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NEW AGRICULTURAL POLITICS IN TURKEY: THE ECONOMETRIC ASSESSMENT OF COTTON PRODUCTION AND YIELD 1925 – 2015

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ABSTRACT

This study was conducted to evaluate causality between long-term relationships among production amount, cultivated area and yield of cotton lint for Turkey for the period 1925 to 2015, and to determine the strength and direction of the relationships by means of vector error correction model (VECM) and cointegration analysis. After taking the first differences of the original (non-stationary) time series data on cotton lint, stationary time series data were obtained and exposed to cointegration analysis to determine whether any long-term relationships among the variables exist and whether the series were integrated. Both production amount and cultivated area had a positive effect on yield. The effect of production amount on yield is more than that of cultivated area. In order to find the direction of the long term relationship and the short term effects, vector error correction model (VECM) analysis was used and the analysis presented evidence of a causality relationship between cotton production and yield in Turkey. Holt exponential smoothing method was used to forecast cultivated area, amount of production, and yield from the period 2016 – 2026. The results of Holt method revealed that cultivated area, amount of production, and yield are expected to increase for the above-mentioned time period. New agricultural policies should be formulated in order to cut back on an estimated 20 billion dollars forecasted to be spent on cotton imports between 2016 and 2026.

Key Words: Cointegration, vector error correction model, exponential smoothing method, cotton, production economics.

INTRODUCTION

Cotton is an important cash crop which generates considerable income for rural households (Minot and Daniels, 2005). In addition to its agricultural value, cotton is also an intensely-traded agricultural commodity, utilized mainly in textile industry, and creating jobs in vertically and horizontally linked industries (Fortucci, 2002). As a textile producing country, keeping a continuous flow of cotton into the country is important for economic development of Turkey (Ali *et al.*, 2015). According to FAO (2013), China is the world leader in cotton lint production with 6,298,989 tons, followed by India (6,020,000 tons) and the USA (2,842,000 tons). Turkey is ranked at 8th with 832,500 tons. According to 2015 records of the TUIK (2015a, Turkish Statistical Institute), the amount of cotton produced in Turkey was 738,000 tons.

There are a few studies in the literature on the time series analysis of cotton. Narala and Reddy (2012) focused on growth and instability in cultivated area, production and productivity of cotton for the period 1951 – 2011 in India through exponential functions. Reddy *et al.* (2012) tested the data on compound growth rates by means of exponential function for cultivated area, production and productivity of the cotton in Gujarat, India for 1981 – 2008. However, causality relationship between production amounts, cultivated area and yield of cotton lint was inconclusive. Ali *et al.* (2015) used Auto Regressive Moving Average (ARMA) and Auto Regressive Integrated Moving Average (ARIMA) models in order to forecast yield and production of sugarcane and cotton for the period 2013 – 2030. Anwar *et al.* (2010) evaluated the impact of liberalization policies on cotton lint exports of Pakistan for 1971 – 2008 by cointegration analysis and ADF unit-root test. Sheikh (2014) conducted a shift-share analysis to evaluate the growth trend and competitiveness of cotton exports of India for 1994 – 2012. Boansi *et al.* (2014) performed cointegration analysis for cotton lint exports from Mali for 1980 – 2011.

Use of cointegration analysis for cotton is rare; however, some authors used this analysis in explaining the relations between inflation, economic growth, and interest rates. Granville and Mallick (2004) applied cointegration analysis to time series data and found a long-term relationship between inflation and interest rates. Simsek and Kadilar (2006) used cointegration analysis for the Turkish economy with the aim of testing the hypothesis and the validity of the link between long-term interest rates and inflation. Heryán and Stavárek (2010) studied the relationship between interbank interest rates and corporate loan rates in the European Union by employing cointegration analysis and Granger causality test. Incekara *et al.* (2012) tested the validity of Fisher Hypothesis for Turkey for the period 1989:Q1 – 2011:Q4 using Johansen cointegration analysis. Dritsakis (2013) investigated the long-run equilibrium relationship between economic growth, exports and external debt in Greece over a period of 50 years from 1960 to 2011.

