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Price Forecasting of Mango in Varanasi Market of Uttar Pradesh

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Abstract

The study had been made to forecast the price of mango using ARIMA model in one of the major markets of Uttar Pradesh as the state ranks first position in production of mango in India. Varanasi market was selected purposively on the basis of second highest arrival market of mango in the state. Using ARIMA methodology on the monthly prices of mango collected from the Agricultural Produce Market Committee (APMC), Varanasi for the year 1993 to 2015. As the mango fruit having property of alternate bearing, only six month data from March to August was available in the market and accordingly had been used for forecasting analysis using E-views 7 software. The results revealed that the price in selected market was found to be highest during the start of the season using ARIMA (1,0,6) model, confirming the validity of model through Mean Absolute Percentage Error (MAPE). The MAPE was found to be less than 10 per cent for one step ahead forecast of year 2015. Forecasted price for the month of March was almost double than the price of other months. It indicates the necessity of adopting pre and post harvest management technologies for getting the benefit over increase in prices.

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Introduction

Mango being the major fruit enacts stunning role in meeting the variety of food requirements in civilized and uncivilized area of the nation. The fruit ranks first position in terms of area and that's why it is known as king of fruits in India. Being the king of fruits, the productivity of mango crop (7.3 Mt/Ha) was much lesser than the other fruit crops (Banana-37.0 Mt/Ha, Citrus-10.3 Mt/Ha, Papaya-42.3 Mt/Ha, Guava-13.7 Mt/Ha, Apple-21.8 Mt/Ha, Grapes-15.8 Mt/Ha and Pomogranate-10.3 Mt/Ha), (Indian Horticultural Database, 2014). The yield of a crop has more effects on price of a fruit. Price of mango fruit depends upon its production and ultimately on its yield, but in some ways pre and post harvest management also affects the price of fruit. So, efforts have moreover

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been made to forecast price of mango on the basis of arrivals in the market and to know how it will help in reducing pre and post harvest losses of mango fruit.

Forecasts had been used traditionally in structural econometric models. At present focus were disposed on the univariate time series models known as auto regressing integrated moving average (ARIMA) models. These types of models were enormously applied for forecasting economic time series[2,6] and generalization of the exponentially weighted moving average process. A variety of techniques for recognizing special cases of ARIMA models had been suggested by Box- Jenkins[1] and others. In this paper, these models were executed to forecast the price of mango fruit in Uttar Pradesh. This would helps to predict expected price for the year 2016. Such an exercise would validate the policy makers to look forward in the future requirements for storage, import and export of mango thereby enabling them to take appropriate measures in this regard. The forecasts would thus retain much of the valuable resources of our country which otherwise would been wasted.

Methodology

Study was conducted in Uttar Pradesh as the state ranks first in the production of Mango. Out of five markets in the state, Varanasi market was selected purposively on the basis of maximum arrivals. The price data was collected from Agricultural Produce Market Committee (APMC) Varanasi for the twenty three years from 1993-94 to 2015-16. As the mango crop being seasonal in nature the data was available only for six months of the year. It was available only in the months from March to August in Uttar Pradesh. So, the data was collected only for the six months from March to August. The data was analysed with the help of E-views 7 software using the ARIMA methodology developed by Box and Jenkins[1].

In statistics Autoregressive Moving Average (ARMA) models, was also known as Box-Jenkins models after the interactive Box-Jenkins methodology usually used to estimate them and it was applied to time series data. The accuracy of forecasts for both Ex-ante and Ex-post were tested using the following tests[9].

Mean average percentage error (MAPE): the formula for this is[13,14,15,16,17]

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\frac{|X_t - \hat{X}_t|}{X_t} \times 100$$

Where, X_t=Actual values $\hat{X}_t$=Predicted values

Results and Discussion

Prices Forecasting of Mango in Varanasi Market

The detailed results of price forecasting of mango in Varanasi market had been stated below. The above procedures were followed for forecasting the prices of mango in the Varanasi market.

