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INFLUENCE OF WHEAT AND CORN YIELD AND PRICE PARITY FROM THE CURRENT YEAR ON FOLLOWING YEAR SOWING STRUCTURE

UTICAJ PRINOSA I PARITETA CENA PŠENICE I KUKURUZA IZ TEKUĆE GODINE NA SETVENU STRUKTURU NAREDNE GODINE

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ABSTRACT

The subject of this research is the production characteristics and price parity of wheat and corn in the Republic of Serbia. The aim of this research is to determine whether there is a relationship between the yield and price parity from the current year and the sowing structure of these two crops in the following year. The analysis was performed for the period 2011-2021. Statistical processing was performed using descriptive statistical analysis and multiple linear regression. Research results determined that the average area under wheat was about 600 thousand hectares, while the average area under corn was about 400 thousand hectares than the area under wheat. The yield of wheat in the observed period was relatively stable, while the yield of corn showed significant variations. The average production of corn was about 3.6 million tons, i.e. it was 2.3 times higher than the average wheat production. The price parity of wheat and corn averaged 1.12. The regression model's results determined a statistically significant influence of the yield and price parity of wheat and corn from the current year on the areas under wheat and corn in the following year.
Keywords: wheat, corn, sowing structure, yield, price parity, Republic of Serbia

REZIME

Predmet ovog istraživanja su proizvodne karakteristike i paritet cena pšenice i kukuruza u Republici Srbiji. Cilj ovog istraživanja je da se utvrdi da li postoji veza između prinosa i pariteta cena pšenice i kukuruza iz tekuće godine i setvene strukturu naredne godine ova dva useva. Analiza je izvedena za period od 2011-2021. godine. Statistička obrada analiziranih proizvodnih parametara i pariteta cena izvedena je primenom deskriptivne statističke analize, a za utvrđivanje uticaja prinosa i pariteta cena iz tekuće godine na setvenu strukturu naredne godine primenjen je model višestruke linerne regresije. Rezultatima istraživanja utvrđeno je da su prosečne površine pod pšenicom, u posmatranom periodu, iznosile oko 600 hiljada hektara, dok su prosečne površine pod kukuruzom bile za oko 400 hiljada hektara veće od površina pod pšenicom, površine obe posmatrane kulture bile su relativno stabilne u posmatranom periodu. Prinos pšenice u posmatranom periodu bio je relativno stabilan, dok je prinos kukuruza pokazao značajne varijacije., Prosečna proizvodnja kukuruza iznosila je oko 3,6 miliona tona, tj. bila je 2,3 puta veća u odnosu na prosečnu proizvodnju pšenice. Paritet cena pšenice i kukuruza iznosio je prosečno prosečno 1,12. Rezultatima regresionih modela utvrđen je statistički značajan uticaj prinosa i pariteta cena pšenica/kukuruz iz tekuće godine na površine pod pšenicom i kukuruzom u narednoj godini.

Ključne reči: pšenica, kukuruz, setvena struktura, prinos, paritet cena, Republika Srbija

INTRODUCTION

The subject of research in this paper is the areas of the most important types of cereals in the Republic of Serbia, wheat and corn. We started from the assumption that the size of the sown area of wheat and corn, depends on the achieved yields, as well as on the price elements from the previous year. Since wheat and corn are mutually competitive with sowing (as the most important cereals), we started from the assumption that the parity of the selling prices of wheat/corn from the previous year has an effect on the sown area in the current year. The aim of the research was to statistically examine the aforementioned dependence of wheat and corn areas on realized yields and price parity from the previous year. That is, to quantify that dependence and statistical significance. Knowledge of the legality of the mentioned influences is important for predicting the areas of grain crops, both for the needs of planning the sowing of individual producers, as well as macroeconomic planning at the level of Serbia. Regression models are widely used in agriculture, whether it is normal time series or the so-called "moved" series, in which the influence of characteristics from the previous year on the dependent variable in the following year is observed (Mutavdžić et al. 2006, Mutavdžić et al. 2016, Mutavdžić et al. 2022, Novković et al. 2006, Novković et al. 2020, Novković et al. 2021, Tekić et al. 2021).