Although Turkey is known as a textile-producing country, a great majority of the cotton lint used in textile industry comes from abroad. According to 2015 Cotton Report of the Ministry of Customs and Trade of the Turkish Republic, the value of Turkey's cotton exports amounts to 76,439,000 USD while cotton imports costs 1,232,451,000 USD (Anonymous, 2016). This is a great imbalance for a country which has a comparative advantage in global textiles markets. Therefore, it may be said that, in order for Turkey to be a major producing country rather than an intermediate processor of textiles, domestic cotton production should be increased. Increasing cotton production will benefit domestic cotton producers and cut import costs. As a result, a new policy approach, with an emphasis on subsidizing cotton production, should be adopted. Such policies should utilize such tools as input subsidies, direct income support per ha of cotton cultivated and product support per kg of cotton produced.

The aim of this study was therefore to determine the causality relationship among the production, the cultivated area and yield of cotton lint in Turkey for the period of 1925 – 2015 using time-series analysis. Description of relationships among determinant variables under investigation may be helpful in planning production of cotton lint as part of efficient agricultural policies that would be developed by the governments of upcoming years.

MATERIALS AND METHODS

Data on amount of production, yield and cultivated area of cotton lint in Turkey over a period of 90 years from 1925 to 2015 were obtained from TUIK (2015b) and FAO database. TUIK (2014) population data, forecasted annually over a period of 13 years from 2013 to 2026, were also used in the study.

Method: Johansen-Juselius (1990) method, cointegration analysis and vector error correction model (VECM) were used in the study to analyze relationships between amount of production, cultivated area and yield of cotton lint over a period of 90 years from 1925 to 2015.

The stability of the time series is tested by using ADF (Augmented Dickey Fuller-ADF) unit- root test, before examining causality relationships (Dickey and Fuller, 1981). Theoretically, the mean, variance and covariance of the stationary time series within the studied time period are invariant (Darnell, 1994). There exist three situations in ADF test for any time series; a random process that has intercept and trend (*t*), a random process involves that has intercept but no trend and a random process that includes no intercept and no trend (Wang *et al.*, 2007). These situations are shown with the following equations.

$$\Delta X_t = \gamma X_{t-1} + \sum_{i=1}^{k} \beta_i \Delta X_{t-i} + e\_t \quad (1)$$

$$\Delta X_t = \alpha_0 + \gamma X_{t-1} + \sum_{i=1}^{k} \beta_i \Delta X_{t-i} + e\_t \quad (2)$$

$$\Delta X_t = \alpha_0 + \alpha_1 t + \gamma X_{t-1} + \sum_{i=1}^{k} \beta_i \Delta X_{t-i} + e\_t \quad (3)$$

Equation (1) is a pure random walk model with lag terms. Equation (2) has a drift whereas Equation (3) comprises of both drift and a time trend. The null hypothesis for ADF test is $H_0: \gamma = 0$, and the alternative is $H_1: -2 < \gamma < 0$ (Yau and Nieh, 2006).

Given that all series in the model are $I(1)$ processes, the next test is to check if variables are cointegrated. First, considering the sensitivity of vector auto regression (VAR) model to the number of lags of the variables, optimal lags of the variables involved in the model must be specified (Wu *et al.*, 2012). In this study, various goodness of fit criteria such as Sequential Modified Likelihood Ratio Test Statistic (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) and Hannan-Quinn Information Criterion (HQ) were measured.

When the variables are non-stationary and integrated of the same order, the long-run relationships are assessed by means of the residual-based test by Engle and Granger (1987) and the VAR-based test by Johansen (1988) and Johansen and Juselius (1990), referred to as the cointegration tests. In the Pesaran (2001) test, regardless of whether the variables are static at different levels, more than one cointegration vector could be determined (Pesaran *et al.*, 2001). In as much as the time series in the analysis is *I*(1), multivariable cointegration analysis proposed by Johansen-Juselius (1990) test is used to identify cointegration between the variables.

The Johansen-Juselius test employs two test statistics in order to describe the number of cointegrating vectors: the trace test statistic and the maximum Eigen-value test statistic. The trace test statistic is given by

$$Trace = -T \sum_{i=r+1}^{n} ln(1 - \lambda_i) \quad (4)$$

Where T is the sample size, n is the number of variables in the system and the Eigen-values are real numbers such that $1 > \lambda_1 > \lambda_2 > \cdots > \lambda_n > 0$. The maximal Eigen-value test does not have nested hypotheses and in some cases the maximal Eigen-value and trace tests imply different conclusions. In that case, the results of the trace tests should be preferred (Alexander, 2008).

