COMPARISON OF TREND ANALYSIS AND DOUBLE EXPONENTIAL SMOOTHING METHODS FOR PRICE ESTIMATION OF MAJOR PULSES IN PAKISTAN

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ABSTRACT: The present study was designed to find out suitable forecasting method among the two forecasting methods namely trend analysis and double exponential smoothing. Measures of accuracy (MAPE, MAD and MSD) were used as the model selection criteria that could best describe the trend of prices of major pulses such as gram, mash, masoor and mung during 1975-76 and 2009-10. Double exponential smoothing method was found to be pertinent for price estimation of major pulses in Pakistan because of smaller values of accuracy measures. Six-year's forecasts of prices of gram, mash, masoor and mung in Pakistan in 2010-11 were Rs.31.80, Rs.84.09, Rs.72.06, and Rs.47.69 per kg respectively along with 95% prediction intervals. The results showed that if the present growth rates remain the same then prices of these pulses in Pakistan would be Rs.37.64, Rs.120.26, Rs.89.55 and Rs.55.03 per kg, respectively in 2015-16. An increasing trend in the estimated prices will turn down the demand of these pulses and consequently poor class of the economy who do not have enough resources to buy expensive livestock-based protein-rich food will be badly affected.

Key Words: Pulses; Trend Analysis; Double Exponential Smoothing; Price Estimation; Pakistan.

INTRODUCTION

Pulses are the most important source of vegetable protein in Pakistan. They are cultivated on 5% of the total cropped area. Their use ranges from baby food to delicacies of the rich and the poor (PARC, 2012). Normally the area under pulses in the country is around 1395200 ha out of which major pulses contributed 1298300 ha with a production of 701800 t in 2009-2010 which was declining over the year. Among major pulses, gram is the major winter food legume and mung is the major summer legume (GoP, 1980, 2010).

Due to low production of pulses, Pakistan imports large quantities of pulses to meet the ever increasing gap between the domestic production and requirements (Chaudhry et al., 2002). Moreover, the price of pulses has increased much as compared to other food items such as wheat. This has serious implications for the supply of protein to the poor population who do not have resources to buy expensive livestock-based protein-rich food. In a failed attempt to halt this decline, the government has to spend considerable foreign exchange on the import of pulses (Ali and Abedolla, 1998).

Increase in prices can be attri-

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buted to both supply and demand factors. The per capita availability of some of the items such as cereals and pulses has been declin-ing resulting in some pressure on their prices (Sher, 2012). A farmer cultivated a crop on his farm keeping in mind its price in previous year profitability and allocated his limited resources for that crop which is stable and less risky however pulses price was highly unstable. Hence instability in price was deeply influenced by the production instability in all the major pulses (Rani et al., 2012).

Reliable and well-timed forecast provides essential and valuable inputs for proper foresight and informed planning more so, in agriculture which is full of uncertainities. Now-a-days agriculture has become highly input and cost intensive. Under the change scenario today, forecasting of various aspects related to agriculture have become essential (Agrawal, 2005). Because of the high volatility of prices of agricultural commodities over the past decade, the importance of accurate price forecasting for decision makers has become even more acute (Brandt and Bessler, 1983).

Traditionally different forecasting techniques such as regression models, Auto regressive integrated moving average (ARIMA) model introduced by Box and Jenkins, (1976) and exponential smoothing methods have been employed to forecast crop yield and production. These models are also helpful for forecasting economic time series, inventory and sales modeling etc (Brown, 1959; Holt et al., 1960).

Many attempts have been made to forecast the price of agricultural commodities but little work is done on the pulses in Pakistan. Therefore the study is designed to estimate the prices of major pulses (gram, masoor, mash and mung) but before esti-mating the price it is necessary to estimate the forecasting model that best fits the time series data. Here, an attempt is made to identify the best method for price estimation of major pulses in Pakistan using two forecasting methods on the basis of accuracy measures. Therefore the goal of the study is to forecast price of major pulses in Pakistan using the best fitted models.

