GAZİOSMANPAŞA BİLİMSEL ARAŞTIRMA DERGİSİ (GBAD)
Gaziosmanpasa Journal of Scientific Research
ISSN: 2146-8168
http://dergipark.gov.tr/gbad
Araştırma Makalesi/Research Article

Cilt/Volume : 10
Sayı/Number: 3
Yıl/Year: 2021
Sayfa/Pages: 16-22

***Alınış tarihi (Received)*:** 04.06.2021
***Kabul tarihi (Accepted)*:** 06.09.2021

Forecasting Fig Production in Turkey by Arima Model

Figen ÇUKUR[1*], Tayfun ÇUKUR[2]

[1]*Muğla Sıtkı Koçman Üniversitesi, Milas MYO, Yönetim ve Organizasyon Bölümü, Muğla, Türkiye*
[2]*Muğla Sıtkı Koçman Üniversitesi, Milas MYO, Pazarlama ve Reklamcılık Bölümü, Muğla, Türkiye*

**Sorumlu yazar: figencukur@hotmail.com*

ABSTRACT: Many fruits are grown in Turkey thanks to ecological conditions and climate eligibiliy. Turkey ranks first in the world in the production and export of many fruits. Turkey ranks second in fig production and first in fig exports in the world. The purpose of the current study is to forecast the amount of fig production for the period of 2020-2025. To this end, fig production in Turkey in this period was forecasted with Box Jenkins ARIMA model by using fig production data covering the period between 1990 and 2019. According to the results of the study, fig production in Turkey was estimated to be 314659.4 tons in 2025. The increasing trend in fig production can be evaluated as a positive development in terms of both domestic demand and export.

Keywords– time series, fig, forecast, ARIMA

Türkiye İncir Üretiminin Arima Modeli İle Tahmini

ÖZET: Ekolojik koşulların ve iklimin uygunluğu sayesinde Türkiye'de birçok meyve türü yetiştirilmektedir. Türkiye birçok meyve türünün üretimi ve ihracatında dünyada ilk sıralarda yer almaktadır. Türkiye dünyada incir üretiminde ikinci, incir ihracatında ise ilk sırada yer almaktadır. Bu araştırmanın amacı, 2020-2025 dönemine ait incir üretim miktarlarının tahmin edilmesidir. Bunun için 1990-2019 dönemlerini kapsayan incir üretim verileri kullanılarak, Box Jenkins ARIMA modeli ile Türkiye'de incir üretimi tahmin edilmiştir. Araştırama sonuçlarına göre Türkiye'de 2025 yılında incir üretimi 314659.4 ton tahmin edilmiştir. İncir üretimindeki artış eğilimi gerek yurt içi talep gerekse dışsatım açısından olumlu bir gelişme olarak değerlendirilebilir.

Anahtar kelimeler– Zaman serileri, incir, tahmin, ARIMA

1. Introduction

Fig is a type of fruit that has been grown in the parts of the United States of America, South America, Australia and Southwest Asia which have similar climatic conditions with all the Mediterranean countries. As can be seen, it is grown in subtropical and tropical regions and partly in temperate climates (Isin et al., 2004). Turkey is one of the countries with high fruit production potential in the world. Turkey is the gene centre of many fruit varieties and 80 out of 140 fruit varieties grown worldwide are grown in Turkey (Isin et al., 2007).

In 2019, figs were produced in 289818 hectares of land in the world. Turkey ranks second in the area of fig production after Morocco (21.73%) with 52116 hectares (17.98%). Turkey is followed by Algeria (13.61%), Egypt (10.93%) and Iran (6.44%). In the same year, 1,315,588 tons of figs were produced in the world. Turkey ranks first in production with 310000 tons (23.56%). Turkey is followed by Egypt (17.13%), Morocco (11.67%), Iran (9.91%) and Algeria (8.67%) (FAO, 2021). Turkey's fig export in 2019 is 85037 tons and it ranks first in the world fig export ranking with a share of 54.95%.

Changes that will occur in the production of fresh figs in Turkey, which is the world's largest producer, will affect the world markets (Çakan, 2020). Therefore, the purpose of the current study is to forecast the amount of fig production for the period of 2020-2025. In the study, fig production in Turkey was forecasted with the ARIMA model, using the fig production data covering the period between 1990 and 2019.

2. Materials and Methods

The main material of the study was obtained from various sources of the Turkish Statistical Institute (TSI, 2021; TSI, 2014). In addition, the statistics of the Food and Agriculture Organization (FAO) and previous research on the subject were also used.

