How to cite: Uzundumlu, A. S., A. Zeynalova & S. Engindeniz, 2023. Cotton production forecasts of Azerbaijan in the 2023-2027 periods. Ege Univ. Ziraat Fak. Derg., 60 (2): 235-245, https://doi.org/10.20289/zfdergi.1296642

Research Article
(Araştırma Makalesi)

Ege Üniv. Ziraat Fak. Derg., 2023, 60 (2):235-245
https://doi.org/10.20289/zfdergi.1296642

Cotton production forecasts of Azerbaijan in the 2023-2027 periods

Azerbaycan'ın 2023-2027 dönemi pamuk üretim tahminleri

Ahmet Semih UZUNDUMLU[1]

Ayten ZEYNALOVA[2]

Sait ENGİNDENİZ[3]*

[1] Atatürk University Faculty of Agriculture Department of Agricultural Economics, 25240, Erzurum-Türkiye

[2] Azerbaijan State Agricultural University, Faculty of Agronomy, Department of General Agriculture, Genetics and Selection, Ganja-Azerbaijan

[3] Ege University, Faculty of Agriculture, Department of Agricultural Economics, 35100, Bornova/Izmir-Türkiye

* Corresponding author (Sorumlu yazar)

sait.engindeniz@ege.edu.tr

Received (Alınış): **13.05.2023** **Accepted** (Kabul Tarihi): **04.06.2023**

ABSTRACT

Objective: The objective of this study was to estimate the production area and amount for the years 2023-2027, taking into account the 1992-2022 cotton production area and production data of Azerbaijan, one of the countries that left the Union of Soviet Socialist Republics (USSR) in 1992.

Material and methods: The data used in this study were obtained from FAOSTAT and the State Statistical Committee of the Republic of Azerbaijan. The ARIMA method, which is one of the most commonly used methods for univariate time-series estimation, was used in this study.

Results: It was estimated that the production area will decrease continuously in 2023-2027, the average production area and production will be 91,942 ha and 324,156 tons, respectively, and the yield will be 3,549 kg/ha in these five years.

Conclusion: These results indicated that although the increase in productivity in Azerbaijan provides a significant increase in production, the production area should also be increased to become one of the leading countries in the world market. For this, government support needs to be increased.

Keywords: Azerbaijan, cotton growing, cotton production, forecast, ARIMA

ÖZ

Amaç: Bu araştırma, 1992 yılında Sovyet Sosyalist Cumhuriyetler Birliği'nden (SSCB) ayrılan ülkelerden biri olan Azerbaycan'ın 1992-2022 pamuk üretim alanı ve üretim verilerini dikkate alarak 2023-2027 yılları için üretim alanı ve miktarını tahmin etmeyi amaçlamaktadır.

Materyal ve Yöntem: Bu araştırmada kullanılan veriler FAOSTAT ve Azerbaycan Cumhuriyeti Devlet İstatistik Komitesinden temin edilmiştir. Araştırmada, tek değişkenli zaman serisi tahmini için en yaygın kullanılan yöntemlerden biri olan ARIMA yöntemi kullanılmıştır.

Araştırma Bulguları: 2023-2027 yıllarında üretim alanının sürekli bir düşüş yaşayacağı, ortalama üretim alanı ve üretimin sırasıyla 91.942 ha ve 324.156 ton olacağı, verimin ise ortalama 3.549 kg/ha olacağı tahmin edilmektedir.

Sonuç: Bu sonuçlar göstermektedir ki, Azerbaycan'da verimlilik artışı üretimde önemli bir artış sağlamakla birlikte, dünya pazarında lider ülkelerden biri olabilmek için üretim alanının da artırılması gerekmektedir. Bunun için destekler arttırılmalıdır.

Anahtar sözcükler: Azerbaycan, pamuk yetiştiriciliği, pamuk üretimi, tahmin, ARIMA

INTRODUCTION

Cotton is an important and strategic crop since it makes a significant contribution to the country's economy and its added value. In terms of processing, it is the raw material of the gin industry, the textile industry with its fiber, the oil and feed industry with its core, and the paper industry with its linter (Türkekul & Kantur, 2021).

In 1961-1991, according to the 31-year production area average, 33.40 million hectares of land was allocated to cotton production worldwide and 22.95% of this land was in India, 15.09% in China, 14.04% in the USA, 9.56% is in Brazil, 8.69% in the USSR and 6.02% in Pakistan. While the cotton production areas of Azerbaijan in 1992 constituted 8.04% of the cotton production areas of the USSR in 1961-1992, the cotton production areas of Azerbaijan in 1961-1992 period constituted approximately 0.70% of the cotton production areas of the World. In addition, according to the average of the 30-year production area in 1992-2021, 32.91 million hectares of land was allocated to cotton production in the world and 30.77% of this land was in India, 14.15% in China, 13.73% in the USA, 8.57% in Pakistan, 4.18% in Uzbekistan, and 3.26% in Brazil. During the same period, the cotton production areas of Azerbaijan, which ranked 34th in terms of cotton production area, constituted 0.31% of the world's cotton production areas. In this sense, the cotton production area of Azerbaijan has decreased by 50% in the world share (FAOSTAT, 2023).

In 1961-1991, an average of 41.13 million tons of cotton was produced in the world and 20.73% of the production was made in China, 18.25% in the USSR, 17.76% in the USA, 9.40% in India, 5.75% in Pakistan and 4.50% in Brazil. In addition, Azerbaijan cotton production in 1992 constituted 4.48% of the USSR cotton production in 1961-1992, while Azerbaijan cotton production in the 1961-1992 period constituted approximately 0.82% of the world cotton production. In addition, according to the 30-year production average in 1992-2021, 62.76 million tons of cotton was produced worldwide and 26.00% of this production was made by China, 18.17% by India, 15.44% by the USA, 8.31% by Pakistan, 5.40% by Uzbekistan and 5.00% by Brazil. In addition, cotton production in Azerbaijan, which ranked 30th in the world during the same period, constitutes 0.34% of the world's cotton production. When the 1961-1991 and 1992-2022 periods are compared, the share of Azerbaijan in cotton production decreased by more than half (FAOSTAT, 2023).

