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# Modeling and Forecasting of Potato Production in Rajasthan and their Yield Sustainability

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

This study examined trends, sustainability, and forecasted potato area, production, and productivity in India and Rajasthan from 1970 to 2030. Annual potato production data was analyzed using an autoregressive integrated moving average (ARIMA) model. The models were trained using data

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from 1970 to 2020 and assessed with a validation set from 2021 to 2023. In the training set, a box exhibited the optimal performance. The ARIMA models yielded the minimal predicted errors. The leading models project potato production till 2030. In 2023, potato production in Rajasthan and India was 260.50 thousand tonnes and 61,250.50 thousand tonnes, respectively. By 2030, Rajasthan and India are projected to yield 301.31 thousand tonnes and 63,318.26 thousand tonnes, respectively. The predictions can aid in food security planning and agricultural policy formulation in the region. Rajasthan and India exhibit significant sustainability in potato yield for the period from 1998 to 2023.

*Keywords: Trend; sustainability; ARIMA; time series; policy.*

## 1. INTRODUCTION

Potato (*Solanum tuberosum*) is an annual herbaceous tuber crop belonging to the family Solanaceae, one of the most horticulture crops that have the highest nutrition and dry matter production per unit area and time of any major food crop. It is the world's most significant crop for food, with a 78% water content and a 22% dry matter content. 20% fat, 2.1% protein, 1.1% dietary fiber, 0.9% ash, and 0.3% carbs. Potato is another important source of raw materials for the extraction of starch, with starch extraction typically ranging from 9% to 25%. According to the total amount of mineral compounds accumulated in potatoes, they exceed many types of fruits and vegetables, 18 amino acids are found in potato proteins. Potatoes possess significant nutritional value and serve as a source of vitamins C, A (carotene), B group, and K. Consuming an average of 300 g (about 10.58 oz) of boiling potatoes daily supplies essential carbohydrates, phosphorus, 8% vitamin content, 10-12% amino acids, 30-40% vitamin C, 40-50% vitamin B, 20-25% potassium, 55-60% calcium and iron, and 1-2% carotene. Sustainable agriculture is characterized as agriculture that, in the long term, enhances environmental quality and the resource foundation essential for agriculture; meets fundamental human needs for food and fiber; is economically sustainable; and improves the quality of life for farmers and society at large.Agriculture has consistently been marked by significant and unpredictable fluctuations in location, demand, and yield; thus, forecasting is advantageous for farmers, governments, and the agribusiness industry.

Due to the critical role that food production plays in a nation's stability, governments are becoming major providers and users of agricultural prediction (Mishra et al.,2015).The area of potato production in India during 2022-23 is 2332Thousand ha, withproduction of **61250.50 MT (Metric ton) anda yield of 257 q/ha.**Thetotal area, production, and productivity of potato in Rajasthanin 2021 is about 13.59 Thousand ha,256.00thousand tonnes, and 188.33 q/ha (Ministry of Agriculture and Farmer Welfare, Govt. of India,2023).

Mishra et al. (2024) employed ARIMA (Auto Regressive Integrated Moving Average) and ETS (Error-Trend-Seasonality) forecasting models to project potato production. Kumari et al. (2024) This study emphasizes the critical necessity for accurate forecasting of potato prices, vital for enhancing production, marketing strategies, and inventory control. Yadav et al. (2024) employed autoregressive integrated moving average (ARIMA) models, state space models, and gradient-boosting machine learning techniques to examine annual potato production data from 1967 to 2020.Sahu et al. (2024) employed time series data concerning area, production, productivity, market prices, export quantity, and export value in the principal cultivating states, markets, and importing countries, respectively. The study by Devi et al. (2021) examined the sustainability and instability of wheat production in Haryana.

## 2. MATERIALS AND METHODS

### 2.1 Source of Data

In the present investigation,secondary data has been gathered. A glance at Agricultural Statistics (2022) provided the area, production, and yield data on potato for the years 1970–2023 for Rajasthan and Whole India.

### 2.2 Descriptive Statistics

Descriptive statistics are frequently used to make numerical data easily understandable. We have the option of using one or more criteria to assess a large sample of people. We can make sense of very large datasets by using descriptive statistics. The three categories of descriptive statistics are central tendency (CT), dispersion, and association measures.

### 2.3 Trend Models

A (Mishra et. al. 2015) model is a way to illustrate a system or process. Statistical models often follow the course of the process together with its statistical characteristics and implications.

