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Turkish Journal of Forecasting

Journal Homepage: tjforecast.xyz

Forecasting of Apricot Production of Turkey by Using Box-Jenkins Method

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A R T I C L E I N F O

Article history:

Received 15 Nov 2018
Revision 6 Jan 2019
Accepted 8 Jan 2019
Available online 9 Jan 2019

Keywords:
Apricot production
Time Series Analysis
ARIMA
Box-Jenkins
Turkey

A B S T R A C T

Turkey is the first largest apricot producer in the world. In 2016, Turkey was responsible for 9,21% of world apricot production with 730 thousand tons. Turkey also generated 11,31% of world apricot exports in 2016. The main aim of this research was to forecast apricot production of Turkey for the period of 2017-2022. The data of this study was obtained from the database of the Food and Agriculture Organization and the time series covered the period of 1961-2016. Box-Jenkins Model was used to forecast apricot production. In the study, it was determined that the time series were not stationary and the series became stationary after the first difference was taken. Moving Average Model ARIMA (2, 1, 1) was determined as the most appropriate model for the stationary data type. The research results show that apricot production quantities of Turkey in 2017 was forecasted as minimum 383.206 tons, maximum 920.409 tons and, average 651.808 tons. However, Turkey's the apricot production amount in 2022 was forecasted as minimum 271.734 tons, maximum 1.193.113 tones and average 732.423 tons. Considering the increase in demand, it is thought that apricot production will not be sufficient for the country. To protect the current leading position of the country, it is recommended that the government should give enough support to increase apricot production in Turkey.

1. Introduction

In 2016, 149 countries in the world produced 7.920.552 tons apricot. Turkey is the biggest producer and one of the main exporter countries in the world. Turkey produced 730 thousand tons apricot and took a share of 9.21% in the world's total apricot production. It was followed by Uzbekistan (8,35%), Iran (3,86%), Algeria (3,24%), Italy (2,99%) and Pakistan (2,24%) (Table 1).

In 2016, apricot was produced in 1.238.052 decare area in Turkey. Malatya accounted for 52,13% of Turkey's apricot production. Other important apricot producer provinces were Mersin (14,28%), Elazig (8,06%), Kahramanmaras (4,54%), Igdir (4,29%), Antalya (2,9%), Isparta (1,99%) and Kayseri (1,49%), respectively [2]. Turkey also accounted for 11,31% of world's total apricot exports [1].

During the period of 1961-2016, apricot plantation areas had increased significantly from 42.010 ha to 123.805 ha. There had been an upward trend in the production of apricot until the nineties. The yield trend had seen downward in 1990s and then there had been again upward trend since 2000s. There had been very high fluctuation in apricot yield especially since the second half of 1990s. Thanks to increases in apricot plantation areas and yields, Turkey's

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apricot production amount had seen an upward trend too. In the examined period, apricot production increased from 114.000 tonnes to 700.000 tonnes. Fluctuated yield also caused extreme amounts in apricot production especially since 2000s (Figure 1).

Table 1. Apricot production in the world [1]

Country	**Production (tonnes)**	**%**
Turkey	730.000	9,21
Uzbekistan	662.123	8,35
Islamic Republic of Iran	306.115	3,86
Algeria	256.771	3,24
Italy	237.021	2,99
Pakistan	177.658	2,24
Others	5.098.960	70,08
Total	7.920.552	100,0

