Agro Economist - An International Journal
Citation: AE: **9**(01): 49-54, March 2022
DOI: 10.30954/2394-8159.01.2022.7

AAEBM
ASSOCIATION OF AGRICULTURAL ECONOMICS & AGRI-BUSINESS MANAGEMENT

Forecasting of Pea Prices of Varanasi Market Uttar Pradesh, India through ARIMA Model

Abha Goyal[1], Prakash Singh Badal[1*], V. Kamalvanshi[1], Pramod Kumar[2] and Biswajit Mondal[3]

[1]*Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India*
[2]*Division of Agricultural Economics, Indian Agricultural Research Institute, New Delhi, India*
[3]*National Rice Research Institute, Cuttack, Odisha, India*

*Corresponding author: psbadal@bhu.ac.in

Received: 09-12-2021 **Revised:** 24-02-2022 **Accepted:** 03-03-2022

ABSTRACT

Pea (*Pisum sativum*) is the most common green pod-shaped vegetable widely grown as a cool-season crop. Green peas are used either- fresh or frozen and canned. India is one of the largest producers of peas in the world and ranks 5th on the of major pea producers. However, fluctuation in the prices of pea are common and lead to often reduced profit to farmers. A prior information about this price could help them in decision making regarding bringing the same for market or opting for processing. For this purpose ARIMA and SARIMA models were used to forecast the prices of pea for Varanasi in Uttar Pradesh using daily time series data of five years from 2017 to 2021. The best model was selected on the basis of R-squared, AIC, BIC, RMSE and MAE. The study revealed that out of ARIMA (3,1,5), SARIMA (1,0,1) (1,0,1) and SARIMA (0,0,1)(0,0,1), the 2nd were best fitted model for forecasting of pea prices for Varanasi. The forecasted values showed that the prices of pea were high in the month of November and February and low in December and January for the forecast year 2022.

Keywords: ARIMA, SARIMA, RMSE, MAE, forecasting, peas

Pea (*Pisum sativum*) is the most common green pod-shaped vegetable widely grown as a cool-season crop. Green peas are used either – fresh or frozen and canned. India occupy fourth position in area (10.53%) and 5th position in production (6.96%)(FAO Stat., 2014). In India pea is grown over an area of 11.50 lakh ha with a production of about 10.36 lakh tonnes (2012-2015). Uttar Pradesh is the largest pea producing state in India producing about 49% of the country's produce, occupying 4.44 lakh ha with annual production of 5.76 lakh tonnes and average productivity of 1,297 kg/ha (FAO Stat., 2014).

Pea is a rich source of proteins, amino acids, sugars, vitamins and minerals namely magnesium, thiamine, phosphorus etc. Green pea straw is a good source of nutritious fodder for livestock. Fluctuation or instability in price is the greatest source of risk next only to weather in agricultural production system. The fluctuating characteristics of agricultural prices enter directly in the decision frame of farmers, both in production and marketing (Naidu *et al.* 2016). Forecasting is the process of making prediction of future and it provides an important and useful input for proper, foresighted and informed planning in agricultural sector, which is full of uncertainties. Now-a-days agriculture has become highly input

How to cite this article: Goyal, A., Badal, P.S., Kamalvanshi, V., Kumar, P. and Mondal,B. (2022). Forecasting of Pea Prices of Varanasi Market Uttar Pradesh, India through ARIMA Model. *Agro Economist - An International Journal*, **09**(01): 49-54.

Source of Support: ICAR –NASF, New Delhi
Conflict of Interest: None

and cost intensive. With the help of forecasted prices, farmer's can find the forecast for the specific month fetching high and remunerative prices of their produce. Therefore, the study was taken up with following specific objectives: (1) To test and identify appropriates time series models for forecasting of pea prices in Varanasi market, and (2) To forecast the prices of pea with the help of best time series model, for Varanasi market of Uttar Pradesh, India.

Kumar, P. *et al.* (2021) worked on the price forecasting of onion for Varanasi market of Uttar Pradesh, India using ARIMA, ARFIMA and ARMA-GARCH models. They found on the basis of MAPE, MSE, RMSE and Theil's U statistics, the ARMA-GARCH model outperformed the others. Gupta *et al.* (2018) did forecasting of arrivals and prices of pulses in Chhattisgarh using time series models. Ozer and Ilkdogan (2013) examined cotton prices in the world by ARIMA model, by using 102 per month data, covered the period January 2004 to June 2012 of the world prices of cotton. Kumar R.R. and Baishya, M. (2020) studied potato prices in India with the help of ARIMA and SARIMA models and found that both of this models were suitable for different states of India Keeping in view of above studies, ARIMA and SARIMA models were compared and subsequently SARIMA was selected in order to forecast the prices of peas for Varanasi market in Uttar Pradesh.

