10.7251/AGSY13031276M

PREDICTION OF VEGETABLE PRODUCTION IN REPUBLIC OF SRPSKA

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Abstract

The subject of this paper is the prediction of production parameters area, yield and total production for major vegetables in the Republic of Srpska: potato, paprika and tomato. The basis for the assessment of adequate model for the prediction has being derived from the data on production parameters of these vegetables during the period of 1996 - 2011 year. On the basis of estimated models, prediction values of the observed parameters have being derived for the year 2016.

The prediction is based on modern quantitative methods, specifically the method of time series analysis and the appropriate ARIMA models. The choice of the form of model is the result of qualitative analysis and statistical criteria.

Prediction of the production area shows that there will be changes in the production structure of the observed vegetables in the Republic of Srpska in 2016. year. Areas of potatoes will be reduced by about 600 ha, while the production area for paprika and tomatoes is going to be increased by the same amount. Yields of potatoes and paprika, in the analysed period are characterized by stability, while smaller fluctuations are indicated for yields of tomatoes. Tendencies that characterize the area and yield of crops observed, have a direct influence on their production. Prediction for potato production shows that the total volume of production in 2016 will be lower by about 2,000 tons compared to 2011, what is the result primarily of the reduction of the area under potatoes. Predicted tomato production will increase by about 500 tons.

The results of prediction can be used as a basis for qualitative analysis of the production and development of vegetable growing in the Republic of Srpska, as well as for general policy and strategy planning for vegetable production in the future, and design of agricultural policy measures to encourage the development of production, consumption, processing and export of vegetables observed.

Keywords: vegetable production, forecasting, Republic of Srpska

Introduction

Vegetable production is one of the most intensive types of plant production, which is confirmed by the yields per unit area and realized economic effects. Bearing in mind the economic benefits of this type of agriculture production for the farmers and for agriculture sector in general, the main directions of its future development are optimal use of available production capacity, increase in production volume and changes in production structure.

The subject of this research is the prediction of the production characteristics of major types of vegetables in the Republic of Srpska: area, yield and total production. The analysis included the following vegetables: potatoes, paprika and tomatos. The analysis covered the period from 1996 till 2011. The aim of the research is to show the importance of vegetable production in Republic of Srpska. The results of the forecasting should serve as a basis for

quantitative analysis of vegetable production in the Republic of Srpska. Also, the results of the research could help in defining the concept of agricultural policy measures for stimulating the development of production, consumption, processing and exporting of types of the vegetables observed in the paper.

Materials and methods

In the market economy, successful production depends on monitoring, analysis and prediction of the results and most important factors that influence these results. Situation analysis and prediction are based on a series of data arranged at equal intervals, and the analysis of time series of observed phenomena. Data used in this paper are related to the production results such as area, yield and total production of potatoes, paprika and tomatoes in the Republic of srpska in the period from 1996 till 2011.
The paper objective to forcast production upon the analysis of the observed time series. This process is managed by the data available from the past on the basis of which time-series models are formulated and evaluated, which were then used to predict future values of series. The verification of the rated models is performed and for this purpose statistical tests and criteria were used which verify the validity of assessed models.
The analysis and prediction method applied in this paper was based on the class autoregressive model of mobile environments (ARIMA (p, q)). The assumption of this models is that the current value (member) series depends on the values of the previous members of the series, the current values of the random process and the previous values of the random process of white noise. For the time series in which the effect of trend, cyclical and seasonal components can be observed, the application of these models includes prior removal of their influence. To eliminate the influence of systematic components of the time series, the operator of differentiation is used. Using the difference of the first order removes the linear trend, other differences removes the quadratic trend, and k - differences eliminates the influence of trend polynomial k - th degree. Trough the differentiation process, we get the class of ARIMA (p, d, q) model, where the values of the original series replace certain differences. Class ARIMA model can be used for analysis and modeling of a number of stationary and non-stationary processes.

