Environment and Ecology 41(3): 1299—1308, July—September 2023
Article DOI: https://doi.org/10.60151/envec/RIAR1851
ISSN 0970-0420

Forecasting of Onion Price in Patna District through ARIMA Model

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Received 15 January 2023, Accepted 5 May 2023, Published on 24 July 2023

ABSTRACT

The present study entitled "Forecasting of onion price in Patna district in Bihar through autoregressive Integrated Moving Average (ARIMA) model". Forecasting of onion price plays an important role in many decisions by policy maker. The secondary data of onion price were collected for 2002 to 2015 from Agriculture marketing (agmarknet.gov.in). The data from 2002 to 2015 were used for analysis of forecasting onion price and validity tests were also calculated. After study, it was found that the ARIMA (1,0,0) model is best fitted among all the models namely ARIMA (0,0,0), ARIMA (0,0,1), ARIMA (0,1,1), ARIMA (0,1,2), ARIMA (1,0,1), ARIMA (1,0,2), ARIMA (2,0,0), ARIMA (2,0,1), ARIMA (2,1,0), ARIMA (2,1,1), ARIMA (2,1,2).The parameters of all these models were computed and tested for their significance. Various statistics were also computed for selecting the adequate and parsimonious model i.e., t-test and chi-square test. This is supported by low value of MAPE, MAE, RMSE, BIC for forecasting of onion price in Patna district of Bihar. Forecasting of onion price for the next four years were calculated by the selected ARIMA model. The results showed that there was a lot of fluctuation in onion price.

Keywords Onion price forecasting, ARIMA models, Box-Jenkins modeling.

INTRODUCTION

Onion is the one of the most important growing bulbous vegetables crop of entire country. Maharashtra state covers maximum area and production of onion in India, while Bihar state has 5th position in area and 4th position in both production and productivity. The onion price were fluctuating for entire season. The reason behind the fluctuation of onion price is the high rate of transportation rate, the rotten problem in onion, with sky-high rise in prices, the demand for onion has fallen drastically, adding that retailers do not carve onions from his personal stock for fear it would cost him as a customer too. As we see, we do not have storage arrangements. Retailer will somehow have to sell the stockpile before it gets destroyed.

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India is world 2nd largest producer of onion, while China is 1st in production. India rank 3rd in export in the world (contribute about twelve per cent of total world exports), in India, Maharashtra has highest area as well as production of onion, in Maharashtra, the onion biggest market is Lassalgoan in our country. For seed germination, the optimum temperature required is 20-25^{0}C and 15-21^{0}C for bulb development. Due to Protoandry mechanism, Onion is highly cross pollinated crop and it is generally pollinated by Honeybees, the reason behind yellow color in onion is due to Quercetin, it is essentially used against sunstroke, and also have a Anti fungal property known as Catechol (phenolics compounds), there is required about1500 kg/ha of bulb for seed production.

The present requirement of vegetables is 280g per day in India, while the per capita availability of vegetables is only about 210g per day in our country. Where the availability per capita of onion is only about 23.43g per day in our country. As per recommend by the ICMR (Indian council of medical research).

Onion is mainly exported to other countries from India like Malaysia, Dubai, UAE, Kuwait, Saudi Arabia, Indonesia and Singapore. Onion is very important in foreign exchange earner among all the vegetable crops. The major and important zones for growing good quality for export of onion varieties are Patna and Biharsarif in Bihar, Budaum in Uttar Pradesh, Pune, Nasik and Satara districts of Maharashtra, Coimbatore district of Tamil Nadu, Bhavnagar and Rajkot in Gujrat, Kolar and Bangalore in Karnataka and Cuddapahin Andhra Pradesh.

Jambhulkar (2013) discussed the ARIMA model for describing and predicting the production of rice in Punjab by using the past data collected. As a result, "ARIMA (1,1,2)" was found to be best suited for forecasting rice production in Punjab.

Jose and Lal (2013) using the "ARIMA (1,1,0)" model to estimate the time difference between search engine crawlers visiting websites. They considered five search engine crawlers, and the results came out to be helpful in analyzing the load of the server.