I. **Linear Model:** $Y_t = b_0 + b_1 t$
II. **Quadratic Model:** $Y_t = b_0 + b_1 t + b_2 t^2$
III. **Compound Model:** $\ln(Y_t) = \ln(b_0) + t \ln(b_1)$
IV. **Cubic Model:** $Y_t = b_0 + b_1 t + b_2 t^2 + b_2 t^3$
V. **Exponential Model:** $Y_t = b_0\, e^{(b_1 t)}$
VI. **Logarithmic Model:** $Y_t = b_0 + b_1 \ln(t)$
VII. **Growth Model:** $\ln(Y_t) = b_0 + b_1 t\ Y_t$
VIII. **Inverse Model:** $Y_t = b_0 + \frac{b_1}{t}$
IX. **Power Model:** $Y_t = b_0 t^{b_1} +$
X. **S Type Model:** $Y_t = e^{\left(b_0 + \frac{b_1}{t}\right)}$
XI. **Logistic Model:** $Y_t = \frac{K}{\left(1+e^{b_0 + b_1^t}\right)}$

### 2.4 Randomness Test

Thecurrent non-parametric test for randomization is based on the quantity of turning points. The method is to tally the series' peaks and troughs. A value that is higher than its two neighbors is referred to as a "peak," and a value that is lower than its two neighbors is referred to as a "trough." The series' highs and lows are regarded as pivotal moments. Therefore, one requires at least those data points to identify a turning moment. There are fewer turning points in the series than there are ups and downs.

Let us consider now a set of values $\mu_1, \mu_2 \ldots\ldots \mu_n$, and let us define a " marker" variable $X_i$ by

$$X_i = 1, \begin{cases} \mu_i < \mu_{i+1} > \mu_{i+2} \\ \mu_i > \mu_{i+1} < \mu_{i+2} \end{cases}$$
$$= 0 \quad \text{otherwise; } i = 1, 2, ...., n-2$$

The number of turning points p is then simply.

$$p = \sum_{i=1}^{n-2} X_i$$

Then,

$$E(p) = \sum E(X_i) = \frac{2}{3}(n-2)$$

$$E(p^2) = E(\sum_{1}^{n-2} X_i)^2 \text{ on simplification,}$$

$$E(p^2) = \frac{40n^2 - 144n + 131}{90} \text{ and}$$

$$V(p) = \frac{16n - 29}{90}$$

### 2.5 Measures of Sustainability

According to Devi et al. (2021) and Vishwajith et al. (2018), sustainability is a complicated, multifaceted phenomenon that has been described in a variety of ways. While highly divisive it is widely accepted that it is complex and needs many evaluations. It can be evaluated by taking into account its biophysical, social, and economic characteristics in its most basic form.

### 2.6 Sustainability Index (SI)

For the sustainability index will divide the potato productivity data into two periods.

- Period -1 (1970 -1997)
- Period -2 (1998 - 2023)
- Whole Period (1970 – 2023)

a) According to **Singh et al., (**1990), the sustainability measure is as follows. Sustainability Index (SI) = $\frac{\bar{Y} - s}{Y_{max}}$

b) According to **Sahu et al.,** (2005) A sustainability index value that is closer to zero is a desirable value. SI = $\frac{Y_{max} - \bar{Y}}{\bar{Y}}$

c) According to **Pal and Sahu** (2007), sustainability increases when the sustainability index value decreases.SI = $\frac{S_i}{\bar{\bar{Y_i}}} \cdot \frac{1}{S_{max}}$

### 2.7 Modeling and Forecasting

The plan looks like a flowchart for time series analysis-based potato production forecasts. The flow is described as follows:

1. Start the procedure's first action.
2. Data on potato production: This appears to be the initial step in which the pertinent data on potato production is recognized as a process input by using SPSS23.
3. Input Potato Production Data (India and Rajasthan): This stage indicates that data on potato production will originate from India and Rajasthan.
4. Training data: After the information is acquired, it is categorized as training data, which is what the forecasting models are fitted to.
5. The training data splits into two routes, signifying the application forecasting techniques:
   The statistical technique known as Autoregressive Integrated Moving Average

(ARIMA) is widely used in time series forecasting.

6. Accuracy for training data: A number of accuracy metrics are used.

**MAE:** Mean Absolute Error, a measure of errors between paired observations expressing the same phenomenon;

**RMSE:** Root Mean Square Error, a measure of the differences between values predicted by a model and the values observed.

**BIC:** Bayesian Information Criterion, a measure of the relative quality of statistical models for a given set of data.

**Mean Absolute Error (MAE):** A measurement of inaccuracies between two observations that represent the same occurrence.

**Root Mean Square Error (RMSE):**A measurement of the discrepancies between data observed and values projected by a model.

**Autocorrelation Function at Lag 1 (ACF1):** A measure of the correlation between time series observations separated by a single time period.

Mean Absolute Percentage Error (MAPE): A measure of forecasting model prediction accuracy.

7. Projecting potato production: The more accurate forecasting model is probably chosen to project future potato production based on the evaluations.

