ABSTRACT

Price discovery is an essential economic function. The price behavior of a commodity plays a crucial role in farm level crop production planning. This study intends to forecast the monthly Cardamom (Large) price for the period of Jan 2016 to Dec 2017 using statistical time-series modeling techniques. Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) was employed to analyze Cardamom (Large) Price data (monthly) in Indian Market from January 2016 to December 2017. By using standard criteria such as mean absolute percentage error (MAPE), mean square error (MSE), root mean square error (RMSE), Schwarz's Bayesian Information criterion (SBC) and Akaike Information Criteria (AIC) and the forecasting performance of the chosen models were evaluated. By using Stata 12, an ARIMA (p,d,q) (P,D,Q)12 model is constructed based on autocorrelation and partial autocorrelation and forecasts were made based on the model developed. On validation of the forecasts from these models, ARIMA (1,0,0) (0,0,0)12 model performed better in forecasting the prices for cardamom(large)in the Indian market. The validation percentage ranged between around 95% from Jan 2016 to Dec 2017.

Keywords: Cardamom(Large), Price Forecast, ARMA model.

1. INTRODUCTION

Species were an essential component in India’s foreign trade and soul of global cuisine since time immemorial. India was able to maintain her supremacy in growing spices and their medicinal applications much before other nations dating back to 6000 B.C to the modern era of the third millennium. Cardamom is the Queen of species. It is one of the most highly
priced exotic spices in the world. Until the year 2000, India used to be the leading producer of cardamom, and thereafter Guatemala took over the first position whereas India was pushed to the next place. Western Ghats are known for Cardamom and is generally identified as cardamom hills of the nation. Cardamom is traded as bulk and graded produce and is graded by using a sieve and fetches different prices based on their size, color and freshness command varied prices. India consumes almost 90% of the domestic production with nearly 45% of the demand coming from the western parts of the country followed by 35% absorbed by northern India.

The Spices Board which was founded in 1987, under the union commerce and industry ministry licenses traders are identified, and they only participate in the different auction centers. Cardamom producers bring their produce to the auction centers. At first the commodity is cleaned, graded and then packed in polythene bags and are stored in the warehouses maintained by the auction centers. After this process auction starts and after the completion of the auctions, the traders who had bought the commodity brings it to the trading centers from where it is exported. From time to time spice board organizes buyer-seller meet (BSM) so as to facilitate the direct selling of the commodity to the exporters thereby avoiding middlemen in this process. In hilly areas where cardamom is produced, collection and transportation of the produce is a problem. Once the electronic auction (platform) is set up, farmers need not take their produce to the market as e-auction will help them to check prices on the website and accordingly make a decision. The board also organizes a buyer-seller meet (BSM) to facilitate selling of products by Sikkim’s farmers directly to exporters. It has significantly helped in establishing a direct link between the exporters and traders thereby avoiding middlemen in this process. The Spices Board is also working to facilitate e-auctions in Sikkim. In hilly areas, collection and transportation of the produce is a problem. Once the electronic auction (platform) is set up, farmers need not take their produce to the market as e-auction will help them to check prices on the website and accordingly make a decision.

As per the cardamom (Licensing and Marketing) rules 1987, producers of cardamom can sell cardamom only through a licensed auctioneer/dealer, even though it is primary foreign exchange earner for India, it is not a freely traded commodity. Spice board organizes the auction centers. Auctions are based on open outcry system before it was converted into an electronic auction system during August 2007. The principal trading centers of cardamom are Vandanmedu(Kerala), Bodinayakanur(Tamilnadu), Kumily(Kerala), Nedumkandam(Kerala),
Puliiyyyanmala (Kerala), Mumbai, Delhi, and Kanpur. Indian spices posted exports worth of ₹17,664.61 crores in terms of volume it is 947790 tonnes during the year 2016-17, inspite of its robust demand and stiff competition in international markets. India exported 665 tonnes of large cardamom during the year 2016-17 and has earned the country ₹ 2011.50 lakh in the global market [1]. Spice board had also predicted that large cardamom cultivation would get a further boost in the upcoming year. Prices of cardamom have already had an impact in international prices of large cardamom, while farmers were able to get six times more prices that the prices prevailed five years ago. Significant factors influencing the price of cardamom in India is its freshness, color aroma, and size, seasonal fluctuations, and arrival of the crop in the market, weather conditions in India, Domestic festival demand. Because of this fluctuation in prices and export, both producers and consumers of cardamom were much affected. The significant benefits of this variation in the rates are the middlemen and speculators. Therefore, it becomes essential to have a close watch on the prices of cardamom. Thus it becomes imperative to forecast the market prices.

