PREDICTIONS OF TOMATO PRODUCTION CHARACTERISTICS IN SERBIA

Gora MILJANOVIC[1*], Beba MUTAVDZIC[2], Nebojsa NOVKOVIC[2], Miljojko JANOSEVIC[3]

[1]High Medical Scholl, Belgrade, Serbia
[2]University of Novi Sad, Faculty of Agriculture, Serbia
[3]University of Defends, Army Academy, Belgrade, Serbia
*Corresponding author: bebam@polj.uns.ac.rs

Abstract

In this work are analyzed tomato production characteristics in Serbia, in the period 1991-2010 year. Production characteristics are: harvested area, yield and year production. Based on that time series, by using the ARIMA model, the production characteristics of tomato were predict until year 2015. Results of analysis are show that the average harvested area of tomato in Serbia in observed period was 20.277 ha, and shows a slight tendency of increasing (change rate 0.29 %). Yield of tomato was 8.6 t/ha, and shows a very slight tendency of decreasing (change rate -0.28 %). Year production was very stable, with average of 174.000 tons, and change rate of 0.01%. The results of prediction show that area of tomato slightly decreasing in predicted period, and in 2015 will be about 20.000 hectares, what is les than 1.200 ha than maximal area in observed period. The yield of tomato also slightly deceasing in predicted period, and in 2015 will be about 8.8 t/ha. Total production of tomato also decreasing in observed period, and in 2015 will be on the level of 177.000 tons.

Key words: *tomato, production, analysis, prediction, Serbia*

Introduction

About forecasting, by using quantitative methods and models in agriculture, write many authors. Jankovic et. al. (2007) predicts development in cattle breading in Serbia. Mutavdzic et al. (2007), in their papers made analysis and predict parity of maze/pig prices. Novkovic et al. (2006) made analisis, and predict parity of wheat/mineral fertilizers prices. Tendency of vegetables development were observ by: Mutavdzic et al. (2011, 2011a), Novkovic et al. (2011, 2012, 2012a, 2013) and Ostojic et al. (2012). Mutavdzic et al. (2013), Novkovic et al. (2009, 2013a) predict tendency in vegetables and potato production.
Subject of this paper is tomato production characteristic in Serbia. The main objective is to predict harvested area, yield and year production of tomato in Serbia, until 2015.
For the prediction will be used ARIMA model, based on data of tomato production in Serbia in the period 1991-2010.

Materials and methods

In this research the quantitative methods are implemented. Observed period of analyzed data is 1991-2010. The data source is official publication of the Institute of Statistics of Serbia, and their databases. Analysis is base for prediction in the future. The goal of this research is to predict tomato production parameters (harvested area, yields, production) in Serbia for the period 2011-15. On the base of observed time-series, there were formulated and tested models of time-series, which are lately used for prediction time-series in the future. Verification of prediction models are done by statistical tests and criteria for review models. For prediction are used ARMA $_{(p,q)}$ models. Program Statistica 10 are used for creating the models, and predict values.

Result and discussion

Basic characteristics of tomato production in Serbia in period 1991-2010 are presented in Table 1. Harvested area, yield, and year production were very stable, which proves low coefficients of variation, and changing rate.

Table 1. Basic characteristics of tomato production in Serbia, in the period 1991-2010

Parameters	Average value	Interval of variation		Coefficient of variation (%)	Change rate (%)
		Minimum	Maximum		
Harvested area (ha)	20,277	18,425	21.209	4.16	0.29
Year Production (t)	174,390	140.725	199.184	9.68	0.01
Yield (t/ha)	8.60	7.39	9,90	9.05	-0.28

For analysis of harvested area under tomato, review model (Table 2) shows that for harvested area in present year, significant influence have harvested area from the previous year.