In the current study, the ARIMA model was used in the estimation of the amount of the fig production in Turkey for the years 2020-2025. A total of 30 years of data belonging to the years 1990-2019 in fig production were analysed with the ARIMA model, and the best model was tried to be determined by considering AIC (Akaike info criterion). AIC is a measure of the goodness of fit of a statistical model. AIC was regulated by limiting the rise created by the variables added to the model. In model comparisons, the model with the lowest AIC value is always preferred (Ucal, 2006). The formula of AIC is shown below.

$$AIC = -2\log(L) + 2k \quad (1)$$

Here;
L= Maximum likelihood value
k= The number of the parameters in the model

<u>ARIMA (Box-Jenkins) Method</u>

The most well-known method used in the analysis of time series is the Box-Jenkins (1976) methodology. This methodology considers whether any series under consideration is stationary and whether there is a seasonal trend (Kutlar, 2017). In general, the ARIMA (p,d,q) model is;

$$W_t = \Phi_1 W_{t-1} + \Phi_2 W_{t-2} + \ldots + e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \ldots - \theta_q e_{t-q} \quad (2)$$

This equation is the version where W_t is written instead of Y_t in the equation in the ARMA model. Here, the non-stationary Y_t process is stabilized by taking the d degree difference, resulting in the W_t process and written as $\Delta^d Y_t = W_t$ (Özer and İlkdoğan, 2013).

3. Results and Discussion

3.1. Unit Root Test for Fig Production Series

In the current study, it was first investigated whether the fig production series is stationary or not. For the control of stationarity, both the Augmented Dickey-Fuller unit root test and the correlogram graph of the series were used.

When Table 1 is examined, it is seen that the fig production series is not stationary at the level and when the first difference is taken, the series becomes stationary. When the absolute value of the Augmented Dickey-Fuller test statistic of the first differentiated fig production series is compared with the absolute values of the critical values, since the ADF test statistic value in all the three equations (intercept, intercept and trend and without intercept and trend) is greater than all of the critical values at all significance levels, the fig production series is accepted to be stationary at the first difference.

Table 1. Stationarity test results for fig production series

Augmented Dickey-Fuller Unit Root Test Results							
Fig Production		**Intercept**		**Intercept and Trend**		**Without Intercept and Trend**	
		Level	**First difference**	**Level**	**First difference**	**Level**	**First difference**
ADF Test Statistics		-2.512589	-5.682243 *	-2.669671	-5.593665 **	0.396401	-5.769123 ***
Test Critical Values	%1	-3.679322	-3.699871	-4.309824	-4.339330	-2.653401	-2.653401
	%5	-2.967767	-2.976263	-3.574244	-3.587527	-1.953858	-1.953858
	%10	-2.622989	-2.627420	-3.221728	-3.229230	-1.609571	-1.609571

*p=0.0001, **p= 0.0005, ***p=0.0000

Figure 1 shows the level and first difference autocorrelation and partial correlation graphs for fig production. The lag number is taken as 12. As can be seen in the figure, the series whose first difference was taken became stationary.

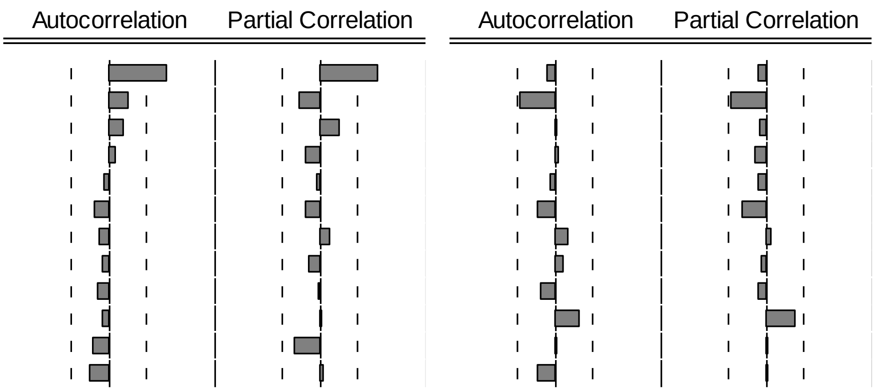

Figure 1. Level and first difference autocorrelation and partial correlation graphs for fig production

3.2. Creating a Model for Fig Production Series

By looking at the correlogram of the differentiated time series, it is determined which of the MA(q), AR(p) or ARMA (p,q) the series fits (Kutlar, 2017).