2. LITERATURE REVIEW

The price behavior of a commodity plays significant role in farm level crop production planning. Review of past literature tries to showlight on the methods and models used in forecasting. The primary objective of [2] this paper is to evaluate the usefulness of the standard in-sample model selection for selecting the best model forecasting inflation in Slovenia. Lot of ARIMA models are compared and finally an out-of-sample forecast was identified. In another study by [3] applied ARIMA time series model on the past data set from November 2003 to January 2014 to forecast the future prices of gold so as to mitigate the risk in purchase of the yellow metal and therefore to give a guideline for the investor when to buy or sell gold. In a study by [4] applied ARIMA models for the data set of three, six, nine and twelve months and found ARIMA models based on six months data is the best fit for forecasting the price of the commodity one day ahead. [5] had applied ARIMA model based on which future stock indices were predicted, identifying a strong influence of the stock prices on the Indian economy. To arrive conclusion, at first ARIMA model was used to forecast by using model forecasting and finally validation of the chosen model was done. [6] built a forecasting model for predicting the export price of pine sawn wood in Brazil by using the Box Jenkins methodology. The time period from January 1995 to August 2007 was considered for model fitting and the period from September 2007 to August 2008 for validating the projections of the model. The choice of the appropriate model was based on the
criteria of AIC and SBC. The results showed that the appropriate model for predicting export price of pine sawn wood in Brazil was ARIMA (3, 1, 0).[7] used BoxJenkins ARIMA and other deterministic growth models to identify the best price forecasting models for shrimp and frozen food exports earnings from Bangladesh. The study had used monthly data and found that ARIMA (2, 2, 0) and among the deterministic type of models quadratic was found to be the best forecasting model to predict the export earnings. The study also revealed that the ARIMA model is more efficient for short-term forecasting than the quadratic model.

[8] The dataset of the major grain produced were analyzed with the annual average prices from the year 1995 to 2006 was taken for study and made predictions for the year 2007 related to crops such as soybean, rice and sweetcorn produced in the Rio Grande do Sul state by applying Box Jenkins methodology. The study had revealed many significant models, but based on the AIC and BIC criteria in addition to the square average error, the best model identified for each crops is ARIMA (0,1,2)(0,1,0) to soybean; the model ARIMA (1,1,0)(1,0,1) to rice and the model ARIMA (2,1,1) (0,1,0) to sweetcorn as the best fit model.

[9] explained the prediction of future price pattern of potatoes in Bangalore urban district. In order to forecast price of potato, univariate seasonal ARIMA techniques were employed to forecast the price of potato and precision of the forecasts had been evaluated using standard criteria adopted in the literature such as MSE, MAPE and Thiel’s U coefficient criteria and the study revealed ARIMA (0,1,1) as the best fit model. [11] in their paper presented a model for forecasting of network traffic by using ARIMA technique. [10] The dataset used in this study is obtained from the internet network traffic activities of the University for a period of a week. The results consist of five ARIMA models which include ARIMA (2, 1, 1) (1, 1, 1) 12, ARIMA (1, 1, 1) (1, 1, 1)12, ARIMA (2, 1, 0) (1, 1, 1)12, ARIMA (0, 1, 0) (1, 1, 1)12, and ARIMA (0, 1, 0) (1, 2, 1)12 and ARIMA (0, 1, 0) (1, 2, 1) 12 was selected as the best model based on AIC and BIC criterion.

