PREDICTION OF SUNFLOWER PRODUCTION IN THE REPUBLIC OF SERBIA

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Abstract

The paper, using a quantitative research method, aimed to create an adequate model for predicting the production parameters of sunflower in the Republic of Serbia in the next three years. The selected trend model was used for that, and the analyzed seventeen-year series of data ranged from 2005 to 2021. The results of research obtained using three measures of accuracy of trend selection (*Mean Absolute Percentage Error, Mean Absolute Deviation, Mean Squared Deviation*) show that all three observed parameters of sunflower have a positive tendency to grow with greater oscillations in production. The results of the research can serve the purpose of making rational strategic decisions in the future when it comes to the production of this oilseed.

Keywords: *Sunflower, Prediction, Trend, Republic of Serbia.*

Introduction

Sunflower (Helianthus annuus L.) is one of the most important oilseeds grown Republic of Serbia. It is one of the five main oilseeds in the world, along with soybeans and oilseed rape (Šimić et al., 2008; Seiler et al., 2017). Sunflower is of great economic importance due to the high content of oil in the seeds, and vegetable oils in the core, which are as much as 60%. Sunflower oil is of very high quality, and has a high energy and nutritional value. Sunflower seeds contain on average 43% oil, 18% protein, 26% cellulose, and 3% minerals (Vratarić et al., 2004). All production characteristics of sunflower as well as its possibility of multipurpose use give immeasurable economic significance, and its production stands out as an important segment of agricultural production of a country. In their earlier works, some of the authors primarily dealt with the economic analysis and profitability of growing oilseeds, including sunflower (Knežević and Popović, 2011; Popović et al., 2016; Božić and Nikolić, 2016; Matkovski et al., 2020 etc.). However, as Mutavdžić (2010) concludes in the market economy, successful production, in addition to monitoring and analysis, also depends on the prediction of results and the most important factors that affect it. Given the previously mentioned, the aim of this paper is to create an adequate model for predicting sunflower, i.e. its production indicators.

Material and methods

Descriptive measures of statistics (average, interval of variation, coefficient of variation and rate of change) were used for data processing, while trend analysis related to the seventeen-year-long data series (2005-2021) obtained by looking at the available SO RS data, was used for forecasting. We obtain trend models based on the following expressions:

a) Linear trend: $Yt = \beta_0 + \beta_1 t + e_t$

b) Square trend: $Yt = \beta_0 + \beta_1 \times t + \beta_2 t^2 + e_t$
c) Exponential trend: $Yt = \beta_0 \times \beta^t{}_1 \times e_t$

According to some authors (Markidakis and Hibon, 2000; Goodvin and Lawton, 1999), three measures of accuracy were used to select an adequate prediction model, namely: mean absolute percentage error (MAPE), mean absolute deviation (MAD), and mean square deviation (MSD).
MAPE (*Mean Absolute Percentage Error*) is a prediction method used in time series where periodicity is especially observed and is obtained on the basis of the following statement:

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

MAD (*Mean Absolute Deviation*) is a dispersion method that is created as a deviation of the modality from the representative parameter and is obtained as follows:

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

MSD (*Mean Squared Deviation*) is the standard deviation that represents the mathematical expectation of how well the arithmetic mean represents the results obtained based on the following expression:

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

Karim et al. (2010) believe that the lowest value of the mentioned measures of accuracy is a correct indicator of the choice of model with minimal errors in prediction.

Results and Discussion

According to FAOSTAT (https://www.fao.org/faostat), the largest producer of sunflower in the world is Russia with a production of 13,314,418 tons in 2020, which was 26.5% of the total world production that year. It is immediately followed by Ukraine with 13,110,430 tons, while the other large producers are Argentina, China, Romania, Turkey, but with far smaller quantities of this oilseed produced. According to the same source, the largest world export in 2020 was realized by Romania with the amount of 1,482,504, while the largest importer was realized by Turkey with 1,206,590 tons.
Regarding the production of sunflower in Serbia, it was on average at the level of 492,142 tons in the observed period, on an average area of over 191,500 ha. Compared to the other two production indicators, sunflower production showed greater variation in the analyzed period measured by the obtained coefficient of variation (cv = 27.3%), but also a higher growth trend (r = 3.49%). The largest produced quantities were realized in 2018 (733,706 t), when the largest areas of sunflower were harvested, while the highest yield was recorded a year later (3.30 t / ha). (Table 1)