Azerbaijan made the largest export of ginned cotton in 2017-2021, exporting 20,037 tons of ginned cotton in 2017 and reaching 122,991 tons in 2021. Exports of cottonseed meal increased from 4,161 tons to 23,486 tons in the same period, while cottonseed exports increased from 0 tons to 27,831 tons, and cotton oil exports increased from 2,058 tons to 5,165 tons. In addition, in this period, only cotton seed imports draw attention to the import of cotton products from Azerbaijan, and the import of this product is 2,000-2,500 tons (FAOSTAT, 2023).

According to the latest data of the State Statistical Committee of the Republic of Azerbaijan 40.1% of cotton growing areas were located in Mil-Mughan region, 27.7% in Karabakh region, 21.7% in Shirvan-Salyan region, 7.9% in Central Aran region and 2.6% in Ganja-Dashkasan region. Parallel to the production area, 38.4% of cotton production was from Mil-Mughan region, 28.3% from Karabakh region, 23.5% from Shirvan-Salyan region, 7.2% from Central Aran region and 2.6% from Ganja-Daskhasan region.

Some studies were conducted in the past on the the technical and economic aspects of cotton growing in Azerbaijan (Guseinov et al., 1979; Aliyev, 2009; Tagiyev, 2015; Bayramli, 2016; Mombekova et al., 2016; Seyidaliyev & Mammadova, 2018; Seyidaliev et al., 2018; Gulaliyev et al., 2019; Prikhodko et al., 2019; Mursalov et al., 2020; Tagiyeva, 2020; Muradzada, 2021; Seyidaliev et al., 2021, Tagiyeva, 2021; Zeynalova, 2022; Zeynalova & Engindeniz, 2023). However, studies that estimate cotton production also need to be conducted. Research on the future of cotton production in Azerbaijan using different methods is important in terms of determining the measures that can be taken for the direction of production and ensuring sustainable production.

With the ARIMA model, forecasts are made for many agricultural production activities. Although it is seen that some studies have been carried out on cotton production, production area, yield, prices, and trade around the World (Debnath et al., 2013; Ozer & Ilkdogan, 2013; Borkar & Tayade, 2016; Darekar & Reddy, 2017; Ghosh, 2017; Umar et al., 2017; Wali et al., 2017; Kusuma et al., 2018; Basaran Caner & Engindeniz, 2020; Mayuri Barai et al., 2020; Elsamie et al., 2021; Mohanapriya & Ganapat, 2021; Rayasingh & Debasis Raut, 2021), no literature has been found on cotton production and trade estimation of Azerbaijan. There are studies in which only some non-agricultural estimations are made (Sivri, 2016; Ahmadova, 2020; Mammadov, 2023).

The main objective of this study was to forecast the cotton production area, production, and yield in Azerbaijan in the coming years using data from the FAO and the State Statistical Committee of the Republic of Azerbaijan and the ARIMA model.

MATERIALS and METHODS

Data

The primary data of the study were obtained using the cotton production area and unginned cotton production data of Azerbaijan for the years 1992-2021 from FAOSTAT and the State Statistical Committee of the Republic of Azerbaijan for the year 2022. In particular, it was necessary to obtain the data of the 1990s from FAOSTAT. It was determined that the data after 2000 were the same data in both institutions. In addition, much study data for the estimation of agricultural products, especially cotton production, and processing, were used as secondary data in this study. Thus, in this study, forecasts for the years 2023-2027 were made using cotton production and area data for the years 1992-2022.

Methods

In this study, the ARIMA method was used for the forecasts for the years 2023-2027, while the SAS 9.4 statistical program was used in the analysis of this method, and the Microsoft Excel program was used to obtain the pre-analysis values and the graphics of the forecast values obtained as a result of the analysis. In addition, yield values were calculated for unginned cotton for the years 1993-2027 by proportioning the cotton production amount to the production area.

ARIMA Models

ARIMA (Autoregressive Integrated Moving Average), is the most widely used model in these series, as it is the easiest and most understandable model for adapting a linear model when considering all-time-series strategies (Tarmanini et al., 2023). Box and Jenkins discovered this model, which is also known as the Box-Jenkins model (Tekindal et al., 2020). While this method is suitable for short-term forecasts, it creates large differences as maturity increases. In order for the Box-Jenkins models to be applied, the data should be stationary, normally distributed, and the data should be complete and not have any missing year values (Uzundumlu et al., 2019). In this method, model determination, parameter estimation, and adequacy control of the model are made, the most appropriate model is determined, and estimations can be made as a result of this model (Hosny et al., 2023).

In the model determination phase, autocorrelations, inverse autocorrelations, partial autocorrelations, and cross-correlations were calculated and whether it was necessary to consider a difference was tested. In the second stage, control statistics were used to evaluate the adequacy of the model during the prediction and diagnostic control stages. Significance tests for parameter estimations are used to check whether the model explains all the variations in the series, and when these tests show a problem, it is necessary to return to the model determination phase to use another model (SAS, 2014). When these two stages are performed safely, the most appropriate models determined by SCAN (Smallest Canonical Correlation Method) and ESACF (Extended Sample Autocorrelation Function), are determined by considering the Akaike Information Criteria (AIC) or Bayesian Information Criteria (BIC) and estimations are made.

The ARIMA method generates the most appropriate models by obtaining a series that includes an autoregressive (AR) and a moving average (MA) model (Zhang & Meng, 2023). Here, AR, or P, represents the number of autoregression terms; MA or Q the number of terms of the moving average, and D, or I, the number of difference operations performed to make a stationary series (Wang & Pan, 2022).

