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FORECASTING AREA AND PRODUCTION OF BARLEY IN PUNJAB, PAKISTAN

Sobia Naheed*, Irum Raza*, M. Zubair Anwar*, Nusrat Habib*, Naheed Zahra* and Sabeen Siddiqui*

ABSTRACT:- This study was designed to estimate barley area and production in Punjab based on time series data from 1976 to 2011. Four models namely quadratic trend, linear trend, exponential growth curve and double exponential smoothing were compared and the best fitting model was chosen by reason of three accuracy measures namely mean absolute deviation (MAD), mean absolute percentage error (MAPE), and mean squared deviation (MSD). The values of these measures were lowest for the double exponential smoothing method, therefore, this method was selected for predicting barley production and area in Punjab from 2012 to 2016. Five years forecast for barley area in Punjab was 26.140, 25.360, 24.580, 23.800, 23.020 ha and forecast of barley production in Punjab was 24.620, 23.950, 23.270, 22.600 and 21.930 tonnes for 2012, 2013, 2014, 2015 and 2016, respectively, with a 95% prediction interval. Declining trends in area and production of barley was observed from original series and this trend will be prevalent in the next five years after being forecasted. The estimates obtained from the results also depict inadequate supply of barley to meet up the ever-increasing food necessities of the country.

Key Words: Barley; Trend Analysis; Forecasting; Area; Production; Pakistan.

INTRODUCTION

Barley is the fifth largest cultivated cereal crop in the world with annual production of 136 mt on about 56 mha. In Pakistan production of barley has decreased to 1.4% in 2011-12 as compared to 2010-11. Similarly area of barley was 77000 ha in 2010-11 and it turned down to 75000 ha in 2011-12 (GoP, 2010). The decrease in barley production and area is because of insufficient compost use, poor groundwork, not have plant safety and reduction of crop for fodder. The consumption of barley crop by humans has now decreased substantially over the years and the use of wheat has become popular. Barley crop is now rapidly being used as poultry feed. Barley is adapted to marginal and stress-prone environments and is considered as a danger aversion crop by deprived farmers (Bilal and Shahbaz, 2008).

Barley the most dietary cereal, contains the right quantity of all the essential nutrients. Barley water is known to have many medicinal belongings and helps in rapid curing of many diseases and disorders. It minimizes/control body weight and is used as an appetite. The use of barley in industries for making health tonics and malt shows that this is an important crop throughout the world (Chand et al., 2008). The Prophet Muhammad (*Sallallahu Alayhi Wasallam*) used barley as bread, talbina (*dalia* of barley) and *sattu*

* *Social Science Research Institute, National Agricultural Research Center, Islamabad, Pakistan.*
Corresponding author: sobianarc@gmail.com

(powdered barley) (Ghaznavi, 1987). Oscarsson et al. (1996) has stated that production of barley except the salt, provides a knowledge/information regarding its routine uses in common life. In the soils where wheat, maize, rice and sugarcane cannot be cultivated easily, barley (*jou*) being a tolerant crop that can resist harsh environments is cultivated. Not only barley gives good yields with lesser agriculture inputs but it can also replenish the damaged soil. The sowing of barley starts with wheat, but due to fast growth rate, it matures early for harvesting. The use of barley has also been emphasized by Noaman et al. (1995).

Keeping in view the significance of barley, it is necessary to appraise technically the upcoming estimates of barley crop stands on earlier period trend. Projection methods in crop growing include prediction of yield, area of harvest and forewarning of incidence of crop pests and infections (Ramasubramanianv, 2009). Reliable and timely forecast provide important and useful input for suitable, foresighted and informed preparation in cultivation. Timely estimates of crop yield are required on behalf of various strategy conclusions relating to storage, allocation, worth, advertising, import-export etc. (Agrawal, 2005). The purpose of this study is to test out the earlier period trends of barley area and production in Punjab and second is to make estimates about production and area for next five years by the most excellent integral statistical model.

MATERIALS AND METHOD

Time series data of barley production and area in Punjab from 1976 to 2011 were gathered from different issues of Agricultural Statistics of Pakistan. Statistical analysis was performed in MINITAB software (2007).

Statistical Analysis

Trend analysis and double exponential smoothing techniques have been used to forecast barley production in Punjab from 2011-12 to 2015-16.

