Original Research Article

Forecasting Area, Production and Productivity of Groundnut in Rajasthan Using Auto Regressive Integrated Moving Average (ARIMA) Model

ABSTRACT

OBJECTIVES: To forecasting the area, production, and productivity of groundnut in Rajasthan

Comment [MM1]: forecast

METHOD: Autoregressive Integrated Moving Average (ARIMA) model, descriptive statistics, autocorrelation, and fitted models used to achieve this.

FINDINGS: Descriptive statistics, autocorrelation, and parameter estimates for the fitted models were also used. The forecast for 2021 predicted an area of 784.04, with an upper confidence limit (UCL) of 928.22 and a lower confidence limit (LCL) of 649.35. The forecasts for 2022, 2023, 2024, and 2025 were 846.27, 905.36, 972.99, and 1043.07 respectively, with corresponding UCL and LCL values. The degree of accuracy attained by ARIMA (0,1,1) was found to be sufficient. The estimated values of Area, Production, and Productivity Groundnut in Rajasthan as relative departure of the allowed limits were also displayed. This study provides new insights into forecasting the Area, Production, and Productivity Groundnut in Rajasthan using the ARIMA model. Forecast for 2021 predicted an area of 784.04, with an upper confidence limit (UCL) of 928.22 and a lower confidence limit (LCL) of 649.35. The estimated values of Area, Production, and Productivity Groundnut in Rajasthan as relative departure of the allowed limits were displayed.

NOVELTY: This study provides new insights into forecasting the Area, Production, and Productivity Groundnut in Rajasthan using the ARIMA model.

KEYWORDS: *Forecasting, ARIMA, SPSS, Groundnut, Area, Production, Productivity.*

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, Arachishypogaea 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. (FAO, 2020). Bikaner and Jodhpur are the most productive groundnut producing districts in Rajasthan, accounting for 30% and 15% of total production, respectively (INDIASTAT, 2020). 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 (APEDA, 2020).In an uncertain sector like agriculture, accurate and timely estimates provide valuable and practical recommendations for successful, foresighted, and attentive planning.

The objectives of this paper is to understand the change in groundnut area, production, and productivity in Rajasthan, as well as to forecast crop area, production, and productivity. This approach enables improved policy decisions in terms of food nutrition security and land use allocation. Among other things, our approach for generating a support policy choice, optimal land use allocation, and environmental concerns.The ARIMA model is most commonly used it for forecasting time series that are based on the publications. A univariate time series model is forecasted using the auto regressing integrated moving average (ARIMA) model.

2. MATERIALS AND METHODS

Rajasthan is India's second greatest producer of groundnuts. According to the availability of time series data connected to groundnut prices from secondary sources, 30 years (from June 1991 to June 2021) have been collected. Forecasting the area, production, and productivity of groundnut in Rajasthan using statistics.

A.Objectives of the study

1. Forecasting of Area, Production and Productivity of of groundnut in Rajasthan

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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

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

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[6]. The model diagnostics were checked using the minimum of root mean squared error (RMSE), Akaike Information Criteria (AIC), and Schwarz Bayesian Information Criteria (SBIC).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:

$$\Phi_p(B)\Delta^d y_t = c + \theta_q(B)a_t$$

where, y = Area, Production, Productivty

B = Lag operator

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

t = time subscript

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

represented as a polynomial in the back shift operator

Δ^d = non-seasonal difference

θ_q(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

Descriptive statistics show the mean, maximum (Max.) and minimum (Min.) values in addition to other statistical properties. Table 1.demonstrates that there was a large fluctuation in the lowest and maximum values of area, production, and productivity of tomato in groundnut in Rajasthan over the period of last thirty years.

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TABLE 1.DESCRIPTIVE STATISTICS FOR GROUNDNUT IN RAJASTHAN FROM 1991-92 TO 2019-20

	Mini	Maxi	Mean	Std. Dev.	CV(%)	Skewness	Kurtosis
Area	195	739.02	359.38	140.25	3.12	1.451	1.171
Production	166.1	1619.33	534.31	407.73	6.10	1.326	0.603
Productivity	687	2191	1374.4	455.04	2.64	0.456	-1.154

(Source: Researcher's own computation from Secondary data)

For Groundnut production, the standard deviation value (Stdev.) for each variable is excessively high, creating an erratic pattern. The coefficient of variation (CV), [1] which compares the amount of variation between two data series, is useful even when the means are significantly different. It is calculated using the ratio of standard deviation to mean. A distribution or data collection is considered to be symmetric (Skewness value around zero) if it appears the same to the left and right of the centre point[2] ,[3],[4] . Kurtosis is a metric used to determine how heavily or thinly tailed the data are in relation to a normal distribution.