The AR model is given in equation 1, and the variable formation is given in equation 2 (Shumway et al., 2000).

$$y_t = \left(\alpha + \sum_{i=1}^{p} \varphi_i * y_{t-i} + \varepsilon_t\right) \text{ and} \tag{1}$$

$$\alpha = \mu\,(1 - \varphi_1 - \varphi_2 \ldots - \varphi_P) \tag{2}$$

The MA model is shown in equation 3.

$$y_t = \left(\alpha + \sum_{i=1}^{q} \theta_i * \varepsilon_{t-i}\right) \tag{3}$$

Some studies and software packages have formulated an MA model with negative coefficients (Shumway et al., 2000).

The ARMA model is expressed in equation 4.

$$y_t = \left(\alpha + \sum_{i=1}^{p} \varphi_i * y_{t-i} + \varepsilon_t\right) + \left(\sum_{i=1}^{q} \theta_i * \varepsilon_{t-i}\right) \tag{4}$$

Equation 5 was obtained by opening the ARMA model (Mishra et al., 2021).

$$y_t = \alpha + \varphi_1 \mathrm{y}_{t-1} + \varphi_2 \mathrm{y}_{t-2} + \cdots + \varphi_p \mathrm{y}_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} \tag{5}$$

Equation 6 is obtained by adding periodic difference operation to the fifth equation in the ARIMA model.

$$y_t = \left(\alpha + \sum_{i=1}^{p} \varphi_i * y_{t-i} + \varepsilon_t\right) * (1 - B)^d + \left(\sum_{i=1}^{q} \theta_i * \varepsilon_{t-i}\right) \tag{6}$$

Another formation of the ARIMA model is given by equation 7 (Afrifa-Yamoah, 2015; Du, 2018).

$$\varphi(B)(1 - B)^d * yt = \theta(B) * \varepsilon_t \tag{7}$$

When the sixth equation was adapted to the seventh equation, the eighth equation was obtained (Kalardar, 2009).

$$(1 - a_1 B^1 - a_2 B^2 \ldots - a_P B^P) * (1 - B)^d y_t = (1 - \theta_1 B^1 - \theta_2 B^2 - \ldots . - \theta_q B^q)\varepsilon_t \tag{8}$$

$(1 - B)^d$ term is the d-order difference operation, $(1 - B)^d\, y_t$ for d=1 and B$y_t = y_{t-1}$ can be written. Moreover for d=2, $B^{\,2} y_t = y_{t-2}$ or $B^{\,1} y_{t-1} = y_{t-2}$ can be written.

ARIMA (2, 1, 1) model for p=2, d=1 and q=1

$(1 - a_1 B^1 - a_2 B^2) * \ (1 - B)^{d=1}\, y_t = (1 - \theta B)\varepsilon_t$ can be written and for p=4, d=1 and q=1 the ARIMA (4, 1, 1) model can be written as follows:

$$(1 - a_1 B^1 - a_2 B^2 - a_3 B^3 - a_4 B^4) * \ (1 - B)^{d=1}\, y_t = (1 - \theta B)\varepsilon_t$$

In the above equations;

yt= the observation values in the series at time t,

α= constant number,

φ_i= Parameters of y_{t-i} in delay time i,

εt= white noise at time t (shown as WN (0, σ^2))

p = maximum delay time for AR,

q = maximum delay time for MA,

θ_i= Parameters of ε_{t-i} at delay time i, $(1\text{-B})^d$= shows the d-order difference operation.

AR and MA components are determined using Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) (Mishra et al., 2022). If the data are stationary, the ARMA model, which includes the AR and MA models, makes predictions, whereas if the data is not stationary, the ARIMA model are used for the estimation (Uzundumlu & Dilli, 2023). In other words, in order to apply ARIMA, the series must be stationary. Any model derived from stationary data will remain constant in different periods and will provide validity for future forecasts. Non-stationary data are converted to stationary data using normal difference or logarithmic transformation (Akgül, 2003; Hosny et al., 2023). Different tests such as the Augmented Dickey-Fuller test (ADF), Kwiatkowski Phillips-Schmidt-Shin test (KPSS) and Phillips-Perron test (PP) were used to check the stationarity of the data, and ADF and PP tests were used in this study. It was determined that the data were not stationary when the unit root tests were carried out; therefore, the data were made stationary by performing the difference operation, and in this case, there was white noise in the data. In this study, in order to convert the difference process into a format suitable for analysis in Excel, 4 columns were opened to the right of the data and three-year lag values were written according to t, t, t_1, t_2 and t_3. Starting from the first line, they are sorted with the numbers t 1992-2022 (1-31), t1 numbers 1993-2022 (1-30) by leaving the first line blank, t2 numbers 1994-2022 (1-29) by leaving the first two lines blank, and the last two lines. The first 3 rows in the column were left blank and included the numbers 1995-2022 (1-28). As a result of the analysis, it was determined that the stationarity condition was met by performing a one-term difference operation on the cotton data.

Up to this stage, the creation of the model and parameter estimations were determined. At this stage, the most suitable models determined by SCAN and ESACF were determined and model confusion was avoided and the most suitable model was determined according to the smallest value of the AIC or BIC criteria (Uzundumlu & Dilli, 2023). In this study, the smallest values of the deviation between the smallest of the AIC, BIC, SBC, SSE, MSE, MAE, MAPE, RMSE, HQC values and the annual average realized value of the 1993-2022 and 2018-2022 annual mean values, the DW was 2.00. and according to the results with R^2 close to 1, the model that met the most criteria was accepted as the most appropriate ARIMA model.

RESULTS and DISCUSSION

Current and estimated cotton production area of Azerbaijan

The evaluation of the most suitable models determined by SCAN and ESACF in terms of certain criteria in the estimations made by considering the cotton production area data of Azerbaijan for the years 1992-2022 is tabulated in Table 1.