Table 2. Parameters of model for prediction harvested area under tomato

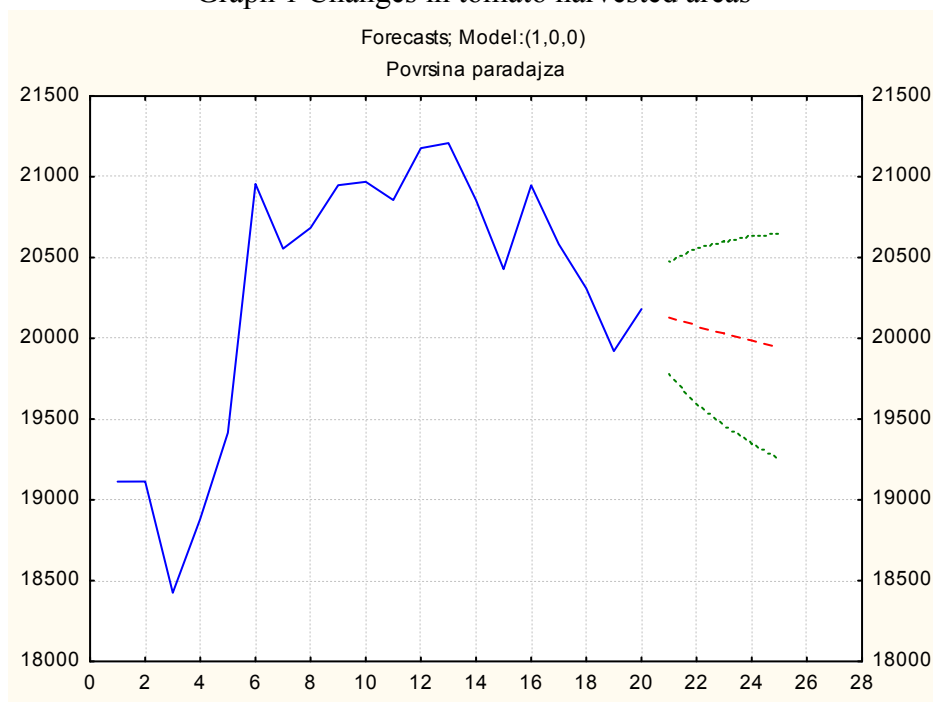|	Input: POVPARAD (povrcesrbija) Transformations: none Model:(1,0,0) MS Residual= 2564E2					
Paramet.	Param.	Asympt. Std.Err.	Asympt. t(18)	p	Lower 95% Conf	Upper 95% Conf
Constant	19234,27	603,5248	31,86990	0,000000	17966,32	20502,23
p(1)	0,94	0,1060	8,90852	0,000000	0,72	1,17

Contrary from the analysed, in predicted period harvested area under tomato shows insignificant decreasing. That prove predicted areas in the period 2011-15 (Table 3). In last year of predicted period (2015) tomato area is about 20,000 ha, what is lower for 1,200 ha than maximal value in analyzed period.

Table 3 Prediction of areas under tomato (2011-15)

	Forecasts; Model:(1,0,0) Seasonal lag: 12 (povrcesrbija Input: POVPARAD Start of origin: 1 End of origin: 20			
CaseNo.	Forecast	Lower 50,0000%	Upper 50,0000%	Std.Err.
21	20128,25	19779,69	20476,82	506,365
22	20078,44	19599,04	20557,85	696,444
23	20031,41	19460,07	20602,75	829,998
24	19987,00	19344,68	20629,31	933,100
25	19945,06	19245,51	20644,61	1016,249

Tendencies in changing of tomato areas are presented on Graph 1.