AR (p) models are generally shown as follows:

$$Yt = \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \ldots + \Phi_p Y_{t-p} + \delta + a_t \quad (3)$$

Here Y_{t-1}, Y_{t-2},….., Y_{t-p} are past observation values, Φ_1, Φ_2,… .. Φ_p are the coefficients for past observation values, δ is a constant value and a_t is an error term (Hamzaçebi ve Kutay, 2004).

MA (q) models are generally shown as follows:

$$Y_t = \mu + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - ... - \theta_q a_{t-q} \quad (4)$$

Here, a_t, a_{t-1}, a_{t-2},……,a_{t-q} denote the error terms, $\theta_1,\theta_2,\dots,\theta_q$ denote the coefficients for the error terms, μ denotes a constant which is the mean of the process (Hamzaçebi ve Kutay, 2004).

ARMA (p, q) models are generally shown as follows:

$$Yt = \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \dots + \Phi_p Y_{t-p} + \delta + a_t + \theta_1 a_{t-1} - \theta_2 a_{t-2} - \dots - \theta_q a_{t-q} \quad (5)$$

Here, $Y_{t-1}, Y_{t-2}, \dots, Y_{t-p}$ denote past observation values, Φ_1, Φ_2,….. Φ_p denote the coefficients for past observation values, δ denotes a constant value, a_t, a_{t-1}, a_{t-2},……,a_{t-q} denote error terms and θ_1, θ_2,…, θ_q denote the correlations related to error terms (Hamzaçebi ve Kutay, 2004).

In order to apply ARIMA models, certain steps must be applied. These basic steps can be summarized as (Karakaş, 2019):

-Determining whether the time series is stationary and, if not, taking a sufficient number of differences of the series to make it stationary.

-Determining the form of the model to be used, that is, revealing whether the series fits AR(p) or MA(q) models.

-Testing whether the parameters of the model obtained and used in making the estimation are statistically significant.

-In case the model is insufficient, it should be revised or in other words, alternative models should be considered and the above steps should be repeated.

If the series is not stationary at the level, ARIMA (p, d, q) is used in model estimation. Since d = 1 in the fig production series, the most suitable ARIMA model was tried to be determined. To this end, p and AIC values were examined. When the models in Table 2 for the fig production series were examined, it was determined that ARIMA (1,1,1) could be used for estimation because in this model, it was determined that the p values of the estimators are less than 0.05.

Table 2. AIC, BIC and HQ values of the alternative models

Model	AIC	BIC	HQ
(1,1,0)	23.36698	23.50843	23.41128
(2,1,0)	23.23038	23.37183	23.27468
(0,1,1)	23.35688	23.49833	23.40118
(0,1,2)	23.16560	23.30704	23.20989
(1,1,1)*	23.40440	23.59300	23.46347
(2,1,1)	23.28979	23.47838	23.34885
(1,1,2)	23.22746	23.41606	23.28663
(2,1,2)	23.23022	23.41881	23.28928

*p value for AR(1) 0.0417, p value for MA(1) 0.0010.

Figure 2 shows the correlogram of the residuals belonging to the ARIMA (1,1,1) model. It was concluded that the model could be used for estimation since the residuals remained within the confidence interval. Since there were no values exceeding the confidence interval in both the autocorrelation graph and the partial correlation graph, and all the p values were greater than 0.05, it was concluded that the errors were with white noise.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.185	-0.185	1.1021	
		2	-0.195	-0.238	2.3688	
		3	-0.074	-0.178	2.5567	0.110
		4	0.096	-0.013	2.8854	0.236
		5	-0.091	-0.140	3.1924	0.363
		6	-0.100	-0.170	3.5795	0.466
		7	0.079	-0.036	3.8335	0.574
		8	0.128	0.060	4.5351	0.605
		9	-0.171	-0.154	5.8468	0.558
		10	0.275	0.299	9.4375	0.307
		11	-0.038	0.047	9.5107	0.392
		12	-0.104	-0.015	10.083	0.433

Figure 2. Residual correlogram of the predicted model (1,1,1)

Six-year forecast values for fig production in Turkey are shown in Table 3. For 2025, Turkey's fig production was estimated to be 314659.4 tons. As can be seen, there is an increasing trend in Turkey's fig production over the years in the period of 2020-2025. This situation is clearly seen in Figure 3. This trend of increase is seen as very important for the sustainability of fig production in Turkey.