Table 1. Sorting criteria tests and estimated deviations by p and q values for the production area

Çizelge 1. *Üretim alanı için p ve q değerlerine göre sıralama kriterleri testleri ve tahmin edilen sapmalar*

p	q	BIC	SSE	MSE	SBC	MAE	MAPE	DW	RMSE	AIC	HQC	R^2	1993-2022	2018-2022
0	0	20.00	178.42	66.08	650.43	19.22	277.89	1.77	25.71	649.09	649.50	0.33	0.00	1.92
0	1	19.81	145.50	53.89	644.72	15.91	77.74	2.03	23.21	643.38	643.79	0.57	-0.26	5.62
2	2	20.04	157.83	58.45	646.99	17.54	168.86	1.82	24.18	645.66	646.07	0.29	0.23	-4.62
3	1	20.02	145.80	54.00	644.77	15.99	75.76	2.03	23.24	643.44	643.85	0.57	-0.27	5.85
4	**1**	20.04	145.26	53.80	644.67	16.02	112.59	2.03	23.20	643.34	643.74	0.56	-0.24	4.58
5	1	20.03	145.40	53.85	644.70	16.01	180.05	2.03	23.21	643.36	643.77	0.57	-0.29	7.06

Note: SSE value $\mathbf{10^8}$, MSE value $\mathbf{10^7}$, MAE and RMSE values must be multiplied by $\mathbf{10^3}$.

As can be seen from the table, the ARIMA (0, 1, 0) model among these models is a good model since the deviation between the estimated values realized in 1993-2022 and 2018-2022 is the least. ARIMA (0, 1, 1) model seems to be a good model when BIC, MAE, MAPE and R2 are taken into account, and ARIMA (4, 1, 1) model has been a good model according to SSE, MSE, SBC, DW, RMSE, AIC, HQC values. This model has been determined as the most appropriate model among these six models, with the deviation between 1993-2022 and 2018-2022 actual and predicted values being -0.24% and 4.58%, and being in the first place in more criterion tests.

In Figure 1, the cotton production area of Azerbaijan for 1993-2022 and the estimated production area for 1993-2027 are given.

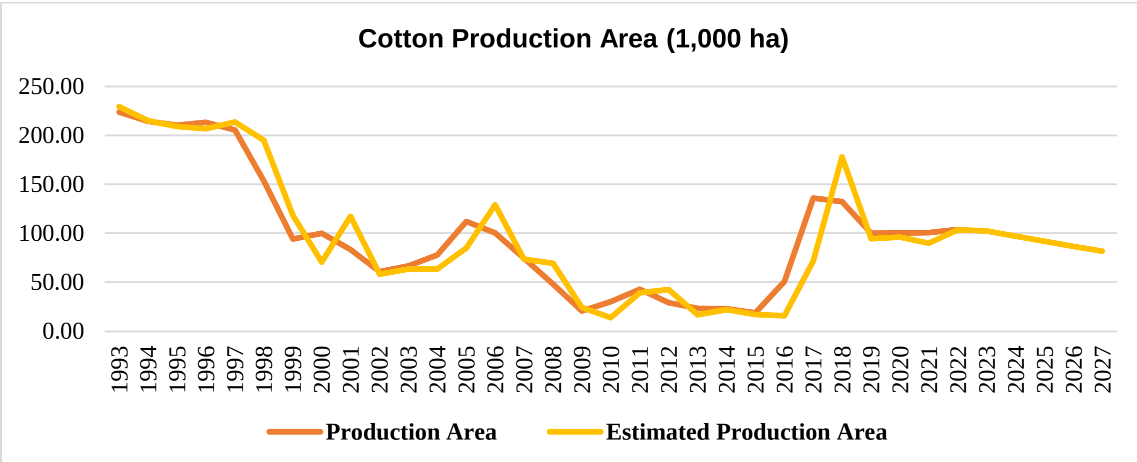

Figure 1. Estimation of cotton production area for 1993-2027 in Azerbaijan.

Grafik 1. *Azerbaycan'da 1993-2027 yılları için pamuk üretim alanı tahmini.*

When the cotton production area of Azerbaijan over the years was examined, while production was made in an area of 230,000 hectares in the first years, it reached 100,000 hectares in 1999 and 60,000-115,000 hectares in the years 2000-2005, and with a huge decrease, it reached 20,000 hectares in 2009. and 40,000 hectares with increases in 2010-2015, and then to 20,000 hectares. It is expected that there will be a small decrease period in 2023-2027 and production will be made in an area of 102,287 hectares in 2023, 97,168 hectares in 2024, 92,024 hectares in 2025, 86,588 hectares in 2026, and 81,645 hectares in 2027. The average for these five years will be 91,942 ha. In addition, in the 1993-2022 period, the annual average cultivated area was 98,370 ha, and the estimated annual average cultivated area was 98,136 ha, that is, the deviation between the actual and estimated values was -0.24%. When the 1961-1991 and 1992-2022 periods for the cotton production area of Azerbaijan were compared, according to FAOSTAT (2023) data, according to the 31-year production area average in 1961-1991, 33.40 million hectares of cotton were planted annually, while 32.91 million hectares of cotton were planted in the years 1992-2021. Total production area (in million hectares) and Azerbaijan's share of world production decreased from 0.70% to 0.31% in the same period.

Current and estimated cotton production of Azerbaijan

Table 2 shows the evaluation of the most suitable models determined by SCAN and ESACF in terms of ranking criteria tests for the estimations made according to the cotton production amount data of Azerbaijan for the years 1992-2022.

Table 2. Sorting criteria tests and estimated deviations according to p and q values for production quantity

Çizelge 2. *Üretim miktarı için p ve q değerlerine göre sıralama kriterleri testleri ve tahmin edilen sapmalar*

p	q	BIC	SSE	MSE	SBC	MAE	MAPE	DW	RMSE	AIC	HQC	R^2	1993-2022	2018-2022
0	0	21.06	586.72	217.30	683.76	30.18	114.19	1.95	46.62	682.43	682.83	0.37	0.00	-7.94
2	**1**	21.28	582.60	215.78	683.56	29.88	211.02	1.90	46.45	682.23	682.64	0.47	-0.44	-3.26
4	1	21.36	592.51	219.45	684.03	30.35	84.75	1.94	46.85	682.70	683.11	0.46	-0.20	-6.27
5	0	21.35	585.41	216.82	683.69	30.20	119.45	1.95	46.56	682.36	682.77	0.37	0.05	-8.03

Note: SSE value 108, MSE value 107, MAE, and RMSE values must be multiplied by 103.

