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Agricultural Product Price Forecasting using ARIMA Model

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***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." (DipankarMitra, 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 Shruti 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.

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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. AshwiniDarekar,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. Amarender 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.

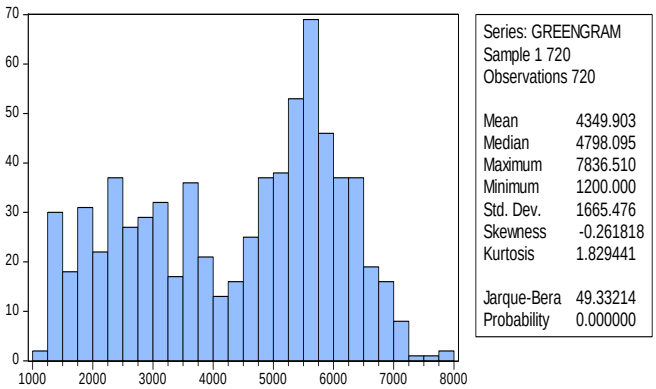

Fig. 1. Normality Test for the Green Gran Weekly Price

As the data series are non normal in nature the nest 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

	Augmented Dickey-Fuller		Phillips-Perron	
	t-Statistic	Prob.*	Adj. t-Stat	Prob.*
test statistic	-16.79901	0.0000	-155.4774	0.0001
Test critical values at 1% level	-3.439358		-3.439230	
Test critical values at 5% level	-2.865406		-2.865349	
Test critical values at 10% level	-2.568885		-2.568855	

*MacKinnon (1996) one-sided p-values.

Fig. 2. *Normality Test for the Green Gran Weekly Price*

As the data is not found stationary at level so the test is carried from 1s order difference. Here the P-value of both ADF and PP test shows 0.0000. So, in this case rejects the hypothesis of non-stationarity 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 $(1,1,1)(1,0,1)_{12}(S=4)$ 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 standardzed residuals like normal quantile plot were also fitted well. Ljung-Box statistics is satisfied as majority ofp-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 monthe i.e from January- June 2018 Which is shown in the below table -2 using SARIMA model (1, 1, 1) (1, 0, 1).

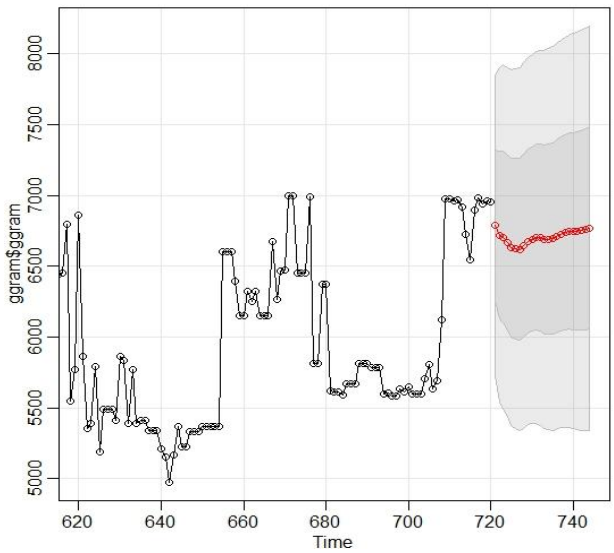

Fig. 2. Pre-sowing and Pre-harvest Price Forecast

Figure-2, shows the graphical representation of the weekly price forecasting of green gram which is represented in red line and the grey lines are the period for forecasting. As per the objective the price forecasting is conducted through SARIMA $(1,1,1)(1,0,1)_{12}(S=4)$ which is considered as best model fit.

The table-2 shows the forecasted price and the actual price for the month from Jan-2019 to June 2019. The result shows that the actual price of green grams is more in comparison to the forecasted price. This phenomenon is found throughout the period. In addition, it is found that the gap between the actual and forecasted price is maximum during the period of April 2019. It means this is a period which has high volatility in respect to price. So the farmers who are fixing the price during such period should understand the price fluctuation and try to quote the appropriate price of the product

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

M	W	FP	AP	M	W	FP	AP
Jan	1st week	6788	6849.28	Apr	1st week	6690	6799.54
	2nd week	6720	6980.42		2nd week	6692	6892.2
	3rd week	6705	6940.86		3rd week	6694	7650.6
	4th week	6670	6982.86		4th week	6709	6280
Feb	1st week	6631	6977.69	May	1st week	6727	7073.01
	2nd week	6624	6977.37		2nd week	6737	7351.85
	3rd week	6620	6976.38		3rd week	6747	6738.42
	4th week	6645	6977.86		4th week	6748	7594.35
Mar	1st week	6678	6975.69	Jun	1st week	6748	7640.74
	2nd week	6692	6953.14		2nd week	6753	6981.02
	3rd week	6705	6977.2		3rd week	6758	6976.87
	4th week	6700	7099.55		4th week	6768	7243.47

FP –Forecast Price
AP – Actual Price

The table-3 shows the percentage change of previous weekly price in forecasted and actual along with it the change of percentage of weekly price between forecasted price and Actual price. This analysis will reveal that how far the price moves between and within the expected price and actual market price.