Regression models were used to determine dependence, where the independent variables were yield and price parity from the previous year, and the dependent variable was the sown area from the current year.

MATERIAL AND METHOD

The research is based on the use of secondary data with the application of standard quantitative methods. The observed features were processed with standard statistical instruments:

1. Average value of the phenomenon-arithmetic mean $(\overline{X})$
2. Extreme values of the phenomenon (min and max)
3. Coefficient of variation (CV)
4. Annual rate of change in % (r)

The rate of change was calculated directly from the absolute data of the analyzed series using the following expression:

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

Where: r- annual rate of change, G- constant relative change of occurrence, Yn- absolute value of the last member of the series, Y1- absolute value of the first member of the series and n- total number of members of the series.

In order to determine the influence of price parity and yield from the current year on the sown area of the following year, a linear regression model was applied. Regression analysis is a method used to identify relationships between observed variables. Additional analysis determines the direction and strength of the identified relationships.

The general form of the regression model is:

$$\hat{Y}_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_p X_{pi} + \varepsilon_i$$

Where Y_i represents the value of the dependent variable, X_{1i} ,X_{2i} , …,X_{pi} represent the values of the independent variables, and β_1, β_2, …, β_p represent the regression parameters. The parameter β_0 shows the average initial level of the dependent variable, while ε_i is a random error (Novaković, 2019). To test the statistical significance of the defined model as a whole, a regression variance analysis was performed.

The data used in the analysis were taken from the website of the Statistical Office of the Republic of Serbia. The data refer to areas, yields and total production of wheat and corn, as well as wheat/corn price parity in the Republic of Serbia, for the period 2011-2021. The STATISTICA program package was used for statistical data processing.

RESULTS AND DISCUSSION

Basic indicators of descriptive statistics for wheat and corn production characteristics, as well as corn/wheat price parity, are shown in the following table (Table 1).

Descriptive statistics analysis of observed cereal crop production parameters showed that the average area under corn was almost 400 thousand hectares or 2/3 larger than the area under wheat. Average annual corn production was about 3.6 million tons or 2.3 times higher than wheat production. Wheat had a higher average price than corn, the average wheat/corn parity was 1.12. The areas of both crops have a slight tendency to decrease, almost to stagnation. In the case of wheat, the annual production shows a growth rate, caused by the increase in yield. In the case of corn, the yield rate is slightly negative, and thus the annual production shows a tendency to decrease, at a rate that is less than one percent per year. The price parity shows a slight tendency to fall, that is, to improve in favor of corn. Both crops have very stable areas, which is indicated by low coefficients of variation of around (4%). The yield of wheat is also relatively stable, while the yield of corn shows significant variations.

In the next part of the research, based on the presented variables, the first regression model was formed to determine the dependence of the next year's sowing structure on the current year's wheat yield and the current year's wheat/corn price parity. For the calculated model, the significance of the model as a whole was first tested using regression variance analysis (Table 2). The initial hypothesis in the case of testing the regression model as a whole has the following form: $H_0: \beta_1 = \beta_2 = \cdots = \beta_k = 0$, if this hypothesis is accepted, it is concluded that the model is not statistically significant.

Based on the results of the regression variance analysis for the observed model, it can be concluded that the null hypothesis is rejected and that the formed model is statistically significant ($p<0.05$). The estimated parameters of the regression model of the dependence of the sowing structure of wheat in the following year on the yield and price parity from the current year are presented in the following table (Table 3).

The estimated regression model has the following form:

$$\hat{Y} = 679.552{,}61 + 31.027{,}39X_1 + 56.643{,}82X_2$$

The obtained regression coefficients (b) indicate a high statistical significance of the regression parameter that profiles the independent variables representing the yield of wheat from the current year and the price parity of wheat/corn from the current year. The direction of action of both variables is positive, and it can be concluded that with an increase in yield by one t/ha, the area under wheat increases by 31,027.39 ha in the next sowing, and that with an increase in price parity by one, the area under wheat increases by 56,643.82 ha.