Research results and discussion

Analysis of the situation

Since the beginning of the analysed period (1996), the area under potatoes in the Republic of Srpska shows the trend of constant decrease (-0.33%). In average, during the analyzed period, this vegetable crop was represented by an area of about 17,400 ha (Table 1). The volume of production, as opposed to the production area, is characterized by the tendency of increase (1.87%) but, at the same time, the production volume shows a large oscillations (Cv = 14.72%).

Table 1 Basic indicators of potato production in the Republic of Srpska, 1996-2011

Production parameters	Average value	Variation interval		Coefficient of variation (%)	Rate changes (%)
		Minimum	Maximum		
Harvested area (ha)	17,370	14,539	21,408	12.51	-0.33
Production (t)	169,304	122,933	208,447	14.72	1.87
Yield (t/ha)	9.9	6.4	12.3	18.64	2.19

The average yield of potatoe had a tendency of increase in the analyzed period, by the average rate of 2.19% per annum, as well as the variability, expressed by the value of the coefficient of variation of 18.64%.

The forcast model (Table 2) shows that the potato production area in the current period is under a significant influence of the size of this area from the previous period. Predicted values (Table 3) confirm the perceived tendency of decrease. Between 2012 and 2016, the area under potato will be constantly reduced to a level of about 14,500 hectares.

Table 2. The parameters of the model for prediction of the potato production area

	Input: POVKRO (rspovrce) Transformations: ln(x) Model:(1,0,0) MS Residual= 6,2102					
Paramet.	Param.	Asympt. Std.Err.	Asympt. t(15)	p	Lower 95% Conf	Upper 95% Conf
p(1)	0,99964	0,06819	14,6587	0,00000	0,85428	1,14499

Table 3. Prediction of potato area (2012-2016)

	Forecasts; Model:(1,0,0) Seasonal lag: 12 (rspovrce) Input: POVKRO Start of origin: 1 End of origin: 16		
CaseNo.	Forecast	Lower 50,0000%	Upper 50,0000%
17	14685,15	2623,100	82213,3
18	14634,50	1281,288	167151,1
19	14584,04	739,027	287803,3
20	14533,78	464,578	454671,7
21	14483,70	308,576	679824,2

Model for the analysis and prediction of potato production in the Republic of Srpska (Table 4) shows that the production volume of the current year is significantly influenced by the production volume from the previous year. Tendency of the increase in potato production in the analyzed period will unfortunately not be characteristic of the period of predictions (Table 5). Predicted values indicate that the potato production will decline within forecast period, and at the end of the prediction period will be at the level of about 172,700 tons.

Table 4. The parameters of the model for prediction of the production volume

	Input: PROIZKRO (rspovrce) Transformations: ln(x) Model:(1,0,0) MS Residual= 9,3222					
Paramet.	Param.	Asympt. Std.Err.	Asympt. t(15)	p	Lower 95% Conf	Upper 95% Conf
p(1)	0,99977	0,06785	14,7349	0,00000	0,85515	1,14439

Table 5. Prediction of potato production volume (2012-2016)

	Forecasts; Model:(1,0,0) Seasonal lag: 12 (rspovrce) Input: PROIZKRO Start of origin: 1 End of origin: 16		
CaseNo.	Forecast	Lower 50,0000%	Upper 50,0000%
17	174557,4	21154,81	1440348
18	174083,2	8805,11	3441747
19	173610,4	4492,19	6709548
20	173139,0	2546,57	11771556
21	172669,0	1544,25	19306901

The forcast model for prediction of the potato yield, (Table 6) shows that the yield for the curent year is significantly conditioned by the yield of this crop in the previous year. Expected values for the period 2012-2016 year (Table 7) show that the yield of potato will be reduced. The average yield by the end of the forecast period will be at the level of about 10 tons per hectare.