Suresh and Krishna Priya (2011) have discussed "ARIMA model" for the forecasting of Tamil Nadu sugarcane region, production and productivity for the data collected from 1950–2007. The result shows that the models ARIMA (1,1,1) and "ARIMA (2,1,2)" are found to be suitable for sugarcane area, productivity, and production. Predicted values are developed using sugarcane-area, production and productivity models.

Borkar and Bodade (2017) made an attempt to predict pulse productivity using the ARIMA model in India for the period 1950 to 2014. The outcome indicated that urdbean and peas have the lowest "MAPE" and the lowest "AIC" values, while mungbean and chickpea have the highest "MAPE" and the highest "AIC" values respectively.

George and Kumar(1979) have develop pre-harvest forecast of cashew yield by adopting the conventional regression techniques. Their prediction equation can forecast the yield one to two month in advance of the first harvest which extends to three to four months, for the groundnut a similar study has been reported by Singh and Mohan (1993). All these investigations, however, have the inherent drawback due to the presence of multicollinearity and an orthogonal transformation of the explanatory variables seems to be useful to tackle this problems to a certain extent. Gupta (1993) has discussed about ARIMA model and forecasts on tea production in India. He developed and applied an ARIMA forecasting model for tea production in India. Min (1995) has discussed about forecasting for the changes in number of hogs and hogs farms .This study was carried out to forecast the changes in the number of pigs and pigs farms in the Korea, Republic by total and herd size using ARIMA models. The ARIMA model for pig production was identified and estimated using quarterly data for 1985 to 1994. Venugopalan Prajneshu (1996) have studied various statistical modeling techniques viz. polynomial function fitting approach, ARIMA, time series methodology and non-linear mechanistic growth modeling approach for describing marine, inland as well as total fish production of the country during the periods 1950-51 to 1994-95.

MATERIALS AND METHODS

Box-Jenkins modeling

The Box-Jenkins forecasting approach differs from most of the approaches because "it does not assume any specific pattern in the historical data of the sequence to be expected. It uses an iterative approach to classify a potential model from a general model class. The selected model is then tested against historical data to see if the sequence is precisely described. The model fits well if the residues are normally small, randomly distributed and do not contain any useful information. If the model described is unacceptable, the process is repeated using a new model designed to improve on the original model. This iterative process continues until a suitable model has been found". Main stages in setting up a Box-Jenkins forecasting model are as follows.

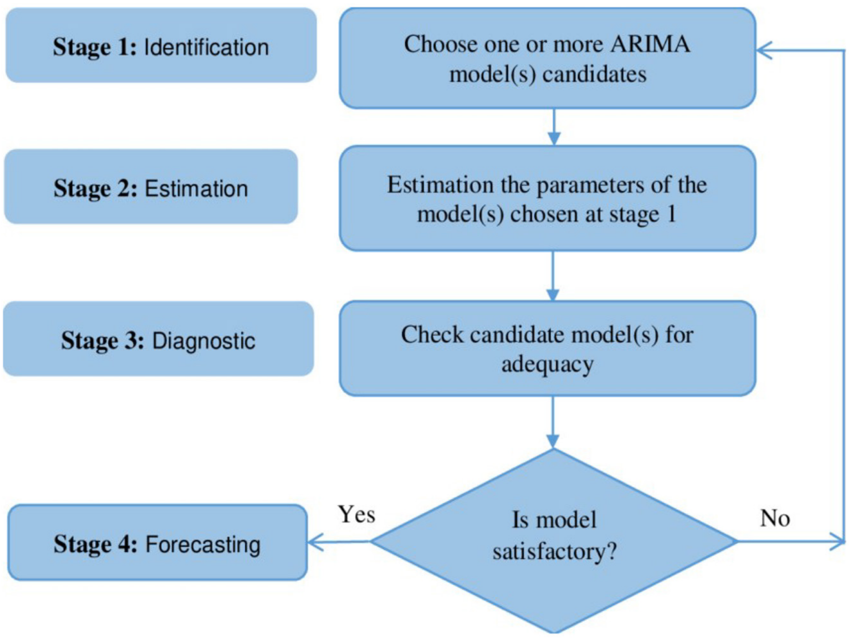
(1) The order of Identification
(2) Model Estimation
(3) Checking of diagnostic for adequacy of the fitted model.

