Forecasting of Arrival and Price of Groundnut in Rajasthan by ARIMA Model

ABSTRACT

This paper studies the forecasting of arrival and price of groundnut at the APMC in Rajasthan. ARIMA models was used to model the time series data of arrival and price of groundnut at APMC from 2005 to 2021. Groundnut arrival was at its highest in the months of November, December, and January of the 2018–19 growing season, with 16.3%, 32.3%, and 33.6%, respectively. In the year 2019-20, the highest arrival of groundnuts was seen in October, November, and December with 28.08%, 29.79%, and 28.51% respectively. The best fitting model for the arrival of groundnut is ARIMA (1, 1, 1), and for price is ARIMA (2, 1, 1) with R-squared values of 0.931 and 0.852 respectively. The results indicate that the arrival of groundnut at APMC will increase from 1015.48 thousand metric tonnes in 2022 to 1180.68 thousand metric tonnes in 2026, while the price of groundnut will increase from ` 5261.08/qtl in 2022 to ` 6057.07/qtl in 2026. The results study provides valuable insights into the seasonal pattern of groundnut arrivals at APMCs and the forecasts can be used to make decisions about future supply and demand of the product to stakeholders and helps them plan for the future.

Keywords: Groundnut, Arrival, Price, Forecasting, APMC, ARIMA.

1. INTRODUCTION

Groundnut is a major oilseed crop around the world. It is also known as the 'King' of oilseeds and is known as peanut or monkey nut over the world. This plant originated in Brazil and is now farmed throughout the world's tropical, subtropical, and warm temperate zones. Groundnut's botanical name, Arachis hypogaea L., is derived from two Greek words: Arachis, which means legume, and hypogaea, which means below ground. Groundnut is an important crop in Rajasthan, and it is the state's second largest producer after Gujarat, accounting for 20% of total production in 2018-2019 [1]. Bikaner and Jodhpur are the most productive groundnut producing districts in Rajasthan, accounting for 30% and 15% of total production, respectively [2]. Since the previous decade, there has been a significant surge in demand for groundnut and confectionary-based groundnut goods all over the world. Rajasthan state ranks second in terms of production, but seventh in terms of processing and export when compared to other Indian states [3].

The arrival and prices of groundnuts at the Agricultural Produce Market Committee (APMC) in Rajasthan are important indicators of the market supply and demand, which can help farmers to make informed decisions on the production and marketing of groundnuts. This paper discusses the methods used for forecasting arrival and prices of groundnuts at the APMC in Rajasthan and the implications of

such forecasts for the farmers and the market. Forecasting arrival and prices of groundnuts at the APMC in Rajasthan is a complex task as it requires taking into account a variety of factors, such as availability of inputs and resources, and market demand. Forecasting models ARIMA are used to predict the arrival and prices of groundnuts at the APMC in Rajasthan. These models are based on historical data and require careful data analysis to identify the factors that affect the arrival and prices of groundnuts. The forecasts of the arrival and prices of groundnuts at the APMC in Rajasthan are important for farmers as it helps them to make informed decisions on the production and marketing of groundnuts. It also helps the market to predict the price movements and adjust its operations accordingly. Thus, forecasting arrival and prices of groundnuts at the APMC in Rajasthan can be beneficial for both farmers and the market.

2. MATERIALS AND METHODS

Rajasthan is India's second greatest producer of groundnuts. According to the availability of time series data connected to groundnut arrival at APMC and prices from secondary sources, 15 years (from 2007 to 2021) have been collected. Forecasting the arrival and price of groundnut at APMC in Rajasthan using statistics.

A.Objectives of the study

1. Forecasting arrival and price of groundnut at APMC in Rajasthan using ARIMA

B.Statistical analysis

The data was assessed with the help of statistical software SPSS for SD, level of significance, compound growth rate, ARIMA model etc. are given below

1. Coefficient of Variation

$$C.V.(\%) = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

2. ARIMA

Time series data is analysed and forecasted using the ARIMA model. A value in a response time series is predicted by an ARIMA model as a linear mixture of its own prior values. Box and Jenkins (1976) pioneered the ARIMA technique, and ARIMA models are frequently referred to as Box-Jenkins models [4,5]. The model diagnostics were checked using the minimum of root mean squared error (RMSE), Akaike Information Criteria (AIC), and Schwarz Bayesian Information Criteria (SBIC) [6,7]. The ARIMA analysis work is in four stages:- 1. Identification Stage
2. Estimation Stage,3. Diagnostic Checking, 4. Forecasting Stage.