3. MATERIALS AND METHODS
Price forecasting using Autoregressive Integrated Moving Average (ARIMA) models was applied to identify the best model which suits to the actual market price of cardamom. The secondary data of monthly wholesale cardamom prices were collected for the study from the published source of Regional Offices of the Spices Board, India. The data of cardamom price in the Indian market was taken for a period from 2012 to 2017 was utilized for model fitting and data for the period i.e. from 2013 to 2017 was used for validation. BoxJenkins (ARIMA) model was used to measure the existing relationship among the observations within the
series. In its general form, the ARIMA model is characterized by notation as ARIMA (p,d,q) (P,D,Q)s, where s is the number of periods per season. The Main Stages in Fitting Box-Jenkins ARIMA Model are

i) Identification,
ii) Estimation of parameters,
iii) Diagnostic checking, and
iv) Forecasting.

**Identification of Models:** The first step in the process of modeling is to check for the stationarity of the series, stationary in 'means' and stationary in 'variance'. A cursory look at the graph of the data and Application of ARIMA Model in Cardamom (Large) Price forecast by using autocorrelation and partial correlation coefficients provides clue for the presence of stationarity. After checking the data for stationary, next is to find the initial values for the parameters of P and Q. This can be done by using autocorrelation and partial autocorrelation coefficients. If first order auto correlation is found to be significant then AR (1), or MA (1) can be tried to start with modelling process.

**Estimation of Parameters:** One or more models are chosen tentatively at the identification stage to get representation of the available data. After that by using least squares method by Box Jenkins precise estimates can be arrived.

**Diagnostic Checking:** Having identified the ARIMA model tentatively, it is necessary to do the diagnostic checking to verify whether the model is adequate fit. Autocorrelation(ACF) and Partial Autocorrelation Function (PACF) with their residuals shows up the adequacy of the model. A model with random residual indicates about the adequacy of the model. The minimum Akaike's Information Criteria (AIC) is used to determine both the differencing order (d, D) and the appropriate number of AR (p) and MA(q) parameters.

**Measurement of Forecast Accuracy:** Forecast accuracy is a significant factor. Historical error forecast determines the efficiency of a forecast. [12] Most commonly used measures for measuring historical errors are the MAD, MSE, RMSE and MAPE. MAD is the Mean Absolute Deviation, MSE is the Average Squared Errors, RMSE is the root mean square of errors and MAPE is the average absolute percent error. Using Stata package for the different value of p, d and q (0, 1 or 2), various ARIMA models were fitted and the appropriate model was chosen corresponding to the minimum value of the selection criterion i.e. Akaike Information Criteria (AIC) and Schwarz's Bayesian Information criterion (BIC).
RESULTS AND DISCUSSION

The performance of the ARIMA forecasted modelling was measured in terms of Mean Absolute Deviation (MAD), Mean Standard Error (MSE) and Mean Absolute Percentage Error (MAPE). The comparative performances of different seasonal ARIMA models for 12 months and 9 months are presented in following table.

Table: 1 ARIMA MODEL

<table>
<thead>
<tr>
<th>Parameters</th>
<th>(1,1,0)(0,0,1)</th>
<th>(1,0,0)(1,1,1)</th>
<th>(2,1,0)(0,0,0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE</td>
<td>3315.973</td>
<td>9228.929</td>
<td>2051.981</td>
</tr>
<tr>
<td>RMSE</td>
<td>57.584</td>
<td>96.067</td>
<td>45.298</td>
</tr>
<tr>
<td>MAPE</td>
<td>4.331</td>
<td>9.166</td>
<td>3.489</td>
</tr>
</tbody>
</table>

The ARIMA (2,1,0) (0,0,0)12 model is the preferred model for forecasting cardamom price due to the minimum value. MSE (2051.51), RMSE (45.38) and MAPE (3.4896) when compared to the other models. The actual prices of cardamom in Indian market and the statically predicted price values for these months by using ARIMA models are presented and the ARIMA forecast was measured in terms of Mean Absolute Deviation (MAD), Mean Standard Error (MSE) and Mean Absolute Percentage Error (MAPE). The comparative performances of different ARIMA models for 12 months and 9 months are presented in following table.