MATERIALS AND METHODS

Present study was carried out during 2022 at BHU, Varanasi using daily data of pea prices of Varanasi market of Uttar Pradesh, India. The daily time series data on pea prices was taken from website http://www.nhb.gov.in for the period from 1st January 2017 to 31st December 2021. With the help of R software the data was analyzed to fit the time series models.

ARIMA stands for *Auto-Regressive Integrated Moving Averages*. An ARIMA describes the correlation between data points and takes into account the difference of the values. An improvement over ARIMA is SARIMA (or seasonal ARIMA). ARIMA model is the combination of Auto-Regressive (AR), Integration (I), and Moving Average (MA). The ARIMA (p,d,q) model can be represented by the following general forecasting equation:

$$Y_t = \mu + \sum_{i=1}^{p} \varphi_i Y_{t-i} + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} + \varepsilon_i$$

Where, Y_t is pricing, μ is the mean of series, φ_1,……φ_p are the parameters of AR model, the θ_1,……. θ_q are the parameters of the MA model and the ε_t, ε_{t-1},……. ε_{t-q} are the noise error term. Further '*p*' stand for the order of autoregressive process, "*d*" is the order of differencing, and '*q*' is the order of moving average process. SARIMA stands for seasonal ARIMA model is to be denoted by ARIMA (*P,d,q*) (*P, D, Q*), where *P* denotes the number of seasonal autoregressive components, *Q* denotes the number of seasonal moving average terms and D denotes the number of seasonal differences required to induce stationarity (Box *et al.* 1994).

The stationary check of time series data was performed with the help of Augmented Dickey-Fuller test (ADF) and it was found to be stationary. Subsequently fitting of ARIMA model and SARIMA models were done to the daily data from January 2017 to December 2021 and used to forecast the prices of pea for the year 2022.

Model Selection: The best fitted model was selected based on the low value of Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and highest value of R-squared.

Model validation: The fitted ARIMA model needed to be validated before using the forecasted result for broader use. The model was verified for accuracy by examining the residuals of the particular model using the Auto Correlation Function (ACF) and partial ACF. If the model shows random residuals, it indicates that the identified model adequately predicts future prices and vice-versa. The ACF and PACF residuals were considered random, when all their ACFs were within limits. After satisfying the adequacy of the fitted model, it was used for forecasting future prices of pea.

RESULTS AND DISCUSSION

Identification of the model was concerned with deciding the appropriate value of (*p,d,q*) for ARIMA and value of (*p,d,q*) (*P, D, Q*) for SARIMA. To check

the stationarity of pea prices, the ADF test was used. The test confirmed that the data was stationary. Thus, there is no need to differencing and then the adopted differenced order is $d = 0$ for SARIMA (p,d,q) (P,D,Q). For the development of this time series model we use t series and forecast packages available in R software. For the development of ARIMA (p,d,q) model we use auto. ARIMA function in R software and we get automatically ARIMA (3,1,5) model for the forecasting of prices of pea. For the development of SARIMA model, in which are to find out the appropriate values of (p,d,q) (P,D,Q) is done by observing the ACF and PACF values. The ACF value helps in choosing the appropriate value for the ordering of Moving Average (MA), and the PACF value for the Auto Regressive terms and d is the differencing term. The ACF and PACF for Varanasi market from ARIMA (3,1,5) and SARIMA (1,0,1) (1,0,1) and SARIMA (0,0,1) (0,0,1) model were obtained and presented in Fig. 1-3.

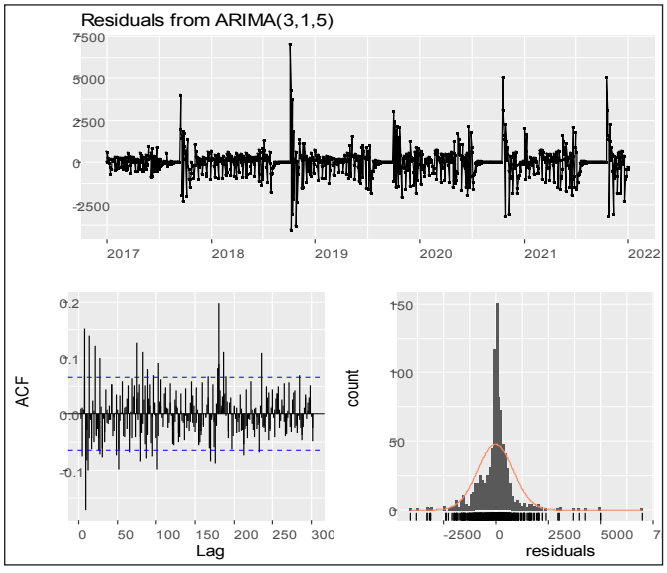

Fig. 1: ACF and PACF graph of ARIMA (3,1,5)

