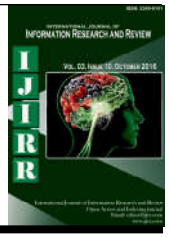
IJIRR

International Journal of Information Research and Review
Vol. 03, Issue, 10, pp. 2887-2897, October, 2016



Research Article

FORECASTING PRODUCTION OF SOME CEREAL IN TURKEY BY TIME SERIES ANALYSIS

***Senol Celik**

Bingol University, Agricultural Faculty, Department of Animal Science, Bingol, Turkey

ARTICLE INFO

Article History:

Received 24th July 2016
Received in revised form
16th August 2016
Accepted 26th September 2016
Published online 31st October 2016

Keywords:
Production Amount,
Exponential Smoothing,
First Difference,
Forecasting.

ABSTRACT

The objective of the investigation was to forecast annual production amounts of some cereal (wheat, barley and maize) produced in Turkey.Holt, Brown and Damped Trend exponential smoothing methods were carried out for statistical model the time series data for the 1965-2015 period. Wheat, barley and maize production amounts for the period 2016 to 2025 were predicted using Holt exponential smoothing method. The conclusion from the research is that, cereals production will be increased in future.

INTRODUCTION

Cereals are very important for human nutrition. Cereals which also of great importance for the national economy have got the large acreage of and the highest production share among field crops. According to FAO (2014) statistics, China ranks first with 126 212 750 tons, India is the second with 94 483 000 million tons, and Russian Federation is the third with 59 711 382 tons of wheat production in the world. According to FAO data (2014), Turkey ranks 10th with wheat production amounts 19 000 000 tons among the world's countries. Wheat production has amounted to 22 600 000 tons in 2015 (TSI, 2015). Wheat production amount is 728 966 757 tons in the world. According to FAO (2014) statistics, Russian Federation ranks first with 20 444 258 tons, France is the second with 11 770 000 tons, and Germany is the third with 11 562 800 tons of barley production in the world. According to FAO data (2014), Turkey ranks 8th with barley production amounts 6 300 000 tons among the world's countries. Barley production has amounted to 8 000 000 tons in 2015 (TSI, 2015). Barley production amount is 144 334 127 tons in the world. According to FAO (2014) statistics, China ranks first with 215 812 100 tons, Brazil is the second with 79 877 714 million tons, and Argentina were the third with 33 000 000 tons of maize production in the world. According to FAO data (2014), Turkey ranks 20th with maize production amounts 5 950 000 tons among the world's countries. Maize production has amounted to 6 400 000 tons in 2015 (TSI, 2015). Maize production amount is 1 038 281 035 tons in the world. Badmus and Ariyo (2011), determined as ARIMA (2,1,2) production of maize using ARIMA model in 1970-2005 period in Nigerian. Michel and Makowski (2013), examined as comparison the performance of eight statistical models, for analyzing yield time series and predicting yield trends. They chose wheat as the crop for this analysis, since wheat is an important cereal crop (27% and 58% of total cereal production worldwide and in France, respectively). Amin *et al*. (2014), evaluated time series models and found that the best model is ARIMA (1, 2, 2) for the objective to forecast the wheat production of Pakistan in 1902-2005 period. Barley production was designed to estimate in Punjab based on time series data from 1976 to 2011 by Naheed *et al*. (2015). They showed that double exponential smoothing method was the finest for forecasting barley production in the Punjab. This work was aimed to forecast annual production amounts of wheat, barley and maize plants in Turkey for between the years 2016 and 2025 using annual production data of the cereals from 1965 to 2015 by means of Holt, Brown and Damped Trend exponential smoothing methods.

****Corresponding author: Senol Celik,***
Bingol University, Agricultural Faculty, Department of Animal Science, Bingol, Turkey.

MATERIALS AND METHODS

The study material consists of data regarding production amounts of wheat, barley and maize plants between 1965 and 2015. The data were obtained from Statistical Indicators Book published by the Turkish Statistical Institute. Likewise, the data of the subsection "cereals and other herbal products/cereals" of Agricultural Statistics in TUIK database were made use of (TUIK 2015).

Time series data of these cereals were used Holt, Brown and Damped Trend exponential smoothing methods.

Exponential smoothing methods are combined methods giving different weights to the time series data at the previous period, and higher weights were given to the data recognizing in the recent past from the previous data in the estimation process, but the weights downward exponentially are given as ones are developed to the former data (Sharpe *et al*., 2010). Exponential smoothing models produce successful results in the short term (Yaffe and McGee, 2000). Holt method, one of the exponential smoothing methods, is used in the estimation of the series having a trend (Hanke and Wichern, 2008). In the Holt model, two coefficients, such as $\alpha$and β, used as smoothing coefficients for estimating the trend are employed. Holt model is expressed as follows:

$$L_t = \alpha Y_t + (1 \quad \alpha)(L_{t-1} + T_{t-1})$$
$$T_t = \beta(L_t \quad L_{t-1}) + (1 \quad \beta)T_{t-1}$$
$$\bar{y}_{t+p} = L_t + pT_t$$

Here,
L_t: New
smoothed value,α: Smoothing coefficient, (0<α<1), Y_t: Actual value at t. period
β: Smoothing coefficient for trend estimation, (0<$\beta < 1$), T_t: Trend predicted value
p:Number of forecasting periods, $\bar{y}_{t+p}$: Forecasting value after p period.

Brown's (1963) double exponential smoothing in the forecast, could be useful. Initially, the observed international inbounds time series are smoothed by adding a weighted estimate of the smoothed lag to the latest observation, y_t, by that means fruitful the smoothed seriesy_t^1. The latter can be smoothed again using the same coefficient, fruitful the doubly smoothed series y_t^2, that is:

$$y_t^1 = \alpha y_t + (1 \quad \alpha)y_{t-1}^1$$
$$y_t^2 = \alpha y_t^1 + (1 \quad \alpha)y_{t-1}^2$$

In the above equations,

y_t^1: The value obtained by single exponential smoothing, y_t^2: the binary exponential flatted value. Hereby, $a_t$andb_t statistics are calculated by the following equations:

$$a_t = y_t^1 + (y_t^1 \quad y_t^2) = 2y_t^1 \quad y_t^2$$
$$b_t = \frac{\alpha}{1 \quad \alpha} + (y_t^1 \quad y_t^2)$$

The damped trend exponential smoothing models are taken into account to perform an excellent forecasting (Sbrana, 2012).The damped method is expressed in the following equations (Grander and McKenzie, 1985).

$$S_t = \alpha Y_t + (1 \quad \alpha)(S_{t-1} + \varphi T_{t-1})$$
$$T_t = \gamma(S_t \quad S_{t-1}) + (1 \quad \gamma)\varphi T_{t-1})$$
$$Y_t(m) = S_t + \sum_{i=1}^{m} \varphi^i T_t$$

The predictive accuracy of the methods applied for the study was measured by Stationary R^2, coefficient of determination R^2, RMSE, MaxAPE and BIC, respectively. It is propounded to employ model fit statistics on BIC (Pektas, 2013), with a recompense which eliminates the advantage of the model that has more parameters.