TABLE: 2

<table>
<thead>
<tr>
<th>AIC AND SBC</th>
<th>ARMA MODEL (p,d,q) (P,D,Q)</th>
<th>AIC</th>
<th>SBC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1,1,0)(0,0,1)</td>
<td>114.058</td>
<td>114.663</td>
</tr>
<tr>
<td></td>
<td>(1,0,0)(0,0,0)</td>
<td>137.872</td>
<td>138.668</td>
</tr>
<tr>
<td></td>
<td>(2,1,0)(0,0,0)</td>
<td>111.042</td>
<td>111.647</td>
</tr>
</tbody>
</table>

By looking into Akaike information criterion (AIC) and Schwarz’s Bayesian Criteria for 12 months, the ARIMA model (2,1,0)(0,0,0) is found to be best model as the value is least (i.e.) 111.042 And 111.647.
It can be seen from the above Table 3 that autocorrelation function (ACF) declined very slowly and as many ACF’s were significantly different from 0 and fell outside the 95% confidence interval, the price of cardamom was non-stationary for the Indian market at the level form and found to be stationary at first difference.

The above forecast graph shows that in mid of 2016, the prices of cardamom declines where the actual figure shows minimum variation. The price increases or decreases due to supply demand of cardamom(large) is taken from the spices board. This forecast graph also shows that prediction of price can be implemented for the future years.
The above chart shows Akaike Information Criteria values for the top 20 models are presented. The model (2,1)(0,0) which has lowest value of 11.642962, is found to best as it is the least value compared with other values, the highest value is (0,3)(0,0) which shows the value of 11.85. The ARIMA (2,1,0) (0,0,0)12 model is the preferred model for forecasting cardamom price due to the minimum value, MSE (2051.51), RMSE (45.38) and MAPE (3.4896) when compared to the other Models. MSE and RMSE are two most common metrics used to measure accuracy for continuous variables. The MSE and RMSE express average model predictions error in units of the variable of interest. Estimates usually range from zero to infinity interpreting lower values are better. Akaike information criterion (AIC) and Schwarz’s Bayesian Criteria for 12 months, the ARMA model (2,1,0)(0,0,0) is found to be the best model as the value is least (i.e.) 111.042 And 111.647. The Akaike information criterion is widely used a measure of a statistical model basically quantifies the goodness of fit, the simplicity, parsimony of the model into a single statistic. In statistics, the Bayesian information criterion (BIC) is a criterion for model selection among a finite set of models, usually measures the efficiency of the parameterized model in terms of predicting the data. Correlogram is an image of correlation statistics. It gives a statement whether or not pairs of data show autocorrelation meaning the significance level. The chart shows the model of fit of models for both actual and forecasted.
5. CONCLUSION
The study had proved that the ARIMA (2,1,0) (0,0,0)12 model was the best fit model for forecasting the price of cardamom (large) during the period under study. Finally, most parsimonious model whose coefficient is significant has been selected for the forecast. The forecasts use the recent trend in the data. Percentage as well as absolute figures of the Forecasts from different ARIMA models for the year 2016-2017 are presented and the best model was chosen from the following ARMA models viz., ARMA (0,1,1) (0,0,0)12, ARMA (1,0,1) (0,0,0)12, ARMA (0,1,1) (0,0,0)12, ARMA (1,0,0) (0,0,0)12, ARMA (1,1,0) (0,0,1)12 and ARMA (2,1,0) (0,0,0)12 on the basis of the least Akaike Information Criteria (AIC) and Schwarz Bayesian Criteria (SBIC). The above ARIMA models were estimated through Stata 12 version of Stata package. The ARMA model (2,1,0) (0,0,0)12 observed least AIC and BIC values. The MAPE for ARMA (2,1,0) (0,0,0)12 was also lowest. Thus, ARIMA model (2,1,0) (0,0,0)12 was the most representative model for the price forecast of cardamom (large) in Indian Market.

6. REFERENCES
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