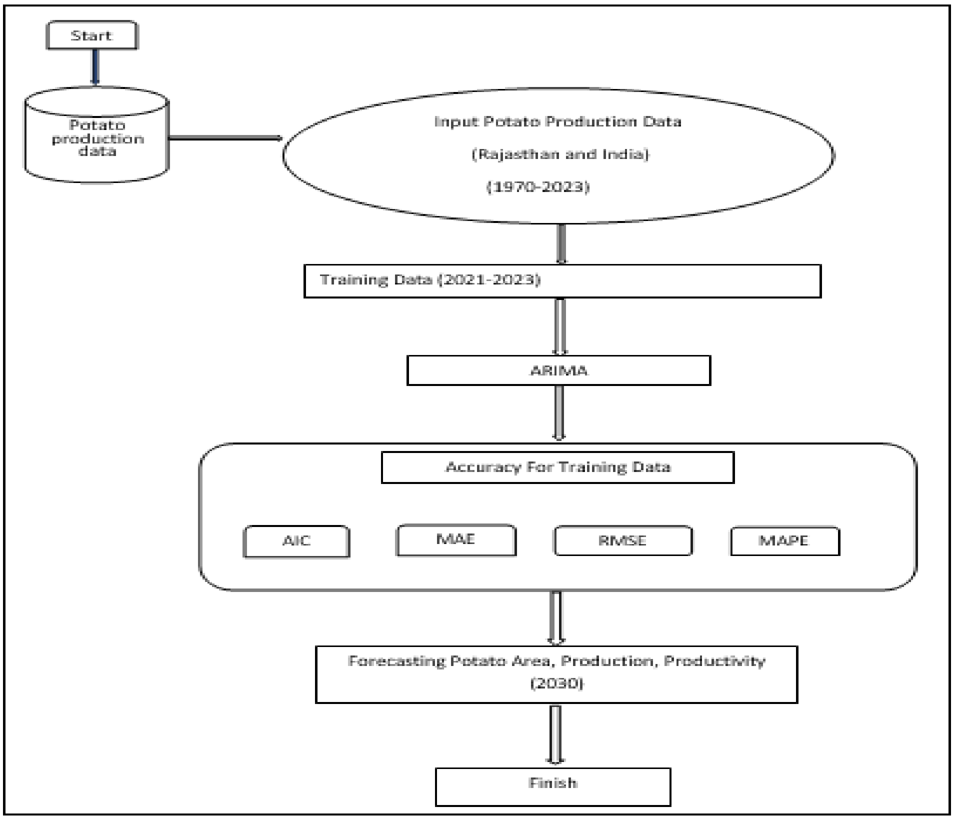
## 2.8 Flow Chart Forecasting

The flow chart 1 is showing the schema of presenting study on potato forecasting. The model accuracy is checked by minimum MAE, RMSE, MAE, RMSE BIC and maximum $R^2$.

### 2.9 Autoregressive Moving Average (ARMA)

The model containing p autoregressive terms and q moving average terms is denoted by the notation ARMA (p, q). The AR(p) and MA(q) models are contained in this model.(Mishra et al 2023)

$$X_t = c + \varepsilon_t + \sum_{i=1}^{p} p_i X_{t-i} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}$$




**Flow chart 1. Schema of forecasting process**

## 3. RESULTS AND DISCUSSION

According to the purpose of the analysis, the secondary source data was evaluated and interpreted.

**Performance of Potato in India and Rajasthan during 1970-2023:** In this section, descriptive statistics such as maximum, minimum, mean, median, skewness, and kurtosis are employed to elucidate the series' pattern and generate a consensus that is examined in Table1. The data Platykurtic structure of potato under area, production, and yield in India and Rajasthan.Rajasthan and India have an average area of 5.59 and 1291.31 thousand ha of potato annually. Rajasthan and India produce an average of 74.69 and 24714.96 thousand tons of potato annually. Rajasthan and India have an average yield of 99.07 and 172.65 q/ha of potato annually. Skewness of 0.41 and 0.94 suggest that the area under potato in India and Rajasthan has been changing over time. positive skewness scores of 1.38 and 0.72 indicate that output increased at the start of the study and stayed almost constant for the duration of the investigation in Rajasthan and India. The positive skewness score was 0.03 and 0.27 in Rajasthan and India.

**Trend Analysis of Potato in India and Rajasthan:** The trend analysis shows (Table 2) that there are cubic trends in potato area, yield, and production throughout India and Rajasthan. Suggesting that in the recent past, most likely, the series have reached their maximum values and then either remained constant or decreased, which is concerning. As can be seen from the data, the area dedicated to potato has grown annually in India and Rajasthan. Figs. 1 to 6, show the non-linear patterns in India and Rajasthan.

**Table1. Performance of Potato area, production, and yield in India and** Rajasthan**during 1970-2023**

| **India** | | | |
|---|---|---|---|
| | **Area ("000 ha)** | **Production (“000 t)** | **Yield (q/ha)** |
| Mean | 1291.319 | 24714.596 | 172.650 |
| Standard Error | 79.023 | 2277.440 | 6.483 |
| Median | 1206.900 | 20709.060 | 167.700 |
| Kurtosis | -1.181 | -0.737 | -0.571 |
| Skewness | 0.414 | 0.729 | 0.273 |
| Minimum | 482.000 | 4451.000 | 88.200 |
| Maximum | 2345.400 | 61250.500 | 277.460 |
| **Rajasthan** | | | |
| Mean | 5.592 | 74.69557 | 99.077 |
| Standard Error | 0.649 | 12.812 | 8.040 |
| Median | 2.752 | 27.151 | 110.835 |
| Kurtosis | -0.809 | 0.570 | -1.083 |
| Skewness | 0.946 | 1.383 | 0.039 |
| Minimum | 1.3 | 3.1 | 13.3 |
| Maximum | 15.985 | 337.991 | 211.442 |