Bayesian information criterion (BIC) was developed by Gideon E. Schwarz (1978), who gave a Bayesian argument for adopting it.

$$BIC = ln(\hat{\sigma}_e^2) + kln(n)/n$$

Here $\hat{\sigma}_e^2$ is the error variance.

Stationary R-Squared statistic was used by Harvey (1989).

Stationary R-Squared

$$R_S^2 = 1 \quad \frac{\sum_t (Y_t - \hat{Y}_t)^2}{\sum_t (\Delta Y_t - \overline{\Delta Y})^2}$$

as defined.

Where ΔY is the simple mean model for the differenced transformed series.

RMSE (Root Mean Square Error): The square root of mean square error. RMSE was calculated for each time series from the **N** available data. RMSE,

$$RMSE = \sqrt{\frac{1}{N}\sum_{t=1}^{N}(Y_t \quad \hat{Y}_t)^2}$$

where Y_t: is the production at time **t**, and $\hat{Y}_t$: the fitted production value obtained at the same time with the model adjusted for all available data. MaxAPE (Maximum Absolute Percentage Error): The largest forecasted error, expressed as a percentage. This measure is useful for imagining a worst-case scenario for your forecasts.

RESULTS

Wheat Production

Figure 1 show the chart of the time series relating to wheat production amount for the period 1965 to 2015. Stochastic trend was actual by the series in the Figure 1. For infer the trend clearer, autocorrelation (ACF) and partial autocorrelation functions (PACF) of the time series are investigated. ACF and PACF graphs of the wheat production were showed in Figures 2 and 3, respectively. Owing to as a matter of fact a vast number of terms of the series in ACF graph exceeded confidence limits, a trend is existent in the series. To comply stationary state of the series, the difference of the series was taken at the first degree. ACF and PACF graphs of the first difference series carve out for supplying the stationary state are given in Figures 4 and 5, respectively.

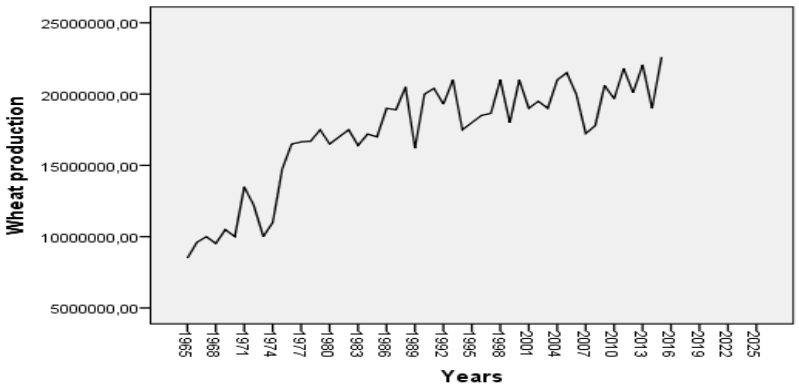


Figure 1. Chart of wheat production (tons)