From the above table it is clear that forecated price follows a trend that is a fall of price for certain month then a rise in price for certain period. Where as the actual market price is following a mixed trend that is in same month one of the week is showing high price and in other of same month is showing a low price. But the cahnge in price in both the case i.e. expected price or market price is maintaining a reasonable change and a continous change i.e. the change is not significant that will affect the pricing decision fof the farmers. However, the comparison analysis between the price forecasting and actual price shows an interesting fact that change of percentage of weekly Actual price is higher from the estimated price result to which it shows a positive change from January 2019 to May 2019 except for the month of 4th week of April and 3rd week of May 2019 perhaps this negative change due to the effect of end of the month as well as seasonal effect of the crop availability.

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

Month	Week	Percentage change from previous week (Price Forecast)	Percentage change from previous week (Actual Price)	Percentage change from (Price Forecast to Actual Price)
JAN	1st week	-0.01002	0.01915	0.00903
	2nd week	-0.00223	-0.00567	0.03875
	3rd week	-0.00522	0.00605	0.03518
	4th week	-0.00585	-0.00074	0.04691
FEB	1st week	-0.00106	-0.00005	0.05228
	2nd week	-0.00060	-0.00014	0.05335

	3rd week	0.00378	0.00021	0.05383
	4th week	0.00497	-0.00031	0.05009
MAR	1st week	0.00210	-0.00323	0.04458
	2nd week	0.00194	0.00346	0.03902
	3rd week	-0.00075	0.01754	0.04060
	4th week	-0.00149	-0.04226	0.05963
APR	1st week	0.00030	0.01363	0.01637
	2nd week	0.00030	0.11004	0.02992
	3rd week	0.00224	-0.17915	0.14290
	4th week	0.00268	0.12628	-0.06394
MAY	1st week	0.00149	**0.00149**	**0.03942**
	2nd week	0.00148	**0.00148**	**-0.08344**
	3rd week	0.00015	**0.00015**	**0.12702**
	4th week	0.00000	**0.00000**	**0.00611**
JUN	1st week	0.00074	**0.00074**	**-0.08634**
	2nd week	0.00074	**0.00074**	**-0.00059**
	3rd week	0.00148	**0.00148**	**0.03821**
	4th week	-	-	-

The above figure-3 shows the clear picture about the percentage change of Price forecast and Actual Forecast which states that the forecasting price is maintianing a balanced level of change i.e. neither it is too high nor too low for the period considered adding to it the change of weekly prices are close to zero it signifies that the price change of green gram is very less from its prious weekly price. But the actual price of the product shows a significant change i.e. the weekly change of green gram is highly volatilie as the change is not close to 0 rather the fluctuation is too high for the time period considered and this volatility is found from March 4th week till June 1st week.

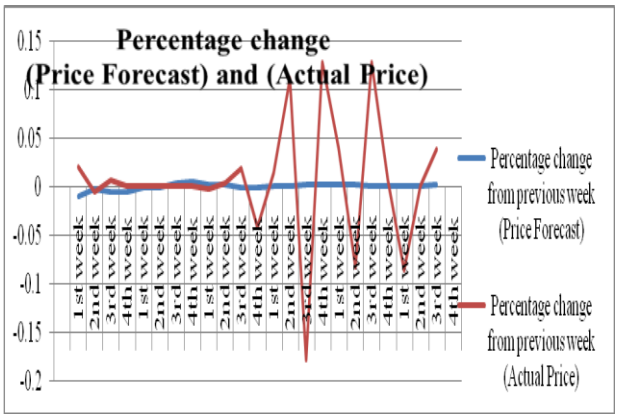

Fig. 3. Change of percentage from Previous week (Price forecast) and (Actual Forecast)

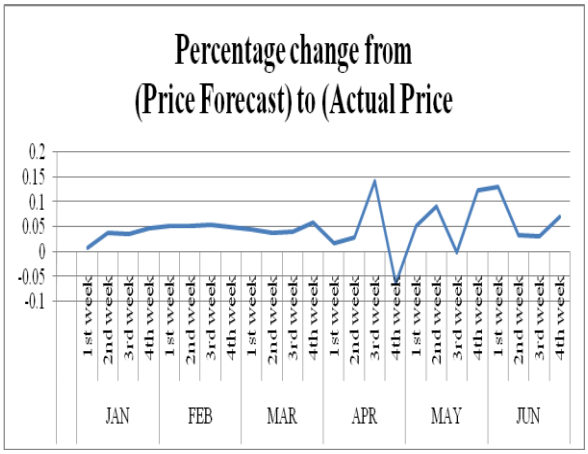

Fig. 5. Weekly Change of percentage from (Price forecast) to (Actual Forecast)

