University of Banjaluka, Faculty of Agriculture

Agro-knowledge Journal

Forecasting Trends in the Apple Production in Bosnia and Herzegovina until 2020

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Abstract

The aim of the paper is to make a forecast of apple production in Bosnia and Herzegovina until 2020. The subject of the research is analysis of production trends in the apple production, namely the number of trees, the total quantity of production and the yield per tree. The analysis covers historical data in the period from 2006 to 2015, and forecasting parameters for the next five years. To interpret the status of apple production, statistical indicators such as arithmetic mean value, interval variation, coefficient of variation, and rate of change have been used. Furthermore, statistical trends have been used for the projections of development of apple production. In order to eliminate the influence of extreme weather conditions in 2012 and 2014, corrections were made of the achieved yield data by calculating the average based on the previous and the following year. Afterwards, the projections have been made in two scenarios, both original and corrected data.

Key words: apple, forecasting, number of trees, quantity of production, average yield

Introduction

The production of apples, aside from the plum production, is the most important fruit type on the territory of Bosnia and Herzegovina. That is why there is no place in this area that does not deal with apple production, which suggests that there are very favourable climatic and soil conditions, as well as high presence of farmers who can export the product to European countries.

Of all fruit varieties, the greatest increase in production has been recorded in apple production. Due to the significance and coverage by apple trees, the basic apple production parameters have been calculated and forecasted, i.e. the number of trees, the average yield and the total production. The aim of the study is to make a forecast of apple production by 2020 with statistical trends. There have been a number of analyses and explanations in agriculture relating to historical data of certain phenomena based on the trend method (e.g. Vukadinović et al., 2017).

A step further in these analyses is projection of movement of the same phenomena in the future, based on the analysis of time series. In their researches, Kranjac et al. (2017) forecasted the sown areas and the total sunflower production based on statistical trends. Novković et al. (2013) forecasted the production of potatoes in the Republic of Srpska. A similar study was carried out by Washim (2011) in Pakistan in the period of 1989-2009, determining the surface trends, the total production and the average yields for 8 different types of fruit. Milić et al. (2016) analysed the trends in fruit production in Vojvodina in the 2006-2015 period and, among other things, noted that the areas and the volume of apple production tend to increase. Hennen and Benning (2009) applied the Trend Impact Analysis to predict future fruit consumption, and, in addition, they included expert opinions on the impact of individual factors on trends.

Material and Methods

This paper analyses the forecast potential of the number of trees, the average yield per tree and the total apple production. Data published by the Agency for Statistics of Bosnia and Herzegovina in 2006-2015 were used for the analysis. To assess the given production parameters, the measures of descriptive statistics were used: arithmetic mean, variation interval (minimum and maximum), coefficient of variation and rate of change, as the ratio of the absolute values of the last and the first member of the time series. Statistical forecasts were used to predict the parameters until 2020. To determine the trend model, a comparison of the coefficient of determination was performed. The coefficient of determination was determined for the linear, parabolic and exponential trends for all the production parameters mentioned above. It is defined as the ratio of the sum of squares of deviation of the interpreted trend model and the sum of the squares of total deviations (Lovrić et al., 2006).

The most appropriate model is the trend with the highest degree of representativeness (R^2).

R^2=Interpreted Variance / Total Variance

Total Variance $\qquad \sigma^2 = \sum (Y - \overline{Y})^2 / N$

Interpreted Variance $\qquad \sigma_p^2 = \sum (Y_C - \overline{Y})^2 / N$

Graphical representations were used to represent the selected trend line and the movement of a given parameter. The 2020 forecast was done by using a formula for the trend model for absolute data for the corresponding year. The obtained results of the forecast are tabulated.

Results and Discussion

The results of the research were presented, first, through the analysis of historical data on the movement of apple production in the period 2006-2015, and then, by forecasting the same production in the 2016-2020 period.

Analysis of the state of production

Table 1 shows the parameters of apple production, namely the number of trees, the total production in tons, and the average yield in kilograms per tree. The analysis covered 2006-2015. From year to year, the number of trees shows a constant increase, which is also shown by a positive rate of change of 6.79%.