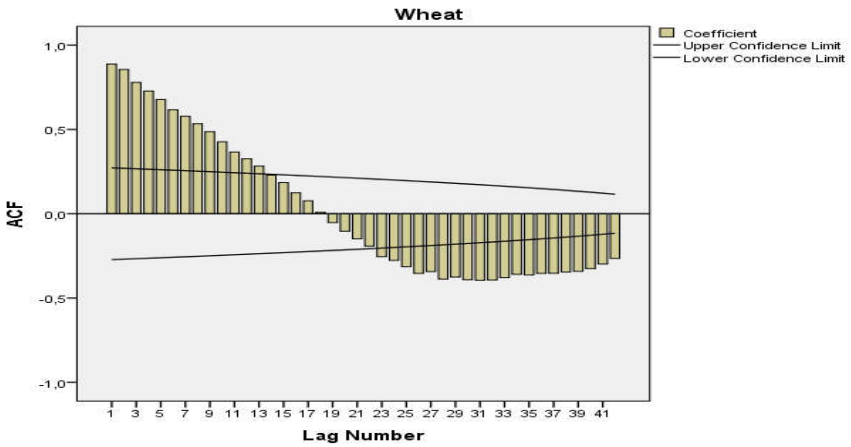


Figure 2. ACF graph of wheat production series

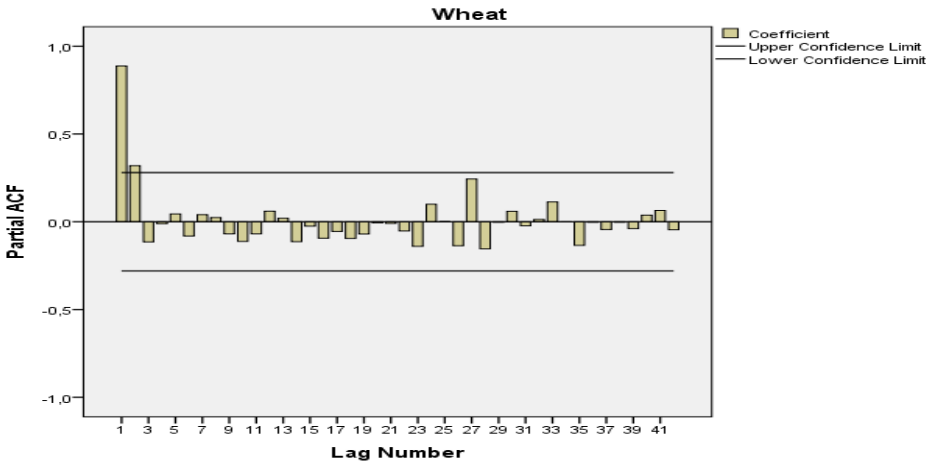


Figure 3. PACF graph of wheat production series

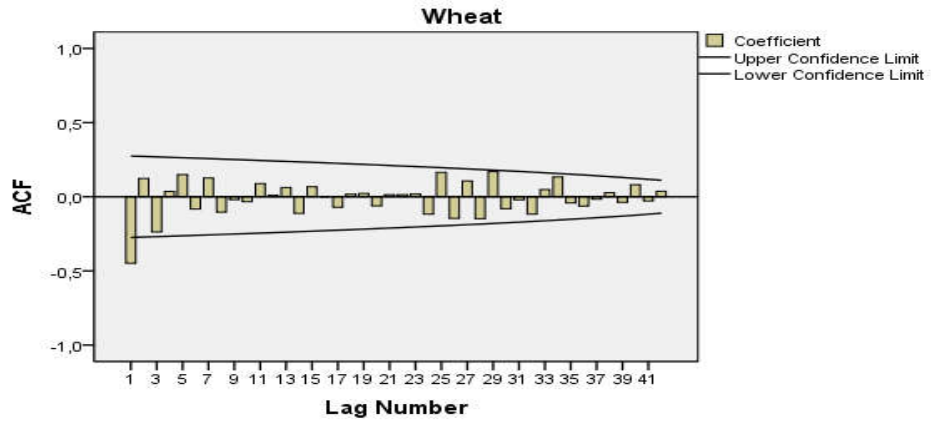


Figure 4. ACF graph of first differences of wheat production series

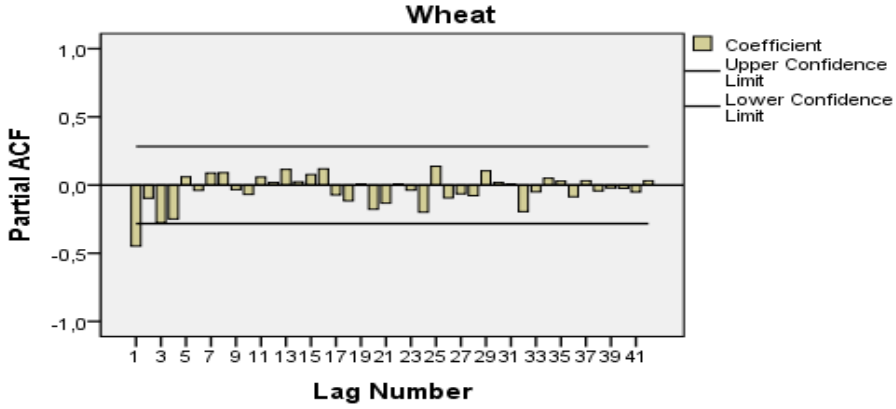


Figure 5. PACF graph of first differences of wheat production series

Following these results, model fit statistics such as stationary R^2, R^2, RMSE, MaxAPE and BIC criteria which were appreciated by Holt, Brown and Damped Trend smoothing methods were given in Table 1. In Table 1, Stationary R-squared values are 0.753, 0.720 and 0.299 according to Holt, Brown and Damped trend methods, respectively.R^2 values are 0.923, 0.788 and 0.824 according to Holt, Brown and Damped trend methods, respectively. Still according to the same methods, RMSE values are 1618043, 1749982 and 128387; MaxAPE values are 35.373, 34.697 and 31.302; BIC values are 28.748, 28.827 and 28.837, respectively. From Table 1, it is well showed that Holt smoothing method that value the lowest RMSE, and BIC value and the highest Stationary R-squared and R-squared were the best method. In Table 2, parameter coefficients of Holt smoothing method were determined as $\alpha = 0.058$ and $\gamma = 0.976$, respectively. In the statistical comparison of the models, it is significant to use statistics like BIC (Pektas, 2013). ACF and PACF graphs of the residuals are represented in Figure 6. In Figure 6, it is seen that relationship amount of lag in the ACF and PACF graphs within the confidence limits.