Identification of the Model

The Augmented Dickey-Fuller (ADF) test, Kwaitkowski-Phillips-Schmidt-Shin (KPSS) test and Phillips-Perron (PP) test were applied to test the stationarity of the data series[15]. After the first difference the series found to be stationary indicating the series was integrated of order one with including the intercept only as the exogenous variable in the series.

Table 1: Stationarity test for Varanasi market price

	ADF test		PP test		KPSS test	
	Level series	1st Differenced Series	Level series	1st Differenced Series	Level s eries	1st Differenced Series
	t-statistic	t-statistic	t-statistic	t-statistic	LM-statistic	LM-statistic
	-1.722	-7.201	-8.519	-50.068	1.246	0.409
	Critical Value for above tests					
1% level	-3.483	-3.483	-3.480	-3.481	0.739	0.739
5% level	-2.884	-2.884	-2.883	-2.883	0.463	0.463
10% level	-2.579	-2.579	-2.578	-2.578	0.347	0.347

Fig. 1: Time plot of Varanasi market price

From above graph it was found that there was a trend in data series. Therefore, stationarity was checked after including the trend and intercept as exogenous variable.

Table 2: Stationarity test for Varanasi market price after including Trend and Intercept as exogenous (original series)

	ADF test		PP test		KPSS test	
	Level series	1st Differenced Series	Level series	1st Differenced Series	Level series	1st Differenced Series
	t-statistic	t-statistic	t-statistic	t-statistic	LM-statistic	LM-statistic
	-3.116	-7.167	-10.140	-50.076	0.235	0.107
	Critical Value for above tests					
1% level	-4.033	-4.033	-4.029	-4.030	0.216	0.216
5% level	-3.446	-3.446	-3.444	-3.444	0.146	0.146
10% level	-3.148	-3.148	-3.147	-3.147	0.119	0.119

