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Shruti Mohapatra
Department of Agricultural Economics, OUAT, Bhubaneswar, Odisha, India

Upasana Mohapatra
Department of Agricultural Economics, OUAT, Bhubaneswar, Odisha, India

Raj Kishore Mishra
Department of Agricultural Economics, OUAT, Bhubaneswar, Odisha, India

Correspondence
Shruti Mohapatra
Department of Agricultural Economics, OUAT, Bhubaneswar, Odisha, India

Price forecasting of groundnut in Odisha

Shruti Mohapatra, Upasana Mohapatra and Raj Kishore Mishra

Abstract
The present study entitled "Price forecasting of Groundnut in Odisha" was undertaken with the objectives to build appropriate forecasting model and to forecast the groundnut price of Jajpur market of Odisha. The major findings explained that Seasonal ARIMA model (1,1,1) (1,0,1) was appropriate for price forecasting of groundnut in Jajpur market. The forecasted groundnut price has increased gradually from January 2018 from the level of Rs.4475.00 and reach up to Rs. 4725.00 in December 2018. The results of the study will help the farmers to take decision on time of marketing in order to reap maximum benefit. In order to encourage the farmers to continue groundnut production, price should be stabilized by introducing fairly high degree of competition among the wholesale functionaries and traders. Accordingly the farmers may be advised to reschedule their crop plan to avoid glut during postharvest season.

Keywords: Price forecasting, groundnut, Odisha

Introduction

Groundnut is the largest oil seed crop in India in terms of production. India is the second largest groundnut producer in the world after China contributing 41 percent of the global output in 2016-17 and India with 11 percent and the leading exporter of shelled groundnuts was forecasted to 600,000 tons forecasted for 2017. Groundnuts account for about a quarter of all oilseeds produced in the country. The main producing States are, by order of importance, Gujarat, Andhra Pradesh, Tamil Nadu, Odisha, Karnataka and Maharashtra. Production is highly vulnerable to rainfall deviations and displays huge fluctuations from year to year, as more than 90 % of the planted area is cultivated under rain fed condition. The remaining 10% of the groundnuts are cultivated under irrigation, as a summer crop, from January to May.

In Odisha, the groundnut price mainly depends upon the major markets of Jajpur. Jajpur is one among the leading groundnut markets in Odisha. The wholesale price in Jajpur controls majority of groundnut growing areas in the state. Any fluctuation in price in the market can influence the state price. So effective Price forecasting can manage volatility to a great extent. Unless Market Intelligence especially price forecasting reaches farmers during Kharif and Rabi Harvest, the capital starved famers will be prone to price as well as income risk. This will result in non adoption or least adoption of cutting edge technology and non competive nationally and globally. Hence the need of designing appropriate forecasting model and price forecasting has to be done.

Methodology

Secondary data had been collected from Agmarknet website and Regulated market committee. For price forecasting and finding the Seasonal Index of groundnut price in Jajpur market, 576 weekly wholesale prices per quintal had been collected starting from January 2006 to December 2017. This had been collected from Regulated market committee Jajpur and Agmarknet website. 576 data points are very much reliable in the sense that minimum of 40 to 50 price figures are sufficient for forecasting. Using this forecasting for another 12 months can be carried on.

Analytical tools and techniques

Trends

To analyze the trends in groundnut prices in Jajpur markets, many functional forms were tried and on the basis of better representation of data linear and exponential forms were used in the analysis.

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Linear trend

The linear trends (per year contribution) of market prices of groundnut, linear trend equations were developed in the form of linear regression as under

Y = a + bt

Where,

Y = Market price

a = Constant

t = Time variable

b = Regression coefficient

Autoregressive Integrated Moving Average (ARIMA) Model

A generalization of ARMA models which incorporates a wide class of non- stationary time series is obtained by introducing the differencing into the model (Zhang 2003) [2]. The simplest example of a non-stationary process which reduces to a stationary one after differencing is Random Walk. A process $\{Y_t\}$ is said to follow an integrated ARMA model, denoted by ARMA (p,d,q), if

$\nabla^d Y_t=(1-B)^d \varepsilon_t$ is ARMA(p,q). The model is written as

$\varphi (B)(1-B)^d Y_t= \theta (B) \varepsilon_t.$

Where $\varepsilon_t \sim WN(0,\sigma^2)$, WN indicating White Noise. The integration parameter d is a non negative integer. When d=0, ARIMA (p, d, q)= ARMA(p,q).

The ARIMA methodology is carried out in three stages, viz. identification, estimation and diagnostic checking (Pai and Lin 2005). Parameters of the tentatively selected ARIMA model at the identification stage are estimated at the estimation stage and adequacy of tentatively selected model is tested at the diagnostic checking stage. If the model is found to be inadequate, the three stages are repeated until satisfactory ARIMA model is selected for the time series under consideration.