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 paeriod that is experieincing 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 farm worker 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 made a comparison between the expected price and actual market price to understand the weekly price movement. But from the analysis it is 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 always in higher side with comparison to forecasted price. As a result a farmer can identify the minimum price of their product through this kind of analysis and 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 single 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 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

1. A Dash, et al. (2017) .Forecasting of food grain production in Odisha by fitting ARIMA model. *Journal of Pharmacognosy and Phytochemistry*. 6(6): 1126-1132. http://www.phytojournal.com/archives/2017/vol6issue6/PartP/6-5-541-759.pdf.
2. AshwiniDarekar and A Amarender Reddy. (2017). Price forecasting of pulses: case of pigeon pea. *Journal of Food Legumes* 30(3): 42-46.
3. Ashwini Darekar, A. Amarender Reddy. (2017). Price forecasting of maize in major states. *MaizeJournal*.
4. Ashwini Darekar, et al. (2017). Forecasting of Common Paddy Prices in India. *Journal of Rice Research* 2017, Vol 10 No. 1. http://www.icar-iirr.org/journal%202017-10-13.pdf.
5. Darekar A and AA Reddy. (2018). Forecasting wheat prices in India. Forecasting wheat prices in India. *Wheat and Barley Research* 10(1).
6. Darekar A and AA Reddy. (2018). Oilseeds Price Forecasting: Case Of Mustard In India. Agricultural Situation in India.
7. Darekar, A. and Reddy, A. A. (2017). Cotton Price Forecasting in Major Producing States. Economic Affairs, 62(3):1-6.Print ISSN: 0424-2513, Online ISSN: 0976-4666, 2017.
8. DipankarMitra. (2017). Hierarchical Time-series Models for Forecasting Oilseeds and Pulses Production in India. *Economic Affairs*, Vol. 62, No. 1, pp. 103-111, March 2017 DOI: 10.5958/2230-7311.2017.00045.9
9. Directorate of Marketing & Inspection (DMI), Ministry of Agriculture and Farmers Welfare, Government of India. Available from: http://agmarknet.gov.in/.
10. Dr V Ramanujam and Dr T Viswanathan. (2018). An Empirical Analysis of Forecasting Volatility of Pepper Price in the Spot Market in India. Research Gate.
11. Gooijer, J.G.D. and Hyndman, R.J. (2006). 25 years of time-series forecasting. *Int. J. Forecasting*. 22(3): 443-73.
12. Hemavathi et al. (2017). Forecasting Food grains Area and Production in India using ARIMA Model. *Statistical Approaches on Multidisciplinary Research*, Volume I, DOI: Surragh Publishers, India, ISSN: 2349 – 4891.
13. Kumar, M. A. (2018). A technical analysis of Indian spot and derivative market through digitization. *ZENITH International Journal of Business Economics & Management Research*, *8*(7), 1-12.
14. Kumar, M. A. Digitized India Announcement volatile the Indian Stock Market with special reference to NIFTY 50 and BSE Sensex-A critical analysis.*International Journal of Creative Research Thoughts*, 6(2), 558-567.
15. PushpaSavadatti. (2017). Forecasting of Area, Production, and Productivity of Food Grains in India : Application of ARIMA Model. *Indian journal of economics and research*.DOI: 10.17010/aijer/2017/v6i6/120114.http://indianjournalofeconomicsandresearch.com/index.php/aijer/article/view/120114.
16. Rahul Tripathy, et al. (2014). Forecasting Rice Productivity and Production of Odisha, India, Using Autoregressive Integrated Moving Average Models. *Advances in Agriculture Article* ID 621313, 9 pages http://dx.doi.org/10.1155/2014/621313. https://www.hindawi.com/journals/aag/2014/621313/
17. ShrutiMohapatra, et al. (2018). Price forecasting of groundnut in Odisha. *The Pharma Innovation Journal* 2018; 7(3): 111-114. Available from: <http://www.thepharmajournal.com/archives/2018/vol7issue3/PartB/7-2-33-193.pdf>.
18. USDA (2018). https://www.usda.gov/media/agency-reports
19. V. Jadhav, et al. (2018). Application of ARIMA Model for Forecasting Agricultural Prices. J. Agr. Sci.Tech.Vol.19:981992.
20. VenkateshPanasa, R. VijayaKumari, G. Ramakrishna and Kaviraju, S. (2017). Maize Price Forecasting Using Auto Regressive Integrated Moving Average (ARIMA) Model. *Int.J.Curr. Microbiol. App.Sci*.6(8):2887-2895.
21. Zotteri, G., Kalchmidt, M. and Caniato, F.(2005). The impact of aggregation level on forecasting performance. *Int. J. Prod. Eco.*, 93-94: 479-91.

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