A cointegration test is conducted to understand whether the stationary variables are co-integrated (Kadilar, 2000). Since calculation of error terms in the cointegration analysis is based on cointegration parameter, the critical values of Engle-Granger (EG) and Expanded-EG (AEG) are used for error terms (Engle and Granger, 1987).

According to Engle and Granger (1987), if two series are co-integrated of the order one, that is, $I(1)$, then there must exist a VECM representation in order to govern the joint behavior of the series of the dynamic system. For this study, it was estimated using VECM as follows:

$$\Delta X_t = \delta + \sum_{i=1}^{k-1} \gamma_i \Delta X_{t-i} + \Omega ECM_{t-1} + \varepsilon_t \quad (5)$$

Equations of VECM used in Equation 5 can be written as follows:

$$\Delta CY_t = \beta + \sum_{i=1}^{k} \beta_{1i} \Delta CY_{t-i} + \sum_{i=1}^{l} \beta_{2i} \Delta CP_{t-i} + \sum_{i=1}^{l} \beta_{3i} \Delta SA_{t-i} + \theta ECM_{t-1} + \varepsilon_{1t} \quad (6)$$

In Equations (5) and (6), ECM_{t-1} represents error correction term while CY represents Cotton Yield, CP represents Cotton Production, CA represents Cultivated Area and ε_t and ε_{1t} are error terms of the relevant Equations. When the parameters (θ) of error correction terms in the equations are different from zero, it is suggested that the long-term relationship providing equilibrium between the variables is found. ECM parameters which are different from zero in equations are sufficient to decide on the existence of causality relationship. In examining the causality relationship according to Equation (6), β_{1i} being different from zero is not a necessary condition (Granger, 1988). Briefly, lag values in independent variables in VECM represent short-term causal effects while error correction term represents the long-term causal effects (Love and Chandra, 2005). The Holt model, the Brown model, and the Damped Trend model were implemented for the deterministic forecast of the series.

Exponential smoothing was initially suggested by Brown and expanded by Holt (Brown, 1962; Holt, 1957). Holt Exponential Smoothing method is given in Equation 7 (Gardner, 1985).

$$A_t = \alpha X_t + (1-\alpha)(A_{t-1} + T_{t-1})$$
$$T_t = \beta(A_t - A_{t-1}) + (1-\beta)T_{t-1} \quad (7)$$

Brown Exponential Smoothing method is given in Equation 8 (Brown, 1962).

$$A_t = \alpha X_t + (1-\alpha)A_{t-1}$$
$$T_t = \alpha(A_t - A_{t-1}) + (1-\alpha) + T_{t-1} \quad (8)$$

Damped Exponential Smoothing method is given in Equation 9 (Gardner and McKenzie, 1985).

$$A_t = \alpha X_t + (1-\alpha)(A_{t-1} + \theta T_{t-1})$$
$$T_t = \beta(A_t - A_{t-1}) + (1-\beta)\theta T_{t-1} \quad (9)$$

Where At represents the attenuated average time series after observing X_t, T_t represents the trend estimate, X_t represents observed values, α *and* β are attenuation constants and θ is the damping parameter.

The estimate accuracy of the methods used in the study was measured by Stationary R^2, coefficient of determination R^2, and BIC, respectively. It is strongly suggested to perform model fit statistics on Bayesian Information Criterion (BIC) (Pektas, 2013). BIC is shown by Equation 10 (Shumway and Stoffer, 2006);

$$BIC = ln(\hat{\sigma}_\varepsilon^2) + k\,ln(n)/n \quad (10)$$

Where $\hat{\sigma}_\varepsilon^2$ is the error variance.

Stationary R^2 statistic was used by Harvey (1989). Stationary R^2 is defined as;

$$R^2 = 1 - \frac{\sum_t (X_t - \hat{X}_t)^2}{\sum_t (\Delta X_t - \Delta \bar{X})^2}$$

RESULTS AND DISCUSSION

In this study, cointegration analysis was adopted to define the relationship between amount of production, cultivated area and yield of cotton lint, and causality analysis based on VECM was performed. Before conducting econometric analyses, unit root test was applied to determine whether the variables were stationary or not. If the variables are stationary at first differences, cointegration relationship (long-term equilibrium relationship) is detected. If there is a cointegration relationship between the variables, short-term causality results are interpreted by estimating VECM.