**Table 2. Trends of Potato in India and Rajasthan**

| | | **India** | | | | | |
|---|---|---|---|---|---|---|---|
| | **Model summary** | | | **Parameter Estimates** | | | |
| | **equation** | **$R^2$** | **Sig.** | **constant** | **$B_1$** | **$B_2$** | **$B_3$** |
| Area | Cubic | 0.980 | 0.000 | 519.639 | 10.237 | 0.588 | -0.002 |
| production | Cubic | 0.976 | 0.000 | 4046.793 | 504.577 | -5.371 | 0.298 |
| Yield | Cubic | 0.936 | 0.000 | 79.466 | 6.563 | -0.188 | 0.002 |
| | | **Rajasthan** | | | | | |
| Area | Cubic | 0.902 | 0.000 | 3.708 | -0.342 | 0.013 | -4.859E-05 |
| production | Cubic | 0.902 | 0.000 | 8.613 | -0.125 | -0.047 | 0.003 |
| Yield | Cubic | 0.752 | 0.000 | -6.880 | 6.541 | -0.143 | 0.002 |

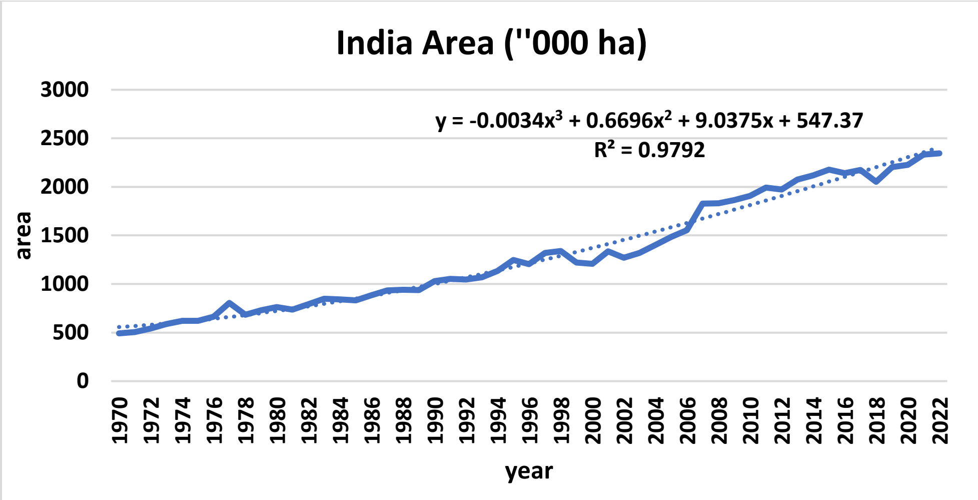



**Fig. 1. Trends of area under potato in India**

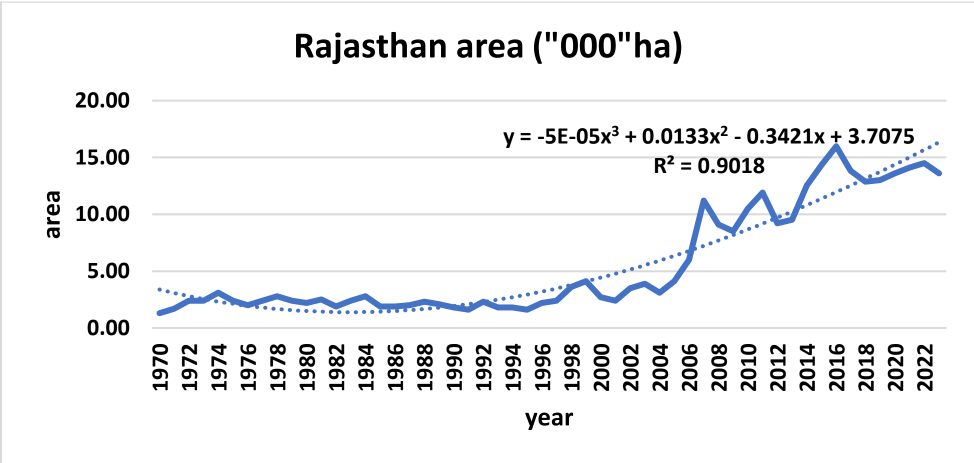



**Fig. 2. Trends of area under potatoin Rajasthan**

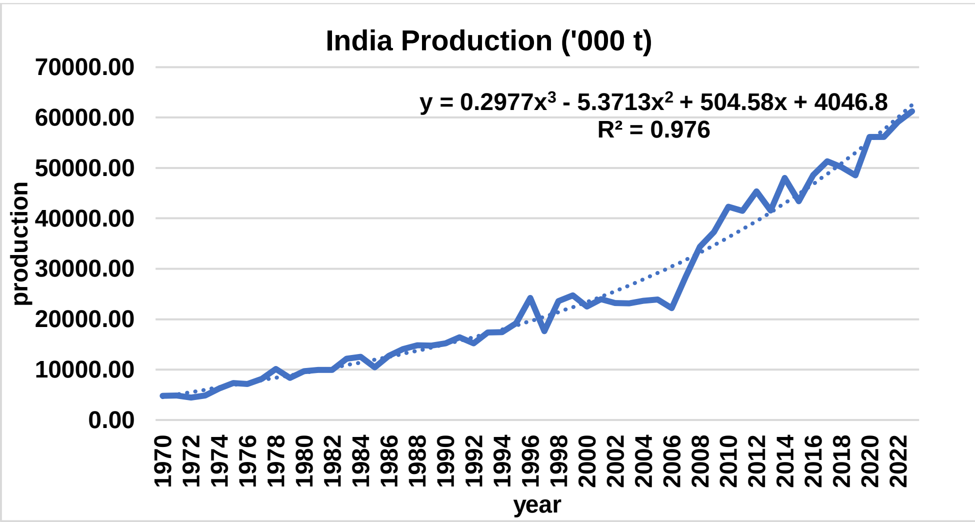



**Fig. 3. Trends of production under potatoin India**

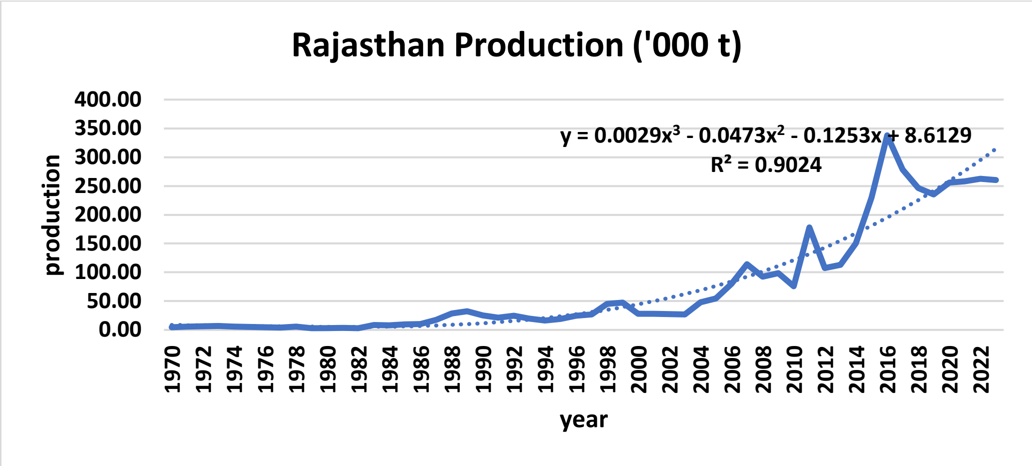



Fig. 4. Trends of production under Potato in Rajasthan

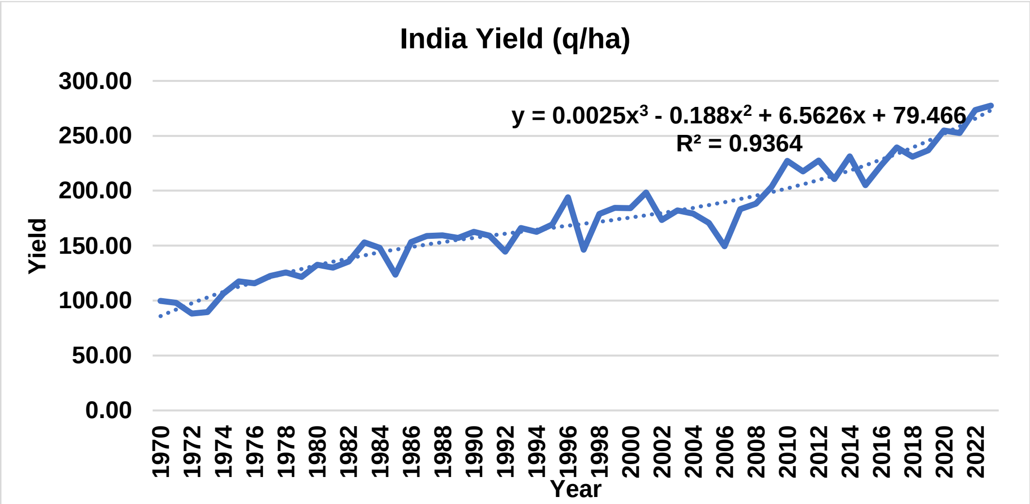



Fig. 5. Trends of yield under Potato in India

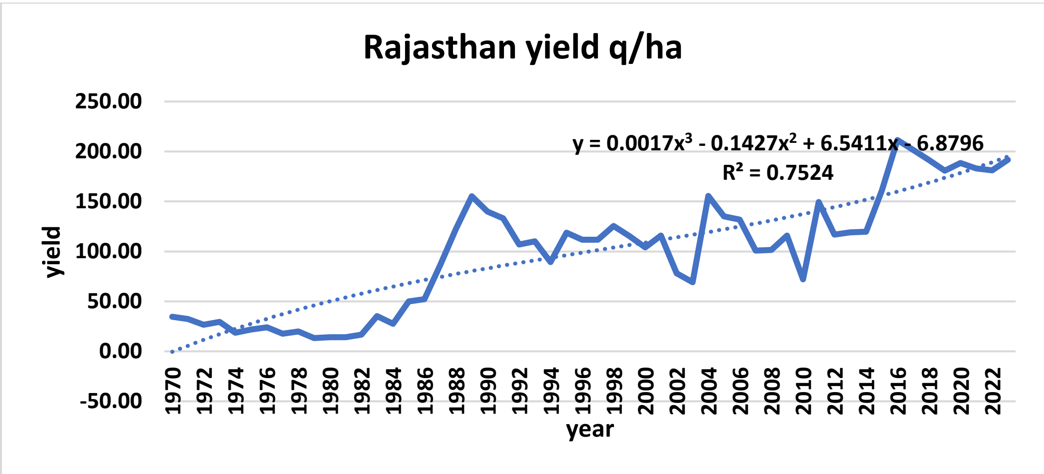



Fig. 6. Trends of yield under Potato in Rajasthan

**Randomness Test:** In table-3shows, that Rajasthan and India exhibit distinct trends in the area, production and yield of potato, as demonstrated by the randomization test.

**Sustainability analysis:**Table 4 presents the results of measuring sustainability in the productivities of potato in Rajasthan and India using sustainability measurement.