Table 2. Parameter estimates of ARIMA Model

				Estimate	SE	t	Sig.
Area-Model_1	Area	Square Root	Constant	.037	.019	1.957	.062
			AR Lag 1	-.534	.172	-3.097	.005
			Difference	2			
			MA Lag 1	.996	4.210	.237	.815
Production-Model_2	Production	Square Root	Constant	.092	.046	2.011	.055
			AR Lag 1	-.609	.161	-3.776	.001
			Difference	2			
			MA Lag 1	.990	2.252	.440	.664
Production-Model_3	Production	Square Root	Constant	.026	.065	.400	.692
			AR Lag 1	-.591	.162	-3.647	.001
			Difference	2			
			MA Lag 1	.990	2.206	.449	.658

(Source: Researcher's own computation from Secondary data)

The table above presents the parameter estimates of an ARIMA model. The estimates are for the area, production and productivity models. The estimates include the constant, AR

Lag 1, Difference, and MA Lag 1. The constant is the intercept of the model and is represented by a number between 0 and 1, indicating the magnitude of the model's intercept. The AR Lag 1 is the autoregressive coefficient, which indicates the magnitude of the effect of the previous observation on the current one. The Difference is the order of the model's differencing, which determines how many times the series must be differenced before it becomes stationary. The MA Lag 1 is the moving average coefficient, which indicates the magnitude of the effect of the moving average error on the current observation. The SE and t values are the standard errors and t-statistics, respectively, which indicate the strength of the parameter estimates. The Sig. value indicates the significance of the parameter estimates, with lower values indicating more significance.

Table 3. DIAGNOSTIC CHECKING OF RESIDUALS AUTOCORRELATIONS

Model Fit Statistics							
Model	**Number of Predictors**	**R-squared**	**MAPE**	**RMSE**	**Normalized BIC**	**Ljung-Box Q Statistics**	**Sig.**
Area	0	.905	9.895	116.825	7.987	15.504	.488
Production	0	.873	28.855	362.824	10.435	19.148	.261
Productivity	0	.496	21.239	658.563	11.964	16.567	.414

(Source: Researcher’s own computation from Secondary data)

The above table shows that the model fit statistics. The Area-Model_1 has 0 predictors and an R-squared value of 0.905, which suggests that the model is a good fit for the data. The MAPE value of 9.895 indicates that the model is reasonably accurate, with an RMSE value of 116.825[5]. The Normalized BIC value of 7.987 indicates that the model is parsimonious. The Ljung-Box Q Statistics (15.504) and the corresponding Sig. (.488) indicate that there is no significant autocorrelation in the residuals of the model[6] .

The Production-Model_2 also has 0 predictors and an R-squared value of 0.873. The MAPE value of 28.855 suggests that the model is still reasonably accurate, with an RMSE value of 362.824. The Normalized BIC value of 10.435 indicates that the model is parsimonious. The Ljung-Box Q Statistics (19.148) and the corresponding Sig. (.261) indicate that there is no significant autocorrelation in the residuals of the model[7] .

Finally, the Pr-Model_3 has 0 predictors and an R-squared value of 0.496. The MAPE value of 21.239 suggests that the model is not very accurate, with an RMSE value of 658.563.

The Normalized BIC value of 11.964 indicates that the model is not very parsimonious[8], [9] . The Ljung-Box Q Statistics (16.567) and the corresponding Sig. (.414) indicate that there is no significant autocorrelation in the residuals of the model[10], [11].

Table 4.FORECAST VALUES OF AREA, PRODUCTION, PRODUCTIVITY

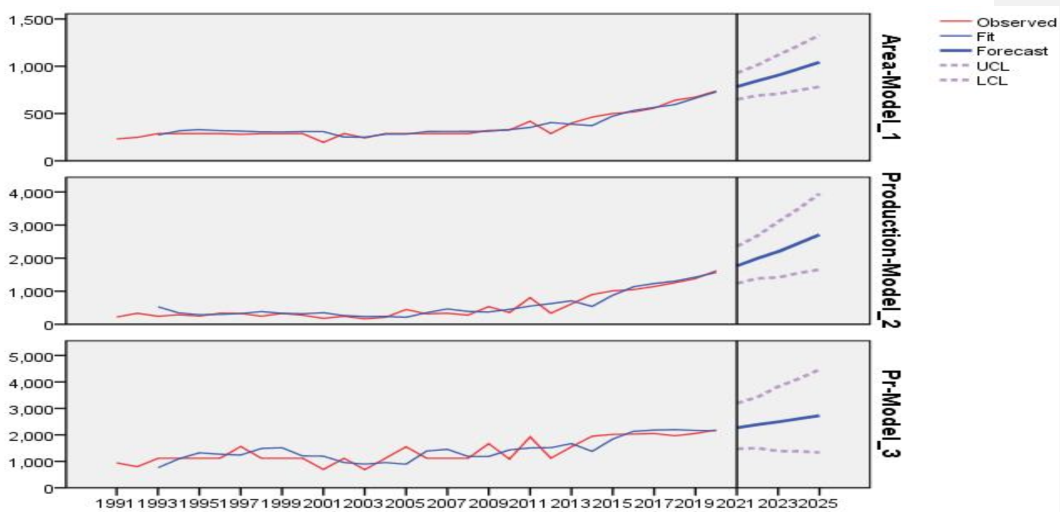
Forecast						
Model		**2021**	**2022**	**2023**	**2024**	**2025**
Area	Forecast	784.04	846.27	905.36	972.99	1043.07
	UCL	928.22	1014.06	1119.96	1220.91	1330.93
	LCL	649.35	690.33	708.66	747.18	782.84
Production	Forecast	1762.47	1992.71	2197.07	2450.87	2708.08
	UCL	2354.97	2678.02	3102.45	3499.96	3950.71
	LCL	1238.01	1387.72	1416.39	1551.22	1653.61
Productivity	Forecast	2271.27	2389.50	2491.43	2610.84	2728.00
	UCL	3193.84	3428.63	3826.49	4121.12	4471.31
	LCL	1474.15	1500.45	1387.74	1380.09	1335.93