Table 1 shows the results of ADF unit root test for the variables studied in the investigation. When Table 1 was considered, null hypothesis of the unit root was accepted for amount of production, cultivated area and yield of cotton lint. This means that the variables were non-stationary. ADF test was applied to describe whether the first differences of amount of production, cultivated area and yield were stationary or not. According to Table 1, it was concluded that first differences were removed from unit root and thus, series were stationary, $I(1)$ ($P<0.01$).

Multiple tests were employed to find the number of appropriate lags. The results of LogL statistic (LogL), LR, FPE, AIC, SC Lagrange Multiplier (LM) and HQ are given in Table 2. Number of appropriate lags was selected as 1, based on AIC, LR, FPE and HQ.

Due to the fact that the first differences of amount of production, cultivated area and yield of cotton lint were stationary, a cointegration test based on Johansen (1988) and Johansen and Juselius (1990) was specified to ascertain whether a long-term relationship between the variables exist (Johansen, 1988; Johansen and Juselius, 1990). The obtained results are summarized in Table 3.

Table 1. Augmented Dickey-Fuller test statistic.

Variables	Level			First different		
	t-Statistic	Test critical values	Prob.*	t-Statistic	Test critical values	Prob.*
CP	-0.965197	-3.504727	0.7627	-1.056610	-3.506484	0.0000
CA	-2.202615	-2.894716	0.2069	-9.442519	-2.894716	0.0000
CY	1.704571	-2.584529	0.9996	-8.633552	-2.584529	0.0000

*MacKinnon (1996) one-sided p-values. *The first difference of the series was not unit root at an alpha level of 5%, **The first difference of the series was not unit root at an alpha level of 1%. Number of lags was unity. CP: Production amount of cotton lint, CA: Cultivated area of cotton lint, CY: yield of cotton lint.

Table 2. Statistics for selecting number of lags.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2269.005	NA	2.34e+20	55.41476	55.50281*	55.45011
1	-2254.863	26.90501*	2.06e+20*	55.28933*	55.64154	55.43074*
2	-2247.408	13.63618	2.14e+20	55.32703	55.94338	55.57449
3	-2239.763	13.42566	2.22e+20	55.36007	56.24058	55.71358
4	-2231.809	13.38616	2.29e+20	55.38558	56.53024	55.84515
5	-2222.557	14.89384	2.29e+20	55.37943	56.78824	55.94505
6	-2221.934	0.957061	2.84e+20	55.58375	57.25672	56.25542
7	-2214.759	10.49952	3.01e+20	55.62827	57.56539	56.40599
8	-2208.163	9.170021	3.26e+20	55.68691	57.88817	56.57068

* indicates lag order selected by the criterion
LR: Sequential Modified LR Test Statistic (each test at 5% level), FPE: Final Prediction Error, AIC: Akaike Information Criterion, SC: Schwarz Information Criterion, HQ: Hannan-Quinn Information Criterion.

Table 3.Unrestricted Cointegration Rank Test (Trace).

Hypothesized No. of Cointegration	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None * ($r = 0$)	0.540913	150.9979	29.79707	0.0001
At most 1 * ($r \leq 1$)	0.419773	82.48852	15.49471	0.0000
At most 2 *($r \leq 2$)	0.324994	34.58694	3.841466	0.0000

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None * (r =0)	0.540913	68.50941	21.13162	0.0000
At most 1 * ($r \leq 1$)	0.419773	47.90158	14.26460	0.0000
At most 2 * ($r \leq 2$)	0.324994	34.58694	3.841466	0.0000

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level, Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level,
**MacKinnon-Haug-Michelis (1999) p-values

According to the results of cointegration test, three cointegrated vectors were chosen from Table 3, showing λi (Eigen values). Null hypothesis (H_0: $r = 0$, H_0: $r \leq 1$ and H_0: $r \leq 2$) was tested against H_1 hypothesis, indicating three cointegrated vectors. Three cointegrated vectors are shown in Table 3 (P<0.01).

Since respective trace statistics were greater than the corresponding critical values, null hypotheses corresponding to $r \leq 1$ and $r \leq 2$ were completely rejected (P<0.01), meaning that the cointegration vector in the evaluated model was not found. In the study, the cointegration test results revealed that there is a long term relationship between amount of production, yield and cultivated area of cotton lint. According to the results from lag$k = 1$, the rank number was decided as 3 on the basis of λ_{trace} and λ_{max} (P<0.01). The case of the cointegration vector can be seen in Table 4.