Mean absolute percentage error (MAPE)

The mean absolute percentage error (MAPE), also known as mean absolute percentage deviation (MAPD), is a measure of accuracy of a method for constructing fitted time series values in statistics, specifically in trend estimation. It usually expresses accuracy as a percentage, and is defined by the formula:

$$M = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right|,$$

where A_t is the actual value and F_t is the forecast value. The difference between A_t and F_t is divided by the Actual value A_t again. The absolute value in this calculation is summed for every fitted or forecasted point in time and divided again by the number of fitted points n multiplying by 100 makes it a percentage error. In general a MAPE of 10% is considered very good, a MAPE in the range 20% - 30% or even higher is quite common.

Results

Jajpur groundnut price is important in deciding the market price of groundnut in whole Odisha. It is one of the leading groundnut markets in the state. Figure 1 shows the graph of time series of groundnut price in Jajpur market. The market was initially very much affected with price fluctuations, later it acquired an increasing trend (Reddy *et al* 2012).

Fig 1: Wholesale groundnut price time series in Jajpur market (Rs./ Quintal)

Fig. 1 indicated the graph of time series of groundnut price in Jajpur market. The graph shows the movement in monthly groundnut price from January, 2004 to February, 2015. So regression analysis involving in it may leads to spurious regression or Non sense regression. In order to proceed for forecasting the series should be stationary. So differencing of the time series should be undertaken.

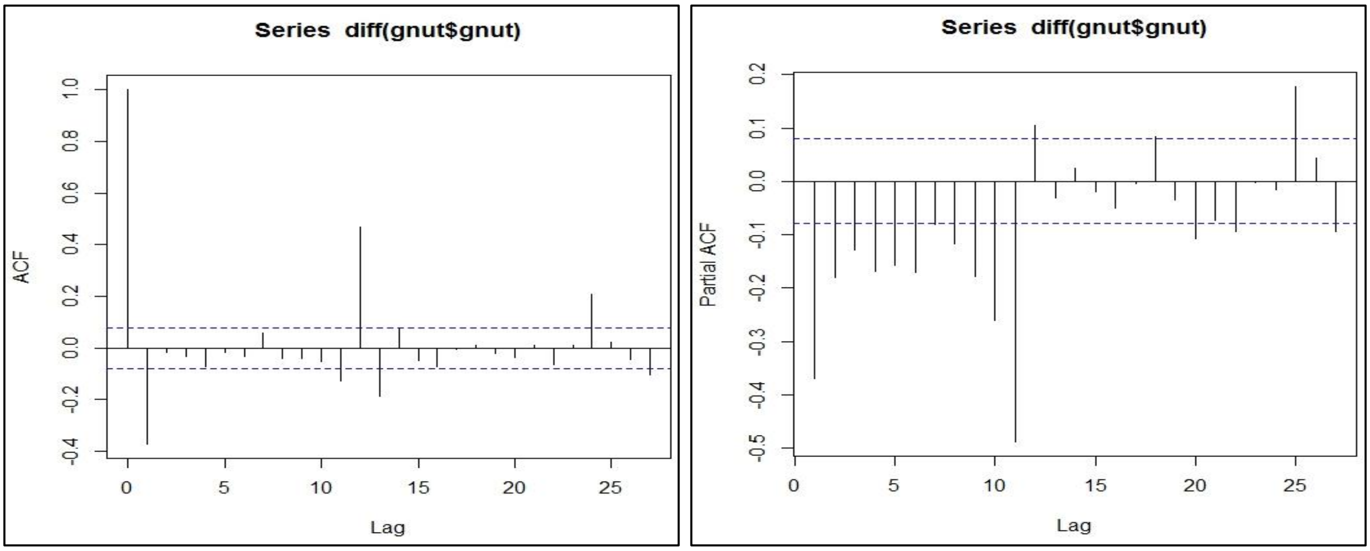

Fig 2: ACF and PACF of the time series

It can also be visualized from the plot of ACF and PACF (Figure. 2) of the series that the decay rate for the ACF of the series was very low. But after differencing of the original series the decay rate became high (Figure. 5) resulting the identification of the order of the model very easy. Here the series were non stationary without differencing and after first differencing the series became stationary.