As can be seen from the table, the ARIMA (0, 1, 0) model is a good model for BIC and DW ranking criteria tests and for the criteria that took place between 1993-2022 and had the least deviation between the estimated values. ARIMA (5 1.0), on the other hand, seems to be a good model since it is the second model with the lowest deviation between the DW ranking criteria test and the estimated values between 1993-2022, while ARIMA (4, 1, 1) is only in terms of the MAPE criterion. ARIMA (2, 1, 1) model is the best model because it ranks first in more criteria than BIC, SSE, MSE, SBC, MAE, RMSE, AIC, HQC and R2 values. In addition, this model was determined as the most appropriate model among these six models, since the deviation between the estimated values in 2018-2022 was -3.26%. In this model, the deviation between the actual and estimated values between 1993-2022 is -0,44%.

In Figure 2, the cotton production amount of Azerbaijan for the years 1993-2022 and the production amount for the years 1993-2027 are estimated.

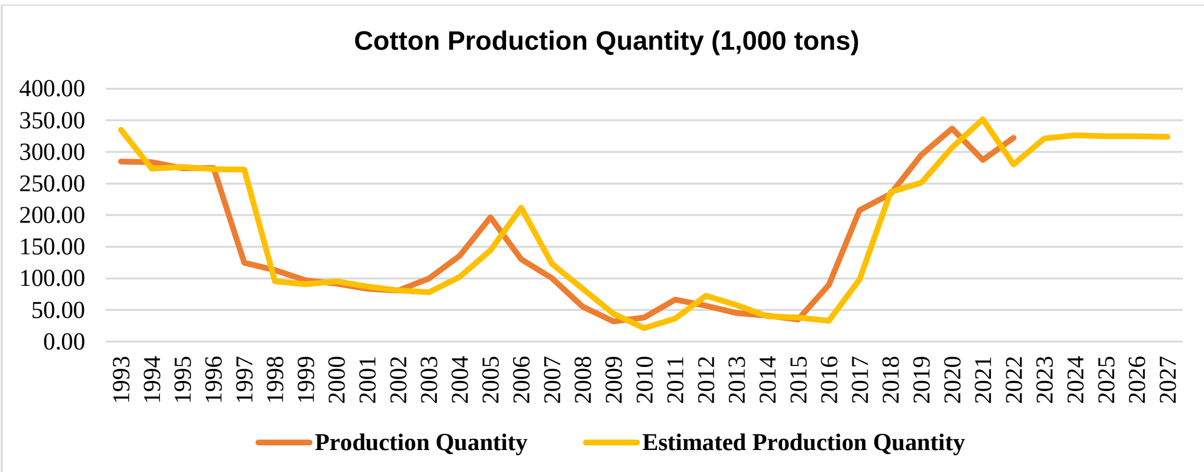

Figure 2. Estimation of cotton production amount for 1993-2027 in Azerbaijan.

Grafik 2. *Azerbaycan'da 1993-2027 yılları için pamuk üretim miktarı tahmini.*

When the cotton production amount of Azerbaijan between 1993-2022 was examined, it was 284,500 tons in 1993, and the amount of production fluctuated from this date until 2003, and it decreased to 80,428 tons in 2002. It reached 196,000 tons with a continuous increase in 2003-2005 and decreased to a production of 100,000-130,000 tons in 2006-2007, while in 2008-2015 it provided a production of 32,000-66,000 tons with increases and decreases. Between 2016 and 2020, it started producing more than 300,000 tons by 2020 by providing a continuous increase. 287,000 tons and 322,000 tons of cotton were produced in 2020 and 2021, respectively. It is expected that approximately 320,000 tons of products will be realized in 2023-2027 with small variations. According to the estimations, 321,324 tons of production will be produced in 2023, 326,102 tons in 2024, 324,968 tons in 2025, 324,773 tons in 2026, and 323,614 tons in 2027. During this period, the annual cotton production was estimated to be 324,156 tons. In addition, while the annual average production was 149,699 tons in the 1993-2022 period, the estimated value was 150,360 tons. Accordingly, the deviation between the actual and estimated values for the estimated annual average cotton production was -0.44%. According to FAOSTAT (2023) when cotton production in Azerbaijan was compared between 1961-1991 and 1992-2022 periods, annual cotton production was 41.13 million tons in the first period, while average production increased to 62.76 million tons in 1992-2021. Azerbaijan's share decreased from 0.82% to 0.34% in world production.

Current and estimated cotton yield of Azerbaijan

The cotton yield of Azerbaijan for the years 1993-2022 is depicted in Figure 3 and yield estimates are obtained from the production area and production amount estimates for the years 1993-2027.

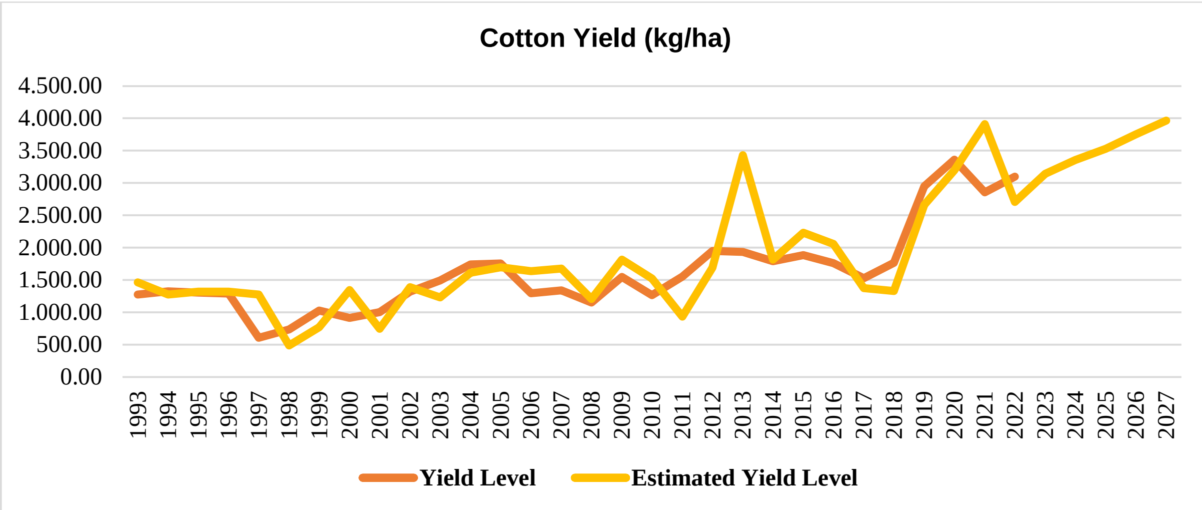

Figure 3. Estimation of cotton yield for 1993-2027 in Azerbaijan.