Table 6. The parameters of the model for prediction of the potato yield

	Input: PRINKROM (Republika srpska povrce) Transformations: none Model:(1,0,0) MS Residual= 2.6728					
Paramet.	Param.	Asympt. Std.Err.	Asympt. t(14)	p	Lower 95% Conf	Upper 95% Conf
Constant	9.84143	0.83762	11.7492	0.00000	8.04491	11.6379
p(1)	0.53851	0.25094	2.1460	0.04988	0.00030	1.0767

Table 7. Prediction of potato yield (2012-2016)

	Forecasts; Model:(1,0,0) Seasonal lag: 12 (Republika srpska povrce) Input: PRINKROM Start of origin: 1 End of origin: 16			
CaseNo.	Forecast	Lower 90.0000%	Upper 90.0000%	Std.Err.
17	10.95001	8.070526	13.82950	1.634855
18	10.43843	7.167955	13.70890	1.856841
19	10.16293	6.787530	13.53833	1.916413
20	10.01457	6.609344	13.41979	1.933346
21	9.93467	6.520849	13.34849	1.938229

Paprika is, in the analyzed period, grown on average 2,383 hectares, with a decreasing trend of the total production area (Table 8). The volume of production and yield of paprika are showing a significant variability in the analyzed period, but they also have significant increasing trend.

Table 8. Basic indicators of paprika poduction in Republic of Srpska, from 1996 to 2011

Production parameters	Average value	Interval of variation		Coefficient of variation (%)	changes rate (%)
		Minimum	Maximum		
Harvested area (ha)	2,383	2,079	2,602	6.41	-0.91
Total production (t)	22,446	13,071	28,806	20.62	3.19
Yield (t/ha)	9.5	5.8	12.2	22.10	4.15

Model for predicting the total production area for paprika, assessed on the basis of the changing values for production area in the analyzed period (Table 9), shows that the share of paprika in production structure is significantly affected by the share of this crop in the previous period

Table 9. The parameters of the model for prediction of the paprika production area

Paramet.	Input: POVPAP (rspovrce) Transformations: none Model:(1,0,0) MS Residual= 14622, Param.	Asympt. Std.Err.	Asympt. t(14)	p	Lower 95% Conf	Upper 95% Conf
Constant	2354,46	89,1088	26,4223	0,00000	2163,34	2545,57
p(1)	0,742	0,2353	3,1515	0,00706	0,237	1,247

Table 10. Prediction of production area for paprika (2012-2016)

CaseNo.	Forecasts; Model:(1,0,0) Seasonal lag: 12 (rspovrce) Input: POVPAP Start of origin: 1 End of origin: 16 Forecast	Lower 50,0000%	Upper 50,0000%	Std.Err.
17	2150,106	2066,377	2233,835	120,9227
18	2202,857	2098,603	2307,111	150,5653
19	2241,991	2128,007	2355,975	164,6178
20	2271,023	2152,023	2390,023	171,8623
21	2292,561	2170,888	2414,234	175,7220

Predicted values of the production area for paprika by 2016. are characterized by a slight increase to a level of almost 2,300 hectares (Table 10). Although we can notice that, by the end of the forecast period, there is a tendency of a slight increase in size of production area, it will not reach even average, nor the maximum of the recorded area in the analyzed period.

Table 11. The parameters of the model for prediction of the production volume for paprika

Paramet.	Input: PROIZPAP (rspovrce) Transformations: ln(x) Model:(2,0,0) MS Residual= 6,6773 Param.	Asympt. Std.Err.	Asympt. t(14)	p	Lower 95% Conf	Upper 95% Conf
p(1)	1,03544	0,27720	3,73535	0,00221	0,44090	1,62998
p(2)	-0,03569	0,28719	-0,12428	0,90285	-0,65167	0,58028

Table 12. Prediction of the production volume for paprika (2012-2016)

CaseNo.	Forecasts; Model:(2,0,0) Seasonal lag: 12 (rspovrce) Input: PROIZPAP Start of origin: 1 End of origin: 16 Forecast	Lower 50,0000%	Upper 50,0000%
17	24031,27	4015,299	143825
18	23968,43	1824,170	314930
19	23906,60	1000,377	571310
20	23844,98	604,056	941275
21	23783,54	387,669	1459122

The volume of production shows a significant increase throughout the analyzed time period and this at a rate of 4.15% per annum. The forcast model (Table 12) shows that the level of production volume for paprika in a current year is significantly influenced by the production from the previous two years.

