is considered that lower values of the tolerance coefficient indicated on the high level of multicollinearity. If the value of this coefficient is around 0.4, it can be said that there is weak multicollinearity.

VIF value represent the reciprocal value of the tolerance coefficient and is calculated to the followinf formula:

$$\frac{1}{1 - R^2}.$$

VIF, in a diference from the tolerance coefficient shows on size of the inflation in standars errors which are correlated with specific beta weight because it arises as a consequence of multicollinearity. If the VIF value is greater than 2.50, it means that there is a relatively high level of multicollinearity between the predictors.

By dint of *Eigen values* can be concluded the closeness between variables, apropos approximate linear dependence which exists between variables. When it is worth for Eigen value close to zero, then that indicates linear dependence in analysis and more closely determines the characteristics of independence.

Finally, a linear trend model is presented that should show how the change in the value of agricultural production will affect the GVA of agriculture in the future. The initial equation has the following form:

$$y = bx+a,$$

and in our case y – value of the dependent variable, x – value of the independet variable, a *i* b - parameter values.

All the above-mentioned analyzes were carried out in order to determine the accuracy of the obtained data and the correctness of the established conclusions.

Statistical data processing was carried out using the SPSS 25 software package.

4. Results and Discussion

Considering that agriculture is an important activity for Serbia because it gives a significant contribution to GDP creating there is a need to review the basic parameters of the GVA participation of agriculture in the country's GDP in the period from 2007 to 2020. (SORS,2014; SORS, 2021).

Table 2: Descriptive statistics of share of GVA of the agriculture in GDP creation in period 2007-2020 (in %)

Variable	Mean	Std. Deviation	Minimum	Maximum	Coefficient of variation
GVA of the Agriculture	6.7	0.5	6.0	7.4	7.9

Source: Author's calculation

Based on shown data in table 2. we notice that the average value of the participation of GVA of agriculture in the creation of GDP from 2007-2020 amounts to 6%. The maximum value of the share of GVA of agriculture in GDP was achieved in 2008, 2011 and 2013 (7.4%) until the minimum value of 6% was noticed in 2017 and 2019. The value of standard deviation shows us the monthly average deviation from the average value, which in our example means that the average deviation from an average share of GDP of agriculture is 0.5%. With a coefficient of variation, we have shown variability of GVA of agricultural activity which is very weak and amount 7.9%.

The activity of agriculture, forestry and fishing is very complex and it includes as well as plant, also and livestock production, including the animal husbandry products. According the SORS methodology, value of agricultural activity represents sum of values of plant and livestock production, agricultural services and production values of inseparable non-agricultural secondary activities of the farm (SORS, 2021). According to this source value of plant production makes grains, industrial fodder plant, vegetables and other plant cultures; until values of livestock production expresses through the increase of livestock, poultry and other animals and livestock products (milk, eggs and other products). Value of agricultural goods and services amounts from values of production of agricultural goods achieved in crop and livestock

production and agricultural services. In following table 3. are given results of descriptive statistics basic indicators od the structural values of agricultural activity.

Table 3: Descriptive statistics of basic indicators in structural value of agricultural activities in period 2007-20200 (in %)

Indicator	Crop productio	Livestock production	Agricultural services
Mean	67.6	29.9	2.5
Std. Deviation	2.0	1.9	0.2
Minimum	64.5	26.4	2.1
Maximum	71.1	33.3	2.9
Coefficient of variation	2.9	6.5	8.2

Source: Author's calculation

Descriptive statistics of analyzed indicators in *plant production* show that this sector has an average share of 67.6% of the total value of agricultural production, whereby the maximum participation was achieved in 2016 (71.1%), while minimal participation is noticed in 2012 (64.5%). The average deviation from the average participation of plant production in the value of agricultural production is 2%. The coefficient of variation shows the variability of plant products which is very weak and amounts to 2.9%.

Livestock production in the structure of value of agricultural production achieve an average share of 29.9%, whereby the highest value is noticed in 2012 (33.3%), and the lowest in 2016. The average deviation from average participation of livestock production in agriculture production value is 1.9%, and the coefficient of variation shows very slow variability and it amounts 6.5%.

Agricultural services in the total structure of agricultural production values achieved an average annual share of 2.5% until the largest values of share are noticed in the first analyzed year (2007), and the lowest in 2011. The average deviation from the average share of agricultural services in the value of agricultural production is 0.2%, and the coefficient of variation shows very weak variability (8.2%).