Grafik 3. *Azerbaycan'da 1993-2027 yılları için pamuk verimi tahmini.*

When the cotton yield of Azerbaijan in 1993-2022 was examined, it was 1,272 kg/ha in 1993 and it did not change much in 1993-1996, and it was 1,330 kg/ha. The average yield was 671 kg/ha as a decrease in 1997-1998, an average of 982 kg/ha with an increase in the period 1999-2001, and an average yield of 1,576 kg/ha with a continuous increase in the 2002-2005 period. There was not much change and the average yield was 1,358 kg/ha, while there was no significant difference in the 2012-2018 period and an average of 1,800 kg/ha, the annual average yield increased in the 2019-2022 period and became 3,066 kg/ha. In 2023-2027, the average yield will be 3,549 kg/ha. It is estimated that the annual yield will be 3,141 kg/ha in 2023, 3,356 kg/ha in 2024, 3,531 kg/ha in 2025, 3,751 kg/ha in 2026, and 3,964 kg/ha in 2027. In addition, while the annual yield was 1,626 kg/ha in the 1993-2022 period, the estimated annual yield was 1,703 kg/ha. Accordingly, the deviation between the actual and estimated values of the estimated annual average cotton production was 4.72%.

CONCLUSION

In the years when Azerbaijan became an independent state and country, the cotton production area was 230,000 ha, the production was 336,000 tons and the yield was 1,440 kg/ha; however, over time, the production area decreased to 20,000 hectares. With the contribution of external income, especially in products such as ginned cotton, cotton seeds, and cottonseed oil, the production area was expanded over time to around 100,000 hectares. In recent years, the average production has increased to 310,353 tons and the yield has increased to 3,066 kg/ha. In 2023-2027, it is estimated that the average production area will be 91,942 ha, the production will be 324,156 tons, and the yield will be 3,549 tons/ha. In this period, it is expected that the production area will be 82,000-102,000 ha and the production will be approximately 321,000-326,000 tons. These results show that the production level of Azerbaijan in the 2023-2027 period will approach the production level in 1992, but the biggest factor in this approach here is due to the effect of the increase in yield over time, and a decline up to 80,000 ha is observed instead of an improvement in the production area. The most important factors in this increase in yield are technology development, innovations in input use and certified seed imports. In addition to this increase in productivity, the production area should also be increased to a certain extent, even if not as much as in 1992s. The textile sector and cotton products of Azerbaijan, which will develop over the years, will be able to respond to the export demand by increasing both the production area, the yield and the production area by making a 2 or3 year alternation of the products that provide a good alternation with cotton.

A study conducted in Azerbaijan revealed that cotton generates less income than competing crops, such as sunflower, corn, alfalfa, and tomato, due to higher production costs. The results suggest that yield should be increased to increase the profitability of cotton production (Prikhodko et al., 2019). Farmers earned $880-$950 per hectare with subsidies, which was found to be low in another study. This study determined that processors earn more income than cotton farmers (Tagiyeva, 2020). These data indicate that the state should support cotton farmers.

In Azerbaijan, the “State Program for the Development of Cotton Production” was implemented for the 2017-2022 years. This program aims to increase cotton production, revive the ginning and processing industry, develop employment opportunities, and improve exports (Zeynalova & Engindeniz, 2023). Through this program, the government became involved in the cotton industry. The government sets the annual supply price of seed cotton and pays additional subsidies per ton. The cotton purchase price was determined to be $470/ton for first grade, $458/ton for second grade, $435/ton for third grade, and $411/ton for fourth grade by its quality in 2022. In addition, from 2022, a subsidy of $100 will be paid to farmers for each ton of cotton in 2022. It also implements policies that facilitate the supply of inputs by the state in Azerbaijan (Ministry of Agriculture of the Republic of Azerbaijan, 2023). The continuation of the price and premium support of the state in Azerbaijan, as well as the application of input support per production area, as in Turkey, will provide important contributions in terms of increasing production.

Developing and sustaining cotton cultivation in Azerbaijan and making its production sustainable, early cotton varieties should be expanded by considering the climatic conditions. Efficient cotton varieties should be developed using breeding studies. Support for the supply of inputs and agricultural machinery to farmers should continue. Cotton purchase prices should encourage farmers, and prices should be stabilized. Farmers should also be encouraged to participate. Farmers should be informed about agricultural insurance, and support should be provided in this direction. Soil structure should be improved in cotton production areas, improvements should be made in cotton production areas and irrigation opportunities should be increased. The number of cotton-processing factories should be increased and their technological infrastructure should be developed.

Azerbaijan exports cotton to Russia and Turkey. The demand of Russia is increasing, whereas Turkey is sustaining a certain demand. According to data from The State Statistical Committee of the Republic of Azerbaijan, Azerbaijan realized 93% of its total cotton (fiber) export (122,991 tons) to Turkey in 2021. Other importing countries include the Islamic Republic of Iran and Russia. In the same year, Azerbaijan made 88% of its total cotton (fabric) export (18,429 tons) to Turkey. Other importing countries include Russia, Pakistan, and Bangladesh. As the global cotton trade stagnates and competition among higher producer’s increases, Azerbaijan needs to become more competitive and improve cotton quality to sustain and develop its market share.