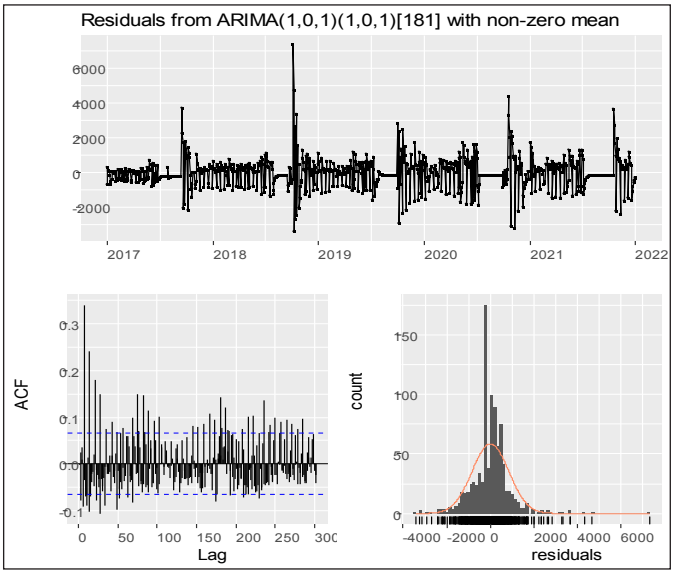

Fig. 2: ACF and PACF graph of SARIMA (1,0,1) (1,0,1)

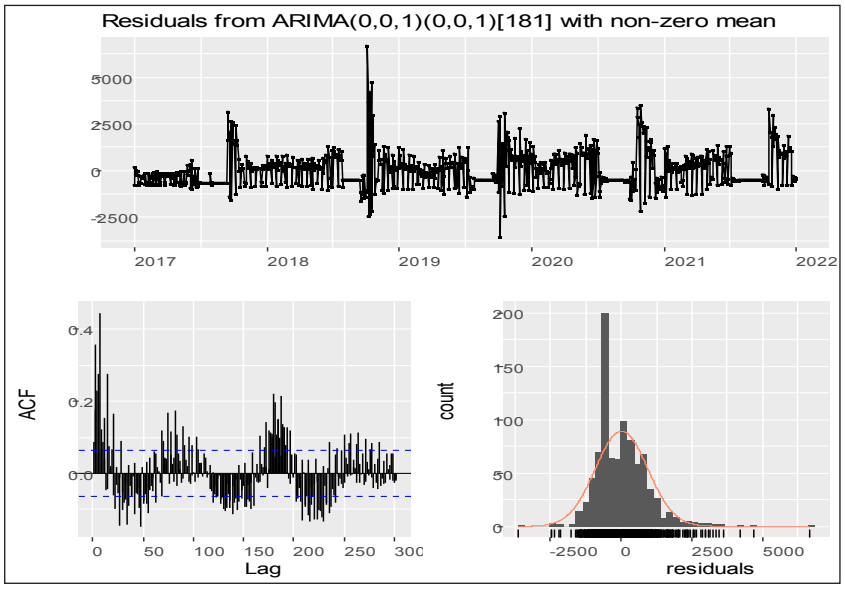

Fig. 3: ACF and PACF graph for of SARIMA (0,0,1) (0,0,1)

Identifying and validating the best fit model

After the identification of the appropriate values of (*p*,*d*,*q*) for ARIMA and (*p*,*d*,*q*) (*P*,*D*,*Q*) for SARIMA, the best model were selected on the basis of highest R- squared, lowest AIC, BIC, RMSE and MAE. From the Table 1, the model SARIMA (1,0,1) (1,0,1) have highest R- squared, lowest AIC, BIC, RMSE, and MAE value, were identified the best fitted models for forecasting of pea prices at Varanasi market in Uttar Pradesh, India.