MATERIALS AND METHOD

The study was conducted using secondary time series data of prices of major pulses (gram, masoor, mung and mash) of Pakistan from 1975-76 to 2009-10 (34 years). Data were collected from the various issues of Agriculture Statistics of Pakistan, published by Ministry of Food and Agriculture, Islamabad. Data were analyzed in Minitab software. Initially time series plot for prices of major pulses (gram, masoor, mung and mash) was created using MINITAB software to evaluate trend and cyclic patterns in data.

Analytical Technique

The models that are used to describe the behavior of variables that vary with respect to time are termed as growth models. In this study trend analysis and double exponential smoothing methods were used

Trend Analysis

It was employed to fit a general trend model to data and provide forecast. The general form of the

trend equation as proposed by Boken (2000), Rimi et al. (2011) is given as:

$Y_t = \beta_0 + \beta t + e_t$ ---------- (1)

where:

Y = Price of gram/masoor /mash/mung

β_0 = Constant

β_t = Regression coefficient (measure the effect of independent variable on the dependent variable)

t = Trend which determines the tendency of time series data to increase or decrease over time.

Double Exponential Smoothing Method

This method provides short-term forecasts. Dynamic estimates are calculated for two components on level and trend. Double exponential smoothing-based prediction (DESP) models a given time series using a simple linear regression equation where Y is the dependent variable, intercept b_0 and slope b_1 are varying slowly over time (Bowerman and Connell, 1993). Double exponential smoothing technique used in this study (Joseph and Laviola, 2003).

The algebraic form of the linear exponential smoothing model, like that of the simple exponential smoothing model, can be expressed in different ways. The "standard" form of this model is usually expressed as follows: S' denote the singly-smoothed series obtained by applying simple exponential smoothing to series Y. That is, the value of S' at period t is given by:

S'(t) = Y(t) + (1-)S'(t-1) ----- (2)

(Under simple exponential smoothing, let Ý(t+1) = S'(t) at this point.) Then let S" denote the doubly-smoothed series obtained by applying simple exponential smoothing (using the same) to series S':

S''(t) = S'(t) + (1-)S''(t-1) ---- (3)

Finally, the forecast Ý(t+1) is given by:

Ý(t+1) = a(t) + b(t) ---------- (4)

where:

a(t) = 2S'(t) - S''(t) the estimated level at period t.

b(t) = (/(1-))(S'(t) - S''(t)) the estimated trend at period t.

Accuracy Measures

The intent of using two forecasting methods was actually to make comparison of the estimates obtained and decide that which forecasting method provides good fit to data on the basis of three accuracy measures. These accuracy measures are Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD). Smaller values for all these measures indicate a better fitting model and a better model yields minimum forecasting error (Karim et al., 2010). The best-fitted method is selected and used for estimating the prices of major pulses (gram, masoor, mung and mash) in Pakistan from 2010-11 to 2015-16.

RESULTS AND DISCUSSION

Initially time series plot (Figure 1) was created to determine the trends in the price of major pulses (gram, masoor, mung and mash) from 1976 to 2010. The prices of gram show an upward trend from 1976 to 2008 but sudden decline is apparent in 2010. An increasing trend is visible in mash price during the study period. The price of masoor

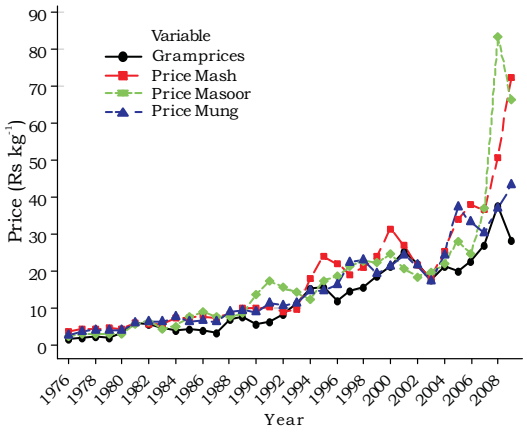

Figure 1. Time series plot of prices of gram, mash, masoor and mung

varies smoothly till 2006 then there was a rapid jump of price in 2008 and after that price turns down during 2010. There is rise in the price of mung throughout.