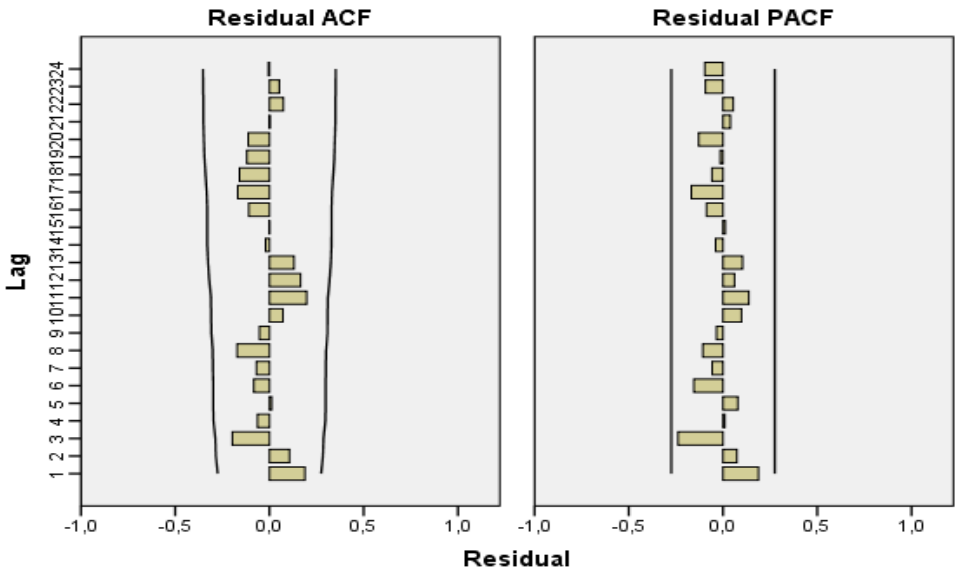


Figure 6. ACF and PACF graphs of residuals of wheat production

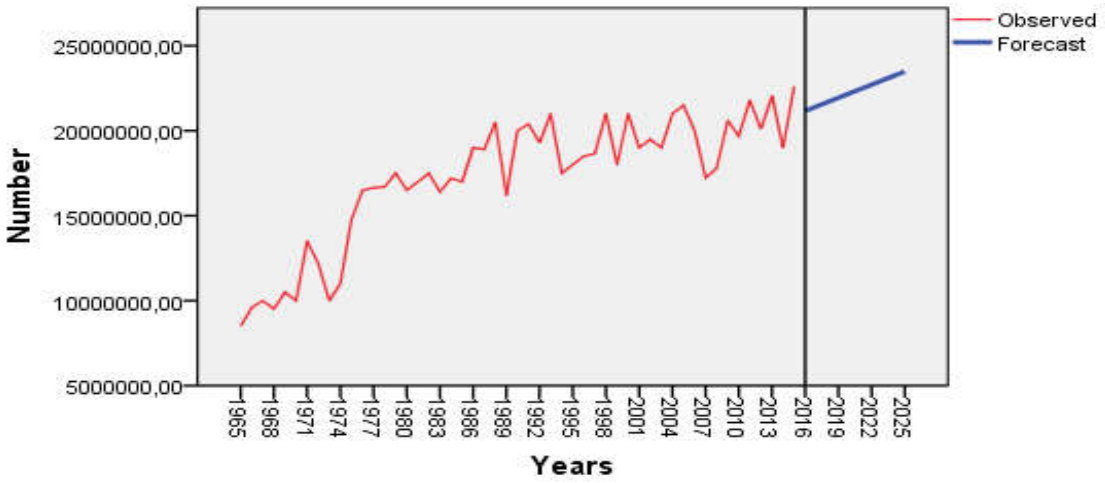


Figure 7. Graph of wheat production series and forecasting series

Table 1. Model fit statistics

Fit Statistics	Holt	Brown	Damped Trend
Stationary R-squared	0.753	0.720	0.299
R-squared	0.923	0.788	0.824
RMSE	1618043	1749982	1628387
MaxAPE	35.373	34.697	31.302
BIC	28.748	28.827	28.837

Tablo 2. Holt Exponential Smoothing Model Parameters

Parameters	Estimate	SE	t	Sig.
Alpha (Level)	0.058	0.050	1.148	0.256
Gamma (Trend)	0.976	0.915	1.067	0.291

Table 3. Forecasting results from the period 2016 to 2025

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Forecast	21166307	21424154	21682001	21939848	22197696	22455543	22713390	22971237	23229084	23486931

Thus, the series is White Noise. Following the results obtained prior, wheat production can be forecasted. Forecasting results are shown in Table 3. An increase in wheat production amounts from the period 2016 to 2025 is expected.

Barley production

Figure 8shows graph of the time series data of barley production amounts from the period 1965-2015. A trend is existing for the time series. ACF and PACF graphs which were drawn for seeing the trend clearer are depicted in Figures 9 and 10, respectively. When ACF and PACF graphs are analyzed in Figures 9 and 10, many terms of the series in ACF graph surpassed confidence limits, and the series formed a trend. Stationary of the series, the first degree difference of the series was taken.ACF and PACF graphs of the first degree series are given in Figures11 and 12, respectively.

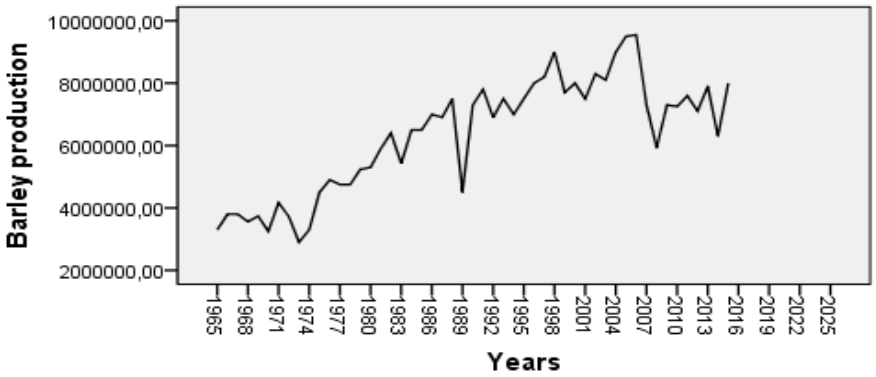


Figure 8. Chart of barley production (tons)

