Price Behaviour of Potato in Agra Market - A Statistical Analysis

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ABSTRACT

The present study was conducted to know the statistical investigation of price behaviour of potato in Agra. Potato is one of the most important food crops of India. The information on price of potato in Agra was collected for the period January 2004 to December 2012. Potato wholesale prices of Agra market were analysed using univariate ARIMA (2,1,1) model. Seasonal indices calculated showed that generally the price is low from November to January and it starts picking up from February, and reaches the maximum in November. Based on the Shwartz Bayes Criterion (SBC) and Akaike Information Criterion (AIC), the estimated best model was ARIMA (2,1,1). Short term forecasts based on this model were close to the observed values. The accuracy measures like MAPE and MSE are considered as the best models to forecast monthly prices. Among all the models, ARIMA (2,1,1) model was best with least Mean Average Percentage Error (MAPE) and Mean Square Error (MSE) value for Agra 20.57, 102.22 respectively. The data analysis is carried out using SAS 9.3.

Key words: *Price behaviour; ARIMA Model; Forecasting, Seasonality; Stationarity; SAS; Wholesale price;*

Price fluctuations are a matter of concern among consumers, farmers and policy makers and its accurate forecast is extremely important for efficient monitoring and planning. Several attempts have been made in the past to develop price forecast models for various commodities (*Ghosh and Prajneshu, 2003, Pavlista and Feuz, 2005*). Potato prices fluctuate over seasons due to the variations in production and market arrival. Thus, modelling and forecasting the monthly price behaviour over the years is of much practical importance (*Chandran et al 2007*). Potato protein has well-balanced amino acid content and the biological value of its protein is comparable to that of eggs and milk.

Potato is one of the most important food crops and most widely consumed in India. Potato is wholesome and nutritious food. It seems somewhat paradoxical that in a developing country like India where the population continues to grow and the demand for food is increasing, The area under potato cultivation in India in 1950 was 0.24 million ha that increased to 1.86 million ha in 2010-11. The wholesale price of potato in India fluctuates over seasons due to the variations in its production and availability in the market. Thus, modelling and forecasting the monthly price behaviour over the years is of practical importance. To this end, autoregressive integrated moving average (ARIMA) methodology has been successful in describing and forecasting the price dynamics of a potato. In the present study ARIMA modelling was used for describing monthly wholesale price of potato in Agra market. There are various purposes for which the present analysis of time series is performed. The objectives may include prediction of future values based on knowledge of the past, control of process producing the time series, to obtain an understanding of mechanism generating series. Study of trend helps compare the long-term behavior of prices. An understanding of periodically moving cycles helps those concerned with planning and development; use of these commodities specifically in the area of short -term and long term forecasting. The latest technique of box-jenkins model is used to analyse non-stationary and seasonal data. The objectives of the study are as follows:

i. To analyze the trend in prices of potato in selected markets of India.
ii. To forecast the prices of potato in the selected markets

METHODOLOGY

The time series data of wholesale price of potato in Agra market from January 2004 to December 2012 has been collected from *www.indiastat.com*, and analyzed with an exploratory aspect. A seasonal decomposition procedure was applied in order to decompose the seasonal series into a seasonal component, a combined trend and cycle component, and an error component. The seasonal Indices were estimated in order to check the distribution patterns on a monthly basis. In the present study, the seasonality of the time series was represented by the 12-month periodicity.

RESULTS AND DISCUSSION

Secular trend: The pattern of trend in prices of potato was almost similar in study markets. The 6th degree polynomial regression equation was fitted and it was found to give the highest R^2 value which is again too low. It shows an increasing trend in prices, of potato though it was fluctuating with ups and downs.

$\hat{Y} = -2E\text{-}07x^6 + 7E\text{-}05x^5 - 0.0086x^4 + 0.499x^3 - 13.816x^2 + 158.26x - 7.7041$

$R^2 = 0.218$

Where, $\hat{Y}$ = Predicted value of trend at time t

x = Years, x = 1, 2 . . . . . n

It could be seen from the above that, the prices of potato showed an increasing trend over the years. The graph of the trend in prices over the years is shown in Fig.1.

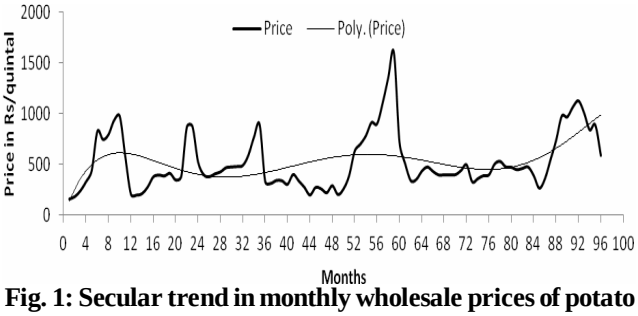

Fig. 1: Secular trend in monthly wholesale prices of potato

The graphs of the wholesale price of potato in Agra market are plotted in Fig. 1. A close look at the graph indicates that wholesale price of potato fluctuates from a minimum of Rs 160 per quintal to a maximum of Rs 1600 per quintal.