We conclude that in the structure of agricultural production dominant share takes to plant and livestock production until agricultural services have a negligible share. Because of that, from the further analysis, we exclude the value of agricultural services in the total value of agricultural production.

In the following table are given results of descriptive statistics of basics indicators of structure plant and livestock production, in order to get a better picture of their contribution to the creation of GVA (table 4).

Table 4: Descriptive statistics of basic indicators of the structure of agricultural production in period 2007-2020 (in %)

Variables	Mean	Std. Deviation	Minimum	Maximum	Coefficient of variation
Grains, including seed	27.8	3.2	20.9	33.7	11.6
Industrial plants	9.7	0.8	8.7	10.7	8.1
Forage crops	4.3	0.9	2.9	5.6	20.3
Vegetable and horticultural products	6.2	1.5	4.3	9.2	24.7
Potato, including seed	2.5	0.6	2.0	3.8	23.1
Fruit	11.1	1.9	8.6	14.2	16.8
Wine	5.9	1.5	3.8	8.0	24.9
Other plant products	0.1	0.0	0.1	0.2	24.9
Cattle	5.7	0.5	4.5	6.5	9.2
Pigs	10.6	1.0	9.2	12.4	9.5
Horses	0.0	0.0	0.0	0.1	164.1
Sheep and goats	1.7	0.3	1.0	2.1	16.7
Poultry	2.6	0.3	2.2	3.0	10.4
Milk	6.6	0.6	5.8	7.5	9.3
Eggs	2.3	0.4	1.6	2.9	18.2
Other products of livestock production	0.4	0.2	0.1	1.0	52.9

Source: Author's calculation

Data represented in table 4 shows that plant production achieved an average share of 67.6%, that is livestock production 29.9% in the total value of agricultural production, which fits the data shown in table 3. If we observed the structure of plant production, we notice that crop production takes a significant share of the total value of agricultural production with 41.8%; following the fruit-growing sector with 11.1%; vegetable and horticulture with 8.7%, viticulture with 5.9%, and other plant production with only 0.1%. In the structure of livestock production values, the dominant share takes pigs production with 10.6%, then goes milk production with 6.6%, and cattle production with 5.5%. Other lines of production (sheep and goats, poultry, eggs production, and other produce of husbandry) make 6.9% of the total structure of agricultural production values.

The following tables provide an analysis of the coefficients that explain the influence of the value of crop and livestock production on the total GVA of agriculture using a regression model.

First of all, it should be emphasized that the regression model is set so that GVA is set as the dependent variable, while the independent variables are represented by the realized values of crop and livestock production. A simple linear regression model has the following form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon,$$

in our case is Y – GVA of agriculture (current prices), X_1 – value of the plant production (current prices), X_2 – values of the livestock production (current prices), β_0, β_1, β_2 – regression parameters, ε - error term.

The following table shows the variability of the assumed model of the dependent variable Y from the independent variables X_1 i X_2 (table 5).

Table 5: Correlation coefficient, coefficient of determination and standard error of the regression model of the influence of the value of crop and livestock production on the GVA of agriculture

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.928[a]	.861	.835	116.3246

Source: Author's calculation

The correlation coefficient shows us that there is a strong positive correlation between variables (0.928). The coefficient of determination shows us that 86.1% of variations in GVA of agriculture can be explained by the strong influence of plant and livestock production until the corrected coefficient of determination shows that 83.5% of the variability of GVA of agriculture depends on the value of plant and livestock production. The remaining 16.5% represents the influence of other factors (e.g. agricultural services which are excluded from further analysis because of a lower share in the total value of agricultural production and other influences which are not considered). Also, the standard error of regression shows that exists a deviation from the regression line in the amount of EUR 116.3246 mln.

Below are the results of testing the assumed regression model, and the last column of Table 6 shows us that the set model is statistically significant.