Price Forecasting

Appropriate model selection

The SARIMA model (1,1,1,) $(1,0,1)_{12}$ is selected based upon considering the lowest AIC, AICc and BIC values and considering the ACF and PACF of the wholesale price series by comparing similar and close SARIMA models - SARIMA(1,1,1)$(2,1,1)_{12}$, SARIMA(2,1,1)$(1,1,1)_{12}$, SARIMA(2,1,2)$(1,1,1)_{12}$ and SARIMA(3,1,1)$(1,1,1)_{12}$ those satisfies the conditions like the sample autocorrelation coefficients of the residuals are within the limits and Ljung – Box tests (Fig. 4). But their AIC, AICc and BIC values are greater than ARIMA model (1,1,1,) $(1,1,1)_{12}$. D.S. Dhakre and D. Bhattacharya (2013) studied the statistical investigation of price behaviour of potato in Agra. Based on the low value of Shwartz Bayes Criterion (SBC) and Akaike Information Criterion (AIC), the estimated best model was SARIMA (2,1,1). Short term forecasts based on this model were close to the observed values (Tseng *et al* 2001) [4].

Table 1: Selected measure of predictive performance.

Model	AIC	AICc	BIC
ARIMA(1,1,1)(1,1,1)	13.07	13.08	12.10
ARIMA(1,1,1)(2,1,1)	12.90	12.91	11.94
ARIMA(2,1,1)(1,1,1)	13.07	13.07	12.11
ARIMA(2,1,2)(1,1,1)	13.08	13.08	12.12
ARIMA(3,1,1)(1,1,1)	13.07	13.08	12.12
ARIMA(1,1,1)(1,0,1)	13.07	13.09	12.11

The ARIMA model (1,1,1,) (1,0,1) is selected based upon considering the lowest AIC, AICc and BIC values, parameters and considering the ACF and PACF of the wholesale price series by comparing similar and close ARIMA models- ARIMA(1,1,1)$(2,1,1)_{12}$, ARIMA (2,1,1) $(1,1,1)_{12}$, ARIMA (2,1,2) $(1,1,1)_{12}$ and ARIMA(3,1,1)$(1,1,1)_{12}$ those satisfies the conditions like the sample autocorrelation coefficients of the residuals are within the limits and Ljung – Box tests. But their AIC, AICc and BIC values are greater than ARIMA model (1,1,1,) $(1,0,1)_{12}$.

Table 2: Parameters estimates of the ARIMA (1, 1, 1) model

Conditional Least Square Estimation- Ground nut				
Parameter	**Estimate**	**Standard Error**	**t Value**	
CONSTANT	5.27	1.26	4.20	AIC = 13.07
AR1	0.28	0.04	6.43	BIC = 12.11
MA1	-0.94	0.01	-63.20	
SAR1	-0.03	0.12	-0.26	
SMA1	-0.08	0.12	-0.73	

The above table explains the Parameters and their estimates and standard errors of the ARIMA (1, 1, 1) model. (AR1- autoregressive parameter of order 1, MA1- moving average parameter of order 1, SAR1- seasonal autoregressive parameter of order 1, SMA1- seasonal moving average parameter of order 1). MA1 had the lowest standard error -0.0149 and SMA1 had the SE of 0.1159 (Nogales *et al* 2002).

MAPE Validation

MAPE Validation

Mean absolute percentage error of the Jajpur market groundnut price was observed as 5.7. This value was lower in the sense that forecasted values were very much close to the actual values, and was very much helpful in improving the accuracy of forecast. This value was lower in the sense that forecasted values were very much close to the actual values, and was very much helpful in improving the accuracy of forecasting. D.S. Dhakre and D. Bhattacharya (2013) 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. Mean absolute percentage error of the Jajpur market groundnut price was observed as 5.7. This value was lower in the sense that forecasted values were very much close to the actual values, and was very much helpful in improving the accuracy of forecast.

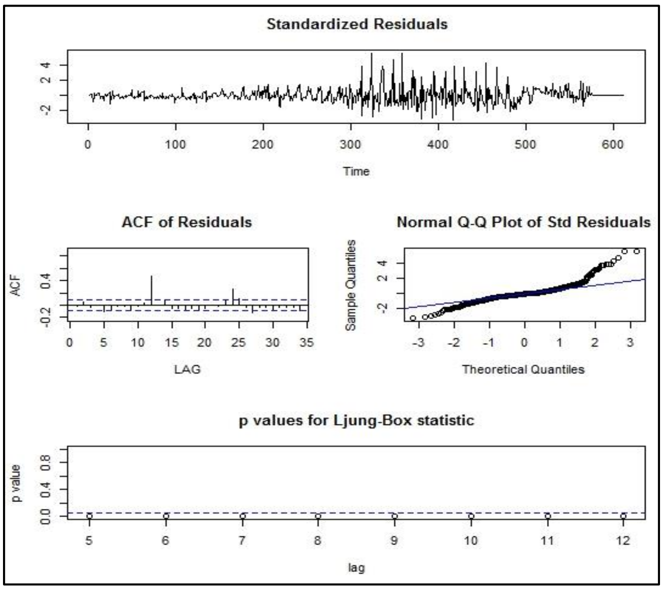

Fig 3: Standardized Residuals, ACF of Residuals, Normal Q-Q Plot of Standardized Residuals and p values for Ljung- Box statistic of ARIMA(1,1,1)$(1,0,1)_{12}$ after 1st differencing.