The model validation checked using ACF and PACF plots and distribution of residuals by the Ljung-Box test plot, a statistical test that assesses whether any of a group of autocorrelations of a time series are different from zero which will the influence the accuracy of the model. The pea price residual plots evaluate autocorrelation of selected model. It was determined that most spikes fall within significance limits, which indicate that the errors are not autocorrelated. The fitted model is valid and can be used for forecasting and the residuals are normally and independently distributed. The result of Box-Ljung *Q* statistic represented in Fig. 4-6.

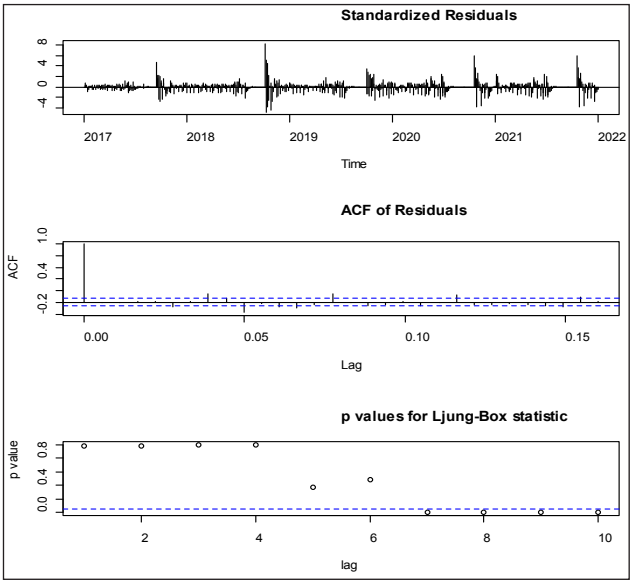

Fig. 4: Residual analysis of Model ARIMA (3,1,5)

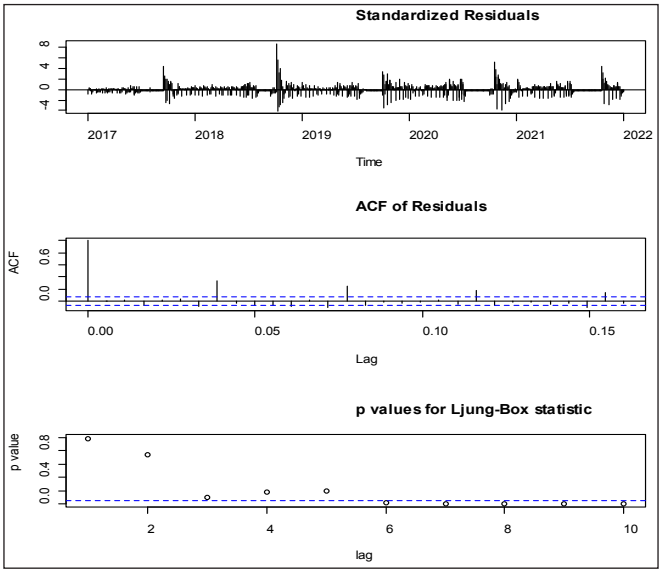

Fig. 5: Residual analysis of Model ARIMA(1,0,1) (1,0,1)

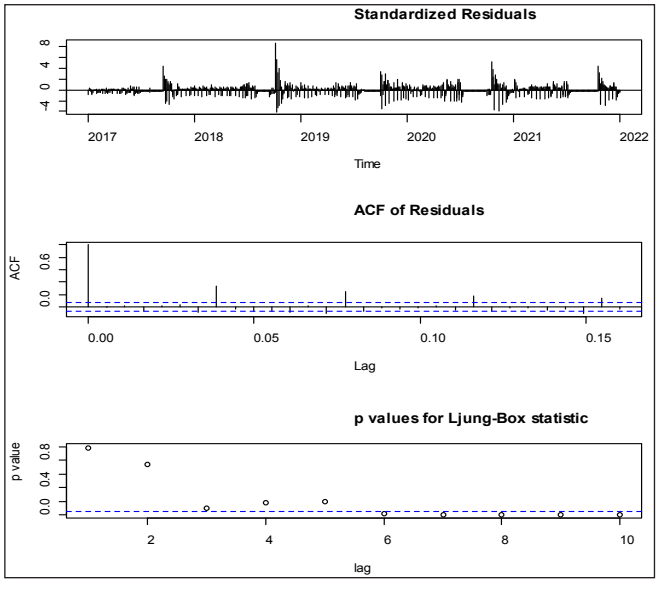

Fig. 6: Residual analysis of Model ARIMA (0,0,1) (0,0,1)

