Agricultural Product Price Forecasting using ARIMA Model

Saroj Kanta Biswal, Anita Sahoo

Abstract: The study consider the comparison of actual market price of green gram and the forecasted price of green gram to identify how close the forecasting tools help to identify the market price of agro product in future. This analysis will help to identify the expected fluctuation from the expected price and actual price of a commodity that will support the farmers and middle to decide the price of a particular commodity. In this study the green gram price of Odisha (India) is taken into consideration for analysis. The study will also explore the best method to identify the future market price. For the analysis weekly price of the product is considered and seasonal ARIMA (1, 1, 1) (1, 0, 1), S=4 model is used as it was found to be the best model for forecasting. It is expected that this analysis will benefit the farmers in deciding the price of the products and support in rescheduling their crop as per the price movement in future.

Keywords: Forecasting price, ARIMA, Indian Agro Products, Green Gram.

I. INTRODUCTION

In India particularly in Odisha, most of the population are dependent on agriculture. Now day’s women are dominating the men in farming work for sustaining livelihood. There is a quote by Dinye (2003) which is highly applicable for people of Odisha i.e. “feminization in agriculture has risen while going far against the cultural norm”. Apart, from several physical support and financial support the farmers of Odisha are still facing several challenges in selling their products. It is observed that due to negligence or several different factors like cultural barriers, political interference and economic issues, lack of mobility, credit facilities and etc. restrict the farmers to sell successfully in the market (Mandi).

This issue in Odisha is experienced mainly in case of cash crop like turmeric, green gram, cotton and etc. Amongst all green grams is an agricultural product of Odisha that produce the maximum. It is observed that India is at 19th position out of top 30th country in exporting the green gram. Rajasthan, Gujarat, Andhra Pradesh, Maharashtra, Odisha are top five Greengram producers in India. But unfortunately they are not effective in selling those at international markets while the Myanmar is depended on the India regarding the supply of green gram. Even after a huge demand in global market, India is not able to satisfy the requirement. The reason is many but the major reason is selling it on right time and at right price. This issue is observed in all the state of the nation but it is prominently found in Odisha state perhaps famers are ignorant of market price and the forecasted rate of the competitor.

As a result the study try to focus on finding the measurement tools that will help the famers in identifying the future change in price and able to find out how much the forecasted price will deviate from the actual market price.

There are several ways of measuring the price of any products in advance. Forecasting using Time-series model is used as a basis for manual and automatic planning in many application domains; an important statistical analysis technique (Gooijer and Hyndman, 2006). “Forecasts are calculated using mathematical models that capture a parameterized relationship between past and future values to express the behavior and characteristics of a historic time series.” (Dipankar Mitra, et al. 2017).

II. PURPOSE OF THE STUDY

The aim of the present study is to design appropriate forecasting model of green gram in Odisha market and to measure the forecast weekly price of green gram in Odisha market. The study is trying to solve the research questions like: Does appropriate information in right time for right people lead to better efficiency and whether weekly price forecasting is efficient than monthly price forecast? As the price volatility of green gram creates risks to producers, suppliers, consumers and other stake holders; it is important to forecast green gram price at weekly basis in-order to diminish the error term at monthly forecasting basis. The Government has fixed the MSP (Minimum Support Price) for medium staple green gram as Rs. 4020 per Qtl and Rs. 4320 per Qtl. for long staple green gram. (agricoop, 2018)

III. REVIEW OF LITERATURE

Applying ARIMA model Shrutih Mohapatra, et al. (2018) forecasted Odisha groundnut monthly price and her fitted model was found as ARIMA (1,1,1) (1,0,1). Rahul Tripathy, et al. (2014) forecasted area, production and productivity of Rice in Odisha by using ARIMA model and compared it with all India data and found contribution. Pushpa Savadatti (2017) forecasted area, production and productivity of food grains in India by using ARIMA model. Dipankar Mitra (2017) Established time series model for forecasting Oil seed and pulses price in India. A Dash, et al. (2017) forecasted kharif rabi food grains production in Odisha. Ashwini Darekar,et al. (2017) forecasted price of common paddy for India by using ARIMA technique.
Applying ARIMA model Darekar and Reddy(2017) forecasted Kharif Paddy price of India from September to November 2017-18; and performance was measured testing AIC, BIC and MAPE; Darekar and Reddy (2017) using Box-Jenkins ARIMA modelling method, forecasted Pigeon pea price in India during November to January 2017-18 and tested reliability of model using goodness of fit methods like MAPE, AIC and BIC; Darekar, A. and Reddy, A. A. (2017) have attempted forecasting of Soybean price India by using ARIMA approach and performance of model got tested using AIC, SBC and MAPE approach; Darekar, A. and Reddy, A. A. (2017) forecasted Green gram price in India using ARIMA modelling method and performance got measured using AIC, SBC and MAPE approach; AshwiniDarekar, A. Amarendra Reddy. (2017) suggested farmers to increase acreage under Maize at Suitable condition as the forecasted Maize price (Using ARIMA model) during harvesting season in Indian market from September to December 2017-18 seems to be increasing; VenkateshPanasa, et al. (2017) forecasted maize monthly modal prices in Telangana, India using ARIMA model with the help of SAS 9.3 software; Hemavathi et al. (2017) forecasted food grains area and production in India using ARIMA model. ARIMA (1, 1, 0) model for forecasting area and ARIMA (0, 1, 1) for forecasting production in India for four leading years; V. Jadhav, et al. (2017) forecasted Maize, Ragi and Paddy of Karnataka state of India for the year 2016. Evaluation of forecast was done using the criteria of MSE, MAPE and Theils U coefficient criteria; Dr V Ramanujam and Dr T Viswanathan. (2018) forecasted Black Peeper price in India; Darekar and Reddy (2018) forecasted Mustard prices in major Mustard producing states of India using ARIMA (0, 1, 0) (0, 1, 1); Darekar A and AA Reddy. (2018) forecasted Wheat price in India using ARIMA (0, 1, 1) (0, 1, 1) model.