Identification of model

The Box-Jenkins method cannot be applied for non-stationary sequences. We estimate the increasing or decreasing trend in price movements and also experienced the seasonality of 'ACF' and 'PACF'. "The input series for ARIMA must therefore be stationary, i.e. it should have a constant mean, variance and autocorrelation over time. To determine the stability of the data, we can check through the ADF or PP test, or even look through the ACF and PACF corlogram pattern. If the ACF graph of the time series values either cuts off fairly quickly ordies down fairly quickly, then the time series values should be considered stationary. If the ACF graph dies extremely slowly, the time series values should be considered non-stationary. If the series is not stationary, it can be transformed into a stationary series by differentiation. Differences are made until a data plot indicates that the series varies at a fixed level and that the ACF dies down fairly quickly". The number of differences required to achieve stationary is indicated by d.

Parameters estimation

Box-Jenkins time series models written as 'ARIMA (p, d, q)' amalgamate three types of processes, i.e., "auto-regressive (AR) or order p; the difference in order to make the sequence stationary of degree d and the moving average (MA) of order q. Once an attempt model has been chosen, the parameters for that model must be calculated. The goal at the esti-



Box-Jenkins iterative approach for model building.

mation stage of the parameter is to obtain estimates of the provisionally defined Stage-I ARMA model parameters for the given values of p and q. Parameters in ARIMA models are calculated by reducing the number of suitable error squares. In general, these least square estimates must be achieved using the least square nonlinear method. In general, ARIMA coefficients (the ϕ's and Θ's) must be calculated using a non-linear least square technique, while several non-linear least square methods are available, the most widely used t estimation of ARIMA models is known as Marquardt's compromise. A nonlinear least square method is essentially an algorithm that seeks a minimum amount of squared error. Once the least square estimates and their standard errors have been calculated, the values can be constructed and interpreted in the usual way. Parameters that are known to be significantly different from nil are kept in the equipped model".

Checking for diagnostic for adequacy

This is the 3rd stage of the model formulation process. The decision on the statistical sufficiency of the model is taken at this point. "The most important test of statistical adequacy for the ARIMA model involves assumptions that random (at) shocks are independent. In the absence of self-correlation, since random shocks cannot be observed in practice, the residual (at) estimate is used to test the hypothesis of an independent random shock. This is mainly done by the residual ACF, the residual ACF and the residual ACF–2 test based on L-Jung and the residual autocorrelation panel".

After all, at the diagnostic checking stage, an appropriate model is selected based on the following goodness of fit statistics.

a) Information criterion for Bayesian:

$$BIC = \ln V^* (p, q) + (p + q) [\ln (n)/n]$$

Where, V* shows the estimate of white noise varience, and it is obtained by fitting the correspondence ARIMA model.

b) Root Mean Squared Error The RMSE is defined as,

$$RMSE = \sqrt{\frac{\sum (X - \hat{X})^2}{n}}$$

The smaller the value of RMSE is good

c) Error (Mean Absolute MAE) :The MAE is defined as ,

$$MAE = \frac{\sum | X - X |}{n}$$

d) Mean Absolute Percentage Error (MAPE) :

MAPE is defined using absolute values of percent error

$$MAPE = \frac{1}{n}\sum_{t-1}^{n} | PE_t |$$

e) Mean Squared Error (MSE) :The MSE is defined as,

$$MSE = \frac{\sum (X - \hat{X})^2}{n - p}$$

"The lower the values of above statistics, the better are the model. A statistically adequate model is one whose random shocks are independent".

f) One Step Ahead Forecasting (OSAF)

The last observation is not measured in the OSAF method and the model is fitted to the data set. The last value is estimated from the model and compared to the actual value.

The percentage forecast error is defined as,

$$PCFE = \left| \frac{X(t) - \hat{X}(t)}{X(t) \times 100} \right|$$

Where, "X(t) is the observed value and X(t) is the predicted value. The smaller the value of PCFE, the better is the model. This is used as naïve estimator for comparison of other selected models".

ARIMA model

ARIMA model is an algebraic statement telling how the observations on a variable are statistically related to past observation on the same variable. In fact, ARIMA model is a family of models consisting of three kinds of model, which are given below:

a) Autoregressive model: This can be represented as

$$Z_t = C + \phi 1\, Z_{t-1} + a_t \quad \ldots(1)$$

Where

C = μ (1- ϕ1) = Constant term

μ = Constant parameter

ϕ = Deterministic coefficient its value determines the relationship between Z_t and Z_{t-1} (Lagged observation)

a_t = Random shock having some continuous statistical distribution.