Tab. 1. Basic indicators of apple production in B&H in 2006-2015
Основни показатељи производње јабуке у БиХ у периоду 2006-2015.

Production parameters	Average	Interval of variation		Coefficient of variation (%)	Rate of change (%)
		Minimum	Maximum		
Number of trees	5,168,118	3,711,458	6,704,417	20.9	6.79
Total production (tons)	73,463	51,946	91,471	17.2	5.17
Yield per tree (kg/tree)	14.4	12.4	15.7	7	-1.58

Source: Authors' calculation.

The production of apples is characterized by high variability (coefficient of variation 17.2%). It ranges from 51,946 to 91,471 tonnes.

Because of the increase in the number of trees, the total production in tonnes is growing and the growth rate for this parameter was 5.17%.

The average yield per tree was 14.4 kg. It is characterized by relatively low instability (coefficient of variation 7%), the largest was in the first year of analysis. Since the maximum yield was in the first year, this ultimately reflected the negative growth rate of -1.58%. Because of the negative rate of yield growth, the total production in the relative amount grew slower than the number of trees.

Production forecast for 2020

Tab. 2: The coefficient of determination of the characteristics observed in the previous period

*Коефицијент детерминације за посматрана обиљежја у претходном периоду*

Function of trend	Number of trees	Total production	Yield per tree
Linear function	0.987	0.899	0.267
Square (parabolic)	0.991	0.900	0.271
Exponential	0.992	0.859	0.238

Source: Authors' calculation.

The coefficient of determination shows high representation in reference with the number of trees and the total production, while the average yield shows little adaptability in all trend models. The forecast projection of the number of trees is best shown by the exponential trend, since it has the highest determination coefficient ($R^2 = 0,992$ or 99.2%), while the total production and the average yield will be forecasted by the parabolic trend.

The graph shows the movement of the number of trees in the observed period. Then, comparison of the degree of adaptability of the linear, exponential and parabolic trend was made to determine the corresponding function of the trend. The best adaptability was shown by the exponential trend (the degree of adaptability is 99.26%). Using the exponential trend, it is estimated that the number of apple trees in 2020 would be around 9.8 million, if the factors that acted in the observed period would continue to operate approximately with the same intensity and direction without significantly affecting new factors. The impact of weather conditions, droughts in 2012 and the hail in 2014 resulted in very low yields per tree, which ultimately reflected on the relative low production of those years.

Because of this, the projection was made in two variants, with original and corrected data.
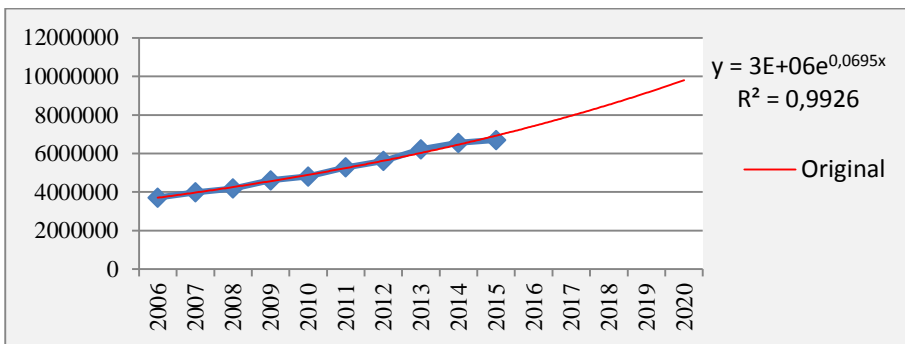
Graph 1. Projection of the number of apple trees in B&H for 2016-2020
Пројекција броја стабала јабуке у БиХ за период 2016-2020