Trend Analysis

Three trend analysis models employed to make comparison and select the appropriate one based on forecasting errors includes quadratic, linear and growth trend models and described as specified in the (MINITAB software, 2007) are explained below:

Linear Trend

$$Y_t = \beta_0 + \beta_1 t + et$$

where,

Y = Production of barley in time t

β_0 = Constant

β_1 = Regression coefficient

t = Time

Quadratic Trend

The quadratic trend model accounts for simple curvature in the data.

$$Y_t = \beta_0 + \beta_1 * t + \beta_2 t_2 + et$$

·Exponential Growth Model

For exponential growth or decay the exponential growth trend model accounts where Y is the dependent variable, β_0 is intercept and β_1 is slope that varies over time.

$$Y_t = \beta_0 * \beta_1 t * et$$

Double Exponential Smoothing Method

This method smoothes data and provide short term forecasts (Brown, 1959). This technique is also recomm-

ended by Bowerman et al. (1993).

The general form of linear exponential smoothing model can be articulated in algebraic form as given below: S' signify the smoothed sequence acquired by means of relating to series Y simple exponential smoothing. That is, at period t and the value of S' is given by:

$$S'(t) = \alpha Y(t) + (1-\alpha)S'(t-1)$$

Let S" denotes the double smoothed sequence attained by relating uncomplicated exponential smoothing.

$$S''(t) = \alpha S'(t) + (1-\alpha)S''(t-1)$$

As a final point, the forecast

$Y(t+1)$ is given by:

$$Y(t+1) = a(t) + b(t)$$

where,

$a(t) = 2S'(t) - S''(t)$ the predictable point at time t.

$b(t) = (a/(1-\alpha))(S'(t) - S''(t))$ projected trend at phase t.

Accuracy Measures

Forecasting methods were compared on the basis of three forecasting errors namely Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD) and the one with minimum value of these Error was selected for forecasting purpose (Karim et al., 2010).

RESULTS AND DISCUSSION

Original Series

Barley production in Punjab had a declining trend from 1976 to 1978. Barley production in 1978 was 55400 t and it grew rapidly up to 65100 t in 1979. Then there was a sudden decline in barley production during 1980. Again notable figure of production (112500 t) was found in 1981. An abrupt turn down of barley production was found after 1981 and then the production of barley showed a stagnant or constant pattern till 2011. The area of barley showed a decreasing trend from 1976 to 1978. Area under barley was 78100 ha in 1978 and then it raised to 89800 ha in 1979. A sudden rise in the area was found in 1981 (177600 ha). Therefore, increase in barley production during 1979 and 1981 might be improved usage of agricultural inputs and policy maker's decisions. A severe turn down in barley area had been observed from 1982 to 2011. Therefore, the expansion of production of barley is not adequate sufficient to assemble the forever rising foodstuff necessities of the Punjab.

Selection of the Model

The value of MAPE for double exponential smoothing method (12.33) was lowest as compared to the values of MAPE for linear (19.84), quadratic (16.22) and growth (15.29), respectively (Table 1). Similarly the values of MAD and MSD for double exponential smoothing method (6.45 and 143.11, respectively) were smaller than their corresponding values of MAD for

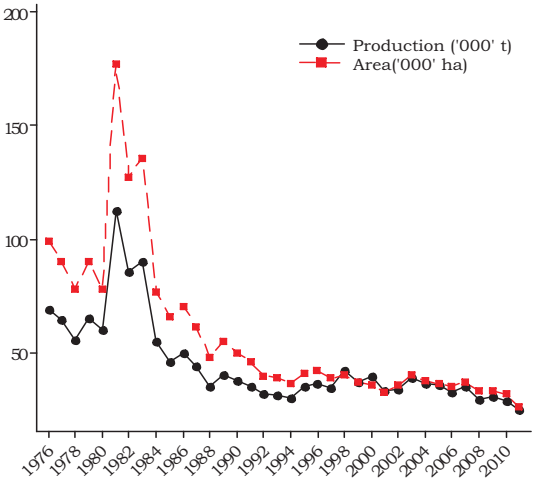

Figure 1. Time series plot showing trends of barley production and area in Punjab

Table 1. Diagnostic measures for the selection of best forecasting method for barley production and area in Punjab

Forecasting model	Production ('000't)			Area ('000'ha)		
	MAPE	MAD	MSD	MAPE	MAD	MSD
Linear trend	19.846	9.043	177.230	26.545	15.010	486.754
Quadratic trend	16.227	8.124	152.036	16.011	11.651	416.563
Exponential growth	15.297	7.612	169.830	16.244	11.151	459.541
Double exponential	12.332	6.456	143.110	12.680	9.440	423.863

linear (9.04), quadratic (8.12) and growth (7.61) and the values of MSD were 177.23, 152.03 and 169.83, for linear, quadratic and growth, respectively. These values suggest that double exponential smoothing method provides improved well to the figures and is suitable for expecting upcoming barley production in the Punjab province of Pakistan.