The term $\phi_1 Z_{t-1}$ is autoregressive term, and the longest lag attached to it is t-1 thus, above is autoregressive model of order 1, denoted as AR (1). The parameters of model (1) are estimated by least square method. Approximate estimates for μ and ϕ_1 can be obtained as Z (mean of the available observation) and r_1 (autocorrelation function) respectively. Similarly, second order autoregressive model denoted as AR (2) can be represented as

$$Z_t = C + \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + a_t$$

In this model, Z_t is linearly related to the past observation Z_{t-1} and Z_{t-2}. The lease square estimate of ϕ_1 and ϕ2 are approximated by

$$\phi_1 = r_1 (1-_{r2}) / 1-r^2_1 \text{ and } \phi_2 = r_2 - r^21) / 1-r^21$$

Where,

r_1 and r_2 are autocorrelation function for first and second lag respectively.

In general, one can represent autoregressive model of order p denoted as AR (p) as a linear combination of p-past values and a random term i.e.

$$Z_t = C + \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + \ldots + \phi_p Z_{t-p} + a_t$$

b) Moving average (MA) Model: A moving average model of order one denoted as MA (1) can be represented as

$$Z_t = C – \Theta 1\, a_{t-1} + a_t \qquad \ldots(2)$$

Where,

C = μ (1- Θ_1) = constant term

Θ_1 = Moving average coefficient determines the statistical relationship between Z_t and a_{t-1} (Lagged random shock)

a_t = random shock with mean ‘0’ and variance σ^2.

c) Estimation of parameters of MA model: Estimation of parameters of MA model is more difficult than an AR model because efficient explicit estimators cannot be found. Instead some numerical iteration method is used. For example, to estimate μ and Θ of Equation 2 i.e.

$$Z_t = C – \Theta_1\, a_{t-1} + a_t$$

residual sum of square (RSS) $\sum a^2_t$ in terms of observed Z’s and the parameters μ and Θ are obtained and then it is differentiated with respect to μ and Θ to obtain estimated μ and Θ. Unfortunately, the RSS is not a quadratic function of the parameters and so explicit least square estimates cannot be found. An iterative procedure suggested by Box-Jenkins is used in which suitable values of μ and Θ such as μ = Z and Θ given by the solution of Equation 3.

$$Z_t = C + \phi_1 Z_{t-1} + \ldots + \phi_p Z_{t-p} – \Theta_1 a_{t-1} \ldots - \Theta_q\, at – q + a_t \qquad \ldots(3)$$

Then the RSS may be calculated recursively from

$$a_t = Z_{1-c} + \Theta_1\, a_{t-1} \text{ with } a_0 = 0$$

This procedure then can be repeated for a grid of points in (μ, Θ) plane. We may then by inspection choose that value of (μ,Θ) as estimates which minimized RSS. The lease square estimates are also maximum likelihood estimated conditional on a fixed value of a_0 provided a_t is normally distributed.

d) Autoregressive moving average model (ARMA): The combination of AR (p) and MA (q) models to describe a given series is known as ARMA (p, q) which can be represented as

$$Z_t = C + \phi_1 Z_{t-1} + \ldots + \phi_p Z_{t-p} - \Theta_1 a_{t-1} \ldots - \Theta_q a_{t-q} + a_t$$

Test for normality of the residuals (Shapiro-Wilk Test)

The purpose of the Shapiro-Wilk test is to provides an index or to test the supposed assumptions of normality regarding residual distribution. The statistic is an important measure of normality against a broad range of non-normal alternatives, including for small samples (n<20). The statistics are invariant in size and origin, and thus provide a test of the composite null normality hypothesis. Here we test the null hypothesis.

"H_0 : The residuals are normally distributed, V/s H_1: there are not normally distributed".

To compute the value of statistic, given a complete random sample of size n, '(x_1, x_2,...x_n)' one proceeds as follows:

(i) The observation are arranged to obtain an ordered sample $Y_1 \leq Y_2 \leq \ldots . Y_n$.