Table 1. Dynamics of sunflower production in the Republic of Serbia (2005-2021)

	Average	Interval of variation		Coefficient of variation (%)	Rate of change (%)
		Min.	Max.		
Surface area (ha)	191.507	154.793	239.148	12,76	0,45
Production (t)	492.142	294.502	733.706	27,309	3,49
Yield (t/ha)	2,55	1,80	3,30	17,61	3,03

Source: Auhtors' calculation based on data of the Statistical Office of the Republic of Serbia

When analyzing the measures of accuracy of the observed trend models, we notice that the square trend model has the lowest values, and we take it to predict sunflower production in the next three years. (Table 2) A visual representation of the trends of the projected areas under sunflower can be seen in Figure 1, while the actual values of the projected areas can be seen in Table 3.

Table 2. Accuracy measures

	MAPE	**MAD**	**MSD**
Linear	8	14602	310610912
Square	7	12549	226160831
Expon.	8	14253	301738944

Source: Authors' calculation

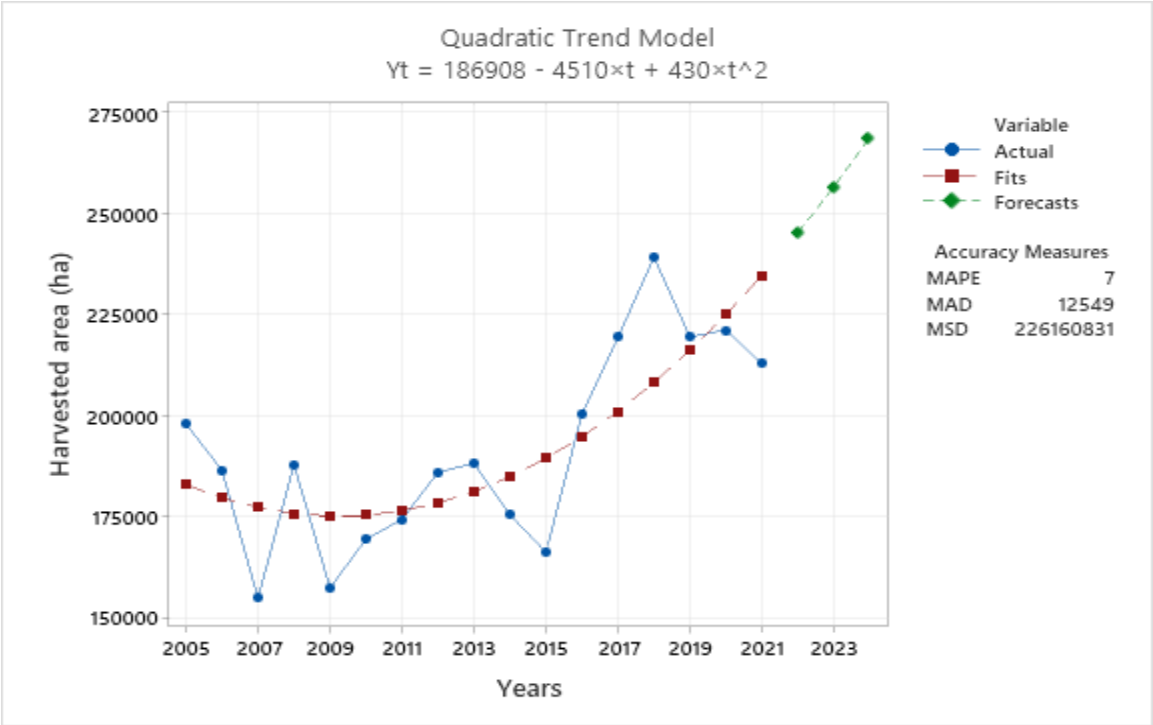

Figure 1. Sunflower surface trends

Table 3. Projected area under sunflower

Years	2022	2023	2024
Surface area	245.166	256.579	268.852

Source: Authors' calculation

As with surfaces, so with production we take the square trend as a more adequate trend model. (Table 4). The visualization of production trends is presented in Graph 2 below, and the realized predictive values of production are visible in Table 5.