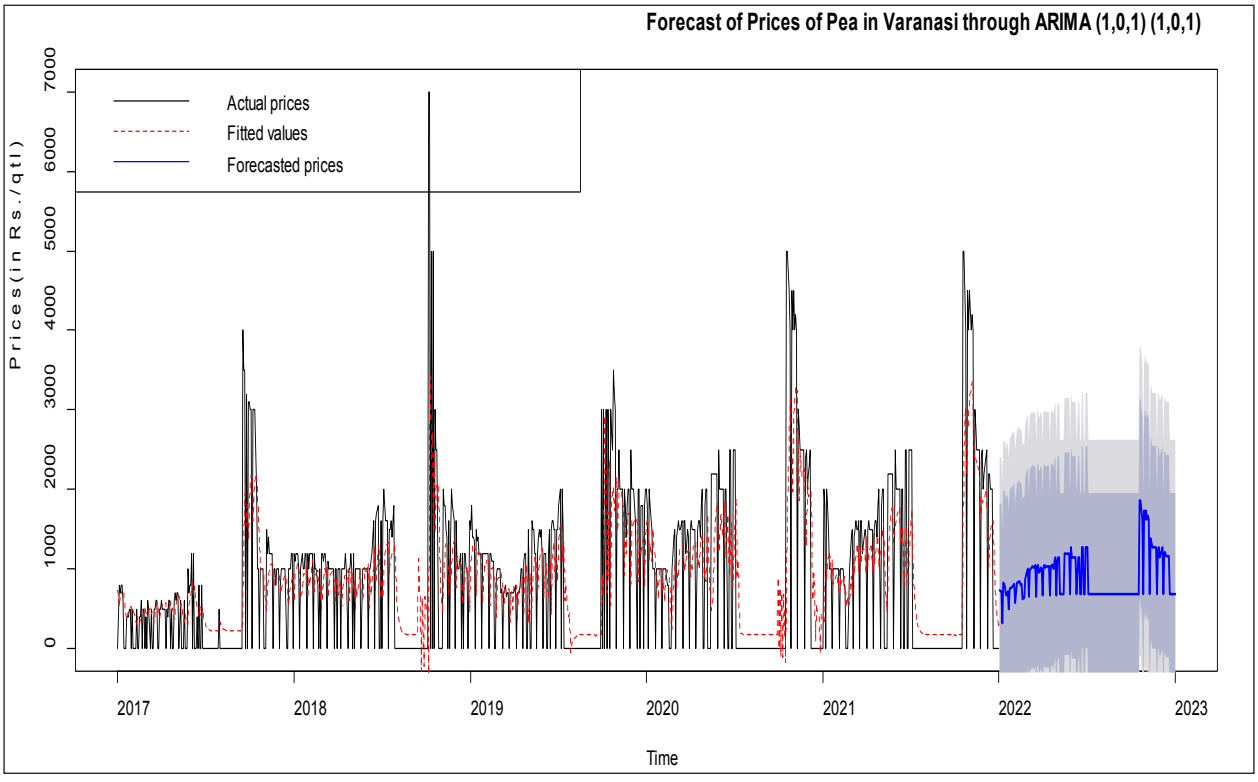

Fig. 7: Forecasting of pea prices for Varanasi market through SARIMA (1,0,1) (1,0,1)

Table 1: Residual analysis of daily prices of pea at Varansi market in Uttar Pradesh, India

Sl. No.	Model Selection Criteria	ARIMA (3,1,5) model	SARIMA (1,0,1) (1,0,1)	SARIMA(0,0,1)(0,0,1)
1	AIC	14786.25	**14759.87**	14975.63
2	BIC	14829.52	**14824.73**	14994.87
3	R Squared	0.3752552	**0.3818665**	0.2485978
4	RMSE	844.8467	**840.3646**	926.5372
5	MAE	602.868	**557.1838**	701.2808

Table 2: Forecasted price of pea in Varanasi for the year 2022

Sl. No.	Year	Month	Week	Forecasted range of price of pea (₹ / qtl)
1	2022	January	1st	320 – 807
2	2022	January	2nd	487 – 781
3	2022	January	3rd	574 – 843
4	2022	January	4th	623 – 1003
5	2022	February	1st	658 – 1033
6	2022	February	2nd	665 – 1043
7	2022	February	3rd	669 – 1051
8	2022	February	4th	675 – 1151
9	2022	March	1st	676 – 1147
10	2022	March	2nd	677 – 1266
11	2022	March	3rd	677 – 1149
12	2022	March	4th	677 – 1267
13	2022	April	1st	677 – 1267