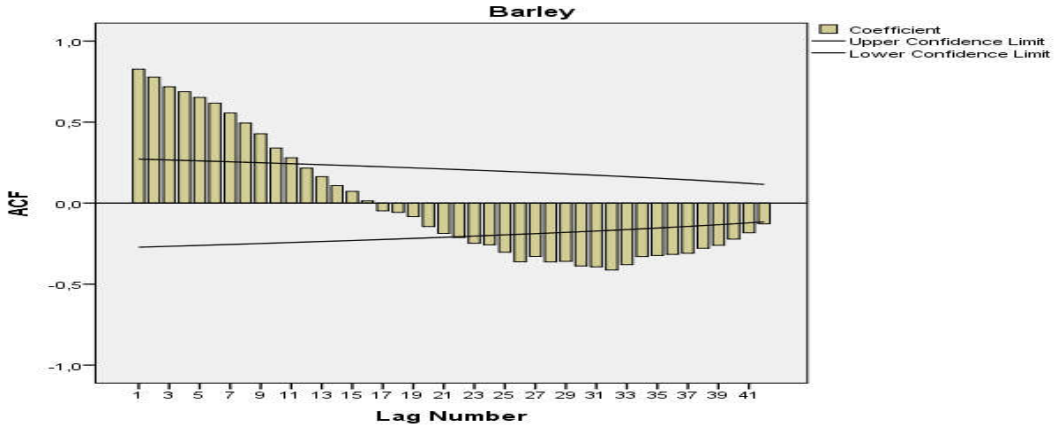


Figure 9. ACF graph of barley production series

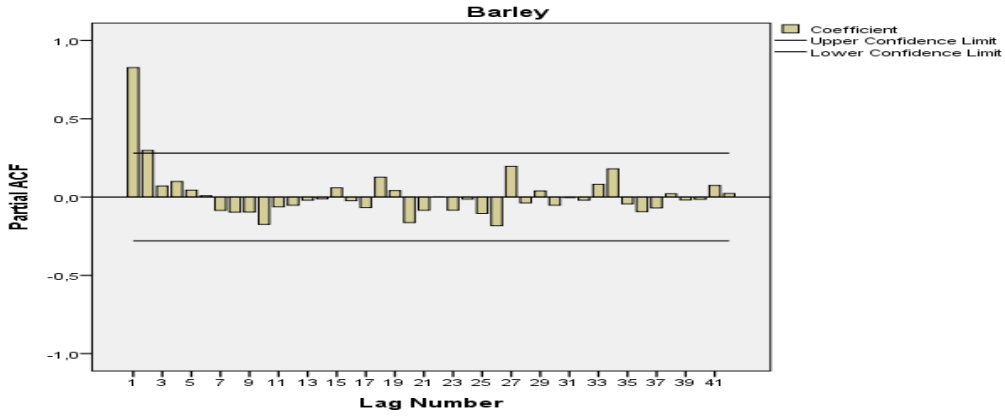


Figure 10. PACF graph of barley production series

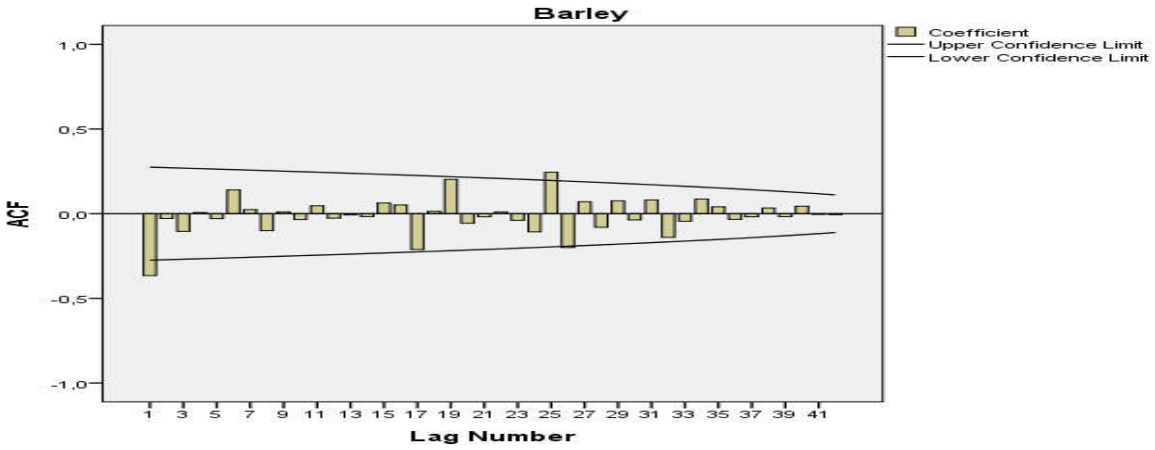


Figure 11.ACF graph of first differences of barley production series

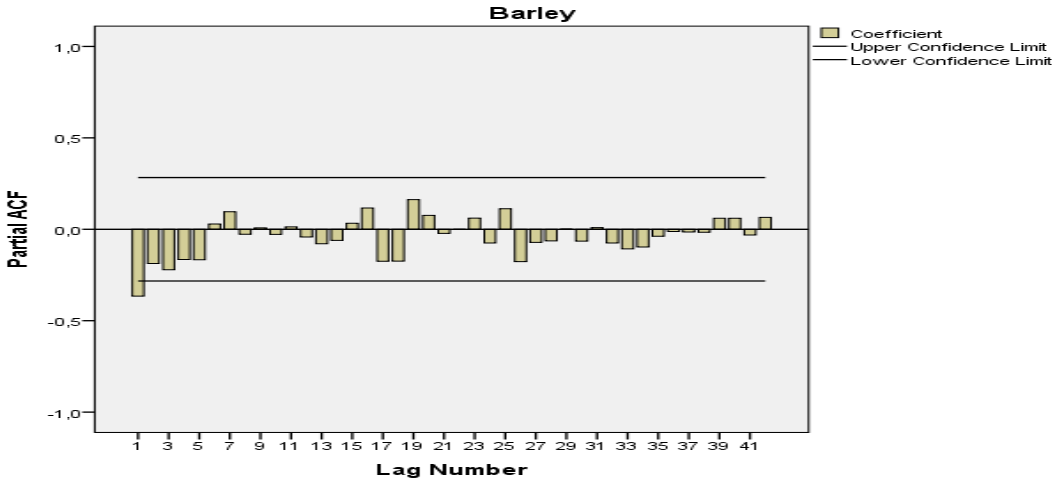


Figure 12. PACF graph of first differences of barley production series

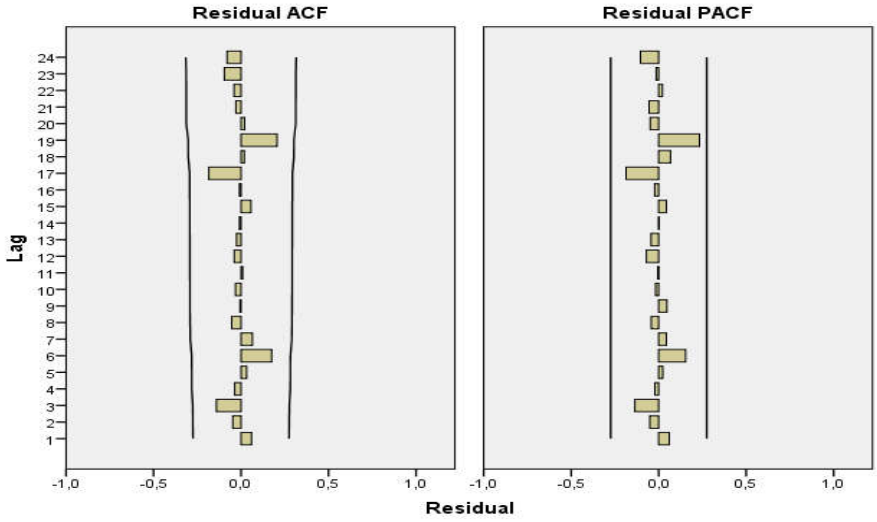


Figure 13. ACF and PACF graphs of residuals of barley production

When Figures 11 and 12 were looked over, terms of ACF and PACF graphs for the first difference time series were within confidence limits because of being produced the stationary time series. In this case, the best smoothing one among Holt, Brown and Damped Trend smoothing methods was selected by using Stationary R^2, R^2, RMSE, MaxAPE and BIC As can be seen from Table 4, generally the most appropriate method was Holt smoothing method. Coefficients of Holt smoothing method are showed in Table 5 was estimated as alpha $\alpha = 0.4$ andgamma $\gamma = 0.0$, respectively. The ACF and PACF graphs of the residuals for barley production are represented in Figure 13.