According to indexes provided by SI-1 (Singh et al., 1990), SI-2 (Sahu et al., 2005), and SI-3 (Pal and Sahu, 2007), as measured by various formulas for accuracy, it is evident the entire country of India is highly sustainable in yield of potato in period-2 (1998-2023) and Rajasthan is highly sustainable in yield of potato in period-2 (1998–2023).

## 3.1 Modeling and Forecasting

We employed the Box-Jenkins approach for this purpose. The model was constructed utilizing data from 1970 to 2020 and subsequently validated with data from 2020 to 2023. Predictions for future series are generated with the models that best accommodate the data. All of them lack stability, as clearly demonstrated by the ACF and PACF graphs of the original series, and first-order differencing suffices to achieve stability. ARIMA models, initiated from the model-building technique outlined in the materials and methods section, spanning from (0, 1, 0) to (1, 1, 5), are suitable for forecasting and predicting potato production behavior. Utilizing data from 1970 to 2023, the study subsequently employs the differenced series to estimate ARIMA equations for all parameters. It subsequently generates forecasts extending to 2030. Nonetheless, ACF and PACF graphs are employed to conduct diagnostic evaluations on residuals.

Fig.10 displays the ACF and PACF plot of the first difference, or the area under potato, for Rajasthan and India. These plots indicate that p=1 and q=5 for Rajasthan and p=1 and q=5 for India would be a reasonable range for the area under potato. Consequently, Table5 demonstrates the ARIMA (1,1,5) areas under potato have the highest $R^2$ value and the lowest RMSE, MAPE, MaxAE, and MAE values in India. butthe ARIMA (1,1,5) areas under potato have the highest $R^2$ value and