Table 3. Fig production forecast between 2020 and 2025 (tons)

Years	ARIMA (1,1,1)
2020	311800.9
2021	311680.5
2022	312941.4
2023	313209.2
2024	314191.0
2025	314659.4

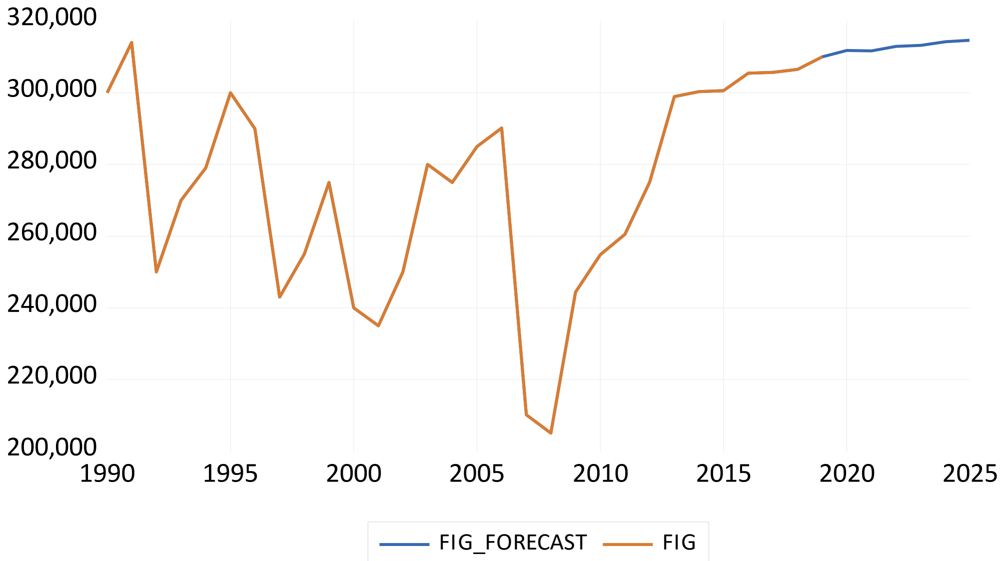

Figure 3. Actual and estimated values of fig production

In the current study conducted to forecast the amount of the fig production in Turkey in the period of 2020-2025, it was determined that the fig production in Turkey in the period examined would be in an increasing trend. In the study conducted by Çakan (2020), Turkey's fresh fig production and export estimation was made for the years 2019-2025, and it was estimated that fig production would reach 317000 tons in 2025. When the literature is examined, it is seen that there are very few studies where fig production is estimated. On the other hand, many studies have been found in which production estimates of other fruits except figs were made.

In the study conducted by Hamjah (2014) in Bangladesh, production estimates of mango, banana and guava fruits were made using ARIMA models. In the study conducted by Karabacak and Uzundumlu (2020), the amount of apricot production of the provinces that are important in apricot production in Turkey was estimated for the period of 2019-2025. In the study conducted by Bars et al. (2018), Turkey's hazelnut production was estimated for the period of 2018-2022. In the study conducted by Topuz et al. (2018), Turkey's apricot production estimation was made for the years 2017-2022. In the study conducted by Başer et al. (2018), Turkey's chestnut production and export were estimated for the period of 2017-2021. In the study conducted by Eyduran et al. (2020), Turkey's banana production was estimated for the period of 2016-2025 and it was determined that banana production would be in an increasing trend. In the study conducted by Akın and Eyduran (2017a) to estimate the strawberry harvest area and production in Turkey for 2016-2025, the estimated production for 2025 was found to be 519816 tons. In the study conducted by Akın and Eyduran (2017b) to estimate the avocado production in Turkey for the years 2016-2025, the estimated avocado production for 2025 was found to be 3156 tons. Production estimates for nuts (pistachios, walnuts, hazelnuts, almond and chestnuts) for the period of 2012-2020 were made in the research conducted by Çelik (2013).

4. Conclusion

Turkey is a country that is suitable for the cultivation of a large number of fruit varieties with its lands and climate. Turkey ranks first in the world in terms of fig production and fig export. Many families in Turkey are engaged in fig farming and their livelihoods are provided entirely with the income they earn from this product. Figs are not only consumed fresh and dried directly, but also jam, dessert, fruit pulp and food can be made from figs. In addition, figs are also used in the cosmetics industry. In other words, fig creates an important added value for the agricultural economy of the country.