Production of paprika in the future period has a tendency to decrease, what is indicated by the predicted value at the end of 2016 (Table 12). It is expected that the production of paprika at that time will be at a level of almost 23,800 tons.

The yield for paprika in the analyzed period shows some oscillations, and in some years there has been sensible decline in yields, but significant increase allready in the next year. The forcast model for predicting the yield for paprika in the future (Table 13) indicates that the yield of the current year is under a significant impact of production results from the previous period.

Table 13. The parameters of the model for prediction of the yield for paprika

Paramet.	Input: PRINPAP (rspovrce) Transformations: ln(x) Model:(1,0,0) MS Residual= ,28599 Param.	Asympt. Std.Err.	Asympt. t(15)	p	Lower 95% Conf	Upper 95% Conf
p(1)	0,99975	0,06443	15,5161	0,00000	0,86241	1,13708

Table 14. Prediction of the paprika yield (2012-2016)

CaseNo.	Forecasts; Model:(1,0,0) Seasonal lag: 12 (rspovrce) Input: PRINPAP Start of origin: 1 End of origin: 16 Forecast	Lower 50,0000%	Upper 50,0000%
17	11,59296	8,010574	16,77742
18	11,58593	6,869643	19,54013
19	11,57890	6,105044	21,96069
20	11,57188	5,526646	24,22960
21	11,56487	5,062449	26,41926

Anticipated yield values for the period 2012-2016 (Table 14) show that the yield for paprika is expected to decline by about 100 kg per hectare each year and will reach the level of about 11.6 tonnes per hectare.

Basic indicators for tomato production in the Republic of Srpska in the analyzed period are given in Table 15.

Table 15. Basic indicators for tomato production in the Republic of Srpska, 1996-2011

Production parameters	Average value	Interval of variation		Coefficient of variation (%)	changes rate (%)
		Minimum	Maximum		
Harvested area (ha)	2,094	1,851	2,439	7.77	-0.25
Total production (t)	19,502	12,012	26,620	21.85	1.25
Yield (t/ha)	9.4	5.6	13.6	23.09	1.48

In a period from 1996 to 2011, tomato has grown on an average area of 2,100 hectares. During this period, the production area was relatively stable (CV = 7.77%), and from year to year showed a tendency to decrease at a rate of - 0.25%. The volume of tomato production in this period showed significant variability with a tendency of increase at a rate of 1.25% per annum and the average value stood at 19,500 tonnes. Tomato yield is characterized by the tendency to increase at a rate of 1.48% per annum.

For the analysis of the production area under tomato, the forcast model was developed (Table 16) that indicates that the production area of the current year is significantly inluenced by the production area for tomato in the last year.

Table 16. The parameters of the model for prediction of the production area for tomato

Paramet.	Input: POVPAR (rspovrce) Transformations: none Model:(1,0,0) MS Residual= 18109, Param.	Asympt. Std.Err.	Asympt. t(14)	p	Lower 95% Conf	Upper 95% Conf
Constant	2014,55	137,029	14,7015	0,00000	1720,65	2308,45
p(1)	0,720	0,2944	2,44627	0,02824	0,089	1,352

Table 17. Prediction of the production area for tomato (2012-2016)

CaseNo.	Forecasts; Model:(1,0,0) Seasonal lag: 12 (rspovrce) Input: POVPAR Start of origin: 1 End of origin: 16 Forecast	Lower 50,0000%	Upper 50,0000%	Std.Err.
17	1896,766	1803,589	1989,944	134,5684
18	1929,726	1814,900	2044,552	165,8335
19	1953,462	1828,881	2078,044	179,9221
20	1970,557	1841,206	2099,908	186,8111
21	1982,868	1851,111	2114,625	190,2860

Unlike the analyzed period, in the forcast period, it will come to a slight increase in the production area for tomatoes. This is confirmed by the values of production area forcasted for a period 2012-2016 (Table 17). In the last year of the forcast period, tomato will be grown at the area of about 2,000 acres.