(ii) Computations of

$$S^2 = \sum_{t=1}^{n} (y_i - y_i)^2 = \sum_{t=1}^{n} (X_i - X_i)^2$$

(iii) (a) If n is even, n=2 k say, we compute

$$b = \sum_{i=1}^{n} a_n - i + 1 \ (y_n - i + 1 - y_i)$$

where, the value of $[a_{n-i+1}]$

(b) If n is odd, {n – 2 k + 1} say, the computation is just as in (iii) (a), since $\{a_{k+1}=0\}$ when {n=2 k + 1}. Thus, on finds

$b = \{a_n (y_n - y_n) + \ldots + (y_{k+2} - y_k)\}$

$b = \{a_n (y_n - y_n) + \ldots + (y_{k+2} - y_k)\}$

where, "the value of y_{k+1}, the sample median, does not enter the computation of b".

(iv) Computations of $[W = b^2/S^2]$.

(v) Small value of W are significant, i.e. indicate non-normality. It is pointed out that α present points of the distribution of W.

Test of normality of the residuals (kolmogorov-smirnov)

The Kolmogorov-Smirnov test is used to decide. If a sample comes from a population with a specific distribution and it is only work when the mean and variance of the normal distribution, are assumed to known under the null hypothesis. The Kolmogorov-Smirnov test is defined by: "H_0: The residuals are normally distributed, V/s H_1: These are not normally distributed".

The Kolmogorov-Smirnov test is defined and given by :

$$D = \frac{max}{1 \leq i \leq N} (F(Y_i) - i{-}1, N{-}F(Y_i))$$

Where, "F is the theoretical cumulative distribution of the distribution being tested which must be a continuous distribution and must be completely defined when the test figures D is larger than the critical value obtained from the table, the hypothesis about the distributional form is rejected. Within the literature there are many variants of these tables which use some what different scaling for the statistics and critical regions of the K-S test".

RESULTS AND DISCUSSION

Forecasting of onion price by using ARIMA model

In this study we have used different models in order to know the best model for the forecasting of the onion price. For the model comparison, monthly and yearly

Table 1. ACF of original (Z_t) and first order difference series (ΔZ_t) for Patna district of Bihar.

Lag	Z_t	t-value	ΔZ_t	t-value
1	0.930	11.625	0.930	11.625
2	0.854	6.470	-0.076	7.045
3	0.771	4.701	-0.083	-0.463
4	0.698	3.753	-0.073	-0.446
5	0.650	3.218	-0.048	-0.361
6	0.617	2.870	-0.033	-0.223
7	0.600	2.655	-0.017	-0.146
8	0.599	2.538	-0.001	-0.072
9	0.596	2.433	-0.003	-0.004
10	0.609	2.388	0.013	-0.012
11	0.616	2.333	0.007	0.049
12	0.607	2.223	-0.009	0.026

price of onion was considered. The detailed analysis of forecasting of onion price in Patna district of Bihar has been presented.

Model identification

The first and foremost stage in the identification of an ARIMA is the judging stationary behavior of the underlying process. "The model was firstly identified on the basis of Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) for the different data series Yt of Patna district for selected markets. The computed values of ACF and PACF for the all selected markets of Patna district are shown in the Tables 1-2. The numbers of lags shown as 12 lags. The calculation of ACF and PACF indicate that the presence of seasonality in the given data. While,

Table 2. PACF of original (Z_t) and first order difference series (ΔZ_t) for Patna district of Bihar.

Lag	Z_t	t-value	ΔZ_t	t-value
1	0.930	11.625	0.930	11.625
2	-0.080	-1.000	-1.010	-12.625
3	-0.092	-1.150	-0.012	-0.150
4	0.031	0.388	0.123	1.538
5	0.142	1.750	0.109	1.363
6	0.060	0.750	-0.080	-1.000
7	0.083	1.038	0.023	0.288
8	0.107	1.338	0.024	0.300
9	0.010	0.125	-0.097	-1.213
10	0.153	1.913	0.143	1.788
11	0.017	0.213	-0.136	-1.700
12	-0.064	-0.800	-0.081	-1.013

Table 3. Output of fitting ARIMA (1, 0, 0) of Patna district of Bihar for Onion Price Estimation of parameters.