the lowest MAPE and MAE values in Rajasthan.The projected areas for potato in Table6 demonstrate Rajasthan and India in 2023 were 13.51 thousand hectares and 2423 thousand hectares, respectively, while the actual areas were 13.60 thousand hectares and 2345.40 thousand hectares. India is predicted to have 2620 thousand hectares and Rajasthan will have 15.54 thousand hectares in 2030 respectively.Fig. 11. displays the ACF and PACF plot of the first difference, or the value of production under potato in Rajasthan and India.The ARIMA (0,1,5) and ARIMA (0,1,5) were therefore determined to be appropriate for the Production of potato in Rajasthan and India. Table5 further shows that India has the highest $R^2$ value along with the lowest values of MAPE, MaxAPE, and MAE, however, Rajasthan ARIMA (0,1,5) potato production has the highest value of $R^2$ along with the lowest values of RMSE, MAE, and MaxAE.In Table7 contrast to the predicted 274.22 thousand tones and 63318.26 thousand tones, the production of potato in Rajasthan and India in 2023 was 260.50 thousand tons and 61250.50 thousand tons, respectively. Rajasthan is predicted to produce 301.31 thousand tons, while India is forecast to produce 69806.76 thousand tons in 2030.The yield under potato in Rajasthanand India, as indicated by the ACF and PACF plot of the first difference Fig. 12. It may be concluded that ARIMA (1,1,3) and ARIMA (1,1,5) are the ARIMA models that are most suited for yield under potato in Rajasthan and India. Moreover, Table5 examination showed that while Rajasthan had the highest $R^2$ value and the lowest MAE value, India yield potato highest $R^2$ and lowest MAPE, MAE and Normalized BIC values across all of India. In

