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STATE AND TENDENCIES OF PRODUCTION CHARACTERISTICS OF WHEAT AND MAIZE IN SERBIA
STANJE I TENDENCIJE PROIZVODNIH KARAKTERISTIKA PŠENICE I KUKURUZA U SRBIJI

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ABSTRACT

The aim of the research is to determine the state and tendencies in the movement of production parameters of wheat and corn in Serbia for the period from 2005-2020. Analyzed parameters are harvested area, yield and total production. Descriptive statistics were used to determine the state and tendencies of the observed features. In order to predict the value of production parameters from 2021 to 2023, two methods were used: ARIMA model and extrapolation of the average rate of change of the analyzed parameters. Since the ARIMA model did not give satisfactory results due to a short time series (16 years), annual rates of change were used to extrapolate the production characteristics for the period 2021-2023. Using extrapolation of the average rate of change, the authors concluded that the yield of corn and wheat in the analyzed period showed a tendency to grow, with the areas of both crops showing a tendency to fall. Total wheat and corn production have a tendency to grow when compared with the averages of the analyzed period in previous years. The results of the forecast indicate that the volume of wheat production is expected to be 15.54% higher, and the volume of corn 28.41%, during the prediction period in relation to the multi-year averages of the analyzed period.

Keywords: yield, harvested area, production, state, tendencies.

REZIME

Cilj istraživanja je da se utvrde stanje i tendencije u kretanju proizvodnih karakteristika pšenice i kukuruza u Srbiji u periodu od 2005-2020 godine. Analizirani su površina, prinos i ukupna proizvodnja. Za utvrđivanje stanja i tendencija posmatranih obeležja korišćena je deskriptivna statistika. Za predviđanje vrednosti obeležja u periodu 2021-2023 godina korišćena su dva metoda: ARIMA model i ekstrapolacija prosečne stope promene analizirane pojave. ARIMA model nije dao zadovoljavajuće rezultate usled kratke vremenske serije koja je analizirana. Primenom ekstrapolacije prosečne stope promene, autori su zaključili da je prinos kukuruza i pšenice u analiziranom periodu ispoljio tendenciju rasta, pri čemu su površine oba useva ispoljile tendenciju pada. Ukupna proizvodnja pšenice i kukuruza imaju tendenciju rasta za vreme perioda predikcije u odnosu na višegodišnje proseke analiziranog perioda. Rezultati predviđanja ukazuju da je za očekivati 15,54% veći obim proizvodnje pšenice, a kukuruza povećanje za 28,41%,

Ključne reči: prinos, površina, proizvodnja, stanje, tendencije.

INTRODUCTION

Cereal production is one of the most important in crop production. Its importance from the economic aspect for the producer and the development of the domestic economy as a whole define the basic directions of its future development: increasing the volume of production, efficient use of natural resources and increasing the degree of finalization of grain products. Wheat is considered the dominant crop and food source. Almost 66% of global production is used for human consumption, while 16.6% for animal nutrition (*Devi, et al*, 2021). Corn, the most widespread cereal around the world, is also one of the most important agricultural products used to meet the needs of mankind. Taking into account their importance for the agricultural production of Serbia, the subjects of research in this paper are the production characteristics (cultivated area, yield and total production) of wheat and corn in the Republic of Serbia in the period 2002-2020 and predicting their movement for the period 2021-2023. The aim of this paper is to determine the state and tendencies of the observed features using scientific prognostic methods, to establish the course of development of the mentioned production lines and to uncover the current state and untapped development potentials. Two methods were used: ARIMA model and extrapolation of the average rate of change in order to predict production characteristics of wheat and corn for the period 2021-2023. Since the ARIMA model did not give satisfactory results due to a short time series (16 years), annual rates of change were used to extrapolate the production characteristics for the period 2021-2023. The obtained results of this research could be very useful for making strategic plans and decisions, which would concern the further development of these production lines.

Forecasting in agriculture is very important and useful both for the agricultural producers and the agribusiness sector as a whole, as well as for the agricultural policymakers. Numerous authors have emphasized the importance of forecasting in agriculture (*Geoffrey et al., 1994; Li et al., 2022*; *Niyigaba and Peng, 2020*). Novković et al (2021) were analyzing the production characteristics of grapes in Serbia, emphasizing the importance of proper analysis of the situation and tendencies of the mentioned indicators. Due to the economic and nutritional importance of wheat and corn, monitoring and predicting their production characteristics have been the focus of numerous researchers (*Li et al., 2022; Novković et al., 2020; Mutavdžić et al., 2016; Malinovský, 2021*). Novkovic et al. (2020) analyzed the volume, stability and tendencies of the major productively and economically important crops in Serbia and predicted their changes for the period 2019 to 2023.