Parameters	Estimates	SE	t- value
Constants	-175.507	38.977	-4.503**
Φ	0.842	0.044	19.264**

Correlation matrix of estimated parameter:
Auto regressive factor:-φ (B) = 1- 0.842B
Forecast model:-$Z_t - Z_{t-1} = -175.507+0.842\ (Z_{t-1} - Z_{t-2}) + a_t$
Diagnostic check:

No. of lags	ACF for residual	t-value
1	0.131	1.638
2	0.107	1.321
3	-0.051	-0.622
4	-0.150	-1.807
5	-0.113	-1.345
6	-0.075	-0.882
7	-0.088	-1.023
8	-0.051	-0.593
9	-0.060	-0.698
10	0.051	0.586
11	0.162	1.862
12	0.195	2.191

Model fit parameter:

RMSE	MAPE	MAE	BIC	R^2
186.889	12.307	115.260	10.526	0.870

Q-Statistics (L-Jung Box Test) = 32.771**
DF = 17

the series were found to be stationary, since the co-efficients are dropped to zero after the second lag. Each and every coefficient of ACF and PACF were tested for their significance by using t-test. Further, the absence of peak at first values clearly indicate suitability of the choice of non-seasonal difference d=1 to accomplish stationary series. Hence, on these basis that is ACF and PACF, many models were tested and Finally, model (1, 0, 0) was identified as the best model for forecasting of prices of onion in Patna market".

Parameter estimation

The estimates of the model have been presented in output Table 3. For this models the parameter estimates along with standard deviation and t-ratio

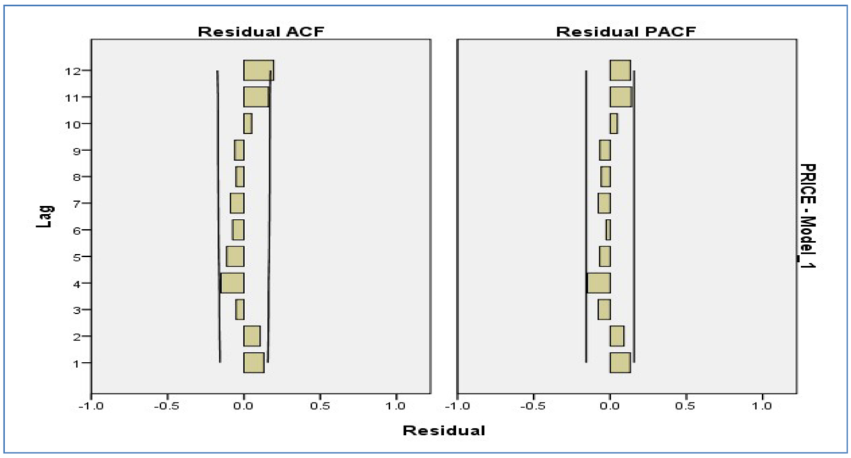


Fig. 1. Residual ACF and PACF plot for best fit ARIMA (1,0,0) of Patna district of Bihar for onion price.

have been computed. The correlation matrix of the estimated parameters has also been calculated for testing the stability of the estimated parameters. The output table contains the autoregressive factor and/or moving average factor along with respective forecast model. The autocorrelation of the residual have been computed for the diagnostic checking of the model. L-Jung Box test is used as a measure of Q-statistics for testing the significance of residual autocorrelations. The study of the Table 3 shows that the output of fitting ARIMA (1,0,0) for Patna district of Bihar. The fitted model satisfies the assumption of normality of error and found to be adequate. For price of onion the ARIMA (1,0,0) has low value of RMSE, MAPE, MAE and BIC. So the best fit model is ARIMA (1,0,0).