The value of MAPE is lowest (12.68) for double exponential smoothing model in contrast to the values for linear trend (26.54), quadratic trend (16.01) and exponential growth (16.24) (Table 1). In the same way smaller value of MAD (9.44) was found for the double exponential smoothing model as compared to linear trend (15.01), quadratic trend (16.01) and exponential growth (16.24). The value of MSD was lowest for quadratic model (416.56) but the values of MAPE and MAD were smallest for double exponential smoothing method suggesting that it can be used as an appropriate model for estimating area of barley in Punjab. Similar studies show application of exponential smoothing methods as well as trends for estimating wheat production in Bangladesh (Karim et al., 2010) and price estimation of major pulses (Rani and Raza, 2012). MAPE, MAD and MSD were used as a model selection criteria.

Forecasting Barley Area and Production using Double Exponential Smoothing Method

The projected results of area with 95% forecast interval showed that if the present growth remains the same then the area of barley will be 23020 ha in 2016 (Table 2). It is obvious from the analysis that area of barley will decline in the coming years. Double

Table 2. Five years 95% forecast of barley production and area in Punjab using double exponential smoothing model

	Description	Forecast year				
		2012	2013	2014	2015	2016
Production	Lower limit	08.8084	02.5941	04.0200	10.8300	17.7500
	Forecast	24.6245	23.9514	23.2782	22.6051	21.9319
	Upper limit	40.4407	45.3087	50.5836	56.0400	61.6100
Area	Lower limit	03.0200	04.6670	12.9100	21.4400	30.1400
	Forecast	26.1400	25.3600	24.5800	23.8000	23.0200
	Upper limit	49.2700	55.3900	62.0800	69.0500	76.1800

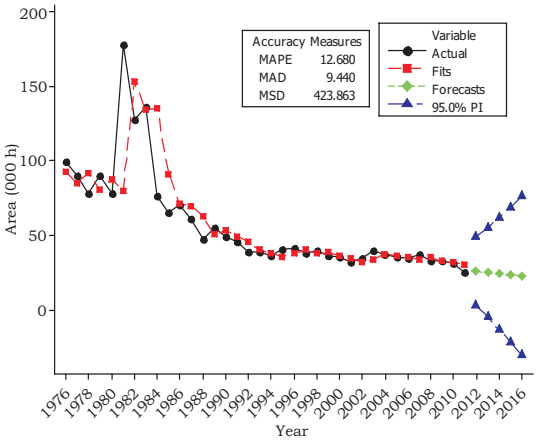

Figure 2. Double exponential smoothing plot for barley area in Punjab

exponential smoothing plot (Figure 2) also depicts that area of barley is decreasing up till the future estimates. Similarly the forecasted production of barley in the Punjab during 2012 was 24620 t with 95% prediction interval. The research revealed that if this growth rate remains the similar after that barley production in the Punjab would be 21930 t in 2016. It implies that barley production in Punjab will also decrease in the following years which are apparent (Figure 3). This decrease

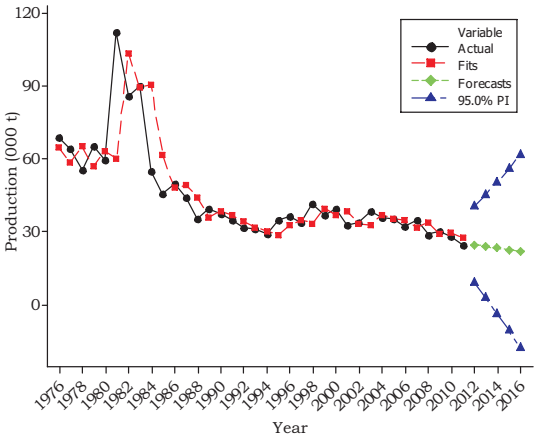

Figure 3. Double exponential smoothing plot for barley production in Punjab

in barley area and production might be reluctance of the government and policy makers in forming policies about the growth of this crop and secondly lack of the interest of farmers in growing this crop. So the current production of barley is not significant adequate to convene the always rising food necessities of the country.

CONCLUSION AND RECOMMENDATION

The study showed that double exponential smoothing method was the finest for forecasting barley area and production in the Punjab due to smaller values of the accuracy measures. Barley is an important major crop and has lot of health benefits. Unfortunately production of barley over the years is decreasing at an alarming rate. It is therefore recommended that government should promote barley production in the Punjab province of Pakistan. Proper use of agricultural inputs can definitely augment barley production and meet the basic food necessities of the country.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

S. No	Author Name	Contribution to the paper
1.	Ms. Sobia Naheed	Conceived the idea, Results and discussion, Data collection, Overall management of the article
2.	Ms. Irum Raza	Methodology, Data analysis, Wrote abstract
3.	Dr. M. Zubair Anwar	Technical input at every step
4.	Ms. Nusrat Habib	Data entry in SPSS and analysis
5.	Ms. Naheed Zahra	Introduction
6.	Ms. Sabeen Siddiqui	Conclusion, References

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