MATERIALS AND METHOD

The descriptive statistics method was used in collecting, arranging and presenting data for analysis in this research. By

calculating individual indicators, descriptive statistics provide basic information important for getting acquainted with the characteristics of the time series (*Novković et al., 2019*). The tools of descriptive analysis used to observe the production parameters of wheat and corn in the period 2005-2020 in Serbia are the average value, the interval of variation (minimum and maximum), coefficient of variation (CV) and average rate of change (r). Two methods were used to predict production characteristics of wheat and corn: ARIMA model and extrapolation of the average rate of change Since the ARIMA model did not give satisfactory results due to a short time series (16 years), annual rates of change were used to extrapolate the production characteristics for the period 2021-2023. The rate of change shows the average annual relative change in occurrence in the analyzed time period. It is calculated directly from the absolute data of the analyzed time series using the expression:

$$G = \left(\frac{Y_n}{Y_1}\right)^{\frac{1}{n-1}} ; \ r = (G-1)*100 \tag{1}$$

where: r - average annual rate of change, G - average annual index of change, Y_1 - absolute value of the first member of the time series, Y_n - absolute value of the last member of the time series, n - length of the time series.

The data on production parameters of wheat and corn were obtained from the website of the Statistical Office of the Republic of Serbia.

RESULTS AND DISCUSSION

The production parameters of wheat production in the Republic of Serbia for the period 2005-2020 are presented in Table 1. In the analyzed period, the lowest prevalence of wheat was in 2017, and in the following year, 2018, it reached its maximum. The minimum wheat yield was recorded in 2010, and the maximum in the last year of the analyzed period. The lowest wheat production in Serbia was also recorded in 2010, while the maximum annual production was achieved in 2016.

Table 1. The production parameters of wheat production in the Republic of Serbia (2005-2020)

Year	Harvested area (ha)	Yield (t/ha)	Total production (t)
2005	630.255	4,00	2.522.565
2006	607.123	3,90	2.367.911
2007	625.912	3,70	2.342.244
2008	612.256	4,30	2.632.091
2009	636.434	4,10	2.598.182
2010	619.403	3,40	2.085.529
2011	619.612	4,20	2.609.188
2012	603.275	4,00	2.399.225
2013	631.640	4,30	2.690.266
2014	604.748	3,90	2.387.202
2015	589.922	4,10	2.428.203
2016	595.118	4,80	2.884.537
2017	556.115	4,10	2.275.623
2018	643.083	4,60	2.941.601
2019	577.499	4,40	2.534.643
2020	581.128	4,90	2.873.503

Source: Statistical Office of the Republic of Serbia

The results of descriptive statistical analysis of wheat production characteristics (Table 2) show that the harvested area devoted to wheat is found to be stable (CV = 3.93%). The average harvested area of wheat was about 608 thousand hectares and ranged from 556 to 643 thousand hectares. The

average annual production of wheat was over 2.5 million tons. The interval of variation ranged from a minimum of 2.1 to a maximum of 2.9 million tons. The average wheat yield of about 4.2 t/ha varied in the range of 3.4 to 4.9 t/ ha.

Table 2. Descriptive statistics for the production parameters of wheat (2005-2020)

Wheat	Average value	Variation interval		Variation coefficient (%)	Rate of change (%)
		Min.	Max.		
Harvested area (ha)	608.345	556.115	643.083	3,93	-0,54
Yield (t/ha)	4,17	3,40	4,90	14,61	2,89
Total production (t)	2.535.782	2.085.529	2.941.601	9,28	0,65

Source: Calculations of the authors

According to the observed parameters during the analyzed period (2005-2020), the highest variability was recorded in yield (CV = 14.61%). Variation of the harvested area and total production is present but at a minimal level. Trends expressed by the average annual rate of change indicate an insignificant decline in harvested area. On the other hand, there is an increase in yield and as a consequence, there is a slight increase in total production (Table 2).

The predicted production parameters of wheat production in Serbia for the period 2021-2023 are presented in Table 3. The harvested area will decrease compared to the last analyzed year. In the last year of the prediction period, a level of about 572 thousand hectares is expected. Yield and production tend to grow according to forecast results. A yield of over 5.3 t / ha is expected, and the total production is around 2.93 million tons (Table 3).