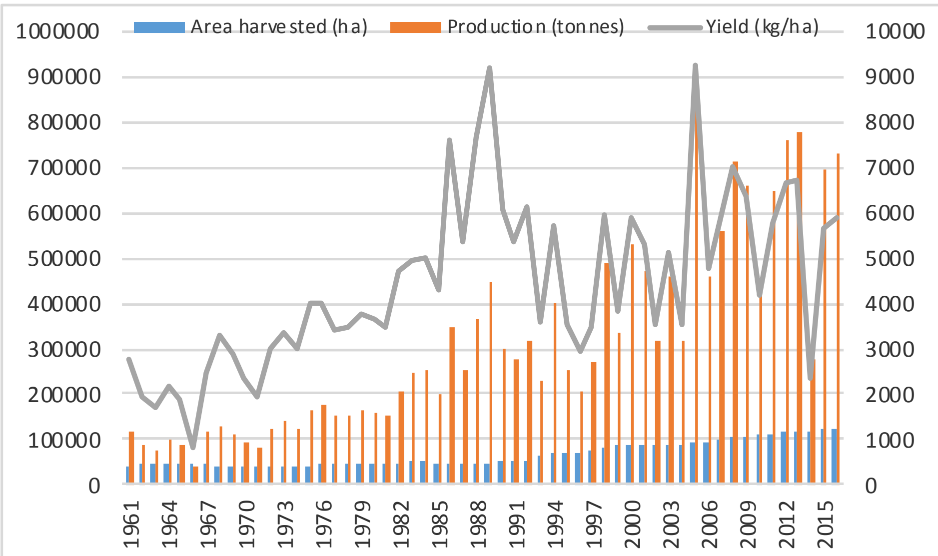

Figure 1. Apricot plantation area, yield and production in Turkey [1]

Apricots are consumed in the world as fresh and dried and are used as raw materials in many sectors such as fruit juice, snack, jam, cosmetic industry and pharmaceutical industry. An important part of the apricot produced in Turkey are evaluated by dried. Therefore, forecasting of apricot production in Turkey is very important for producers, consumers, exporters and industrialists because of directing agricultural policy.

Compared apricot yield of country that leader apricot production in the world, Italy's apricot yield is the highest according to other from 2007 to 2016. Although Turkey is the leader country in the world for production, yield of apricot is very low to other country especially in recent years. In 2016, Turkey's apricot yield is 5.896 kg/ha. Average yield of apricot is the highest in Italy with 12.242, is the lowest in Turkey with 5.641 kg/ha between 2007 and 2016. Other country's average yield of Uzbekistan, Pakistan, Iran and Algeria are 9.632, 6.703, 6.650, 5.715 kg/ha, respectively [1].

In the literature on apricot, most of studies related to apricot are economic analysis and marketing [3-4-5]. And also, sustainability of apricot farms [6], effect exchange rate on dried apricot export in Turkey [7], measuring the technical and economic efficiencies of the dry apricot farms in Turkey [8]. Some research has been done about demand forecasting of apricot [9], econometric analysis of apricot supply, export and demand in Turkey [10] but there was not previous published study reviewing the forecasting of apricot production in Turkey.

The main aim of this research was to forecast apricot production of Turkey for the period of 2017-2022. The reminder of this article is structured as follows. Section 2 explains the material and method for this research. Section 3 presents the results and discussions. Finally, section 4 concludes.

2. Material and Methods

The material of this study was consist of Turkey's apricot production data (ton) derived from the Food and Agriculture Organization (FAO) for the period of 1961-2016.

Time series is a set of observations that are ordered sequentially through time [11]. To forecast the future values of variables based on the time series, some methods have been developed and reported in the literature. Perhaps, one of the powerful methods among these methods is the Box Jenkins approach [12], which is capable to analyse any set of observations. The Box Jenkins approach, also known as ARIMA, is the integration of auto-regressive model and moving average model. ARIMA models allow each variable to be explained by its own past or lagged values, and stochastic error terms [13]. ARIMA (p, d ,q) models have three parameters: p is the order of the autoregressive model, d is the degree of difference, and q is the order of the moving average model.