REFERENCES

Afrifa-Yamoah, E., 2015. Application of ARIMA models in forecasting monthly average surface temperature of Brong Ahafo Region of Ghana. International Journal of Statistics and Applications, 5 (5): 237-246. https: //doi: 10.5923/j.statistics.20150505.08

Ahmadova, E., 2020. “Adaptive method of econometric modeling and forecasting of Azerbaijan's GDP, 184-193”. Proceeding of 55th International Scientific Conference on Economic and Social Development (June 18-19 2020, Baku-Azerbaijan). Varazdin Development and Entrepreneurship Agency, 873 pp.

Akgül, I., 2003. Analysis of Time Series and ARIMA Models. Der Publications, Istanbul-Turkey, 148 pp.

Aliyev, S., 2009. History of cotton agriculture and cotton products in Azerbaijan. Journal of History and Its Problems, 1 (1): 399-403.

Basaran Caner, C. & S. Engindeniz, 2020. Estimating of cotton production of Turkey using ARIMA model. Turkish Journal of Agricultural Economics, 26 (1): 63-70. https: //doi.org/10.24181/tarekoder.681079

Bayramli, G., 2016. The past and present of cotton cultivation in Azerbaijan. The Journal of International Scientific Researches, 1 (2): 16-23. https: //doi.org/10.23834/isrjournal.251520

Borkar, P. & P.M. Tayade, 2016. Forecasting of cotton production in India using ARIMA models. International Journal of Research in Economics and Social Sciences, 6 (5): 1-7.

Darekar, A. & A.A. Reddy, 2017. Cotton price forecasting in major producing states. Economic Affairs, 62 (3): 373-378. https: //doi.org/10.5958/0976-4666.2017.00047.X

Debnath, M.K., K. Bera & P. Mishra, 2013. Forecasting area, production and yield of cotton in India using ARIMA model. Research and Reviews: Journal of Space Science and Technology, 2 (1): 16-20.

Du, Y., 2018. “Application and analysis of forecasting stock price index based on combination of ARIMA model and BP neural network, 2854-2857”. Proceeding of 2018 Chinese Control and Decision Conference (June 9-11, 2018, Shenyang-China). Institute of Electrical and Electronics Engineers, 693 pp.

Elsamie, M.A., T. Ali & D. Zhou, 2021. Using a dynamic time series model (ARIMA) for forecasting of Egyptian cotton crop variables. The Journal of Animal and Plant Sciences, 31 (3): 810-823.

FAOSTAT, 2023. Crop Production and Trade Statistics. (Web page: http: //www.fao.org/faostat/en/#home) (Date accessed: March 2023).

Ghosh, S., 2017. Forecasting Cotton Exports in India using the ARIMA model. Amity Journal of Economics, 2 (2): 36-52.

Gulaliyev, M.G., S.T. Abasova, E.R. Samedova, L.A. Hamidova, S. Valiyeva & L.R. Serttash, 2019. Assessment of agricultural sustainability (Azerbaijan Case). Bulgarian Journal of Agricultural Science, 25 (Suppl. 2): 80-89.

Guseinov, A., F. Babaev & A. Eminbeili, 1979. Wilt resistant varieties from the collection of the Azerbaijan Scientific-Research Cotton Institute. Khlopkovodstvo, 9 (1): 35-36.

Hosny, S., E. Elsaid & H. Hosny, 2023. Prediction of construction material prices using ARIMA and multiple regression models. Asian Journal of Civil Engineering, 1-20. https: //doi.org/10.1007/s42107-023-00597-2.

Kusuma, G., V. Venkata Krishna & N. Naga Vardhanam, 2018. Forecasting model of cotton production in Andhra Pradesh using auto regressive integrated moving average (ARIMA). International Journal of Management, Technology and Engineering, 8 (12): 168-179.

Mammadov, T., 2023. Azerbaijan natural gas production 2022-2024 forecast by ARIMA (0,1,2) method. International. Journal of Latest Research in Humanities and Social Science, 6 (1): 39-47.

Mayuri Barai, M., G. Yadav & A. Khamborkar, 2020. Forecasting of cotton production in Nagpur District of Maharashtra India. International Journal of Science and Research, 9 (12): 1556-1561. https: //doi.org/10.21275/SR201225183516

Mishra, A.K., S. Singh, S. Gupta, S. Gupta & R.K. Upadhyay, 2022. Forecasting future trends in crude oil production in India by using Box-Jenkins ARIMA. AIP Conference Proceedings, 2481: 1-11. https://doi.org/10.1063/5.0103682.

Mishra, S, D.K. Swain, D. Mishra & G.H. Santra, 2021. “Time series analysis of rainfall for Puri District of Odisha using ARIMA modelling, 419-426”. In: Intelligent and Cloud Computing. (Eds. S. Mishra, D.K. Swain, D. Mishra & G.H. Santra), Springer- Singapore, 834 pp.

Mohanapriya, M. & P.S. Ganapat, 2021. Forecasting futures trading volume for cotton using vector auto regression and ARIMA Model. Madras Agricultural Journal, 107 (10-12): 1-4. https: //doi.org/10.29321/MAJ.10.000550

Mombekova, G., G. Turysbekova & A. Baimbetova, 2016. Managing ınnovational processes at cotton processing enterprises in Central Asia Countries. International Journal of Economics and Financial Issues, 6 (Special Issue-2): 164-171.

Muradzada, F., 2021. Cotton industry in Azerbaijan. Capstone Project, ADA University. Baku-Azerbaijan, 42 pp.

Mursalov, E., K. Mammadov, Z. Kazimov & R. Shahbazov, 2020. Development of the cotton industry and its socio-economic impact on the Azerbaijan economy. Research Paper. ADA University. Baku-Azerbaijan. 12 pp.

Ozer, O.O. & U. Ilkdogan, 2013. The World cotton price forecasting by using Box-Jenkins model. Journal of Tekirdag Agricultural Faculty, 2 (10): 13-20.

Prikhodko, D,, B. Sterk, Y. Ishihara, F. Mancini, H. Muminjanov & H. Weissen, 2019. Azerbaijan: cotton sector review. FAO Investment Centre Country Highlights. Rome, FAO, 37 pp.