Table 6: Evaluation of the fitted regression model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	919465.009	2	459732.504	33.975	.000[b]
	Residual	148845.526	11	13531.411		
	Total	1068310.535	13			

Source: Author's calculation

In the following table we see that value β_1, $\beta_2 \neq 0$, and the given model took the following form:

$$Y = -1004.815 + 0.603 X_1 + 1.070 X_2 + \varepsilon$$
$$(453.544) \quad (0.114) \quad (0.337)$$

Table 7: Results of placed regression model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-1004.815	453.544		-2.215	.049		
	Plant production	.603	.114	.671	5.296	.000	.788	1.268
	Livestock production	1.070	.337	.402	3.173	.009	.788	1.268

Source: Author's calculation

Data given in table 7. shows that the achieved value of plant production has the biggest influence on realized GVA of agriculture. More precisely, a standardized beta coefficient is highest at the plant (0.671) than livestock production (0.402), which indicates that is the biggest contribution of plant production in the creation of GVA in agriculture. Interpretation of value non-standardized beta coefficient in plant production indicates a conclusion that with the increasing the value of the plant production for EUR mln grows and GVA of agriculture with EUR 0.603 mln. In other words, in order to increase the GVA of agriculture, a prerequisite is to increase the value of crop production.

Finally, the correlation between the independent variables in the set model will determine whether there is a certain degree of association between the predictors (independent variables), as well as whether their association affects the achieved regression results. The degree of association between the predictors was determined using the tolerance level, VIF, and Eigen value (tables 7 and 8).

The calculated values in the Tolerance column (0.788) and VIF (1.268) indicate a weak presence of multicollinearity, the set regression model is valid, so we conclude that crop and livestock production are weakly collinear. The following table shows the eigenvalue, which should show the degree of closeness between the variables (table 8).

Table 8: Diagnosing the impact of independent variables on agricultural production

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions		
				(Constant)	Plant production	Livestock production
1	1	2.993	1.000	.00	.00	.00
	2	.005	25.067	.25	.96	.08
	3	.003	33.999	.75	.04	.92

Source: Author's calculation

The Eigen value of 2.993, 0.005 and 0.003 for β_0, β_1 and β_2 gives low worth for variables. However, Eigen values are closest to zero when the Condition Index values are very high, and in our case amounts 33.999 for β_2. This result indicates that present

multicollinearity in the highest measure is the consequence of the influence of the independent variable X_2 (livestock production).

As we said, regression analysis of the influence of the value of plant and livestock production on realized GVA of agriculture has shown a slightly bigger influence of plant relative to livestock production. With problems in livestock in Serbia were engaged many authors. Some of them (Novkovic i sar., 2011), considered that the reduction of livestock production comes to a proportional reduction of livestock production value in the total value of agricultural production. Author Madžar (2014) points out that the value of this production has been declining for decades due to the reduction of livestock, which contributes that the livestock fund of Serbia becomes poorer every year, instead of representing, together with plant production a significant branch of Serbian agriculture. Development of Serbia's livestock sector has been restricted by many factors, the most important of which are: the reduced purchasing power of consumers, lack of investment funds for investments in the livestock sector, high price of animal feed, representation of production predominantly in hilly and mountainous areas, which are exposed to high population migrations and other factors that threaten this production (Petrović et. al., 2012; Petrović et. al., 2013; Oljača et. al., 2008; Đorđević et. al., 2008).

Because of that, the value of livestock production will be excluded from further analysis, while the influence of plant prediction on the GVA of agriculture will be considered from aspects of the crop, fruit-growing, and viticulture production because they contribute the highest influence on GVA of the agriculture. The plant production analysis will be started with descriptive statistics of basic indicators for three mentioned lines of production (table 9).

Table 9: Descriptive statistics of basic indicators of structure of plant production in period 2007-2020 (in %)

Variables	Crop production	Fruit-growing production	Viticulture production
Mean	41.8	11.1	5.9
Std. Deviation	2.7	1.9	1.5
Minimum	35.5	8.6	3.8
Maximum	46.0	14.2	8.0
Coefficient of variation	6.6	16.8	24.9

Source: Author's calculation

In table 9 we can see that only crop production share 41.8% of total value of agricultural production, until viticulture production is characterized with high coefficient of variation 24.9%. Because of that, in following tables will be explained influence of these lines of plant production on total GVA of agriculture by using regression model which is set as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon,$$

in our case Y – GVA of agriculture (current prices), X_1 – value of crop production (current prices), X_2 – value of fruit-growing production (current prices), X_3 – value of viticulture production (current prices), β_0, β_1, β_2, β_3 – regression parameter, ε - error term.

In table 10 is given review of variability of the assumed model of the dependent value Y from independent variables X_1, X_2 and X_3.