The detailed literature helps the researchers to solve the main objective i.e. How to forecast the price of agro products in advance? And is there any gap between the estimated price and actual price? This paper tries to identify the best method of forecasting the price of green gram for Odisha that can support the farmer to sell at right price and at right time. This forecasted price can help the farm workers to identify the expected price growth or fall basing upon which they can harvest the crops and try to store till the market gets in their favor.

IV. METHODOLOGY

This study applies ARIMA technique which is very popular in various function areas. The application of this technique is very limited in agriculture sector due to lack of data, weather fluctuation, pest attack, natural calamity etc.

The research paper consist of longitudinal in nature collected from secondary sources i.e. AGMARKNET website. The analysis carries 732 weekly price of green gram of Odisha from January 2004 to December 2018. The data are considered to forecast the price of green gram. As it is a secondary form of data hence it is valid. For the analysis the seasonal ARIMA (1, 1, 1) (1, 0, 1) model is best fitted for forecasting of green gram price as study reveals. The weekly price forecasting is done for six months i.e. from January to June 2019. Before applying the forecasting tool, the data analysis is carried on after the data stationary and normality.

V. RESULT & DISCUSSION

A normality test is carried on to identify the existence of normality of data. The data consists of weekly price data of green gram for fourteen years. The normality test is carried on by the help of JB statistics. Fig.1 below shows the output of normality test. Here the result of skewness is expected to be 0 and kurtosis as 3 but the result shows -0.261818 and 1.829441 respectively which means it is negatively skewed and less than the normal value of kurtosis. The probability value is 0.000 it states that the data series are not normally distributed.

![Normality Test](image)

As the data series are non normal in nature the next step is to analyse the stationarity of data. The stationarity of data can be performed unit root test. Table-1, below shows the result of stationarity test through Augmented-Dickey Fuller test Philips Perron Test.

**Table 1: ADF Test and PP test Result after 1st order difference**

<table>
<thead>
<tr>
<th>Augmented Dickey-Fuller</th>
<th>Phillips-Perron</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-Statistic</td>
<td>Prob.*</td>
</tr>
<tr>
<td>Test critical values at 1% level</td>
<td>-16.79901</td>
</tr>
<tr>
<td>Test critical values at 5% level</td>
<td>-3.439358</td>
</tr>
<tr>
<td>Test critical values at 10% level</td>
<td>-2.865406</td>
</tr>
<tr>
<td>Test critical values at 10% level</td>
<td>-2.568855</td>
</tr>
</tbody>
</table>


![Stationarity Test](image)

As the data is not found stationary at level so the test is carried from 1st order difference. Here the P-value of both ADF and PP test shows 0.0000. So, in this case rejects the hypothesis of non-stationary of data series is rejected i.e the value of mean and variance remain constant for specific period of time.
As the data series is found to be non normal in nature and has stationary it means the forecasting of price is utmost required as the price of green gram of Odisha is found that it is not following a random walk.

It explains the ACF standardized residuals and P-values for L-jung-Box statistics of ARIMA (1,1,1)(1,0,1)\(_{(S=4)}\) after 1st differencing. In the fitted model the standardized residuals becomes stationary. This model is good model as most of the sample autocorrelation coefficients of the residuals were within the limits. Other plots of standardized residuals like normal quantile plot were also fitted well. Ljung-Box statistics is satisfied as majority of p-values of all lags lies between 5 and 35. Thus a good fitted ARIMA model was found.

The forecasting of price series is done considering the weekly data of green gram of Odisha since January 2004 to December 2018 and the forecasted is done for six months i.e from January- June 2018 Which is shown in the below table -2 using SARIMA model (1, 1, 1) (1, 0, 1).