**Table 3. That Rajasthan and India exhibit distinct trends in the area, production and yield of potato, as demonstrated by the randomization test**

| Test of randomness | India | | | Rajasthan | | |
|---|---|---|---|---|---|---|
| | **Area** | **Prod** | **yield** | **Area** | **Prod** | **yield** |
| No. of Observation | 54 | 54 | 54 | 54 | 54 | 54 |
| No. of Point (p) | 21 | 27 | 29 | 24 | 17 | 27 |
| E (P) | 38.67 | 38.67 | 38.67 | 38.67 | 38.67 | 38.67 |
| V(P) | 10.34 | 10.34 | 10.34 | 10.34 | 10.34 | 10.34 |
| $t_{cal}$ | -5.49 | -3.63 | -3.01 | -4.56 | -6.74 | -3.63 |
| Inference | Trend | Trend | Trend | Trend | Trend | Trend |
| outliers Test | NO | NO | NO | NO | NO | NO |

**Table 4. Sustainability potato yield measurement**

| | India | | |
|---|---|---|---|
| **Sustainability Index** | **Period 1 (1970-1997)** | **Period 2(1998-2023)** | **Whole Period (1970-2023)** |
| SI 1 | 0.570 | **0.640** | 0.451 |
| SI 2 | 0.414 | **0.316** | 0.607 |
| SI 3 | 0.004 | **0.003** | 0.006 |
| | **Rajasthan** | | |
| SI 1 | **0.092** | 0.459 | 0.189 |
| SI 2 | 1.505 | **0.520** | 1.134 |
| SI 3 | 0.013 | **0.005** | 0.010 |

**Table 5. Different ARIMA Model for area(“000”ha), production (“000”tons), and yield(q/ha) under potato in India and Rajasthan**

| | | | | | India | | | |
|---|---|---|---|---|---|---|---|---|
| | **ARIMA** | **$R^2$** | **RMSE** | **MAPE** | **MAE** | **MaxAPE** | **MaxAE** | **Normalized BIC** |
| Area | (1,1,5) | 0.990 | 62.696 | 3.577 | 42.235 | 16.938 | 189.079 | 8.876 |
| Production | (0,1,5) | 0.978 | 2600.236 | 9.818 | 1902.447 | 39.111 | 7002.540 | 16.176 |
| Yield | (1,1,5) | 0.922 | 13.916 | 5.962 | 9.633 | 27.145 | 40.554 | 5.790 |
| | **Rajasthan** | | | | | | | |
| Area | (1,1,5) | 0.946 | 1.186 | 16.608 | 0.741 | 61.810 | 5.120 | 0.865 |
| Production | (0,1,5) | 0.930 | 26.366 | 55.422 | 14.353 | 276.300 | 91.400 | 6.994 |
| Yield | (1,1,3) | 0.852 | 23.616 | 24.279 | 15.962 | 106.590 | 71.750 | 6.698 |

**Table 6. Model Validation and forecasting of Area (000’ha) under potato in India and Rajasthan**

| | | India | |
|---|---|---|---|
| **year** | **Observed** | **Predicted** | **Prediction error percentage** |
| 2021 | 2225.75 | 2276.36 | -2.27 |
| 2022 | 2332.05 | 2352.92 | -0.89 |
| 2023 | 2345.41 | 2422.88 | -3.30 |
| 2024 | | 2413.99 | |
| 2025 | | 2487.86 | |
| 2026 | | 2474.06 | |
| 2027 | | 2559.1 | |
| 2028 | | 2547.16 | |
| 2029 | | 2628.77 | |
| 2030 | | 2620.14 | |
| **Rajasthan** | | | |
| 2021 | 14.10 | 14.71 | -4.32 |
| 2022 | 14.50 | 14.45 | 0.34 |
| 2023 | 13.60 | 13.51 | 0.66 |
| 2024 | | 14.32 | |
| 2025 | | 14.62 | |
| 2026 | | 14.59 | |
| 2027 | | 14.86 | |
| 2028 | | 15.08 | |
| 2029 | | 15.31 | |
| 2030 | | 15.54 | |

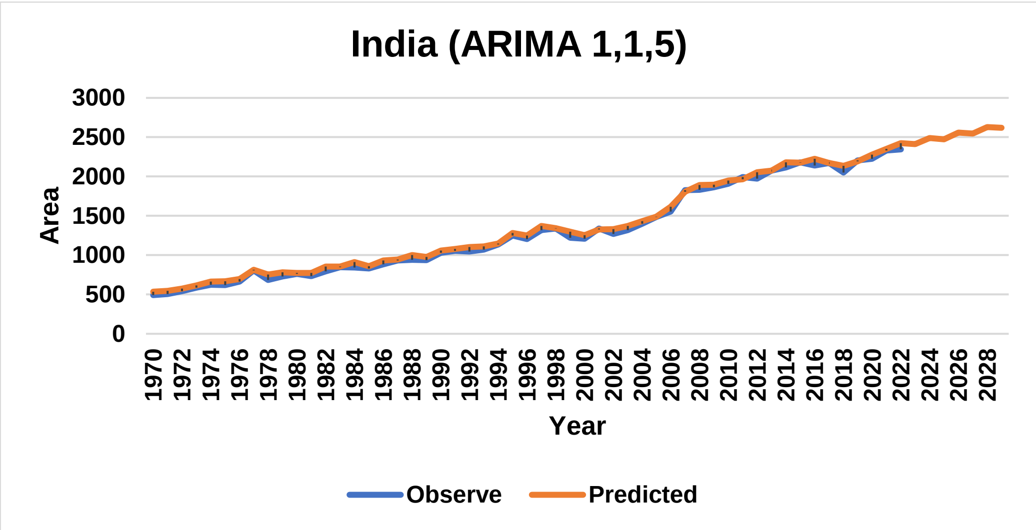
Table8 contrast to the predicted 264.13 q/ha and 191.33q/ha, the yields of India and Rajasthan in 2023 and yield in 2023 were 277.46 q/ha and 191.54q/ha, respectively. Rajasthan is anticipated to receive 209.25q/ha, while India is expected to receive 274.09 q/ha in 2030.