Table 10. Coefficient of correlation, coefficient of determination, and standard error of regression model of the influence of values of the plant production on GVA of agriculture

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.919	.845	.798	128.7075

Source: Author's calculation

The coefficient of correlation shows us that there is a strong positive correlation between variables (0.919). Based on the coefficient of determination we notice that 84.5% of the variation in GVA of agriculture can be explained by the strong influence of analyzed lines of plant production until the corrected coefficient of determination shows that 79.8% of the variation of GVA of agriculture depends from values which achieved crop, fruit-growing and viticulture production. Remain 20% represents the influence of other factors (i.e. vegetable and horticultural production and other influences that haven't been considered). The standard error of regression shows that there is a deviation from the regression line of the sample in the amount of EUR 128.7075 mln.

In Table 11 are given results of testing of assumed regression model, and last column in table shows us that assumed model is statistically important.

Table 11: Evaluation of the assumed regression model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	902654.412	3	300884.804	18.163	.000[b]
	Residual	165656.123	10	16565.612		
	Total	1068310.535	13			

Source: Author's calculation

In the following table we see that the values β_1, β_2, $\beta_3 \neq 0$, and a given model has the following form:

$$Y = 339.270 + 0.647 X_1 + 1.009 X_2 + 1.066 X_3 + \varepsilon$$

$$6.250) \quad (0.144) \quad (0.407) \quad (0.535)$$

Table 12: The results of placed regression model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	339.270	306.250		1.108	.294		
	Crop production	.647	.144	.582	4.504	.001	.930	1.075
	Fruit-growing production	1.009	.407	.365	2.480	.033	.716	1.397
	Viticulture	1.066	.535	.293	1.991	.075	.717	1.395

Source: Author's calculation

Given data in table 12 shows us that the achieved value of crop production has the highest influence on realized GVA of agriculture. Statistically significant difference only exist in crop production (Sig. = 0.001), where the standardized beta coefficient is highest (β_1 = 0.582). The interpretation of values of non-standardized beta coefficient in crop production indicates the conclusion that with increasing of this line of production with EUR mln grows GVA of the agriculture for EUR 0.647 mln. This kind of result is logical with consideration that crop production takes a high share of the value of realized agricultural production. The same conclusion are get the authors Užar and Radojević (2017) who concluded by using the simple linear regression method, that in frame of plant production dominant share have crop production with 51.5%.

Finally, in an assumed regression model is analyzed the degree of correlation between predictors, and their influence on the achieved results of regression will depend on the value of the Tolerance level, VIF, and Eigen value (Table 12 and 13).

Based on those values in column *Tolerance* is approximately 0.4 and *VIF coefficient* is lowest than 2.5, it can be concluded that at these independent variables is a weak level of multicollinearity, and the presented regression model is valid. In other words, crop production, fruit-growing production, and viticulture production are weakly collinear.

Table 13: Diagnosing the influence of independent variables in plant production

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	Crop production	Fruit-growing production	Viticulture
1	1	3.931	1.000	.00	.00	.00	.00
	2	.043	9.556	.05	.06	.00	.73
	3	.019	14.541	.02	.10	.96	.26
	4	.007	23.082	.92	.85	.04	.01

Source: Author's calculation

The Eigen value of 3.931, 0.043, 0.019 and 0.007 for β_0, β_1, β_2 and β_3 obviously give a low value for variables. However, eigen values are closest to zero in case of very high values of Condition Index, and in our case, the values are 14.541 and 23.082 za β_2 and β_3. This kind of result indicates the presence of multicollinearity in large measure as a consequence of the influence of independent variables X_2 and X_3 (fruit-growing and viticulture production).