Selection of good model

A good model contains parsimonious, stationary and invertible. The estimated coefficients will be of high quality and stable. The eight models under comparison fulfills the stationary and invertibility condition wherever necessary. For selection of the parsimonious

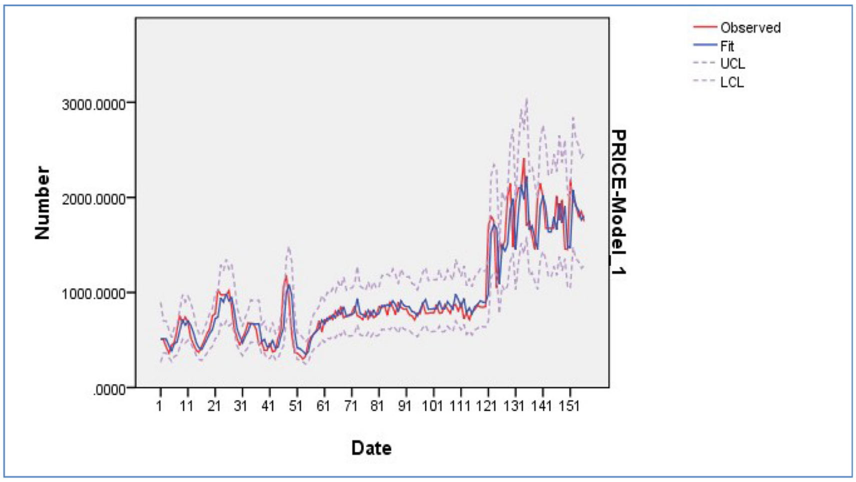


Fig. 2. Observed and fit values of price along with upper and lower limit by using ARIMA (1,0,0).

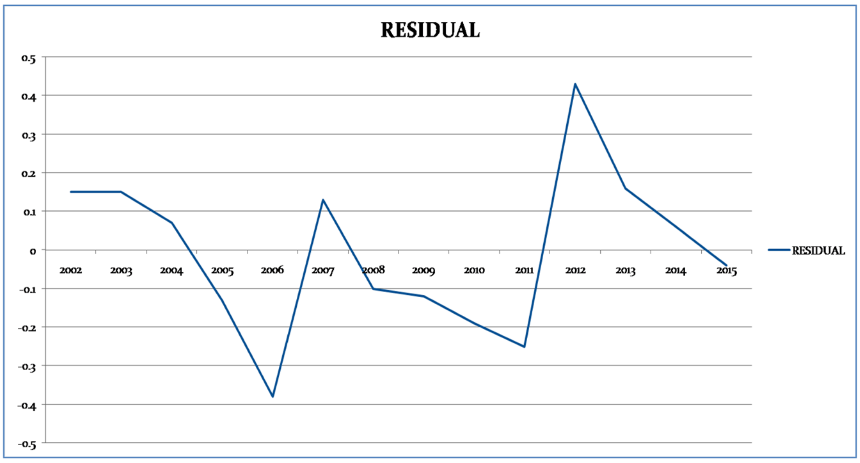


Fig. 3. Graph of year v/s Residual for best fitted ARIMA (1,0,0).

model, a guiding principle suggested by Box and Jenkin. Based upon the significance of estimated coefficient ARIMA (1,0,0), - ARIMA (2,0,0) and ARIMA (0,0,1) results in a parsimonious model. The t test and chi-square test for all the models has been computed. A comparison of different models suggests ARIMA (1,0,0) fulfills stationary and parsimonious condition.

The cross validation of the selected best fit ARIMA (1,0,0) without constant model for onion price in Patna district presented on the Table 3 shows that the RMSE, MAPE, MAE and BIC are quite low, thus the selected model is successfully validated. Fig. 1 explain about Residual ACF and PACF plot for best fit ARIMA (1,0,0) of Patna district of Bihar for onion price. Fig. 2 explain about Observed and fit values of price along with upper and lower limit by using ARIMA (1,0,0). Fig.3 explain for Graph of year v/s Residual for best fitted ARIMA (1,0,0). Fig. 4 explain for Graph of Residual v/s Actual yield v/s Forecast (Year wise) for best fitted ARIMA (1,0,0). Fig. 5 says about Graph of Actual yield v/s Forecast v/s LCL v/s ULC for best fitted ARIMA(1,0,0). All figure from Figs. 1-5 also satisfying that model ARIMA (1,0,0) is best fit.