Table 4. Normalized cointegrating coefficients and Adjustment coefficients.

1 Cointegrating Equation (s): Log likelihood -2462.014									
Normalized cointegrating coefficients (standard error in parentheses)									
CY					CP			CA	
1.000000					-0.000100			-5.92E-05	
					(2.4E-05			(1.9E-05)	
Adjustment coefficients (standard error in parentheses)									
D(CY) -0.403860					D(CP) 5523.059			D(CA) 9857.261	
(0.14966)					(1062.01)			(1031.38)	
2 Cointegrating Equation (s): Log likelihood -2438.063									
Normalized cointegrating coefficients (standard error in parentheses									
			CY			CP		CA	
1.000000			0.000000			4.93E-05		(1.3E-05)	
0.000000			1.000000			1.083688		(0.19089)	
Adjustment coefficients (standard error in parentheses)									
D(CY) -1.621464			3.29E-05	D(CP) -1.251716			-0.594406	D(CA) 8583.087 - 0.994401	
(0.	(1.2E-05)	(1.	(1637.47)	(2.	(0.09343)	(3.	(1808.27)	(4.	(0.10318)

D: the first difference of the series. The bracketed values are standard errors of the adjustment coefficients.

When yield was specified as a dependent variable, the prediction equation of the cointegration illustrating a long-term relationship can be written as in Equation (7):

$$CY = 0.0001\,CP + 0.0000592\,CA \qquad (7)$$

(2.4E-05) (1.9E-05)

In Equation 7, figures in parentheses are standard errors (SE). According to the prediction equation expressed in Equation 7, an increase of 1 ton in amount of cotton produced causes an increase of 0.0001 in cotton yield. Similarly, according to the Equation 7, an increase of 0,1 ha in cultivated area causes an increase of 0.0000592 in yield. Examining the cointegration vector, we found a positive relationship between yield and amount of production and the cultivated area of cotton lint, meaning that a 0,1 ha increase in the cultivated area of cotton lint causes an increase of 0,0000592 in yield. Null hypotheses of the significance tests of the regression coefficients of amount of production and cultivated area were rejected completely, meaning that the coefficients were significant. The long-term effects of both variables on yield were noted in the study. In the light of these findings, it can be suggested that increasing amount of production and cultivated area is a desirable development in increasing the yield.

Long-term and short-term causality relationships between the variables were investigated by VECM. Results of VECM used in the long-term causality analysis are summarized in Table 5. When cotton yield was dependent and other variables (amount of production and cultivated area) were independent, the coefficient ECM_{t-1} of the error correction term was found as -0.404 and significant at P<0.05, which was an indicator of a long-term relationship between the variables tested in the study. The established model was accepted as significant with the detection of a significant value of F-statistic (P<0.01). A negative short-term causality relationship was found between yield and amount of production of cotton lint, as well as between yield and cultivated area, since the sum of coefficients ΔCP_t and ΔCA_t were negative. According to Table 5, yield with one period lag has been affected negatively from amount of production (-5.64E-05) and cultivated area (-2.95E-06). Amount of production had a significant impact on yield while the effect of cultivated area on yield was insignificant. The lagged error correction term showed that the difference between the long-term yield and the actual yield in cotton lint was removed at 40,4 (%) per annum. F-statistic values were found to be significant for Equation (6), (P<0.01).

To forecast amount of production and cultivated area of cotton lint over a 10-year period between 2016 and 2026, performances of Holt, Brown and Damped exponential smoothing methods were tested comparatively. Table 6 gives model performance results for amount of production and cultivated area of cotton lint. The most appropriate model was established with Holt method since this method had Stationary R^2 and BIC values. Parameter estimates (Holt linear trend) for the model established with the Holt method are presented in Table 7. Amount of production and cultivated area of the cotton lint from the period 2016 – 2026 were forecasted annually by Holt method. Consumption of cotton lint was forecasted by using the forecasted population values. Amount of production, cultivated area and yield values forecasted from the period 2016 – 2026 are given in Table 8.