Two types of the Box Jenkins models are autoregressive models and moving average models. The model given in equation (1), called the moving average order of q, is as follows:

$$Z_t=\delta+a_t-\theta_1 a_{t-1}--\theta_2 a_{t-2}-\ldots--\theta_q a_{t-q} \quad (1)$$

Here, a_t; a_{t-1}; a_{t-2}; … ; a_{t-q} are random shocks that are assumed to have been randomly selected from a normal distribution that has zero mean and constant variance. Furthermore, the random shocks are assumed to be statistically independent. θ_1; θ_2; θ_3; …; θ_q are unknown parameters that must be estimated from sample data. δ is a constant term and it can be proved that for the moving average model of order q, $\delta=\mu$.

The model given in equation (2) is called the autoregressive order of p;

$$Z_t=\delta+\varnothing_1 Z_{t-1}+ \varnothing_2 Z_{t-2}+\ldots+ \varnothing_p Z_{t-p}+a_t \quad (2)$$

Here a_t are random shocks $\varnothing_1, \varnothing_2, \varnothing_3, \ldots, \varnothing_p$ are unknown parameters that must be estimated from sample data. δ is a constant term and it can be proved that for the autoregressive model of order p, $\delta=\mu(1- \varnothing_1- \varnothing_2-\ldots- \varnothing_p)$.

The mixed type of these two models called ARIMA (p,q) is given equal (3) as fallows:

$$Z_t=\delta+\varnothing_1 Z_{t-1}+ \varnothing_2 Z_{t-2}+\ldots+ \varnothing_p Z_{t-p}+a_t-\theta_1 a_{t-1}--\theta_2 a_{t-2}-\ldots--\theta_q a_{t-q} \quad (3)$$

Here $a_t, a_{t-1}, a_{t-2}, \ldots, a_{t-q}$ are random shocks that are assumed to have been randomly selected from a normal distribution that has mean zero and constant variance; $\theta_1, \theta_2, \theta_3, \ldots, \theta_q$ and $\varnothing_1, \varnothing_2, \varnothing_3, \ldots, \varnothing_p$ are unknown parameters of a moving average model and autoregressive model that must be estimated from sample data. Constant term $\delta=\mu(1- \varnothing_1- \varnothing_2-\ldots- \varnothing_p)$ [13-14].

In order to realize the ARIMA model based on Eg (3), a plot of the 56-year apricot production data was done using Minitab program. After the plot, the data was investigated for stationarity, using the plots of the autocorrelation functions (ACF) and Partial autocorrelation functions (PACF). The apricot production series derived from the plots were found to be stationary, hence differencing was used to achieve stationarity. Stochastic regularity was achieved after the first differencing.

3. Results and Discussion

Autocorrelation (ACF) and partial autocorrelation (PACF) graphs were plotted to determine whether the series is a stationary (Figure 2). In the ACF graph, it was determined that the lag exceed the confidence limit, namely they are stationary. In this case, the first difference was applied to the series and the series was tried to be cleared from the trend. When the ACF and PACF graphs of the series with the first difference are examined, it is seen that the series has become stationary (Figure 3). The model is determined by looking at the ACF and PACF graphs of the stationary series. Accordingly, while the ACF graph decreased rapidly, it was determined that the PACF graph decreased more slowly. So, the most suitable model is moving average model. The degree of the model, because of relationship of the first two lag, is significant in PACF graph, p=2, relationship of the first lag is significant in ACF graph, q=1 and it was determined that the most suitable model is ARMA (2,1). Since the first difference of the series is stationary, d=1. The model used in this case is ARIMA (2,1,1). The results of the analysis for the appropriate model using Minitab program in estimating of the parameters are presented in Table 2. Accordingly, it was determined that the estimation of parameter is significant ($p<0.05$).