Rayasingh, M. & A.B. Debasis Rout, 2021. Forecasting of cotton prices in major producing states using ARIMA. International Engineering. Journal for Research and Development 6: 1-8. https: //doi.org/10.17605/OSF.IO/93CSB

SAS, 2014. SAS 13.2 User’s Guide the ARIMA Procedure. SAS Institute Inc., Cary, NC, USA. (Web page: https: //support.sas.com/documentation/onlinedoc/ets/132/ARIMA.pdf) (Date accessed: March 2023).

Seyidaliev, N.Y., K. Khalilov & M.Z. Mamedova, 2021. Influence of different seeding methods and fertilization rates on the structural performace of cotton varieties. Research in Agricultural and Veterinary Sciences, 5 (3): 117-120.

Seyidaliyev, N.Y. & M.Z. Mamedova, 2018. Effect of integrated agronomic practices on the growth of cotton. World Science, 2 (2): 7-8.

Seyidaliyev, N.Y., A.O. Hasanova, & M.Z. Mamedova, 2018. Effect of integrated agronomic practices on the growth and development of cotton. European Sciences Review, 1-2: 204-209.

Shumway, R.H., & D.S. Stoffer, 2000. Time Series Analysis and Its Applications. Springer Texts in Statistics, Springer Science and Business Media, New York, 543 pp.

Sivri, U., 2016. "Investigation of time series properties of Azerbaijan gross domestic product series, 515-520". Proceeding of Third International Symposium on Turkic World Studies (25-27 May 2016, Baku-Azerbaijan), Baku Eurasian University, 588 pp.

Tagiyev, A.A., 2015. Agrobiological, economic value and technological quality indicators of fiber of new regionalized and promising cotton varieties. Azerbaijan Agrarian Scientific Journal, 2: 52-55.

Tagiyeva, L., 2020. "The role of cotton in the development of regions, 652-657". Proceeding of 55th International Scientific Conference on Economic and Social Development (18-19 June 2020, Baku-Azerbaijan), Varazdin Development and Entrepreneurship Agency, 873 pp.

Tagiyeva, l., 2021. "Improving state Support for the Development of the Cotton Sector in Azerbaijan, 375-380". Proceeding of 70th International Scientific Conference on Economic and Social Development (25-26 June 2021, Baku-Azerbaijan), Varazdin Development and Entrepreneurship Agency and University North, 1207 pp.

Tarmanini, C., N. Sarma, C. Gezegin & O. Ozgonenel, 2023. Short term load forecasting based on ARIMA and ANN approaches. Energy Reports, 9: 550-557.

Tekindal, M.A., H. Yonar, A. Yonar, M. Tekindal, M.B. Cevrimli, H. Alkan & B. Mat, 2020. Analyzing COVID-19 Outbreak for Turkey and Eight Country with Curve Estimation Models, Box-jenkins (ARIMA), Brown Linear Exponential Smoothing Method, Autoregressive Distributed Lag (ARDL) and SEIR Models. Eurasian Journal of Veterinary Sciences, 36 (Covid-19 Special Iss): 142-155. https: //doi.org/10.15312/EurasianJVetSci.2020.304

The Ministry of Agriculture of the Republic of Azerbaijan, 2023. Agricultural Supports. (Web page: https://www.agro.gov.az/en) (Date accessed: April 2023).

The State Statistical Committee of the Republic of Azerbaijan, 2023. Crop production and trade statistics. (Web page: https: //www.stat.gov.az/search/?q=cotton) (Date accessed: April 2023).

Türkekul, B. & Ç. Kantur, 2021. International competitiveness of the Turkish cotton and cotton weaving products: a constant market share and revealed comparative advantage analysis. Journal of Agriculture Faculty of Ege University, 58 (4): 615-628. https: //doi.org/10.20289/zfdergi.871428

Umar, S.N., W. Krishna, B.R. Murthi, T. Gangaram & P.S. Aali, 2017. Forecasting of cotton area, production, productivity using ARIMA models in Andhra Pradesh. Bulletin of Environment, Pharmacology and Life Sciences, 6 (3): 138-141.

Uzundumlu, A.S., A. Bilgic & N. Ertek, 2019. Prediction of hazelnut production quantity with the ARIMA model of Turkey's provinces leading hazelnut production in the last seven years. Academic Journal of Agriculture, 8: 115-126. http: //doi.org/10.29278/azd.591588

Uzundumlu, A.S. & M. Dilli, 2023. Estimating chicken meat productions of leader countries for 2019-2025 years. Ciência Rural, 53 (2): 1-12. https: //doi.org/10.1590/0103-8478cr20210477

Wali, V.B., D. Beeraladinni, & H. Lokesh, 2017. Forecasting of area and production of cotton in India: an application of ARIMA Model. International Journal of Pure and Applied Bioscience, 5 (5): 341-347. https: //doi.org/10.18782/2320-7051.5409

Wang, J. & W. Pan, 2022. "Flight delay prediction based on ARIMA, 186-190". Proceeding of International Conference on Computer Engineering and Artificial Intelligence (ICCEAI) (22-24 July 2022, Shijiazhuang-China), The Institute of Electrical and Electronics Engineers, 895 pp.

Zeynalova, A. & S. Engindeniz, 2023. "An evaluation on the sustainability of cotton growing in Azerbaijan, 188-200". Proceeding of Avrasya 7th International Conference on Applied Sciences (10-12 March 2023, Budapest-Hungary), Academy Global Publishing House, 449 pp.

Zeynalova, A., 2022. Study of sowing quality, oiliness and resistance to wilt disease of seeds of geographically distant cotton varieties. Research in: Agricultural and Veterinary Sciences, 6 (2): 104-110.

Zhang, Y. & G. Meng, 2023. Simulation of an adaptive model based on AIC and BIC ARIMA predictions. Journal of Physics: Conference Series, 2449 (2023): 1-8. https: //doi.org/10.1088/1742-6596/2449/1/012027