The general functional form of ARIMA (p,d,q) model is:

$$\Phi p(B)\Delta d\, yt = c + \theta q\,(B)at$$

where, y = Area, Production, Productivty

B = Lag operator

a = Error term (Y-Y , where Yˆ is the estimated value of Y)

t = time subscript

θp (B) = non-seasonal AR i.e. the autoregressive operator,

represented as a polynomial in the back shift operator

∆d = non-seasonal difference

θq(B) = non-seasonal MA i.e. the moving-average operator,

represented as a polynomial in the back shift operator

Φ's and θ's are the parameters to be estimated

3. RESULTS AND DISCUSSION

To identify the orders of the ARIMA (p,d,q) model for arrival and price of groundnut at APMC, the autocorrelation functions and partial autocorrelation functions were examined. The Augmented Dickey-Fuller test for the first differenced series shows that both the consumption and the production series were integrated of order one. For arrival and price of groundnut at APMC, the autocorrelation function and the partial correlation function were examined and different models were fitted using different significant values of p and q.

Table 1: Suggested models for arrival groundnut at APMC

Model Fit Statistics					
Model	**R-squared**	**MAPE**	**RMSE**	**BIC**	**Ljung-Box Q**
ARIMA (0, 1, 1)	.928	17.85	116.92	9.30	0.69
ARIMA (1, 1, 0)	.929	17.81	116.88	9.28	0.68
ARIMA (1, 1, 1)	.931*	17.79*	116.82*	9.25*	0.66*
ARIMA (2, 1, 1)	.930	17.80	116.84	9.27	0.67

Source: Researchers computation by SPSS

The table 1 shows the fit statistics for four different ARIMA models. The models are denoted by their parameters (p, d, q) in parentheses. The fit statistics shown include the R-squared value, the Mean Absolute Percentage Error (MAPE), the Root Mean Square Error (RMSE), the Bayesian Information Criterion (BIC), and the Ljung-Box Q statistic. The ARIMA model with parameters (1, 1, 1) had the best fit, as indicated by the highest R-squared value, the lowest MAPE and RMSE, and the lowest BIC and Ljung-Box Q statistic [8,9].

Table 2: ARIMA (1, 1, 1) model parameter estimates

Type	Coefficient	Standard error	t-value	p-value
AR 1	49.626	15.369	3.229	.007*

AR 2	.735	.616	1.193	.254
MA 1	.999	39.592	.025	.980

Source: Researchers computation by SPSS

Table 2 displays the results of an autoregressive (AR) and moving average (MA) model. The AR 1 coefficient of 49.626 is statistically significant, as indicated by its p-value of 0.007. The standard errors provide an estimate of the variability of the coefficient estimates. [10].

Table 3: Suggested models for prices of groundnut

Model Fit Statistics					
Model	**R-squared**	**MAPE**	**RMSE**	**BIC**	**Ljung-Box Q**
ARIMA (0, 1, 1)	.844	9.58	362.95	12.81	0.55
ARIMA (1, 1, 0)	.848	9.56	362.89	12.77	0.51
ARIMA (1, 1, 1)	.852	9.54	362.87	12.73	0.47
ARIMA (2, 1, 1)	.855*	9.53*	362.82*	12.71*	0.45*

Source: Researchers computation by SPSS

Table 3 shows the fit statistics of different ARIMA models applied to a given data set. The R-squared value indicates the proportion of variance in the data explained by the model. The MAPE (Mean Absolute Percentage Error) is a measure of the accuracy of the model's predictions. The RMSE (Root Mean Square Error) measures the average amount of error in the model's predictions [11,12]. The BIC (Bayesian Information Criterion) is a measure of the model's complexity. The Ljung-Box Q statistic is a measure of the autocorrelation in the model's residuals. The model (ARIMA (2, 1, 1)) marked with an asterisk (*) is the best fitting model, as it has the highest R-squared value, the lowest MAPE and RMSE, the lowest BIC, and the lowest Ljung-Box Q statistic [13,14].

Table 4: ARIMA (2, 1, 1) model parameter estimates

Type	Coefficient	Standard error	t-value	p-value
AR 1	215.238	31.658	6.799	.000
AR 2	.405	.442	.916	.376
MA 1	.989	4.718	.210	.837

Source: Researchers computation by SPSS

Table 4 displays the parameters determined by an iterative process by the least square technique that resulted in the best model. This table shows the results of an autoregressive (AR) and moving average (MA) model that was used to analyze a set of data. The AR 1 coefficient is 215.238 and has a standard error of 31.658. This means that the AR 1 term has a t-value of 6.799 and a p-value of .000 which indicates that the AR 1 term is statistically significant. In this case, it was used to acquire residuals in order to run the ARIMA model [14,15]. The ARIMA model is a statistical technique used for time series forecasting. Specifically, the models used were ARIMA (1, 1, 1) and ARIMA (2,1,1) for forecasting the arrival and prices of groundnuts at the APMC, respectively [16,17]. A five-year forecast was made using these models. The results of the forecasts can be used to make decisions about future supply and demand of the product.