As seen in Table 8, it is forecasted that annual amounts of production and cultivated areas will increase for each year within 2016 – 2026 period. It is estimated that, amount of production will increase from 779,306 tons in 2016 to 881,616 tons in 2026, meaning an increase of 13.13% during the 10-year period. It is expected that cultivated area will increase by 10,73% from 450,862 ha in 2016 to 499,241 in 2026. Meanwhile, yield will vary from 173 to 177 kg per 0,1 ha within the 2016 – 2026 period. When population considered, it can be seen that the amount of cotton per head was 9.44 - 11.47 kg within the last 3 years (2013 – 2015) in Turkey. With time series forecasting, two compounds like amount of production and amount of cotton lint imported per annum were forecasted separately over 2016 – 2026. Amount of total cotton used is defined as the sum of these two compounds. The required amount of total cotton per head is the proportion of the amount of total cotton used to population size. Accordingly, the amount of production and amount of cotton lint imported per annum for the year 2026 were forecasted as 10.23 kg and 13.40 kg, respectively. When price of cotton ($1.93/kg) in 2013 is taken as base price (FAO.http://faostat3.fao.org/download/T/TP/E), it is expected that a total of 21,830,538,800 dollars should be paid for amount of cotton lint to be imported into Turkey in 2016 – 2026 period (Table 9). These results reveal that amount of production in subsequent years will not be able to meet the requirements of the Turkish population and it is necessary to increase amount of produced cotton. Results of the study shows that Turkey should formulate precautionary policies for the promotion of cotton production in order to keep a valuable portion of its foreign currency deposits within the country, which would otherwise be used in the realization of various other development targets.

Table 5. Vector Error Correction Estimates

Error Correction:	D(CY)	D(CP)	D(CA)
ECM_{t-1}	-0.403860*	5523.059	9857.261
	(0.14966)	(1062.01)	(1031.38)
	[-2.69848]	[5.20057]	[9.55731]
D(CY(-1))	-0.188211	-9.854.265	-4.592.749
	(0.15574)	(1105.15)	(1073.28)
	[-1.20848]	[-0.89167]	[-4.27916]
D(CP(-1))	-5.64E-05	-0.463196	0.420696
	(2.5E-05)	(0.17822)	(0.17308)
	[-2.24722]*	[-2.59908]	[2.43069]
D(CA(-1))	-2.95E-06	0.255731	-0.108878
	(2.3E-05)	(0.15986)	(0.15525)
	[-0.13101]	[1.59970]	[-0.70130]
C	0.056123	-2.014.426	-2.405.478
	(1.06669)	(7569.27)	(7350.99)
	[0.05261]	[-0.26613]	[-0.32723]
R-squared	0.417934	0.453965	0.626268
Adj. R-squared	0.389882	0.427650	0.608257
Sumsq. resids	8295.657	4.18E+11	3.94E+11
S.E. equation	9.997383	70941.95	68896.19
F-statistic	14.89885	17.25120	34.77105

( ) - standard errors; [ ] - t-statistics.*, % 5 , ** % 1. Model was selected based on AIC criterion. The lag number was 1.

Table 6. Model fit statistics

Amount of Production			
Fit Statistics	**Holt**	**Brown**	**Damped Trend**
Stationary R-squared	0.566	0.507	0.032
R-squared	0.961	0.956	0.961
BIC	22.154	22.216	22.210
The cultivated area			
Fit Statistics	**Holt**	**Brown**	**Damped Trend**
Stationary R-squared	0.584	0.529	0.042
R-squared	0.868	0.851	0.869
BIC	22.482	22.547	22.540
Import			
Fit Statistics	**Holt**	**Brown**	**Damped Trend**
Stationary R-squared	0.730	0.730	0.261
R-squared	0.920	0.920	0.922
BIC	22.940	22.847	23.009

Table 7. Exponential Smoothing Model Parameters

Production (Holt linear trend)				
Parameters	Estimate	SE	T	Sig.
Alpha (Level)	0.759	0.106	7.183	0.000
Gamma (Trend)	0.002	0.013	0.150	0.881
Sown area (Holt linear trend)				
	Estimate	SE	T	Sig.
Alpha (Level)	0.701	0.101	6.903	0.000
Gamma (Trend)	5.726E-06	0.039	0.000	0.999
Import (Brown linear trend)				
	Estimate	SE	T	Sig.
Alpha (Level)	0.231	0.044	5.253	0.001

Table 8. Forecasts of amount of production, cultivated area and yield of cotton lint.

