Original scientific paper

Forecasting of plum production in Republic of Srpska

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Abstract

In this paper, a quantitative research method was used in order to forecast the trend of plum production parameters movement in Republic of Srpska for the period from 2020 to 2024. For this purpose, a quadratic trend model, as the most appropriate for the analyzed twenty-year data series (2000-2019), was used. The results of the research show that in the five-year forecast period not only the growth of fruit-bearing plum trees can be expected, but also a continuing decline of production and yield. Such results can serve as a way of considering the adoption of some of the strategic decisions in this production.

Key words: Forecasting, Trend, Plum, Republic of Srpska

Introduction

Plum is the most important fruit in Republic of Srpska and also Bosnia and Herzegovina. This is supported by the fact that the plum is the most common fruit in Republic of Srpska and that its production of 73,736 t in 2019 was higher by slightly over 8,300 t than the apple production, which is the second fruit in Republic of Srpska with the production of 64,425 t in the same year (https://www.rzs.rs.ba). The ancient Slavs grew plums in their homeland, although the true origin of this culture is from Asia Minor (Drkenda et al., 2010). Plums are valued for fresh consumption and also for the fact that various products can be obtained from them (jams, compotes, jellies, candied fruit, frozen fruit, liqueurs, brandies) (Butac, 2010). They are the type of fruit with the highest nutritional value and with a high content of carbohydrates, minerals and vitamins that stimulate the human body health (Milošević & Milošević, 2018; Botu & Botu, 2007).

The economic importance of plum production is reflected in enabling entry into new markets, increasing employment and the degree of capacity utilization in agriculture and the food industry, which encourages the development of entrepreneurship and the national economy (Prodanović, 2015). The economics of plum production is determined by numerous factors. The most important ones are: variety selection, location, application of agro and pomotechnical measures, production costs and market prices (Prodanović et al., 2017). In addition, modern plum growing systems imply technology that allows fast achievement of full fertility, regular fertility and high quality of fruit (Glišić et al., 2016). Some varieties have a special significance in processing such as the variety known as Požegača (Madžarka, Savka) in the Balkan (Cvetković and Glišić, 2020).

Global plum production is at the level of 12,601,312 t. The largest producer is China with more than half of the world's production (6,995,738 t). China is followed by Romania with 692,670 t, as well as Serbia with 558,930 t in 2019. The largest exporter of this fruit in 2019 was Chile with 155,217 t of exports, while the largest importer of plums in the same year was also its largest producer, China (together with Hong Kong), with a volume of 85,115 t of imports. Regarding the participation in global production, it can be noted that the production of plums in Bosnia and Herzegovina is minimal and amounts only 0.47%, or 59,970 t in 2019 (http://www.fao.org/faostat/en/#home).

Due to the economic importance that plum has, greater emphasis should be placed on forecasting the movement of its production parameters. Thus, Mutavdžić (2010) considers that in the market conditions, successful production depends on monitoring, analysis and forecast of results and the most important factors that affect it. In their previous research, some of the authors have dealt with the analysis of fruit production (Maksimović, 2012; Keserović et al., 2014; Vlahović et al., 2015; Milić et al., 2016, Stanković and Vaško, 2018; Užar et al., 2019). Nedeljković and Potrebić (2020) used the evaluated trend model to forecast apple production in Republic of Srpska. Namely, they found that the growth of fruit-bearing trees and apple production could be expected in the three-year forecast period (2019-2021). On the contrary, a decrease of yield of this fruit can also be expected.

The subject of this paper is the analysis of the movement of plum production in Republic of Srpska, which would aim to select an appropriate trend model that would forecast the movement of production parameters of this fruit in the next five years.

Material and Methods

Available data from the Institute of Statistics of Republic of Srpska, as well as the FAOSTAT database, were used as the source of the research. Apart from the standard indicators of descriptive statistics (average, interval of variation, standard deviation and coefficient of variation), linear, quadratic and exponential trend models were used for the observed twenty-year period as well as for the five-year forecast (2020-2024).