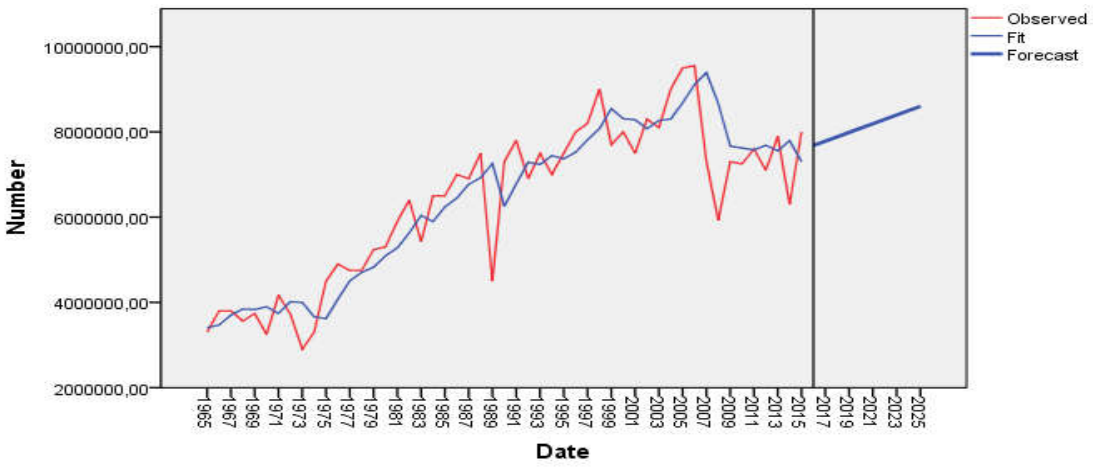


Figure 14. Graph of barley production series and forecasting series

Table 4.Model fit statistics of the series of barley production

Fit Statistics	Holt	Brown	Damped Trend
Stationary R-squared	0.708	0.692	0.222
R-squared	0.786	0.772	0.787
RMSE	856972.138	875933.703	863573.261
MaxAPE	61.263	66.856	60.544
BIC	27.477	27.443	27.569

Table 5. Exponential Smoothing Model Parameters (Holt) for barley production data

	Estimate	SE	t	Sig.
Alpha (Level)	0.400	0.119	3.350	0.002
Gamma (Trend)	0.000	0.080	0.001	0.999

In figure 13, the degree of relationship between the residuals in ACF and PACF graphs were found within confidence limits. The common graph of the original series and forecasting series is shown in Figure 14. Forecasting results of barley production data from the period 2016 to 2025 are presented in Table 6.

Table 6.Forecasting results from the period 2016 to 2025 (barley production)

Years	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Forecast	7681370	7783419	7885468	7987516	8089565	8191614	8293663	8395712	8497761	8599810

Maize production

Graph of maize production data from the period 1965-2015 is given in Figure 15.Stochastic trend was obtained from data. However, ACF and PACF graphs which are more informative on the trend are presented in Figures 16 and 17, respectively.

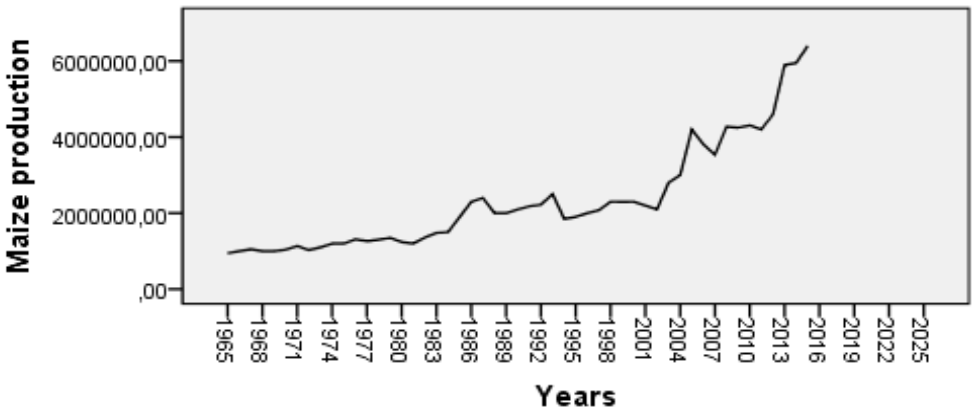


Figure 15. Chart of maize production (tons)