Table 1. Descriptive statistics of selected wheat and corn production parameters and wheat/corn price parity

Crop	Production parameter	Average	Minimum	Maximum	Coefficient of variation (%)	Rate of change (%)
Wheat	Area (ha)	600,080.00	556,115.00	643,083.00	4.15	-0.34
	Total production (t)	2,678,754.00	2,275,623.00	3,442,308.00	12.64	2.81
	Yield(t/ha)	4.45	3.90	5.70	11.77	3.10
Corn	Area (ha)	995,858.00	901,753.00	1,057,877.00	4.17	-0.16
	Total production (t)	6,262,470.00	3,532,602.00	7,951,583.00	23.55	-0.72
	Yield (t/ha)	6.28	3.60	7.90	23.77	-0.49
Price parity	Wheat/corn	1.12	0.90	1.55	13.72	-0.32

Table 2. Regression variance analysis for the first regression model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	235.413.682.500,21	2	11.770.6841.200,61	200,45	0,000
	Residual	3.836.268.577,51	8	479.533.572,19		
	Total	6.190.405.402,73	10			

Table 3. Regression model of wheat sowing structure dependence

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	679.552,61	117.857,71		15,766	0.000
	Yield	31.027,39	16.821,64	0,533	21,844	0.002
	Parity	56.643,82	82.650,65	0,198	15.685	0.045

In the next part of the research, a second regression model was formed, where the corn area in the following year is the dependent variable, and the corn yield from the current year and the wheat/corn price parity from the current year are the independent variables. As in the case of the first model, first, the significance of the model as a whole was tested using the regression variance analysis (Table 4).

Table 4. Regression variance analysis for the second regression model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	358.046.854,900,31	2	179.023.427.400,65	111,051	0,003
	Residual	13.628.643.085,42	8	1.703.580.385,68		
	Total	17.209.111.634,73	10			

Based on the results of the regression variance analysis for the observed model, it can be concluded that the null hypothesis is rejected and that the formed model is statistically significant (p>0.05).

The estimated parameters of the second regression model are presented in the following table (Table 5).

Table 5. Regression model of corn sowing structure dependence

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	868.158,67	166.218,94		5.223	0,001
	Yield	12.936,28	8.925,46	0,470	13,449	0,005
	Parity	-48.808,31	154.530,97	-0,102	-12,316	0,007

The estimated regression model has the following form:

$\hat{Y} = 868.158{,}67 + 12.936{,}28X_1 - 48.808{,}31X_2$

The obtained regression coefficients (b) indicate a high statistical significance of the regression parameter that profiles the independent variables representing the current year's corn yield and the current year's wheat/corn price parity. The direction of action of the first observed independent variable is positive, and it can be concluded that with an increase in yield by one t/ha, an increase in the area under corn by 12,936.28 ha in the next sowing can be expected, while the direction of action of the second independent variable is the price parity of wheat/ corn is negative, and it can be expected that with an increase in price parity by one, the area under corn will decrease by 48,808.31 ha.

CONCLUSION

The results of the research in this paper showed:

- Significant positive impact of wheat yield and wheat/corn price parity from the current year, on the area under wheat in the following year. An increase in yield by one ton per hectare increases the area under wheat in the following year in Serbia by about 30 thousand hectares, and an increase in parity by one increases the area under wheat by 56.6 thousand hectares in the following year.

- Significant positive impact of corn yield and negative impact of wheat/corn price parity from the current year, on the area under corn in the next year. An increase in the yield of corn by one ton per hectare increases its area in the following year in Serbia by about 13 thousand hectares, and an increase in parity by one decreases the area of corn by 48.8 thousand hectares in the following year.

- These researches are important when planning the sowing of grain, both from the perspective of the macroeconomic aspect, as well as from the perspective of the producers themselves.

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