Time series analysis is based on estimating the data for the next years by using the data of the previous years. In the current study, ARIMA models were used to estimate the amount of Turkey's fig production for the years 2020-2025 by using 30-year fig production data from 1990 to 2019. As a result of the analysis, it was determined that the most suitable model was ARIMA (1,1,1). According to the results of the model estimation, it was determined that there would be an increasing trend in the fig production in the examined 6-year period. This result is considered important for the sustainability of fig production. The results obtained from the current study are thought to be important for policy makers and for all the stakeholders including fig producers and fig dealers.

5. References

Akın, M., Eyduran, S.P., 2017a. Forecasting harvest area and production of strawberry using time series analyses. Journal of Agricultural Faculty of Gaziosmanpasa University 34(3):19-27.

Akın, M., Eyduran, S.P., 2017b. Predicting avocado production in Turkey for 2016–2025 period using time series analyses. Yuzuncu Yil Unıversity Journal of Agricultural Sciences 27(2):252-258.

Bars, T., Uçum, İ., Akbay, C., 2018. Turkey hazelnut production projection with ARIMA model. Kahramanmaraş Sütçü İmam University Journal of Agriculture and Nature 21(*Special* Issue):154-160.
Başer, U., Bozoğlu, M., Eroğlu, N.A.,Topuz, B.K., 2018. Forecasting chestnut production and export of Turkey using arima model. Turkish Journal of Forecasting 2(2):27-33.
Çakan, V.A., 2020. Forecasts for Turkey fresh fig production and dried fig export: Arima model approach. Journal of Tekirdag Agricultural Faculty 17(3):357-368.
Çelik, Ş., 2013. Modelling of production amount of nuts fruit by using Box-Jenkins technique. Yuzuncu Yil University Journal of Agricultural Sciences 23(1):18-30.
Eyduran, S.P., Akın, M., Eyduran, E., Çelik, Ş., Ertürk, Y.E., Ercişli, S., 2020. Forecasting banana harvest area and production in Turkey using time series analysis. Erwerbs-Obstbau. 62, 281-291.
FAOSTAT, 2021. Data. http://www.fao.org/faostat/en/#data. (16.04.2021).
Hamjah, M.A., 2014. Forecasting major fruit crops productions in Bangladesh using Box-Jenkins ARIMA model. Journal of Economics and Sustainable Development. 5(7), 137-142.
Hamzaçebi, C., Kutay, F., 2004. Electric consumption forecasting of Turkey using artificial neural networks up to year 2010. Gazi University Journal of Engineering and Architecture. 19(3), 227-233.
Isin, F., Cukur, T., Armagan, G., 2007. Factors affecting of the organic dried fig agriculture system in Turkey. Journal of Applied Sciences. 7(5), 748-754.
Isin, F., Çukur, T., Armağan, G., Çobanoğlu, F., 2004. Dünya Ticaret Örgütü Anlaşmaları Çerçevesinde Avrupa Birliği ile Gümrük Birliği ve Olası Tam Üyelik Açısından Türkiye Taze ve Kuru İncir Dış Satım Olanakları Üzerine Bir Araştırma. Aydın Güçbirliği Yayınları No.1, ISBN:975-512-873-5, Aydın.
Karabacak, T., Uzundumlu, A.S., 2020. Apricot production forecasts of the leading provinces in 2019-2025 periods. IBAD Journal of Social Sciences. (*Special* Issue), 561-573.
Karakaş, E., 2019. Türkiye'nin Otomotiv İhracat Gelirinin ARIMA modeli ile Tahmin Edilmesi. Journal of Yasar University. 14(55), 318-328.
Kutlar, A., 2017. Eviews ile Uygulamalı Zaman Serileri. Umuttepe Yayınları, 194s.
Özer, O.O., İlkdoğan, U., (2013). The world cotton price forecasting by using Box-Jenkins model. Journal of Tekirdag Agricultural Faculty. 10(2),13-20.
Topuz, BK, Bozoğlu, M, Başer, U, Eroğlu, NA, 2018. Forecasting of apricot production of Turkey by using Box-Jenkins method. Turkish Journal of Forecasting. 2(2), 20-26.
TSI (Turkish Statistical Institute), 2021. https://data.tuik.gov.tr/Kategori/GetKategori?p=tarim-111&dil=1. (07.04.2021).
TSI (Turkish Statistical Institute), 2014. Statictical Indicators 1923-2013. Publication no: 4361, Ankara.
Ucal, M.Ş., 2006. A brief survey of econometrics model selection criteria. Journal of Economics and Administrative Sciences. 7(2), 41-57.