The linear trend model can be obtained using the following expression:

$$Yt = \beta_0 + \beta_1 t + e_t$$

The quadratic trend model is obtained using the following expression:

$$Yt = \beta_0 + \beta_1 \times t + \beta_2 t^2 + e_t$$

The model of the exponential trend is obtained using the following expression:

$$Yt = \beta_0 \times \beta^t{}_1 \times e_t$$

Three accuracy indicators were used to select the appropriate forecasting model: mean absolute percentage error (MAPE), then mean absolute deviation (MAD) and mean squared deviation (MSD) (Makridakis & Hibon, 2000; Goodwin & Lawton, 1999; Sidik, 2010). According to Karim et al. (2010), the lowest values of all accuracy parameters recommend the selection of the appropriate forecasting model.

MAPE (Mean Absolute Percentage Error) is a forecasting method used in time series where periodicity is particularly observed (Nedeljković & Vujić, 2020). It is expressed by the following formula:

$$\text{MAPE} = \frac{1}{n}\sum \text{I(yt} - \hat{\text{y}}\text{t)/yt I100}$$

Mean Absolute Deviation (MAD) represents a dispersing method that is created as a deviation of the modality from the representative parameter (Nedeljković & Vujić, 2020). It is obtained on the basis of the following formula:

$$\text{MAD} = \frac{1}{n}\sum \text{Iyt} - \hat{\text{y}}\text{tI}$$

MSD is the Mean Squared Deviation that represents the mathematical expectation of how well the arithmetic mean represents the results obtained (Nedeljković & Vujić, 2020). It is expressed on the basis of the following formula:

$$\text{MSD} = \frac{1}{n}\sum (\text{yt} - \hat{\text{y}}\text{t})^2$$

Results and Discussion

The average number of fruit-bearing plum trees in Republic of Srpska in the observed period was almost 5.870 with a very stable trend expressed through the achieved coefficient of variation of 3.74%. As opposed to the trend in the number of fruit-bearing trees, plum production showed a significant variation (cv = 34.18%) with an average of 75,859 t. The maximum production of plums was recorded in 2013 and amounted to 133,581 t. Like production, the yield of plums has a significant and identical variation throughout the analyzed period. The highest yield of over 22 kg per tree was achieved in the same year when the highest production of this fruit was recorded (Table 1).

Table 1. Dynamics of plum production in Republic of Srpska (2000-2019)

Production parameters	Average	Interval of variation		Standard deviation	Coefficient of variation (%)
		Min.	Max.		
Fruit-bearing trees	5.869,10	5.574	6.267	219,299	3,74
Production (t)	75.858,80	26.857	133.581	25929,68	34,18
Yield (kg per tree)	12,92	4,70	22,20	4,315	33,40

Source: Data taken from IS RS

The analysis of the accuracy measure of the evaluated three trend models shows that the quadratic trend model is appropriate for forecasting the movement of the number of fruit-bearing plum trees in the next five years. Namely, the quadratic trend model has the lowest recorded parameter values (MAPE, MAD, MSD) (Table 2).