Graph 2. Changes in tomato year production
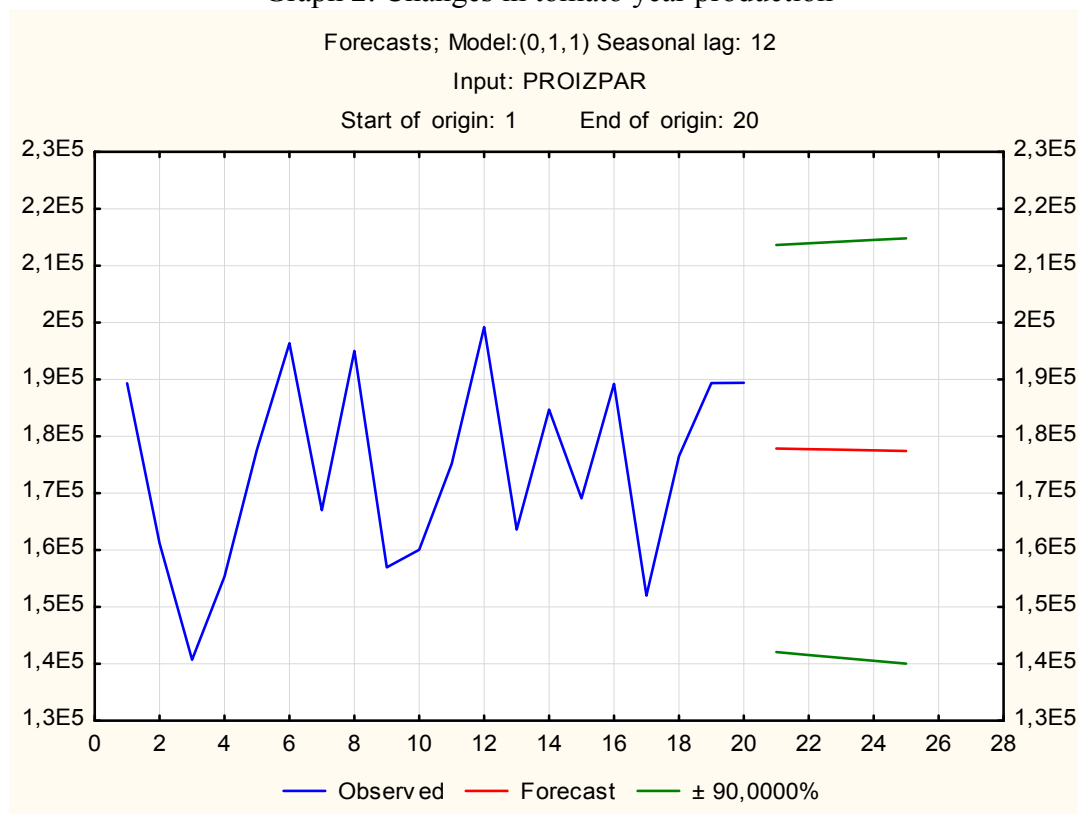
Model for tomato yield prediction (Table 6), show that yield in present year have significant influence yield from previous year.

Table 6. Parameters of model for prediction of tomato yield

Paramet.	Param.	Asympt. Std.Err.	Asympt. t(17)	p	Lower 95% Conf	Upper 95% Conf
Input: PRINPARA (povrcesrbija) Transformations: D(1) Model:(0,1,1) MS Residual= 9794E2						
Constant	-21,8648	83,05874	-0,263245	0,795526	-197,103	153,3738
q(1)	0,6866	0,20322	3,378782	0,003568	0,258	1,1154

Values of tomato yield (Table 7), based of model for prediction shows that, yields, like area and production of tomato have tendencies of insignificant decreasing. Predicted yield of tomato, at the end of predicted period (2015) will be 8.8 t/ha.

Table 7 Prediction of yields under tomato (2011-15)

CaseNo.	Forecast	Lower 90,0000%	Upper 90,0000%	Std.Err.
Forecasts; Model:(0,1,1) Seasonal lag: 12 (povrcesrbija Input: PRINPARA Start of origin: 1 End of origin: 20				
21	8866,030	7144,449	10587,61	989,638
22	8844,165	7040,043	10648,29	1037,086
23	8822,300	6939,252	10705,35	1082,456
24	8800,435	6841,638	10759,23	1126,000
25	8778,570	6746,847	10810,29	1167,921

Conclusions

Results of tomato analysis in the period 1991-2010 in Serbia show that the average harvested area of tomato was 20.277 ha, and shows a slight tendency of increasing (change rate 0.29 %); Yield of tomato was 8.6 t/ha, and shows a very slight tendency of decreasing (change rate -0.28 %). Year production was very stable, with average of 174.000 tons, and change rate of 0.01%.

The results of prediction show:

- Area of tomato slightly decreasing in predicted period, and in 2015 will be about 20.000 hectares, what is les than 1.200 ha than maximal area in observed period;
- The yield of tomato slightly deceasing in predicted period, and in 2015 will be about 8.8 t/ha;
- Total production of tomato also decreasing in observed period, and in 2015 will be on the level
  of 177.000 tons.

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