The above figure explains the Standardized Residuals, ACF of Residuals, Normal Q-Q Plot of Standardized Residuals and p values for Ljung- Box statistic of ARIMA(1,1,1)$(1,0,1)_{12.}$ The standardized residuals became stationary in the fitted model. Most of the sample autocorrelation coefficients of the residuals were within the limits that is sign for good model. Normal Quantile plot of standardized residuals were also fitted well. Majority of p values of all lags between 5 and 35 of Ljung- Box statistics were also above the limit. Thus these satisfied the condition of good fitted ARIMA model. Here figure 1 explains the Standardized Residuals, ACF of Residuals, Normal Q-Q Plot of Standardized Residuals and p values for Ljung- Box statistic of ARIMA(1,1,1)$(1,0,1)_{12.}$ The standardized residuals became stationary in the fitted model. Most of the sample autocorrelation coefficients of the residuals were within the limits that is sign for good model. Normal Quantile plot of standardized residuals were also fitted well. Majority of p values of all lags between 5 and 35 of Ljung- Box statistics were also above the limit. Thus these satisfied the condition of good fitted ARIMA model (Fig. 4).

Forecasted Results

Table 3: Forecasts based on the fitted ARIMA $(1,1,1)(1,1,1)_{12}$ model

Month	Week	Forecasted Price	Month	Week	Forecasted Price	Month	Week	Forecasted Price
January	1	4475	May	1	4560	September	1	4645
	2	4480		2	4565		2	4650
	3	4475		3	4570		3	4655
	4	4485		4	4575		4	4660
February	1	4495	June	1	4580	October	1	4665
	2	4505		2	4590		2	4670
	3	4510		3	4595		3	4680
	4	4515		4	4600		4	4685
March	1	4520	July	1	4605	November	1	4690
	2	4525		2	4610		2	4695
	3	4530		3	4615		3	4700
	4	4535		4	4620		4	4705
April	1	4540	August	1	4625	December	1	4710
	2	4545		2	4630		2	4715
	3	4550		3	4635		3	4720
	4	4555		4	4640		4	4725

From the forecast values obtained by the developed model (Table 3) it can be said that in Jajpur market in 2017 forecasted groundnut price will increase in December 2018 and reaches up to Rs.4725.00.

Forecasting the future groundnut prices can help both the farmers as well as the traders for future planning.

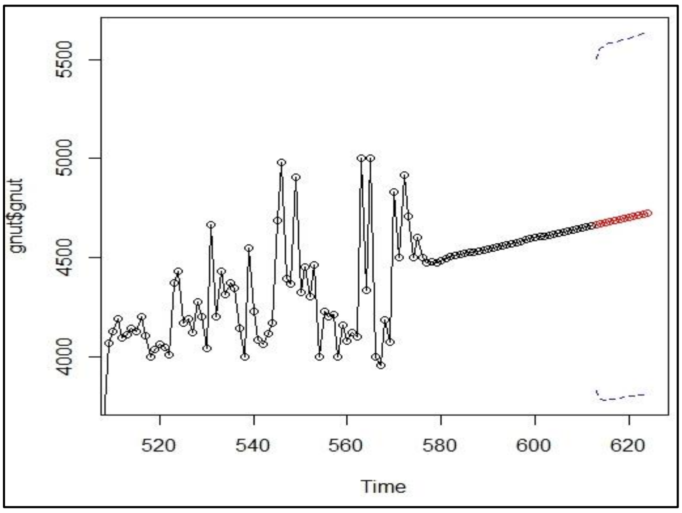

Fig 4: Fitted ARIMA model with data points

Above figure gives idea of the extent of forecasting of groundnut price between the higher and lower significant levels.

Conclusion and Policy Implications

A careful study of the findings would suggest that the farmer suffering from various price risks, 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 discussed. The results of the study would help the farmers to take decision on time of marketing in order to reap maximum benefit. The wider and frequent fluctuations in wholesale prices, affected the gross returns of the groundnut growers. In order to encourage the farmers to continue in groundnut production, price should be stabilized by introducing fairly high degree of competition among the wholesale functionaries and traders. This measure may include introduction of close tender system of sale, establishment of groundnut marketing cooperatives and fixation of minimum and maximum prices for the groundnut apart from fixing minimum support price which is in vogue. The regulated market committee should take necessary step for effective dissemination of the market information among the cotton growers in the remote villages.

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