Table 3. Forecast of the production parameters of wheat production in the Republic of Serbia for the period 2021-2023

Year	Forecast		
	Harvested area (ha)	Yield (t/ha)	Total production (t)
2021	577.989	5,04	2.892.180
2022	574.868	5,19	2.910.979
2023	571.764	5,34	2.929.901

Source: Calculations of the authors

The results of analyzed production parameters of the maize production in the Republic of Serbia for the period 2005-2020. year are presented in Table 4. In the analyzed period, the lowest prevalence of maize was achieved in 2018. The highest yield of maize was recorded in 2020, and the lowest was in 2012 when the lowest production in Serbia was achieved. The maximum annual production was in 2014 when maize occupied the maximum area (Table 4).

The results of descriptive statistical analysis of maize production characteristics (Table 5) present that the average harvested area of maize is about 997 thousand hectares, and ranged from 901 to 1,057 thousand hectares.

The average annual production of maize was over 6.22 million tons. The interval of variation ranged from a minimum of 3.53 to a maximum of 7.95 million tons. The average maize yield of 6.24 t/ha varied in the range of 3.60 to 7.90 t/ha (Table 5).

According to the analyzed parameters during the analyzed period (2005-2020) it can be concluded that the highest variability is recorded for yield and total production (CV = 22.38% and CV = 22.27% respectively). Variation of harvested

areas under maize is present but at a minimal level. Trends expressed by the average annual rate of change signify a slight decline in the harvested area of maize and, on the other hand, the growth of yield, which also influenced the growth of total production (Table 5).

Table 4. The production parameters of maize production in the Republic of Serbia (2005-2020)

Year	Harvested area (ha)	Yield (t/ha)	Total production (t)
2005	1.004.611	7,10	7.085.366
2006	962.636	6,30	6.016.765
2007	992.941	3,90	3.904.825
2008	1.048.815	5,90	6.158.122
2009	994.612	6,40	6.396.262
2010	1014.570	7,10	7.207.191
2011	1.036.589	6,20	6.479.564
2012	976.020	3,60	3.532.602
2013	980.334	6,00	5.864.419
2014	1.057.877	7,50	7.951.583
2015	1.010.227	5,40	5.454.841
2016	1.010.097	7,30	7.376.738
2017	1.002.319	4,00	4.018.370
2018	901.753	7,70	6.964.770
2019	962.083	7,60	7.344.541
2020	996.527	7,90	7.872.607

Source: Statistical Office of the Republic of Serbia

Table 5. Descriptive statistics for the production parameters of maize (2005-2020)

Maize	Average value	Variation interval		Variation coefficien (%)	Rate of change (%)
		Min.	Max.		
Harvested area (ha)	997.001	901.753	1.057.877	3,74	-0,05
Yield (t/ha)	6,24	3,60	7,90	22,38	0,71
Total production (t)	6.226.785	3.532.602	7.951.583	22,27	0,52

Source: Calculations of the authors

Table 6. Forecast of the production parameters of maize production in the Republic of Serbia for the period 2021-2023

Year	Forecast		
	Harvested area (ha)	Yield (t/ha)	Total production (t)
2021	996.028	7,96	7.913.544
2022	995.530	8,01	7.954.695
2023	995.032	8,07	7.996.059

Source: Calculations of the authors

Based on the presented tendencies of maize production characteristics for the period 2021-2023 (Table 6), it can be concluded that the area under maize will decrease compared to the last analyzed year. In the last year of the forecast period, a level of 995 thousand hectares is expected. Yield and production tend to grow according to forecast results. The yield is expected to be around 8.07 t/ha, and the total production of 7.99 million tons.

CONCLUSION

Based on the research results in this paper, it can be concluded that the area under wheat and corn in the Republic of Serbia will have a tendency to decline. However, the yield of both crops shows a tendency to grow in the forecast period. Although the area under wheat is declining, since yield growth is expected to increase, total production will also increase to 2,929,901 tons in the last year of the forecast period which is higher than a multi-year average of 2,535,782 (2005-2020) for 15.54%. When it comes to the total production of maize, the situation is similar to wheat. Despite the tendency of falling areas, the growth of yields in the prediction period will also affect the increase in total production. In the last year of the prediction period (2023), the level of total production of 7,996,059 tons of maize is expected, which is an increase of 28.42% compared to the multi-year average (6,226,785 t).

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