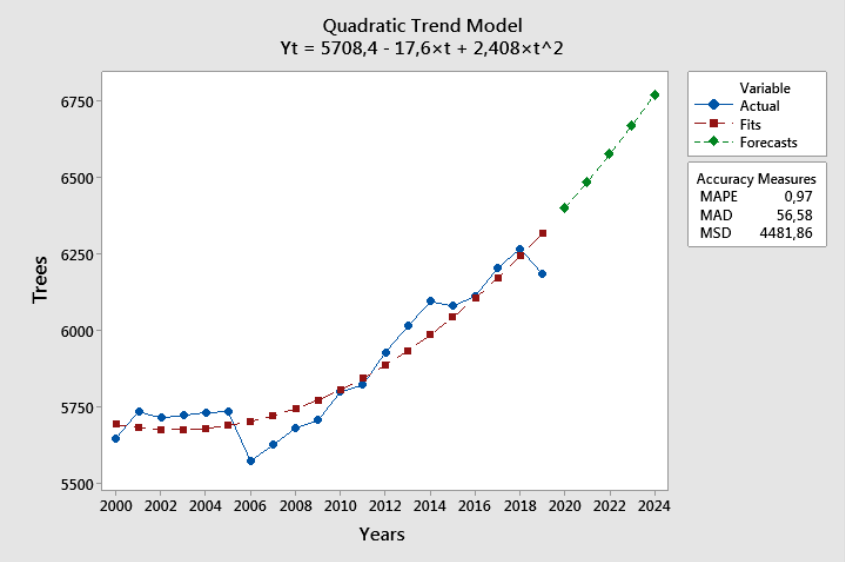
Table 2. Accuracy indicators

Trend model	Parameters		
	MAPE	MAD	MSD
Linear	1,43	83,03	9570,58
Exponential	1,41	81,55	9198,92
Quadratic	**0,97**	**56,58**	**4481,86**

Source: The author's calculation

The following Graph 1 shows the movement of fruit-bearing plum trees in the next five years (2020-2024) and also its actual and default values, while **Table 3** shows the estimated number of fruit-bearing plum trees in Republic of Srpska for the next five years. In the same table, an increase in the number of fruit-bearing trees year after year of the forecast period can be

noticed. The estimated number of fruit-bearing trees in the last year of the forecast period (2024) should be slightly higher than 900.



Graph 1. Movement of the number of fruit-bearing plum trees

Table 3. Forecasting of fruit-bearing plum trees

Period	Estimated value (fruit-bearing trees)
2020	6400,55
2021	6486,48
2022	6577,22
2023	6672,78
2024	6773,16

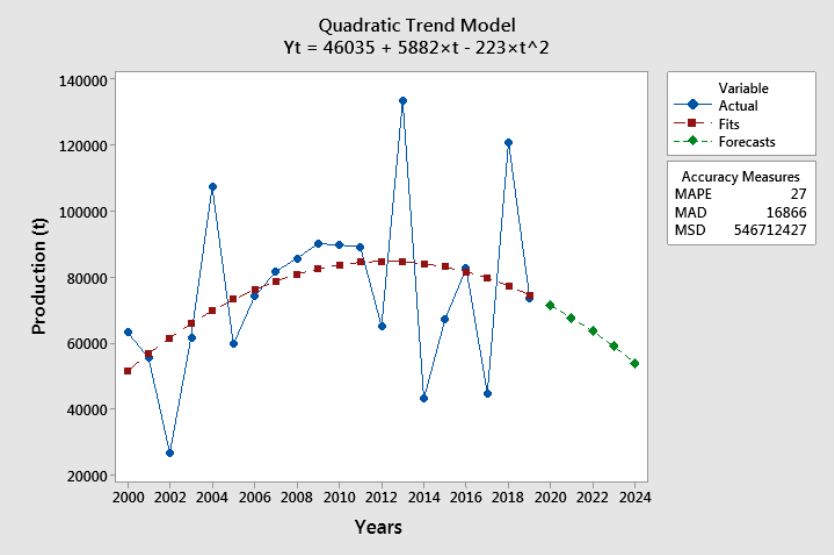
Source: The author's calculation

As far as the fruit-bearing plum trees and also their production is concerned, a quadratic trend model, which is used for forecasting, has the lowest accuracy parameters. (**Table 4**) Graph 2 visualizes plum production movement in Republic of Srpska for the next five years. The data in Table 5 show that production, unlike the number of trees, will continuously fall, and that in the last year of forecasting, it will be at 71% of average production from the period of analysis, 53,983 t.

Table 4. Accuracy indicators

Trend model	Parameters		
	MAPE	MAD	MSD
Linear	31	18962	590195494
Exponential	29	19284	611356533
Quadratic	**27**	**16866**	**546712427**

Source: The author's calculation



Graph 2. Movement of plum production

Table 5. Forecasting of plum production

Period	Estimated value (t)
2020	71407,1
2021	67718,8
2022	63585,3
2023	59006,8
2024	53983,0