Table 4. Accuracy measures

	MAPE	**MAD**	**MSD**
Linear	12	56390	4383046471
Square	11	54367	4178993362
Expon.	11	54550	4249784439

Source: Authors' calculation

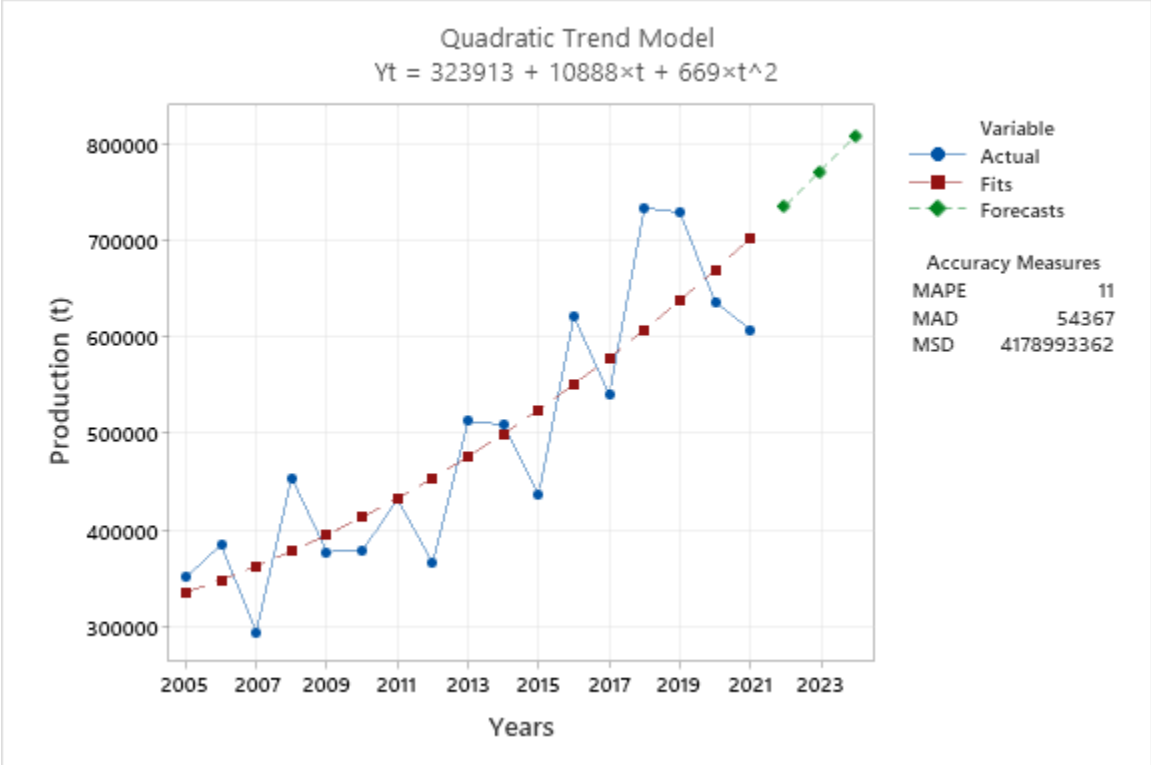

Figure 2. Trends of sunflower production

Table 5. Predicted sunflower production

Years	2022	2023	2024
Production	736.632	772.270	809.247

Source: Authors' calculation

The analyzed measures of accuracy indicate that in terms of yield, the choice of model type is the same as in the previous two cases. (Table 6). The trends and growth of sunflower yield in the analyzed and prediction period is visible in Graph 3, while the following table 7 gives the predicted values of this parameter.