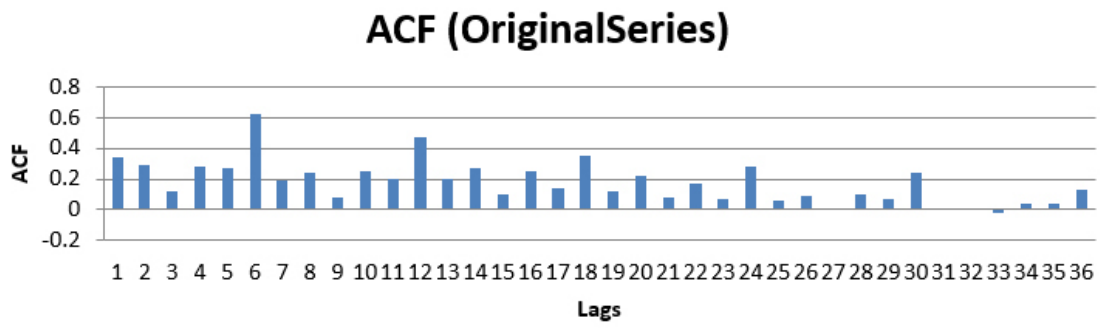

Fig. 2: Autocorrelations of original series in Varanasi market

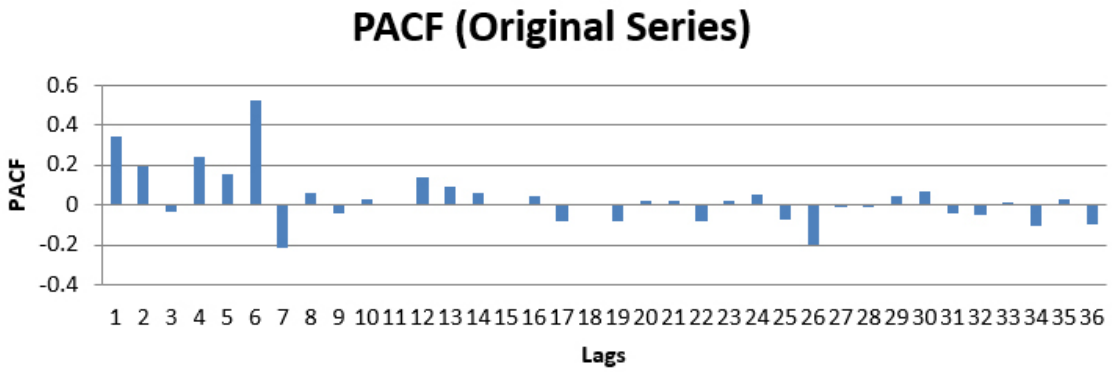

Fig. 3: Partial Autocorrelations of original series in Varanasi market

By plotting correlogram it was found that most of the coefficients of ACF and PACF were not significant. So, it was needed to seasonally differentiate the original series to get significant coefficients of ACF and PACF[10]. The new seasonally differenced series was obtained from the seasonal differencing in the original price series. ADF, KPSS and PP test was used to check the stationarity in the new seasonally differenced series. The results were shown in tables 3.

Table 3: Stationarity test for Varanasi market price (Seasonally differentiated series)

	ADF test	PP test	KPSS test			
	1st Differenced Series	Level series	1st Differenced Series	1st Differenced Series	Level series	1st Differenced Series
	t-statistic	t-statistic	t-statistic	t-statistic	LM-statistic	LM-statistic
	-6.868	-6.854	-8.233	-8.200	0.043	0.034
	Critical Value for above tests					
1% level	-3.485	-4.036	-3.483	-4.033	0.739	0.216
5% level	-2.885	-3.447	-2.884	-3.446	0.463	0.146
10% level	-2.579	-3.148	-2.579	-3.148	0.347	0.119