The forecast which uses the original data comes to illogical results for total production and yield per tree in the years of forecast. The total production in 2020 would be at the level of 86 000 t, which is 5 000 t lower compared to 2015, although the number of trees in 2020 would be higher by 3.1 million compared to 2015. Such a low production is due to low yield per tree, which in 2020 would be lower by almost 5 kg of average yield for the period in respect of which the forecast is done.
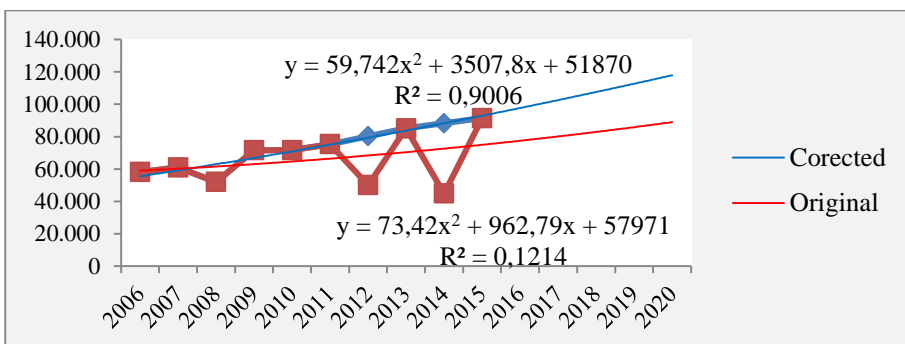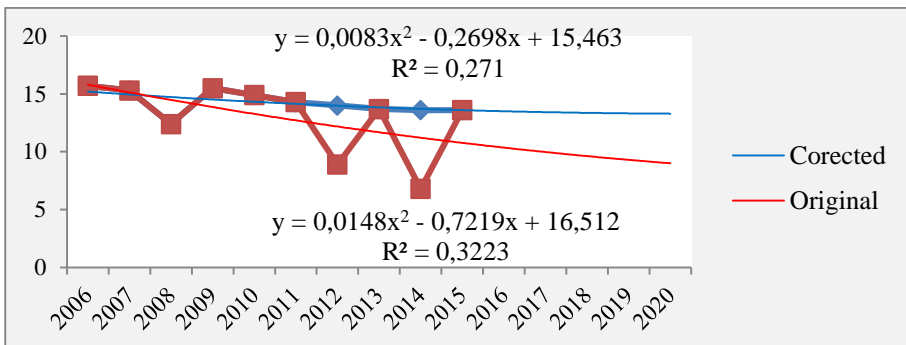

Graph 2. Projection of total apple production in B&H for 2016-2020
Пројекција укупне производње јабуке у БиХ за период 2016-2020. године

Starting from the assumption that catastrophic weather conditions will not happen again during the projected period, data on the total production and the average yield for two extremely "bad" years were simulated.

The quantities for 2012 were calculated as the average of the total production realized in 2011 and 2013, respectively for 2014 as the average of production from 2013 and 2015.

The dispersion diagram of total tonnage production shows a better adaptability in parabolic than linear trend. The reason behind this is high oscillation in the first three years of the analysis, especially in 2008, when production had the lowest value in the observed period. By forecasting this trend, we expect that the production in 2020 will reach the level of 113 thousand tons.

$y = 0{,}0083x^2 - 0{,}2698x + 15{,}463$
$R^2 = 0{,}271$

$y = 0{,}0148x^2 - 0{,}7219x + 16{,}512$
$R^2 = 0{,}3223$

— Corected
— Original

Graph 3. Projection of average yield of apples per tree in B&H for 2016-2020
Пројекција просјечног приноса јабуке по стаблу у БиХ за период 2016-2020

As with the analysis of the forecast of total production, and yield analysis per tree, the best representation was shown by the parabolic trend. The expected yield in 2020 will be 13.3 kg per tree, which is lower than the average of the analysed period. The fall in yield per tree is also the result of the intensification of fruit production, which is reflected in the planting of many trees per unit area and using the "at your fingertips" system.