Year	Production amount (tons)	Cultivated area (ha)	Yield ($kg.da^{-1}$)
2016	779306	450862	173
2017	789537	455700	173
2018	799768	460538	174
2019	809999	465375	174
2020	820230	470213	174
2021	830461	475051	175
2022	840692	479889	175
2023	850923	484727	176
2024	861154	489565	176
2025	871385	494403	176
2026	881616	499241	177

Table 9. The cotton lint amount per head by years (kg).

Year	Population	Production (tons)	Production amount per person (kg)	Import (tons)	Import amount per person (kg)	The used amount (ton)	The used amount per person (kg)
2013	76481847	877500	11.47	869175	11.36	1746675	22.84
2014	77323892	846000	10.94	910000	11.77	1756000	22.71
2015	78151750	738000	9.44	876174	11.21	1614174	20.65
2016	78965645	779306	9.87	901526	11.42	1680832	21.29
2017	79766012	789537	9.90	926878	11.62	1716415	21.52
2018	80551266	799768	9.93	952230	11.82	1751998	21.75
2019	81321569	809999	9.96	977583	12.02	1787582	21.98
2020	82076788	820230	9.99	1002935	12.22	1823165	22.21
2021	82816250	830461	10.03	1028287	12.42	1858748	22.44
2022	83540076	840692	10.06	1053640	12.61	1894332	22.68
2023	84247088	850923	10.10	1078992	12.81	1929915	22.91
2024	84936010	861154	10.14	1104344	13.00	1965498	23.14
2025	85569125	871385	10.18	1129696	13.20	2001081	23.39
2026	86182900	881616	10.23	1155049	13.40	2036665	23.63

DISCUSSION

In literature, there are a limited number of studies on the econometrical assessment of cultivated area, production and yield. Ali *et al.* (2015) determined that ARIMA (2,1,1) was the appropriate model for yield forecasting by using cotton yield data from 1948 to 2012. Anwar *et al.* (2010) reported that the coefficient values of variable world demand (LWD), the openness (LOP), competitiveness (LCM) and magnitude of concentration (LCI) of cotton lint were found as 0.30, 0.20, 0.744 and 0.33, respectively ($P<0.05$), but the coefficient of error correction term was estimated as -0.218.

In another study, Boansi *et al.* (2014) reported that export value, export price, cotton lint production, trade index of export, comparative export performance index and world volume of cotton lint exports had significant effects on the volume of cotton lint exports from Mali. The coefficient of error correction term was significantly found as -0.558.

Our results could not be compared with the results of the previous studies, as there are differences in variables, applied econometric models and number of years covered by the studied periods.

Conclusion: In this study, causality relationship between applied, cultivated area and yield of cotton lint from the period 1925 – 2015 was investigated by cointegration analysis and VECM. The first differences of the variables were taken after ADF unit root test, and thus the stationary variables were derived. The long-term relationship between the variables were tested by Johansen cointegration analysis, and it was observed that amount of production, cultivated area and yield of cotton from the period 1925 – 2015 in Turkey were cointegrated. When cotton yield was taken as a dependent variable, a positive relationship of yield with production amount and cultivated area, according to cointegration vector, was noted. VECM results reflected an apparent long-term causality relationship between the variables. In the study, 40.4% of the imbalances in the long-term is removed within 1 year and equilibrium between amount of production, cultivated area and yield was reached again. Increases in amount of production and cultivated area were forecasted for 2016 – 2026 by Holt exponential smoothing method. The cotton yield per 0,1 ha was estimated between 173 and 177 kg, which was consistent with the yield obtained in recent years. With the increase of Turkey's population, it is expected that amount of production and cultivated area of cotton lint will increase, and it is expected that meeting the cotton lint requirements of a growing population between 2016 and 2026 will represent a challenge for policymakers. In this case, cotton production must be increased in order to prevent the outflow of foreign currency resources. Increasing amount of production and imports, though, also causes an increase in the utilized amount of cotton. Thus, it is inferred that the current per capita utilization amount of cotton should be maintained in order to observe an import value of approximately 20 billion dollars forecasted for the period 2016 – 2026. This policy should also be supported with agricultural policies and programs designed for increasing domestic production of cotton lint in order to meet the demand of a growing population with a higher proportion of domestically-produced cotton in the future.

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