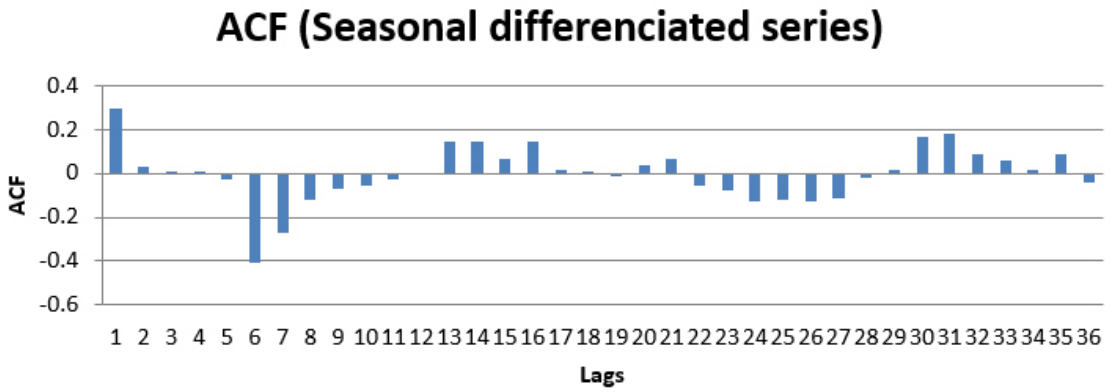

Fig. 4: Autocorrelations of seasonally differenced series in Varanasi market

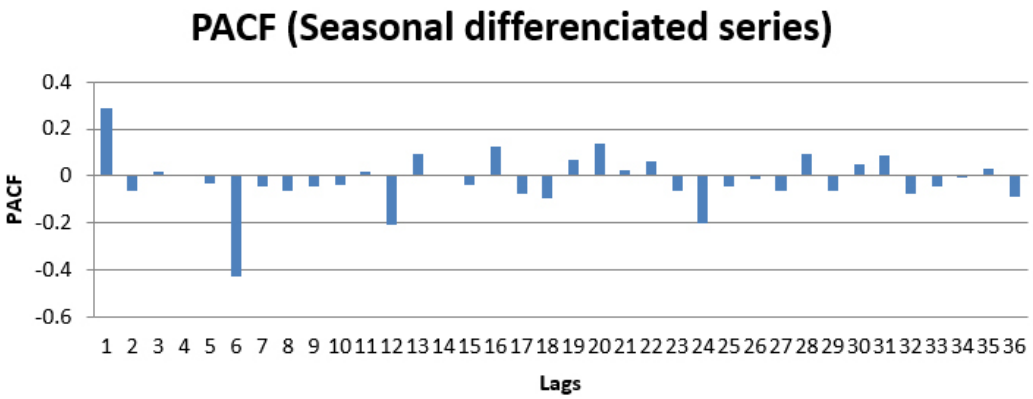

Fig. 5: Partial Autocorrelations of seasonally differenced series in Varanasi market

Estimation

It was found from the above plots of ACF and PACF (Fig 4 and Fig 5), that the values of ACF and PACF were significant[12] with seasonal differentiated series. It helps in obtaining the combinations by observing the lags of ACF and PACF, Lag of AR can be work out through PACF and lag of MA can be work out through ACF. Most probable Combinations were AR(1) MA(1), AR(1) MA(6), AR(1) MA(7), AR(6) MA(1), AR(6) MA(6) and AR(6) MA(7).

These were the most probable combinations but it had been tested for all the possible combinations up to lag observed and select the best combination for forecasting. The best combination can be selected on the basis of minimum values of Akaike Information Criteria (AIC) and Schwarz Bayesian Criteria (SBC)[21].

On the basis of minimum values of AIC and SBC it was found that AR (1) MA (6) i.e. ARIMA (1, 0, 6) model selected for the forecasting[18]. Therefore, using the prices of seasonally differentiated series for the years up to 2013 and 2014, one step ahead forecast was calculate for the years of 2014 and 2015 respectively[20].

Diagnostic Checking

It was found from the above table that the model is valid by observing the Mean Absolute Percentage Error (MAPE). Average MAPE was 10.30 percent and 8.32 per cent for the year 2014 and 2015 respectively[4]. So, the forecasted values for the year 2016 were shown in table 11 using ARIMA (1, 0, 6) model.

Table 4: One step ahead forecast in Varanasi market (Test for validation of the selected model)

	Actual prices	ARIMA forecast	
	(Rs/Qtl)	Prices (Rs/Qtl)	MAPE (%)
MAR-14	2260	2752.46	21.79
APR-14	1075	883.17	17.85
MAY-14	970	1028.32	6.01
JUN-14	860	923.87	7.43
JUL-14	865	937.89	8.43
AUG-14	1100	1096.55	0.31
MAR-15	2650	2290.39	13.57
APR-15	1380	1081.81	21.61
MAY-15	1015	1053.59	3.80
JUN-15	990	960.15	3.01
JUL-15	1040	1074.47	3.31
AUG-15	1255	1197.02	4.62

Forecasting

Table 5: Out of sample forecast of Varanasi market

	ARIMA forecast prices (Rs/Qtl)
MAR-16	2343.77
APR-16	1122.14
MAY-16	1090.04
JUN-16	995.44
JUL-16	1109.41
AUG-16	1231.87

Conclusion

The study concluded that the forecasted price of mango for the year 2016 was found to be highest in the start of the season. For forecasting ARIMA (1, 0, 6) model applied and revealed that there was less than 10 per cent deviation in the forecasted price of 2015 from the actual price, confirming the validity of the model. The fruit price in the start of the month was found to be almost double than the other months. It indicates that the farmers in the region has been benefited during the start of the season and to get its benefit from it they have to adopt pre and post harvest management technologies by which they can able to bring their products in market during the start of season. Our forecast results suggest fruit prices will increase during the less arrivals. These forecasts of rising prices may be encouraging signs for the farmers if they would manage their products accordingly and also it will be a guiding principle for policy makers to develop most appropriate price policy for perishable/seasonal products by which both the consumer and producer get benefitted from it.

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