14	2022	April	2nd	677 – 1280
15	2022	April	3rd	700 – 1287
16	2022	April	4th	665 – 1281
17	2022	November	1st	677 – 1739
18	2022	November	2nd	675 – 1267
19	2022	November	3rd	675 – 1220
20	2022	November	4th	690 – 1345
21	2022	December	1st	670 – 750
22	2022	December	2nd	675 – 800
23	2022	December	3rd	665 – 843
24	2022	December	4th	677 – 900

Forecasted result of price of pea shown in Table 2. Prices appeared to varied from ₹ 320/Qtl. (January 1st week) to ₹ 1739/Qtl (November 1st week) it could be due to the fact that 1st harvest of the crop reaches the market in the first week of November and fetches very high price and December onwards prices start to decline. Similarly the production start declining from the April and therefore it is reflected in high prices of peas. For most of the intermediate months prices vary from ₹ 672/Qtl to ₹ 1150/Qtl.

The price of pea fluctuated widely over the weeks. The prices on pea in Varanasi market was low in January and highest in the month of November. The graph of forecasted price of pea at Varanasi market through SARIMA (1,0,1) (1,0,1) was given in Fig. 7.

CONCLUSION

This study used SARIMA (1,0,1) (1,0,1) model for forecasting the price of pea in Varanasi market for the state of Uttar Pradesh. The model showed a good performance in the case of explaining variability in the data series and also its predicting ability. The price of pea for the month of April and November were the highest compared to other months of the year 2022 prices. Therefore, the farmer can use this forecast information to hedge their positions by storing pea in cold chain and selling them in off-season as frozen pea for getting the higher prices. We also recommend that the government and the private businesses establish the cold chain for reducing volatility in the pea prices. This information could also be used for interstate movement of peas..

REFERENCES

Box, G.E.P., Jenkin, G.M. and Reinse, G.C. 1994. The time series analysis, forecasting, and control. 3rd ed, Prentice-Hall, Englewood Cliffs, N.J.

Box, G.E.P. and Jenkin, G.M. 1976. Time-Series of Analysis, Forecasting, and control. Sam Francisco, Holden-Day, California. The USA.

Gupta, A.K., Singh, A.K. and Rao, V.S. 2018. Forecasting of Arrivals and Prices of Major Pulses in Chhattisgarh Using ARIMA Models. *The Andhra Agric. J.,* **65**(4): 990-993.

Gupta, A.K., Kumar, R.R. and Singh A.K. 2019. Price Behaviour of Pigeon Pea in Kawardha market (*mandi*) of Chhattisgarh. *Indian J. Pure & Appl. Biosc.*, **7**(6): 171-175.

Kumar, R.R. and Baishya, M. 2020. Forecasting of Potato Prices in India: An Application of ARIMA model. *Econ. Affairs,* **65**(4): 473-479.

Kumar, P., Badal, P.S., Paul, R.K.R., Jha, G.K., Venkatesh, P., Kamalvanshi, V., Balasubramaniam, M., Anubukkani, P. and Patel, P. 2021. Forecasting onion price for Varanasi market of Uttar Pradesh, India. *Indian J. Agricul. Sci.,* **91**(2): 249-253.

Kumar, P., Badal, P.S., Paul, R.K., Jha, G.K., Venkatesh, P., Kingsley, I.T., Kamalvanshi, V., Balasubramaniam, M. and Anubukkani, P. 2020. Empowering farmers through future price information: A case of price forecasting if brinjal in eastern Uttar Pradesh. *Indian J. Econ. and Dev.,* **16**(4): 479-88.

Naidu, G.M. and Kala, S.M. 2016. A statistical study of trends in arrival and prices of maize in selected market of Andhra Pradesh. *International Journal of Agricultural and Statistical Sciences,* **12**(1): 89-94.

Ozer, O.O. and Ilkdogan, U. 2013. The world cotton price forecasting by using the Box-Jenkins model. *J. Tekirdag Agricul. Faculty,* **10**(2): 13-20.

Shukla, M. and Jharkharia, S. 2011. Applicability of ARIMA models in the wholesale vegetable market, An investigation. *Int. Conference on Industrial Engineering and Operations Management.* Kuala Lumpur, Malaysia, pp. 22-24.