![Fig. 2. Pre-sowing and Pre-harvest Price Forecast](image)

Table II: Weekly Price forecasting and Actual Price of Green Gram of Odisha for the year of 2019

<table>
<thead>
<tr>
<th>Month</th>
<th>FP</th>
<th>AP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>6788</td>
<td>6849.28</td>
</tr>
<tr>
<td>Feb</td>
<td>6670</td>
<td>6982.86</td>
</tr>
<tr>
<td>Mar</td>
<td>6631</td>
<td>6977.69</td>
</tr>
</tbody>
</table>

Table- III Change of percentage from previous week and from forecast price to actual price

<table>
<thead>
<tr>
<th>Month</th>
<th>Week</th>
<th>Percentage change from previous week (Price Forecast)</th>
<th>Percentage change from previous week (Actual Price)</th>
<th>Percentage change from (Price Forecast to Actual Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAN</td>
<td>1st week</td>
<td>-0.01002</td>
<td>0.01915</td>
<td>0.00093</td>
</tr>
<tr>
<td></td>
<td>2nd week</td>
<td>-0.00223</td>
<td>-0.00567</td>
<td>0.03875</td>
</tr>
<tr>
<td></td>
<td>3rd week</td>
<td>-0.00522</td>
<td>0.00605</td>
<td>0.03518</td>
</tr>
<tr>
<td></td>
<td>4th week</td>
<td>-0.00585</td>
<td>-0.00074</td>
<td>0.04691</td>
</tr>
<tr>
<td>FEB</td>
<td>1st week</td>
<td>-0.01016</td>
<td>-0.00005</td>
<td>0.05228</td>
</tr>
<tr>
<td></td>
<td>2nd week</td>
<td>-0.00060</td>
<td>-0.00014</td>
<td>0.05335</td>
</tr>
<tr>
<td></td>
<td>3rd week</td>
<td>0.00378</td>
<td>0.00021</td>
<td>0.05383</td>
</tr>
<tr>
<td></td>
<td>4th week</td>
<td>0.00497</td>
<td>-0.00031</td>
<td>0.05090</td>
</tr>
<tr>
<td>MAR</td>
<td>1st week</td>
<td>0.00210</td>
<td>-0.00323</td>
<td>0.04458</td>
</tr>
<tr>
<td></td>
<td>2nd week</td>
<td>0.00194</td>
<td>0.00346</td>
<td>0.03902</td>
</tr>
<tr>
<td></td>
<td>3rd week</td>
<td>-0.00075</td>
<td>0.01754</td>
<td>0.04060</td>
</tr>
</tbody>
</table>
Agricultural Product Price Forecasting using ARIMA Model

The above figure shows a comparative weekly price change from the Price forecast to Actual Forecast. The result market price are partial close to the forecasted price but it is observed from the graphical movements that the change of percentage is maximum in case of April 3rd week which shows a rising trend followed with an immediate fall in the 4th week of April and again a rise in 2nd May and so on. So it can be found that a period from April 2019 till June 2019 is paired that is experiencing a price volatility which is due to the seasonal impact of the green gram of Odisha.

VI. CONCLUSION AND POLICY IMPLICATION

There is an old concept that hard work will always be rewarded but this statement is not always true. It is observed that the hard work farmers are not always appreciated in selling their crops. This is due to the ignorance in price fixation of the products. This paper reduces the gap by identifying the price movement of the green gram of Odisha in near future, which shows a significant rise in the 1st week and 4th week of every month and a slight fall in the 2nd and 3rd week, although the trend has a mixed result. From the analysis it can be said that the farmers can try to sell their products in the 1st and last week of every month to gain maximum benefit. Adding to it the study also confirmed a comparison between the expected price and actual market price to understand the weekly price movement. But from the analysis it has been confirmed that if a farmer able to evaluate the forecasting price then the farmers will not face the issue of quoting the appropriate price or face the competitive price because the actual market price is always higher than the comparison to forecasted price. As a result a farmer can identify the minimum price of their product through this kind of analysis and be able to make a maximum benefit by quoting a price as per the market price movement.

But a full dependency on forecasted price may affect the decisions of farmers as the actual market price is too high for the green gram of Odisha. It can be said that there might be certain other factors that affect the volatility in the weekly price of the Green gram of Odisha. The paper used a simple product for price forecasting but this tool can be incorporated on every agricultural product to identify the price trend and forecast the expected rate in near future.

Lastly, the analysis uses the weekly price of green gram but a daily market price can be considered to forecast the price of the day of the week, adding to it the study is undertaken to Odisha region only while other state and area can be considered. Even a significant change might be observed if the analysis is carried on between perishable and non-perishable agricultural commodities so these are some of the area that are left for further studies.

REFERENCES


**AUTHORS PROFILE**

**Dr. Saroj Kanta Biswal**, MBA, MTA, LLB, PhD (Associate Professor) Research area is Behavioral Finance, Business Analytics, Value Investing and Financial Modeling. Published over fifty articles in national and international journals of repute. Produced six PhD scholars.

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