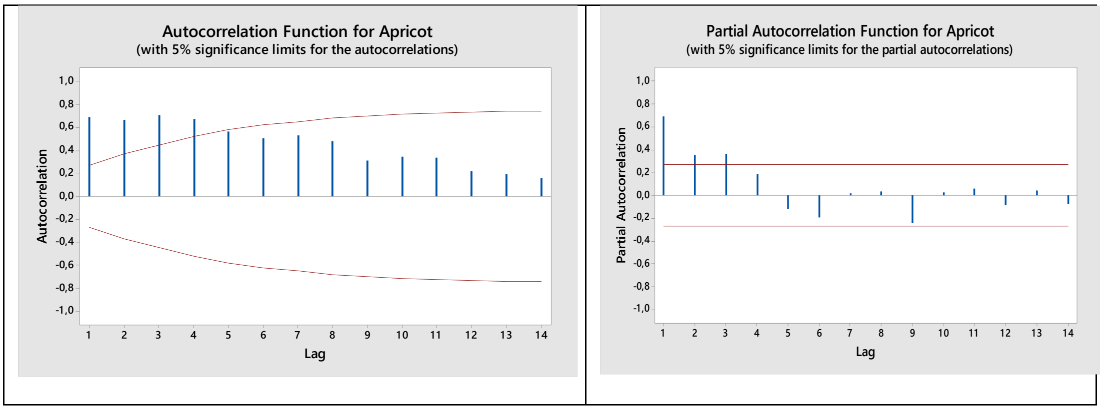

Figure 2. The autocorrelation (ACF) and partial autocorrelation (PACF) plots of apricot production

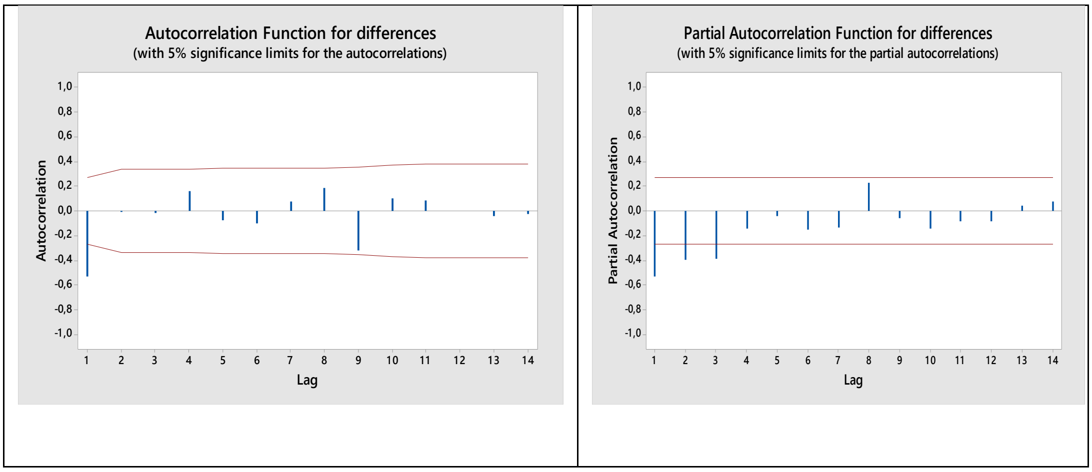

Figure 3. Autocorrelation (ACF) and partial autocorrelation (PACF) plots the series of taken the first difference

Unit root tests were applied to obtain better results for apricot production time series. Whether the changes in the apricot production amount or not have a unit root by Dickey and Fuller (1981)'s Generalized Dickey-Fuller (ADF) test [16]. According to the Dickey-Fuller test statistics, ADF absolute value (8.721356) for the first difference of the series is higher than the absolute value of the critical values at 1%, 5%, 10% significance level (Table 3). This means that series is stationary.

Table 2. Final estimates of parameters

Parameters	Coefficient	SE Coefficient	T-Value	P-Value
AR 1	-1,485	0,233	-6,36	0,000
AR 2	-0,556	0,157	-3,54	0,001
MA 1	-0,935	0,245	-3,82	0,000

Table 3. Results of Dickey-Fuller Test

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.721356	0.0000
Test critical values:	1% level	-3.562669	
	5% level	-2.918778	
	10% level	-2.597285	

*MacKinnon (1996) one-sided p-values.