On the basis of smaller values of measures of accuracy, Trend analysis and Double exponential smoothing methods were employed for the selection of best fitted model in this study. Karim et al, (2010) employed trend analysis, exponential smoothing methods to forecast wheat production for different districts of Bangladesh using the model selection criteria such as Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD) etc. The results of forcasting show that different model is suitable for different district on the basis of selection criteria. The 5 years forcast of wheat production in Bangladesh, Dinajpur, Rajshahi and Rangpur districts in 2005-06 were 1.55, 0.31, 0.24 and 0.37 mt, respectively.

The data showed that all of the values of these accuracy measures are smaller for the double exponential smoothing method, suggesting that this method provides better fit to data and is appropriate for predicting future prices of major pulses in Pakistan (Table 1).

Table 1. Diagnostic measures for the selection of the best forecasting method for prices of major pulses in Pakistan

Measures of accuracy	Trend analysis				Double exponential smoothing			
	Gram	Mash	Masoor	Mung	Gram	Mash	Masoor	Mung
MAPE	47.21	46.91	54.32	34.76	28.19	16.72	31.22	17.91
MAD	2.69	5.10	6.15	3.26	2.38	2.80	4.08	2.45
MSD	11.40	60.13	109.61	16.22	10.65	19.18	79.26	10.69

Price Estimation Using Double Exponential Smoothing Method

Double exponential smoothing was chosen to be the best fitted forecasting method as compared to trend analysis for price estimation of major pulses in Pakistan on the basis of the smaller values of the forecasting errors. The results of the forecasts along with 95% prediction intervals revealed that prices of major pulses tend to rise gradually from 2010-11 to 2015-16 (Table 2). The prediction intervals associated with the forecasts values depict that there is 95% chance that these forecast values will lay within the lower and upper limits.

The forecasted prices of major pulses namely gram, mash, masoor and mung in Pakistan for 2010-11 were Rs.31.80, Rs.84.09, Rs.72.06, and Rs.47.69 per kg, respectively alongwith 95% prediction intervals. The results show that if the present growth rates remain the same then prices of major pulses in Pakistan would be Rs.37.64, Rs.120.26, Rs.89.55 and Rs.55.03 per kg respectively in 2015-16. If there is

Table 2. Six years' 95 % forecasted prices of major pulses in Pakistan

(Rs. kg^{-1})

Pulses	Description	Forecast year					
		2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Gram	Lower limit	25.9446	26.307	26.5852	26.8059	26.9863	27.1379
	Forecast	31.7779	32.9505	34.1232	35.2959	36.4686	37.6413
	Upper limit	37.6111	39.5941	41.6612	43.7859	45.9508	48.1446
Mash	Lower limit	77.2181	76.7534	76.2022	75.6313	75.0529	75.0529
	Forecast	84.085	91.32	98.554	105.789	113.023	120.258
	Upper limit	90.952	105.886	120.906	135.946	150.994	150.994
Masoor	Lower limit	62.0705	62.5642	62.8149	62.9428	63.0019	63.0187
	Forecast	72.0616	75.5602	79.0588	82.5574	86.056	89.5546
	Upper limit	82.053	88.556	95.303	102.172	109.11	116.091
Mung	Lower limit	41.6914	33.422	25.1381	16.8519	8.5648	0.2773
	Forecast	47.6897	49.1585	50.6273	52.0961	53.5649	55.0337
	Upper limit	53.688	64.895	76.116	87.34	98.565	109.79