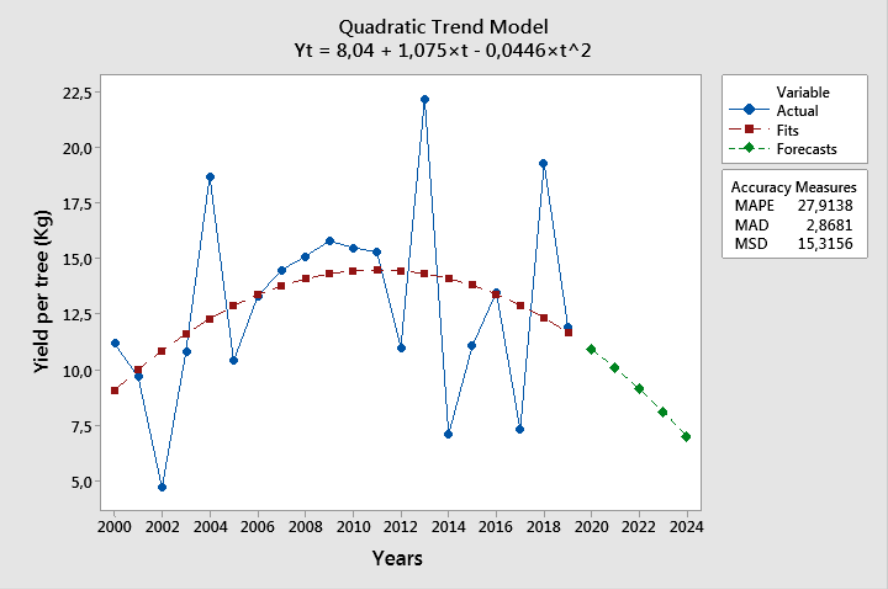
Source: The author's calculation

Also, trend model that is the most appropriate for forecasting of plum yield is the quadratic model due to its lowest values of achieved parameters. (Table 6) The trajectory that shows the decline of plum yield in the observed period, and its further continuation of the constant decline in the next forecast period can be seen in Graph 3. At the end of the forecast period, 7 kg per tree can be expected, which is almost 6 kg per tree less than the recorded yield in the twenty-year observation period (Table 7).

Table 6. Accuracy indicators

Trend model	**Parameters**		
	MAPE	MAD	MSD
Linear	32,0558	3,3351	17,0652
Exponential	30,3354	3,3431	17,6493
Quadratic	**27,9138**	**2,8681**	**15,3156**

Source: The author's calculation



Graph 3. Movement of plum yield

Table 7. Forecasting of plum yields

Period	Estimated value (kg per tree)
2020	10,92
2021	10,07
2022	9,14
2023	8,11
2024	7,00

Source: The author's calculation

Conclusion

From all the above, it can be concluded that in Republic of Srpska the plum represents fruit that has the highest production but minimal participation in global production. In the observed period, plums have large fluctuations in production and yield. Based on the choice of the appropriate trend model, in this case a quadratic trend model, we can expect further growth of fruit-bearing plum trees to the level of 6,773 in 2024. Additionally, a decline of production to 53,983 t, as well as a decline of yield to 7 kg/tree in the last year of the forecast period, is predicted. Even though the number of the fruit-bearing trees has the tendency to increase, it is evident that the decline in yield, caused by poor sortiment and unfavourable weather conditions in a certain period of time, is accompanied by a decline in production of this fruit in Republic of Srpska. Precisely because of its economic importance, further research should be developed in the direction of determining other influences on the plum production trend in Republic of

Srpska, and this research should be used to make better strategic decisions that would concern further progress in this branch of agriculture.

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Predviđanje proizvodnje šljive u Republici Srpskoj

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Sažetak

U radu je primjenom kvantitativne metode istraživanja predviđen trend kretanja proizvodnih parametara šljive u Republici Srpskoj za period 2020-2024.godina. U tu svrhu je korišćen kvadratni trend model, kao najpogodniji za analiziranu dvadesetogodišnju seriju podataka (2000-2019). Rezultati istraživanja pokazuju da se u petogodišnjem periodu predviđanja može očekivati rast rodnih stabala šljive ali i konstantan pad proizvodnje i prinosa. Rezultati istraživanja mogu poslužiti u svrhu razmatranja donošenja nekih od strateških odluka u ovoj proizvodnji.

Ključne riječi: predviđanje, trend, šljiva, Republika Srpska