Seasonal indices: Seasonal indices of prices of potato in Agra market revealed that the highest price index was noticed in the month of November (136.96) and the lowest price index was noticed in the month of January (61.97). The graph of the seasonal index of prices over the years is shown in Fig.2.

Cyclical trend: The cycles in the selected market for prices was found to be uneven. There by it implied that there was large fluctuation in prices of potato in Agra markets. The cyclical trend in selected market showed that there were no constant periods between cycles in prices. The graph of the cyclical index in prices over the years is shown in Fig.3

Table 1. Seasonal index of monthly prices

Months	Jan.	Feb.	March	April	May	June
Index	61.97	63.86	75.26	90.31	107.17	105.94
Months	July	Aug.	Sept.r	Oct.	Nov.	Dec.
Index	109.58	107.24	118.08	136.94	136.96	86.69

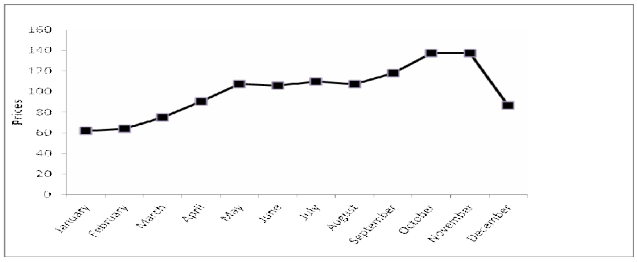

Fig. 2. Seasonal index of monthly prices

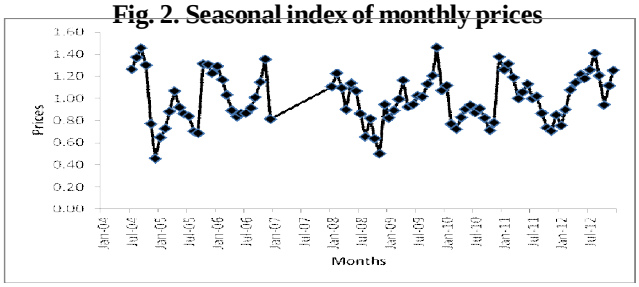

Fig. 3. Cyclical indices of monthly prices

ARIMA: Auto-Regressive Integrated Moving Average: ARIMA (Box-Jenkins model) was employed to predict the future prices of potato in Agra market. For all the time series of potato the estimated models for prices was presented below.

Monthly prices of potato in Agra market (2, 1, 1), (1, 1, 1)

It can also be visualized from the plot of ACF and PACF (Fig. 5) of the series. The decay rate for the ACF of the series is very low. But after differencing of the original series the decay rate becomes high (Fig. 5) resulting the identification of the order of the model very easy. To this end, Augmented Dickey-Fuller (ADF) tests

were used for the test of stationarity, both seasonal and nonseasonal. On the basis of minimum AIC and SBC values and considering the ACF and PACF of the wholesale price series, ARIMA (2, 1, 1) model is selected. (*Paul et al. 2010*)