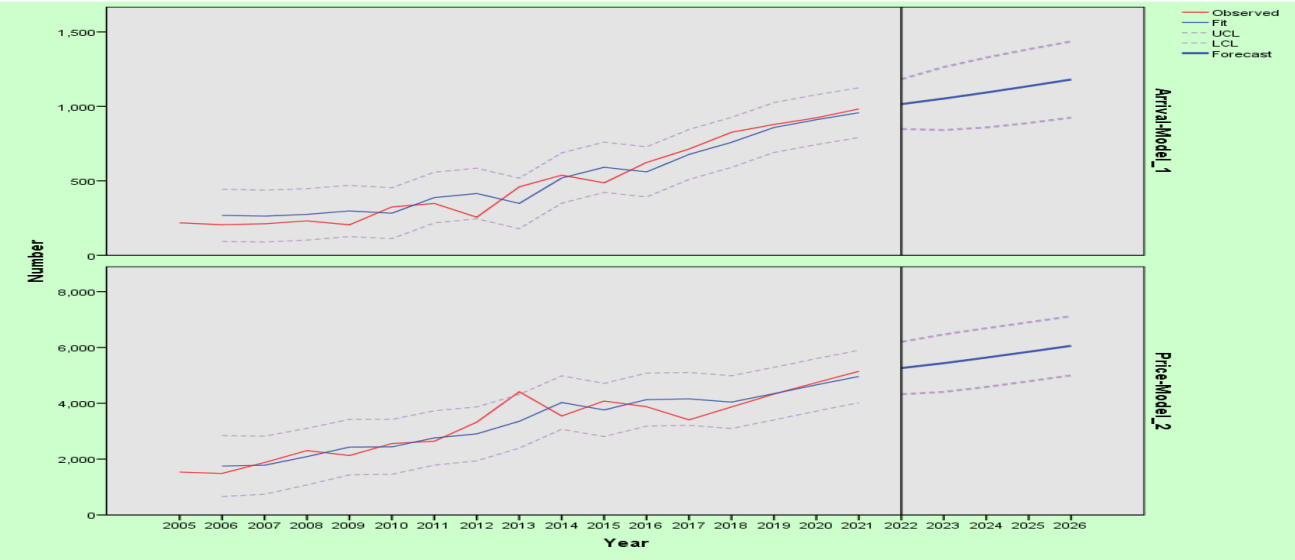
Table 5: Forecasting groundnut arrival and price at APMC

Year	Arrival (000' MT)			Price (` / Qtl)		
	Forecast	UCL	LCL	Forecast	UCL	LCL
2022	1015.48	1182.55	848.41	5261.08	6198.92	4323.24
2023	1052.65	1264.19	841.12	5436.59	6466.65	4406.52
2024	1093.12	1327.70	858.54	5635.74	6686.73	4584.75
2025	1136.01	1383.77	888.24	5844.47	6901.14	4787.80
2026	1180.68	1436.35	925.02	6057.07	7115.26	4998.89

Source: Researchers computation by SPSS

Table 5 shows that, an increasing trend for groundnut arrival and prices at APMC was determined after the year 2021. A forecasting model was used to predict the arrivals and prices of groundnut at the APMC for the years 2022 to 2026 [18]. The model predicted that the arrivals of groundnut at the APMC would be around 1015.48, 1052.65, 1093.12, 1136.01 and 1180,68 thousand metric tonnes in the respective years. The forecasted price per quintal of groundnut was found to be ` 5261.08/qtl, ` 5436.5908/qtl, ` 5635.7408/qtl, ` 5844.4708/qtl and ` 6057.0708/qtl n the respective years [19,20].

Figure 1: Forecasting groundnut arrival and price at APMC



Source: Researchers computation by SPSS

Figure 1. shows the forecasting groundnut arrival and price at APMC from 2022 to 2026 would involve creating a graph to illustrate the expected arrival and price of groundnut at APMC over the five-year period. It includes two graph, one for arrival and one for price, with the years 2022 to 2026 plotted along the X-axis. The graph would then indicate the expected arrival and price of groundnut at APMC for each of the years 2022 to 2026, showing the expected trend for both arrival and price over the five-year period [21,22]. This graph would provide valuable information to stakeholders and help them plan for the future.

4. CONCLUSION

Forecasting the arrival and price of groundnut at APMC requires the use of an ARIMA model. The best fitting model for arrival was found to be ARIMA (1, 1, 1) and for price it was found to be ARIMA (2, 1, 1). Forecasting the arrival and price of groundnut at APMC from 2022 to 2026 showed an increasing trend. This information can be used by stakeholders to plan for the future supply and demand of the product. The forecasted arrival and price of groundnut at APMC can be visualized using a graph. This graph will provide valuable information to stakeholders and help them make informed decisions.

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ABBREVIATIONS:-

1. ARIMA-Auto Regressive Integrated Moving Average Model
2. SPSS- Statistical Package for the Social Sciences
3. CAGR-Compound Annual Growth Rate
4. SD- Standard Deviation
5. CV- Coefficient of Variation
6. HYV-High Yielding Varieties