The forcast model for predicting tomato production (Table 18) shows that the production of the current year is significantly influenced by the production level of the previous year. The estimated value of the production volume (Table 19) shows a tendency of increase from year

to year within forcast period. The expected production in 2016 will be at a level of about 18,000 tons.

Table 18. The parameters of the model for prediction of the production volume for tomato

Paramet.	Input: PROIZPAR (rspovrce) Transformations: D(1) Model:(1,1,0) MS Residual= 3033E4 Param.	Asympt. Std.Err.	Asympt. t(13)	p	Lower 95% Conf	Upper 95% Conf
Constant	27,9514	912,158	0,0306	0,97602	-1942,6	1998,55
p(1)	-0,6585	0,2183	-3,0175	0,00989	-1,13	-0,187

Table 19. Prediction of the production volume for tomato (2012-2016)

CaseNo.	Forecasts; Model:(1,1,0) Seasonal lag: 12 (rspovrce) Input: PROIZPAR Start of origin: 1 End of origin: 16 Forecast	Lower 50,0000%	Upper 50,0000%	Std.Err.
17	17529,70	13708,35	21351,05	5507,621
18	18369,20	14331,28	22407,12	5819,762
19	17862,67	12854,78	22870,56	7217,756
20	18242,63	12896,80	23588,45	7704,811
21	18038,75	12098,80	23978,70	8561,114

Model for the analysis and prediction of tomato yield (Table 20) shows that the yield for the current year is significantly depending on the yield achieved in the previous year.
Tomato yield values predicted on the basis of assessed models (Table 21) show that the yield is going to decrease or increase, alternating from one period to onother and at the end of 2016 will be at a level of 10 tons per hectare.

Table 20. The parameters of the model for prediction of the tomato yield

Paramet.	Input: PRINPAR (rspovrce) Transformations: ln(x),D(1) Model:(1,1,0) MS Residual= ,07879 Param.	Asympt. Std.Err.	Asympt. t(13)	p	Lower 95% Conf	Upper 95% Conf
Constant	0,00756	0,04759	0,1589	0,87616	-0,0952	0,11038
p(1)	-0,6190	0,2283	-2,7108	0,01782	-1,1123	-0,1257

Table 21. Prediction of the tomato yield (2012-2016)

CaseNo.	Forecasts; Model:(1,1,0) Seasonal lag: 12 (rspovrce) Input: PRINPAR Start of origin: 1 End of origin: 16 Forecast	Lower 50,0000%	Upper 50,0000%
17	9,45444	7,781367	11,48724
18	9,97038	8,094727	12,28066
19	9,76665	7,560101	12,61722
20	10,01417	7,599739	13,19566
21	9,98172	7,354042	13,54828

Conclusions

Prediction of vegetable production area indicates that there will be changes in the production structure of the studied crops in the Republic of Srpska by the year 2016. Area under potatoes will be reduced for about 300 ha, while the production area for paprika an tomatoes will increase for the same amount. The yields for potatoes and paprika, are characterized by stability in the period of forcast, while small oscillations are indicated in the case of the yield values for tomato. Tendencies that characterize the production areas and yields of the observed vegetable crops are directly reflected on their production volume. Predicted production volume for potato at the end of 2016 will be lower by about 2,000 tons compared to 2011, and this is primarily caused by reduced production area. The production volume for tomato is predicted to increase by about 500 tonnes at the end of the prediction period.
Predicted results can serve as a basis for quantitative analysis of the vegetable production in the Republic of Srpska, as well as for defining agricultural policy concept and strategy measures for vegetable production in the future to stimulate the development of production, consumption, processing and exporting of the vegetable crops observed in this paper.

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