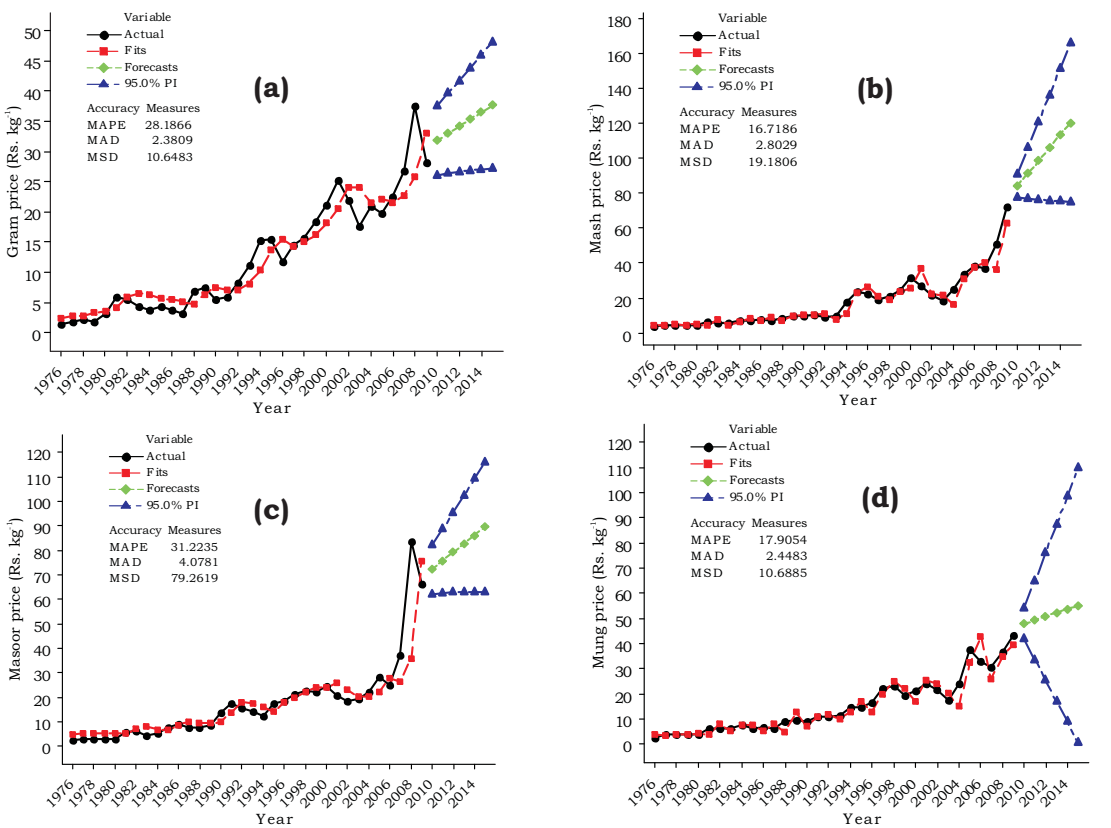

Figure 2. Double Exponential Smoothing Plots for Major Pulses in Pakistan

continuous rise in the price that will affect the people disproportionately especially of the poor people because pulses is the supply of protein to the poor population who do not have resources to buy expensive livestock-based protein-rich food and adversely impacts the achievement of removal of poverty.

Double exponential smoothing plot for gram, mash, masoor and mung respectively in which prices are plotted against time in Figure 2 (a-d). The actual, fitted and forecasts values at 95% prediction interval and accuracy measures (MAPE, MAD and MSD) are also displayed in the figures.

CONCLUSION

The study showed that double exponential smoothing method was appropriate for price estimation of major pulses in Pakistan. The values of the accuracy measures were smaller in double exponential smoothing method in contrast to trend analysis method. For this reason double exponential smoothing method was employed to estimate the prices. The six year's forecasted prices tend to rise in the coming years in Pakistan. The rising in the price of pulses have become a major concern for policy makers for Pakistan. The recent food inflation is largely due to an inadequate supply response to increasing demand, aggravated by various other logistic and market-related constraints and that will badly affect the poor class of the economy.

Therefore there is urgent need to stabilize prices of the pulses. Minimum support prices have been a cornerstone of the agricultural policy. Government should ensure remunerative prices to the growers for their produce to encourage higher investment and production and develop a balanced and integrated price structure in the context of overall needs of the economy while safeguarding the interest of consumers by making available supplies at reasonable prices.

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