Table 6. Accuracy measures

	MAPE	**MAD**	**MSD**
Linear	8,48101	0,21185	0,05543
Square	7,97622	0,19846	0,05316
Expon.	8,74162	0,21994	0,65861

Source: Authors' calculation

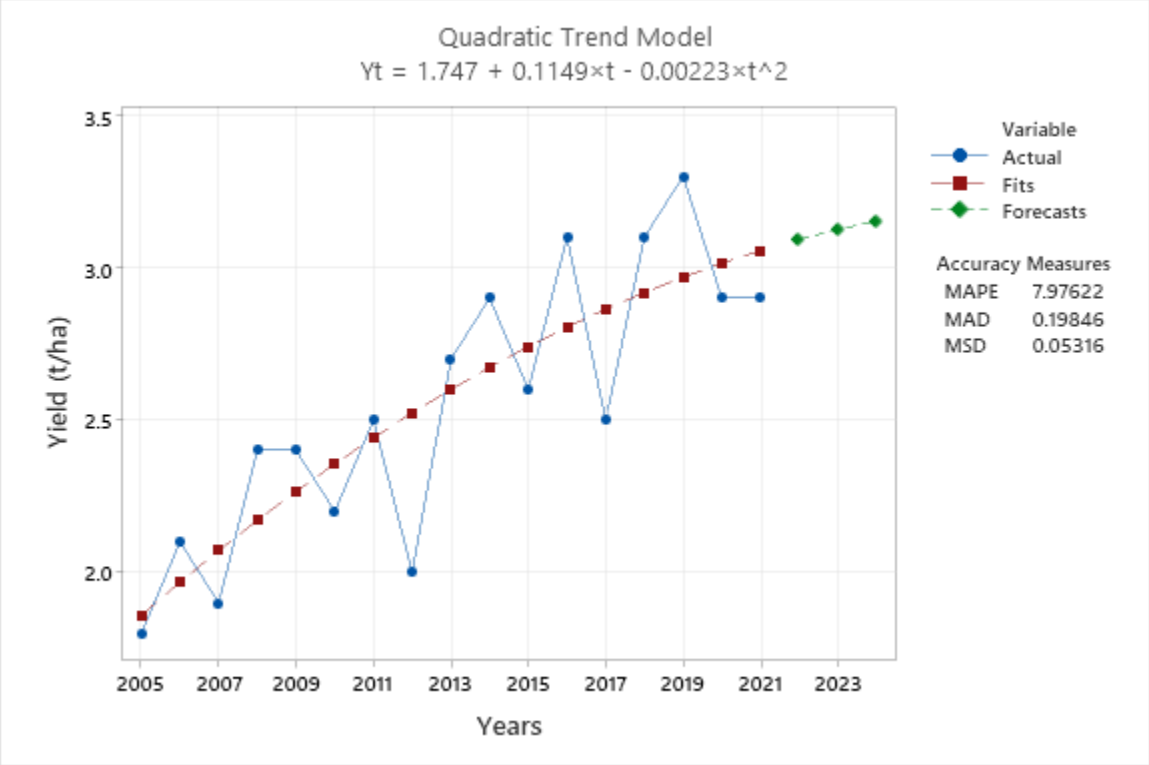

Figure 3. Trends of sunflower yield

Table 7. Predicted sunflower yield

Years	2022	2023	2024
Yield	3,09	3,12	3,15

Source: Authors' calculation

Conclusion

Sunflower is one of the main industrial plants in Serbia with great economic and nutritional significance. In the observed period, slightly over 492,000 tons of sunflower were produced on over 191500 hectares. A slight growth trend of the analyzed indicators of this oilseed crop was observed, with a relatively large variation in production in the seventeen-year-long period.
Based on the used measures of accuracy in obtaining an adequate trend model for forecasting, it was noticed that the observed parameters are constantly increasing in the next three - year period. Namely, according to the obtained results, it can be expected production of 809,247 tons in the last year of prediction (2024) on an area of 268,852 hectares. The projected values of production will be higher by as much as two thirds of the realized average values of production in the previously observed period. In addition, a slight increase in yield is expected, which would amount to 3.15t / ha in 2024.

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