UCL & LCL - Upper and lower confidence limits (95%)

(Source: Researcher's own computation from Secondary data)

Area: The forecast for 2021 predicts an area of 784.04, with an upper confidence limit (UCL) of 928.22 and a lower confidence limit (LCL) of 649.35. This means that the actual area is likely to fall between the two values. The forecasts for 2022, 2023, 2024, and 2025 are 846.27, 905.36, 972.99, and 1043.07 respectively, with corresponding UCL and LCL values. Production: The forecast for 2021 predicts a production of 1762.47, with an upper confidence limit (UCL) of 2354.97 and a lower confidence limit (LCL) of 1238.01. This means that the actual production is likely to fall between the two values. The forecasts for 2022, 2023, 2024, and 2025 are 1992.71, 2197.07, 2450.87, and 2708.08 respectively, with corresponding UCL and LCL values. Pr: The forecast for 2021 predicts a Pr of 2271.27, with an upper confidence limit (UCL) of 3193.84 and a lower confidence limit (LCL) of 1474.15. This means that the actual Pr is likely to fall between the two values. The forecasts for 2022, 2023, 2024, and 2025 are 2389.50, 2491.43, 2610.84, and 2728.00 respectively, with corresponding UCL and LCL values[12], [13].

FIGURE 1. FORECAST VALUES OF AREA, PRODUCTION, PRODUCTIVITY



It was determined that the ARIMA model was more effective at predicting the Area [ARIMA (10,1,1,)] of groundnut in Rajasthan. Table 4 displays the measured values of groundnut area, production, and productivity in Rajasthan along with their corresponding relative deviations[14]. Groundnut production, productivity, and area modelling and forecasting in Rajasthan could all be done successfully using the ARIMA model[15],[16] . The estimated values of Area, Production, and Productivity Groundnut in Rajasthan as relative departure of the allowed limits are displayed in table 4. It has been discovered that there is a considerable upward trend in these variables. For calculating Area, Production, and Productivity of Groundnut in Rajasthan[17],[18]. The degree of accuracy attained by ARIMA (0,1,1) was found to be sufficient.

4. CONCLUSION

In this study has used descriptive statistics, autocorrelation, and ARIMA models to analyze and forecast the area, production, and productivity of groundnut in Rajasthan. The descriptive statistics show that there was a large fluctuation in the lowest and maximum values of the variables over the last thirty years. Autocorrelation revealed that there was no significant relationship between production in different periods. The ARIMA model was found to be effective in predicting the Area of groundnut in Rajasthan with an R-squared value of 0.905, an MAPE value of 9.895, and an RMSE value of 116.825. The Ljung-Box Q

Statistics and the corresponding Sig. values indicated that there was no significant autocorrelation in the residuals of the model. Table IV presents the forecast values for 2021-2025 for area, production, and productivity of groundnut in Rajasthan, along with their corresponding upper and lower confidence limits. Overall, it can be concluded that ARIMA (0,1,1) was a suitable model for forecasting the area, production, and productivity of groundnut in Rajasthan.

Scope of the study

Analysing the current production and productivity of groundnut in Rajasthan. Estimating the future production and productivity of groundnut in Rajasthan region. Estimating the potential areas where groundnut can be cultivated in Rajasthan. Assessing the impact of climate change on the production and productivity of groundnut in Rajasthan. Identifying the challenges faced by the farmers in cultivating groundnut and suggesting the possible solutions to address them. Creating awareness among the farmers about the importance of groundnut cultivation and its benefit to the state.

Limitations of study :

Lack of accurate data: Accurate data is essential for forecasting, but it can be difficult to obtain in the case of groundnut production in Rajasthan. Data may not be available for the historical period, or it may be unreliable or incomplete. Limited resources: Forecasting requires resources such as time, money and personnel. Rajasthan may not have the necessary resources to properly conduct a forecasting analysis. Lack of expertise: To effectively forecast groundnut production in Rajasthan, expertise in areas such as agriculture, economics, climate science and market analysis is required.

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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