Tab. 3. Historical data in apple production in B&H in 2006-2015
Историјски подаци у производњи јабуке у БиХ у периоду 2006-2015

Year	Number of trees	Total production (tons)	Yield per tree (kg)
2006	3,711,458	58,109	15.7
2007	3,982,774	60,969	15.3
2008	4,189,878	51,946	12.4
2009	4,610,256	71,507	15.5
2010	4,812,681	71,659	14.9
2011	5,284,959	75,334	14.3
2012	5,610,522	80,226	14.0
2013	6,223,340	85,117	13.7
2014	6,550,893	88,294	13,6
2015	6,704,417	91,471	13.6

Source: Agency for statistics (Announcement)

The table shows the movement of apple production parameters in the years that were the subject of forecasting. The number of trees in all years has been steadily growing. The total production and average yield are presented in two variants (original and corrected data). The trend-method forecast based on the original data that leads to the total production will be relatively low, with growth in the years of forecasting.

By 2020 it will be below the level accomplished in 2015. The average yield will fall significantly below the average. At the same time, the forecast was based on more optimistic assumptions, i.e. the elimination of the impact of extremely bad years on the movement of total production and average yield.

Tab. 4. Forecast of apple production in B&H for 2006-2020
Предвиђање производње јабуке у БиХ у периоду 2006-2020

Year	Number of trees	Original data		Corrected data	
		Total production (tons)	Yield per tree (kg)	Total production (tons)	Yield per tree (kg)
2016	7,424,532	74,940	10.7	92,914	13.5
2017	7,962,150	77,445	10.3	97,675	13.5
2018	8,543,428	80,096	9.9	102,556	13.4
2019	9,126,184	82,894	9.5	107,557	13.4
2020	9,791,592	85,839	9.2	112,677	13.3

Source: Authors' calculation.

It also showed a slight decrease in the average yield in the years of forecasting, which is offset by an increase in the number of trees, which can lead to constant increase in total production.

Conclusion

The analysis of the data on apple production in B&H in the 2006-2015 period indicates that the number of trees has been constantly increasing, and that total production and the average yield have varied.

Based on historical data and the application of the trend method, the forecast of the number of trees, the total production and the average yield until 2020 was made. Projections using the selected forecast model show that the number of trees will have a constant tendency of increase and in 2020 around 9.8 million apple trees could be expected, i.e. increase of 46% compared to 2015. The forecast of total production and yield per tree based on original data leads to illogical conclusions (the production in 2020 would be lower than production in 2015 by about 6,000 tons, and the average yield in the last year's forecast would be lower by about 4 kg from the average yield).

The forecasts based on corrected data (replacing original data with recalculated data for two of 10 analysed years) show that the total apple production in 2020 should increase for about 44,000 tonnes from the average in the analysed period, which is, first of all, the result of an increase of number of trees. The yield per tree drops at a rate of 1.58% and in 2020 a fall in the average yield could be expected up to 13.3 kg per tree.

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Предвиђање трендова у производњи јабуке у Босни и Херцеговини до 2020. године

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Сажетак

Циљ истраживања је био да предвиди производњу јабука до 2020. године у Босни и Херцеговини. Предмет истраживања је анализа кретања производних параметара производње јабуке, односно броја стабала, укупне производње и приноса по стаблу. Анализа се базирала на историјским подацима у временском периоду 2006-2015, а пројекција одабраних параметара је извршена за наредних 5 година. За интерпретацију стања производње јабуке кориштене су статистички показатељи: аритметичка средина, интервал варијације, коефицијент варијације, стопе промјене, а за предвиђање развоја производње јабуке кориштен је метод статистичких трендова. Да би отклонили утицај екстремних временских неприлика у 2012 и 2014. години извршена је корекција података о оствареном приносу израчунавањем просјека на бази претходне и наредне године и урађена пројекција у двије варијанте, са оригиналним и коригованим подацима. Резултати предвиђања говоре да ће број стабала имати константан раст и да ће у 2020. години достићи ниво од око 9,8 милиона стабала. Принос по стаблу ће имати незнатан пад и очекује се да ће у 2020. години принос по стаблу бити око 13,3 kg, а укупна производња јабуке око 113 хиљада тона. У годинама које су биле предмет предвиђања укупна производња ће имати константан раст, али по мањој стопи у односу на број стабала из разлога благог пада просјечног приноса по стаблу.

Кључне ријечи: Босна и Херцеговина, јабука, предвиђање, број стабала, обим производње, просјечан принос.