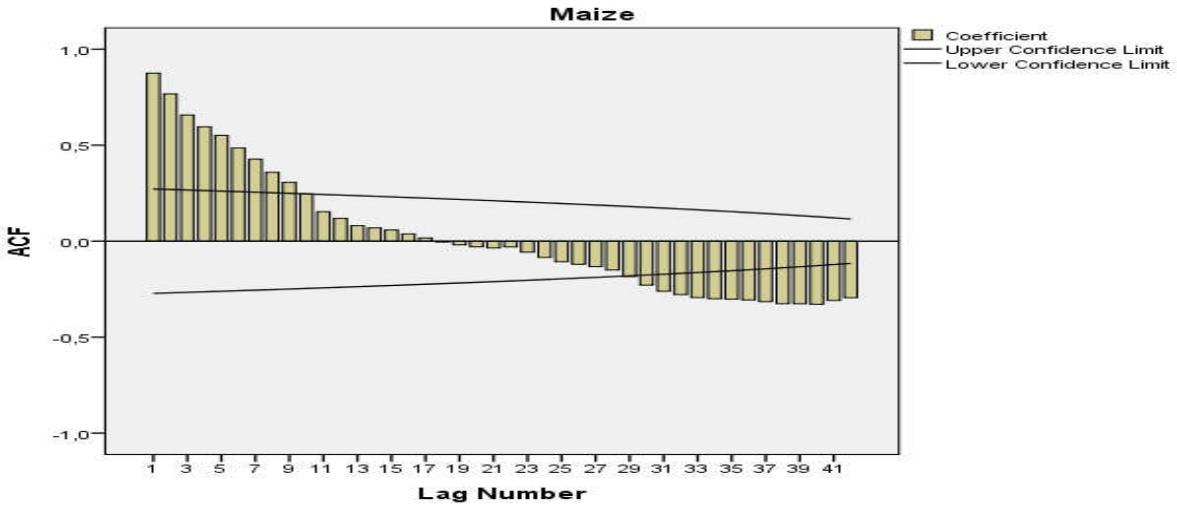


Figure 16. ACF graph of maize production series

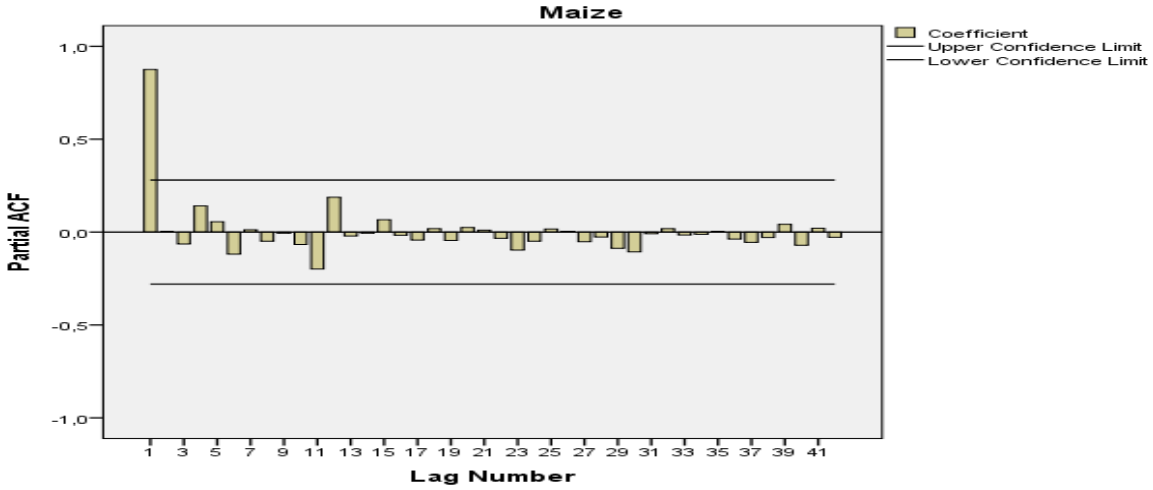


Figure 17. PACF graph of maize production series

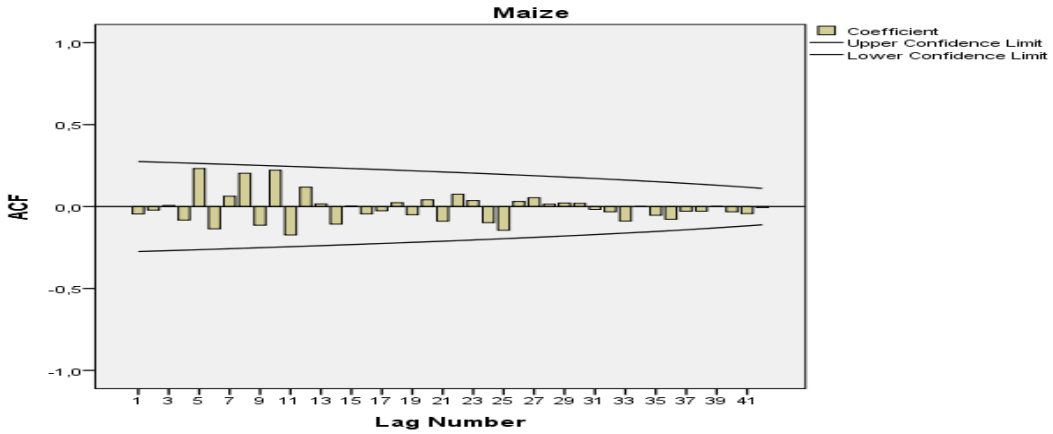


Figure 18. ACF graph of first differences of maize production series

When ACF graph in Figure 16 was observed, it could be seen that there was a trend in this place. To produce the stationary series for maize production data, the first difference of the data must be created. Figures18 and 19present ACF and PACF graphs of the first difference series obtained by the maize production data, respectively. Results of model fit statistics for the exponential smoothing methods in the study are given in Table 7, and demonstrated that Holt exponential smoothing method yielded a better fit owing to its greater stationary R^2cross checked with other methods.

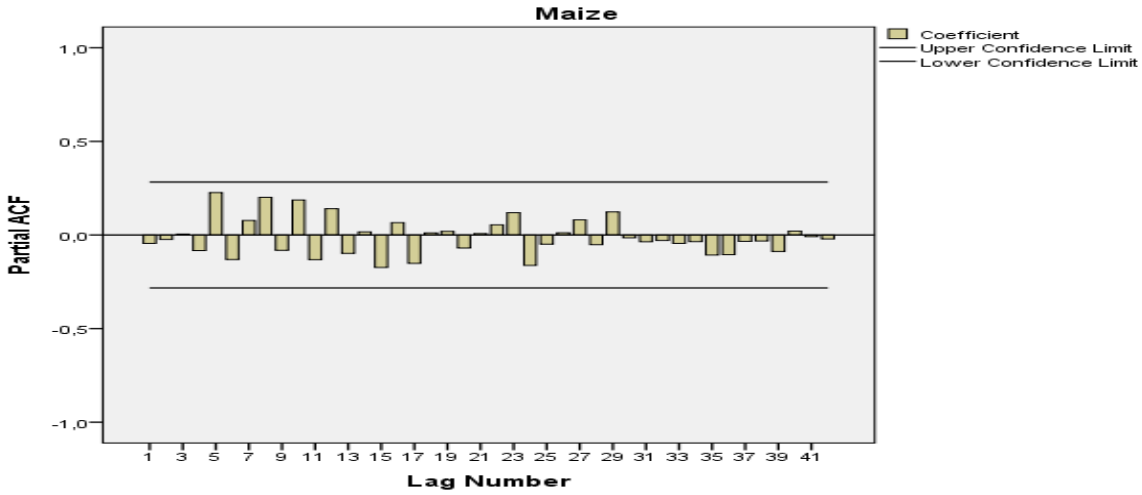


Figure 19. PACF graph of first differences of maize production series

Table 7. Model fit statistics for the maize production data

Fit Statistics	Holt	Brown	Damped Trend
Stationary R-squared	0.516	0.485	0.002
R-squared	0.945	0.941	0.945
RMSE	333169.477	340202.179	336698.604
MaxAPE	37.382	34.837	37.213
BIC	25.587	25.552	25.685

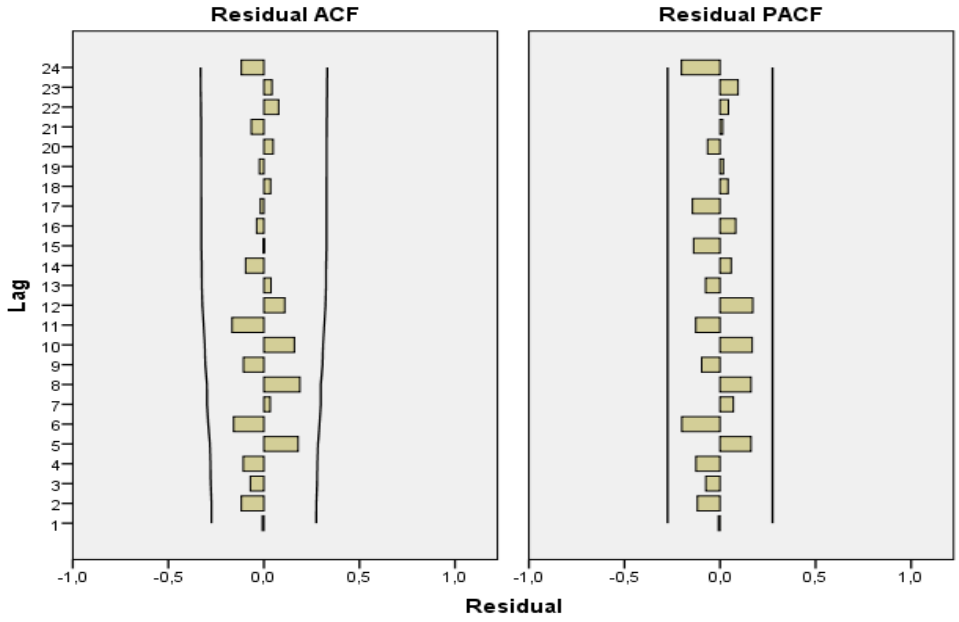


Figure 20. ACF and PACF graphs of residuals of maize production

Table 8. Exponential Smoothing Model Parameters of maize production (Holt model)

	Estimate	SE	t	Sig.
Alpha (Level)	0.868	0.155	5.614	0.000
Gamma (Trend)	0.086	0.098	0.872	0.387

Parameter coefficients of the Holt smoothing method are showed in Table 8, and became equal to $\alpha = 0.868$ and $\gamma = 0.086$, respectively. ACF and PACF graphs of the residuals are given in Figure 20.