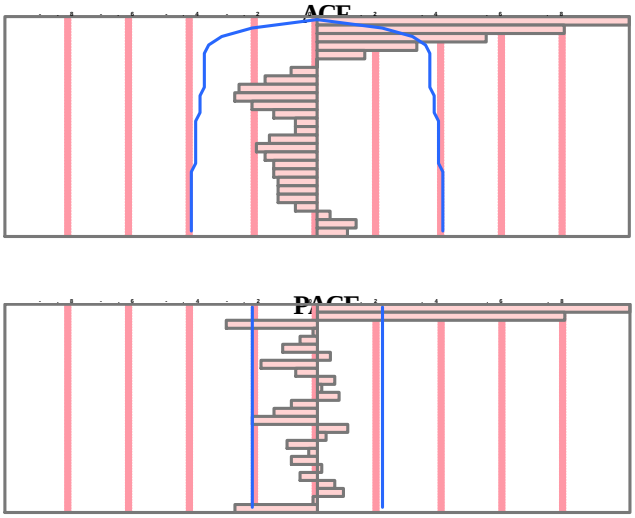

Fig. 4. ACF and PACF of seasonally adjusted series

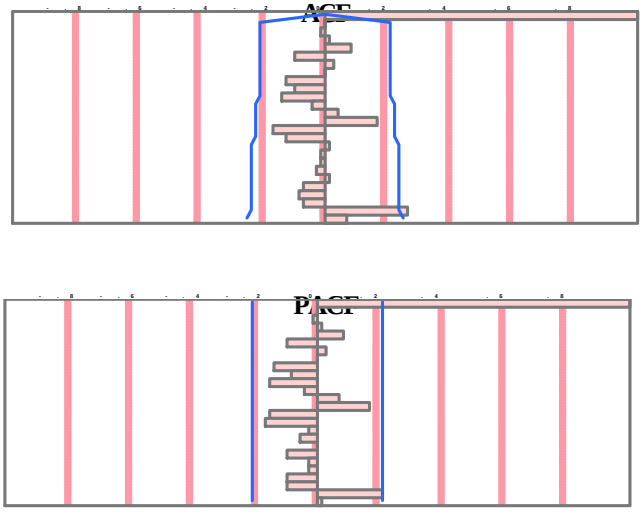

Fig. 5. ACF and PACF of Ist differenced series of

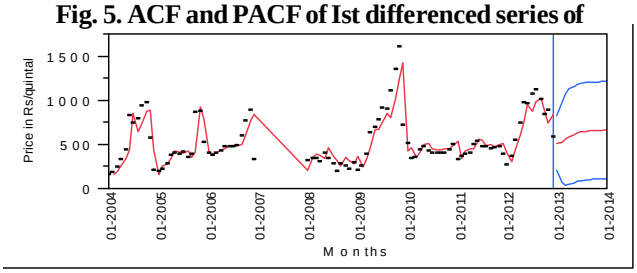

Fig. 6. Fitted ARIMA model with actual data points in Agra market

Table 2. Forecasts based on the fitted ARIMA model

Months	Actual (Rs./q)	Forecast (Rs./q)	Months (Rs./q)	Actual	Forecast (Rs./q)
Jan-12	267	414	Jul-13		641
Feb-12	359	310	Aug-13		648
Mar-12	547	443	Sep-13		653
Apr-12	736	614	Oct-13		656
May-12	974	758	Nov-13		659
Jun-12	966	954	Dec-13		661
Jul-12	1064	877	Jan-14		664
Aug-12	1124	984	Feb-14		666
Sep-12	1006	1020	Mar-14		669
Oct-12	839	879	Apr-14		671
Nov-12	888	740	May-14		674
Dec-12	588	842	Jun-14		676
Jan-13		513	Jul-14		678
Feb-13		523	Aug-14		681
Mar-13		556	Sep-14		683
Apr-13		588	Oct-14		686
May-13		613	Nov-14		688
Jun-13		630	Dec-14		690

Selection of the best forecasting model based on MAPE and MSE: In selecting the best model to forecast the trend for monthly prices of potato, the accuracy measures MAPE and MSE are considered. Among all the models tried, the Box-Jenkins ARIMA (2,1,1) was best fit with least MAPE and MSE values 20.57, 102.22 respectively and the forecasted values from the ARIMA (2,1,1) model were much nearer to the Actual values.

Table 3. Parameters estimate of the ARIMA (2, 1, 1) model

Parameters	Estimate	SE
Constant	2.420902	2.167525
AR(1)	1.044414	0.098678
AR(2)	-0.294075	0.099233
MA(1)	0.999999	0.027734

Table 4. Selected measure of predictive performance.

Model	AIC	SBC	MSE	MAPE	R^2
ARIMA(2,1,1)	1239.10	1249.31	102.22	20.57	0.67
ARIMA(1,1,1)	1249.04	1256.71	101.01	20.71	0.63
Six Degree polynomial	-	-	-	-	0.21

Policy implications: A careful study of the findings would suggest that the farmer suffers from various constraints, which must be removed if their financial position is to be strengthened. Some of the measures

that could be adopted to achieve this result are indicated below (*Gangadharappa H,et al 2005*).

1. The results of the study help the farmers to take decision on sale of their produce to which month, he gets maximum price.
2. The wider and frequent fluctuations in wholesale prices, wide variation in arrivals etc., affected the returns to the potato grower. In order to encourage the farmers to continue in potato product in price should be stabilized by introducing fairly high degree of competition among the wholesale functionaries and traders, introduced in close tender system of sale, establishment of potato marketing cooperatives and fixation of minimum and maximum prices for the potato.
3. The wide seasonal fluctuation in arrivals has consequential unfavourable impact on prices in regulated market over different months of the year. The huge quantity of arrivals during post harvest months of the year lead to decline in prices. The effective use of warehousing facilities and credit to the producer-seller against warehouse receipts would go a long way in avoiding seasonal variation in arrivals and prices.
4. Cyclical fluctuation in market prices were found to be uneven in the market. Hence there is a need to have a constant watch on prices and arrivals of the crop so that the farmers can know the variation occurring in the prices
5. The regulated market should take necessary step to see that the dissemination of the market information regarding the prices reach the farmers of the remote places.
6. With the help of ARIMA, a model price was forecast. The forecast prices showed an increasing trend, with due consideration to seasonality and cycles. In this regard farmers may be advised to plan the production process and decide when to sell the produce, so that they would get a higher price for their produce. The prices during September, October, November and December months were observed to be high and farmers can plan to sell their produce during the months. In this regard Agricultural Produce Market Committees (APMCs) should provide the basic infrastructural facilities to the farmers.
7. Since potato was mainly used in making 'chips' which was processed product. so the establishment of processing units may provide a value addition to potato as indicated lower number of processing industries. This would help farmer to get better income, reduce the price fluctuation, and alternatively trigger the interest of the farmer to produce good quality product.

CONCLUSION

ARIMA model was found to be good. It could be successfully used for modeling as well as forecasting of wholesale monthly price of potato in Agra market. The model demonstrated a good performance in terms of explained variability and predicting power. The relevant forecast interval for the wholesale price can help both the potato farmers as well as the planners for future planning.

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