Diagnostic check

The model under selection diagnostic checks with respect to the independence of random shocks, has been performed. A statistically adequate model is one whose random shocks are not auto correlated. For this purpose, the residual autocorrelation function have

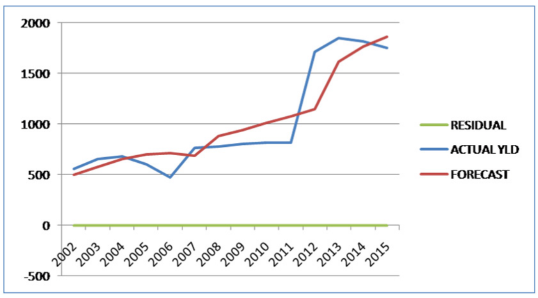


Fig. 4. Graph of Residual v/s Actual yld v/s Forecast (Year wise) for best fitted ARIMA (1,0,0).

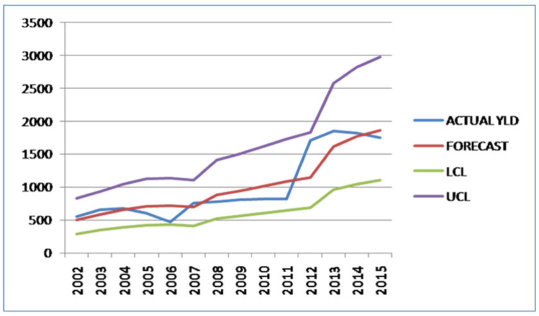


Fig. 5. Graph of Actual yld v/s Forecast v/s LCL v/s ULC for best fitted ARIMA (1,0,0).

Table 4. Forecast and their confidence interval of ARIMA (1, 0, 0) of Patna district of Bihar for onion price.

Periods	Forecast	95% limits Lower	Upper	Actual	% forecast error
2015	1859.52	1105.00	2974.10	1750.00	6.25

been calculated and presented in the output tables. A t-test has been performed to test of the significance of the null hypothesis for Ho :pk (a) = 0 for each residual autocorrelation coefficient. The respective standard error have been computed using Bartlettes approximation formulae. All the t-values of the residual autocorrelation function for the model under selection is non-significance, i.e., less than the critical values suggested the independence of the random shocks. The independence of the random shocks is also confirmed by a chi-square test suggested by L-Jung and Box using Q-statistics. The Q-statistics of L-Jung and Box test for the selected model ARIMA (1,0,0) is 32.771which is less than chi-square value at 17 degrees of freedom (Table 3).Thus the selected ARIMA model of the order (1,0,0) or AR(1) seems to be appropriate. The forecast error for the one step ahead has been computed as 6.25% (Table 4). Checking of the adequacy of the models residuals analysis were carried out. The residual of ACF and PACF were obtained from the tentatively identified model. The adequacy of the models were judged on the values of Box-Pierce Q statistics and Bayesian Information Criterion (BIC) and sum of square of residuals. The model (1,0,0) was found to be the best model for prices in Patna market, since the statistic of BIC and Q statistics was found to be significant.

It is found that through ARIMA (1,0,0) is good for forecasting of the price of Onion in Patna district for the year 2015 which was Rs 1859.52/q.

REFERENCES

Borkar P, Bodade VM (2017) Application of ARIMA model for forecasting pulses productivity in India. *Ind J Agricult Engg Food Technol* 4(1): 22-26.

George MV, Kumar Vijay K (1979) Forecasting of cashew yield. *J Ind Soc Agric Statistics* 31: 95-96.

Gupta GS (1993) ARIMA model forecasting on tea production in India. *The Ind Econ J* 41(2): 88-110.

Jambhulkar NN (2013) Modelling of rice production in Punjab using ARIMA model. *Int J Scientific Res* 2(8): 2-3.

Jose J, Lal PS (2013) Application of ARIMA (1,1,0) model for predicting time delay of search engine crawlers. *Informatica Economica* 17(4): 26.

Min BJ (1995) Forecasting for the changes in number of hogs and hog farms. *Korean J Animal Sci* 37: 558-566

Singh BH, Mohan M (1993) Use of biometrical characters in forecasting the yield of groundnut. *J Ind Soc Agricult Statistics,* pp 45-104.

Suresh KK, Krishna Priya SR (2011) Forecasting sugarcane yield of Tamil Nadu using ARIMA models. *Sugar Tech* 13(1): 23-26.

Venugopalan R, Prajneshu (1996) Trend analysis in all India marine products exports using statistical modeling techniques. *Ind J Fish* 43(2): 107-113.