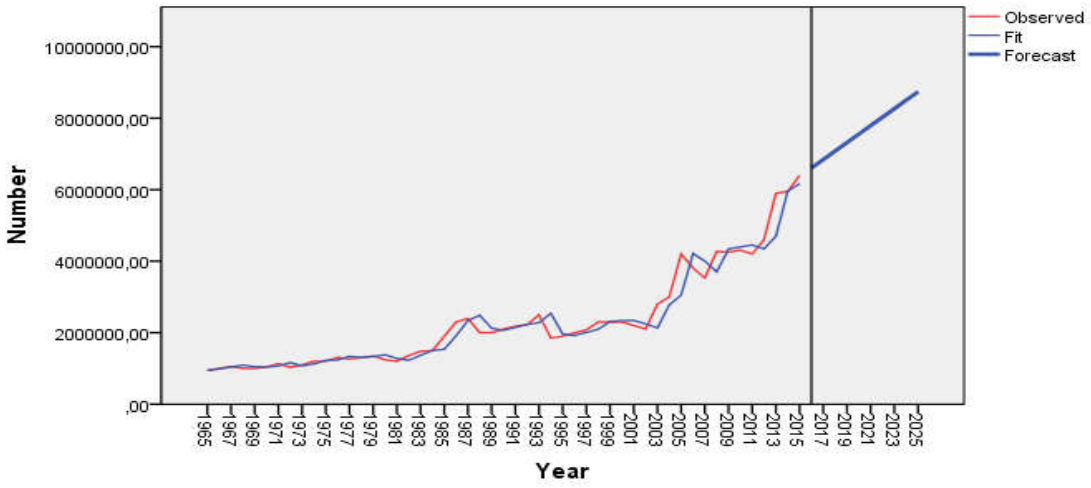


Figure 21. Graph of maize production series and forecasting series

Table 9. Forecasting results from the period 2016 to 2025 (Maize production)

Years	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Forecast	6606859	6843934	7081010	7318085	7555160	7792235	8029311	8266386	8503461	8740536

Accordingly, a series of white noise series. The joint graph of forecasting series and original series is shown in Figure 21. Forecasting series was in settlement with the original series. Forecasting results from the period 2016 to 2025 are given in Table 9. A serious increase in maize production is forecasted. In the present study, forecasting results from the period 2016-2025 also demonstrated an increasing trend in wheat, barley and maize production. In line with this information, it is important that farmers should be supported in grains for increasing the production. It was understood well that more boundless projection works for the researched grains should be performed.

Conclusion

In this research, wheat, barley and maize production amounts in Turkey for the period 2016- 2025 were forecasted with high accuracy by using Holt exponential smoothing method with two parameters, which yielded the best one among exponential smoothing methods on the basis of Stationary R^2, R^2,RMSE, MaxAPE and BIC criteria. In predictive between 2016- 2025, wheat production are from 21 166 307 to 23 486 931 tons, barley production are from 7 681 370 to 8 599 810 tons, and maize production are from 6 606 859 to 8 740 536 to. An increase in the forecasting results of wheat, barley and maize production was significant a development for Turkish economy. In conclusion, Holt method yielded better results than other methods of exponential smoothing, in the analysis of time series data of some cereal production,

REFERENCES

Amin, M., Amanullah, M., Akbar, A. 2014. Time series modeling for forecasting wheat production of Pakistan. *The Journal of Animal & Plant Sciences*, 24(5): 1444-1451.

Badmus M. A., Ariyo, O. S. 2011. Forecasting Cultivated Areas and Production of Maize in Nigerian using ARIMA Model. *Asian Journal of Agricultural Sciences* 3(3): 171-176.

Brown, R. G. 1963. Smoothing, Forecasting and Prediction of Discrete Time Series.Englewood Cliffs NJ: Prentice-Hall.

FAO. Faostat. http://faostat3.fao.org/browse/Q/QC/E (16.09.2016).

Gardner Jr., E.S., McKenzie, E. 1985. Forecasting trends in time series, *Manage. Sci.* 31:1237–1246.

Hanke, J. E., D. W. Wichern. 2008. Business Forecasting. Pearson Education International.

Harvey, A. C. 1989. Forecasting, structural time series models and the Kalman filter. Cambridge: Cambridge University Press.

Michel, L., Makowski, D. 2013. Comparison of Statistical Models for Analyzing Wheat Yield Time Series. Plos One 8(10): 1-11.

Naheed, S., Raza, I., Anwar, M. Z., Habib, N., Zahra, N., Siddiqui. 2015. Forecsting Area and Production of Barley in Punjab, Pakistan. Pakistan Journal Agriculture Research 28(3): 304-309.

Pektaş, A. O. 2013. SPSS ile Veri Madenciliği. Dikeyeksen Yayın Dağıtım, Yazılım veEğitim Hizmetleri San.ve Tic. Ltd. Şti., İstanbul.

Sbrana, G. 2012. Damped trend exponential smoothing: Prediction and control. Journal of Quantitative Economics, 10(2):152-159

Sharpe, R. N., De Vaux, R., Velleman, P. F. 2010. Business Statistics, 2nd Edition, Boston, Addison Vesley - Pearson Education.

Schwarz, G. E. 1978. Estimating the dimension of a Model. Annals of Statistics. 6(2):461-464.

TUIK, 2015. Turkish Statistical Institute. http://www.tuik.gov.tr/PreTablo.do?alt_id=1001 (20.09.2016).

TUIK, 2014. Statistical Indicators 1923-2013. Turkish Statistical Institute, Ankara, Turkey.

Yaffee, R.A. Mc Gee, M. 2000. Introduction to Time Series Analysis and Forecasting with Applications of SAS and SPSS, Academic Press.

****