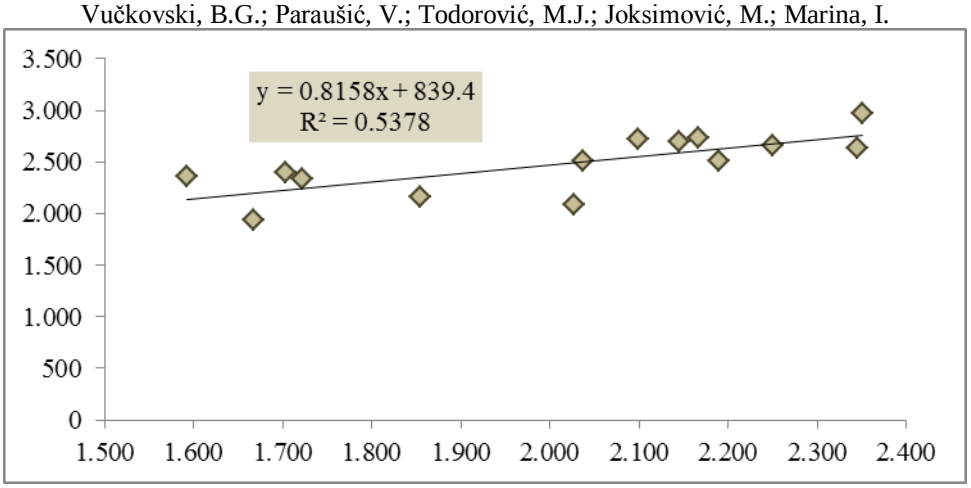
Results indicate that values of crop production give a large contribution to the creation of GVA agriculture, but also that the values of fruit and viticulture production also participate in the creation of GVA of agriculture, only to a lesser extent. The group of authors (Mihailović i sar., 2016), considered that the biggest problem for the development of fruit-growing production is the lack of modern technology for fruit storage, that there is a monopoly of coolers on the market, and that a small number of coolers have a closed process from production and processing to placing the final product on the market. Considering that fruit and viticulture production is more profitable branches of agriculture and that there is a constant demand on the market for fruit and grapes, domestic authors recommend increasing the area under these crops, with the introduction of new varieties and the intensive application of agricultural techniques (Ivanović et al, 2010; Bugarin et. al, 2013).

Considering that is concluded that the value of plant production, specifically crop production in the highest measure contributes to the creation of GVA in Serbia's agriculture, the rest of the paper will be shown a linear model of the trend on the observed variable. This model should show how the change in the value of crop production will be influenced on GVA of agriculture in a future period.

The starting equation of the linear regression model is of the following form:

$$y = bx+a,$$

in our case: y – GVA of agriculture (dependent variable), x – value of crop production (independent variable), *a and b* - parameter values. On graph 2. is given a review of the linear regression model of movement with analyzed variables.



Graph 2: A linear regression model of the movement of GVA of agriculture

Source: Author's calculation

Based on a graphical review can draw the following conclusion - if the value of agricultural production were to increase by EUR one million, we can expect an increase in the GDP of agriculture by EUR 0.8158 mln.

In the frame of crop production in Serbia, grains are leading plant products, well in sowing structure, as well in production volume. Plant production account for 12% of the earth's surface, i.e. 1.53 billion hectares, and the growth of the world's population and the intensive methods of agricultural production in the period 1985-2005, led to an increase in this production by 28%; the areas by 2.4% and average yields by 25% (Foley et al., 2011). Cereal production is important and extremely important for the nutrition of people and animals, and they provide the world's population with as much as 50% of the total amount of calories (Popović and Kovljenić, 2017; Roljević Nikolić et al., 2019).

5. Conclusion

The results of the research have shown that the GVA of agriculture in Serbia gives a significant contribution to the value of GDP because in the observed period (2007-2020) realized an average annual share of 6.7%. The results of the annual rate of change in this period showed that the GVA of agriculture increased by 6.8% on average per year. Considering these two results, we concluded that agriculture does not achieve high participation in the creation of Serbia's GDP; but has a high average annual growth rate, which proves that there is a significant influence of agriculture on the development of the entire economy of Serbia.

The presented regression model led us to a conclusion that the value of plant production has a statistically significant effect on the GVA of agriculture, especially crop production. Although this production is dominated by the structure of GVA of agriculture, cannot be ignored the effect of the value of the fruit-growing and viticulture production.

Since we established that crop production is statistically significant and dominant in the creation of GVA of agriculture in a given period, using the regression model can be concluded that the GVA of agriculture will increase only after the growth of crop production value.

The fitted regression model has shown that livestock production is not statistically significant in the creation of GVA of agriculture, and the basic reason is: decrease of livestock fond due to the lack of investment funds, reduced purchasing power of consumers, costs for the purchase of animal feed, etc.

With the help of previous analyses, we have determined which factors have the greatest influence on the creation of GVA of agriculture, and at the same time the GDP of Serbia. The results of the research can help in the creation of the economic and agricultural policy of Serbia because they show in which sector of agriculture there are problems for further development and in which area and line of agricultural production it is possible to improve the incentive policy.

6. Literature

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