Using ARIMA (2,1,1) model, Turkey's apricot production forecast results for the years of 2017-2022 are given in Table 4. Research results show that according to the base year of 2016, while the apricot production amounts of Turkey would decrease in 2017, 2019 and 2021, the production would increase in 2018, 2020, and 2022. It is estimated that the production increases in the years of 2020 and 2022 would be less compared to 2018. It was forecasted that the apricot production quantity of Turkey in 2017 would be minimum 383.206 tonnes, maximum 920.409 tonnes and average 651.808 tonnes. According to the TURKSTAT, apricot production is 985 thousand tonnes in 2017 (TURKSAT, 2018). However, the apricot production quantity of Turkey in 2022 would be minimum 271.734 tonnes, maximum 1.193.113 and average 732.423 tonnes. 2011 apricot demand will be between 169-208 tons was estimated by Karahan (2011) [9] with artificial neural network method. Dellal and Koç (2003) [10] determined that elasticities of long-run supply of apricots were computed as 0,72.

Table 4. Apricot production forecasts from 2017 to 2022 by ARIMA (2,1,1)

Year	Forecast	Lower	Upper
2017	651808	383206	920409
2018	749073	454497	1043649
2019	648121	297145	999098
2020	743938	354309	1133566
2021	657798	235665	1079931
2022	732423	271734	1193113

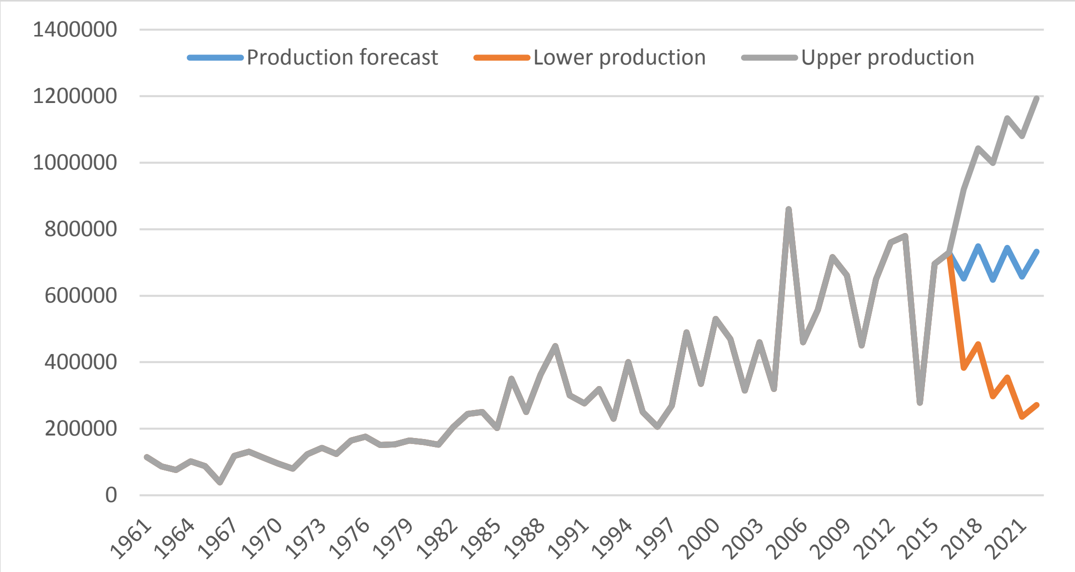

Figure 4. Apricot production forecast (tonnes)

4. Conclusion

In this research, Turkey's apricot production amounts were estimated for the period of 2017-2022 using the model of ARIMA(2,1,1) and R-square of this equation is 0,84. The model estimation concluded that there would be fluctuations in apricot productions in the following years. Thus, it is estimated that apricot production would be higher in 2018, 2020 and 2022 compared to the rest years. Considering the increase in apricot demand, it can be stated that the amount of apricot production in Turkey could not be sufficient for the country needs. To protect the current leading position of the country, it is recommended that the government should give enough support to increase apricot production in Turkey.

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