**Table 7. Model Validation and forecasting of Production ('000' tons) of potato in India and Rajasthan**

| | | India | |
|---|---|---|---|
| **year** | **Observed** | **Predicted** | **Prediction error percentage** |
| 2021 | 56175.75 | 57521.81 | -2.39 |
| 2022 | 59160.34 | 60571.58 | -2.38 |
| 2023 | 61250.50 | 63318.26 | -3.37 |
| 2024 | | 63527.71 | |
| 2025 | | 65419.16 | |
| 2026 | | 65502.66 | |
| 2027 | | 67459.86 | |
| 2028 | | 67654.86 | |
| 2029 | | 69589.11 | |
| 2030 | | 69806.76 | |
| **Rajasthan** | | | |
| 2021 | 258.20 | 264.65 | -2.49 |
| 2022 | 262.50 | 270.85 | -3.18 |
| 2023 | 260.50 | 274.22 | -5.26 |
| 2024 | | 281.81 | |
| 2025 | | 280.31 | |
| 2026 | | 285.88 | |
| 2027 | | 286.75 | |
| 2028 | | 291.61 | |
| 2029 | | 296.46 | |
| 2030 | | 301.31 | |

**Table 8. Model Validation and forecasting of Yield (q/ha) under potato in India and Rajasthan**

| | | India | |
|---|---|---|---|
| **year** | **Observed** | **Predicted** | **Prediction error percentage** |
| 2021 | 252.40 | 249.62 | 1.10 |
| 2022 | 273.56 | 265.24 | 3.04 |
| 2023 | 277.46 | 264.13 | 4.80 |
| 2024 | | 267.81 | |
| 2025 | | 261.24 | |
| 2026 | | 262.94 | |
| 2027 | | 264.48 | |
| 2028 | | 268.45 | |
| 2029 | | 270.55 | |
| 2030 | | 274.09 | |
| | | **Rajasthan** | |
| 2021 | 183.12 | 185.62 | -1.36 |
| 2022 | 181.03 | 183.85 | -1.55 |
| 2023 | 191.54 | 191.33 | 0.10 |
| 2024 | | 194.04 | |
| 2025 | | 195.98 | |
| 2026 | | 198.26 | |
| 2027 | | 200.79 | |
| 2028 | | 203.5 | |
| 2029 | | 206.33 | |
| 2030 | | 209.25 | |



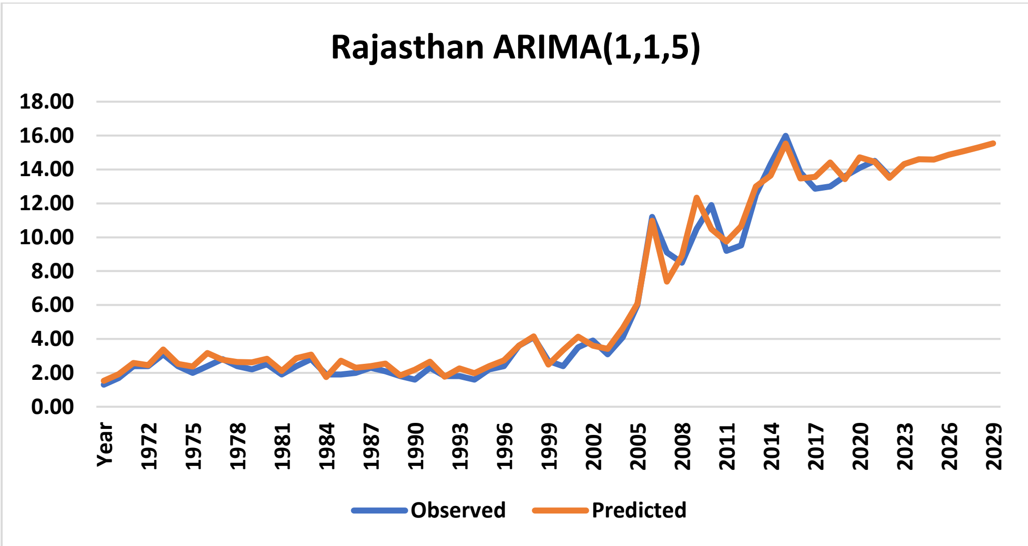
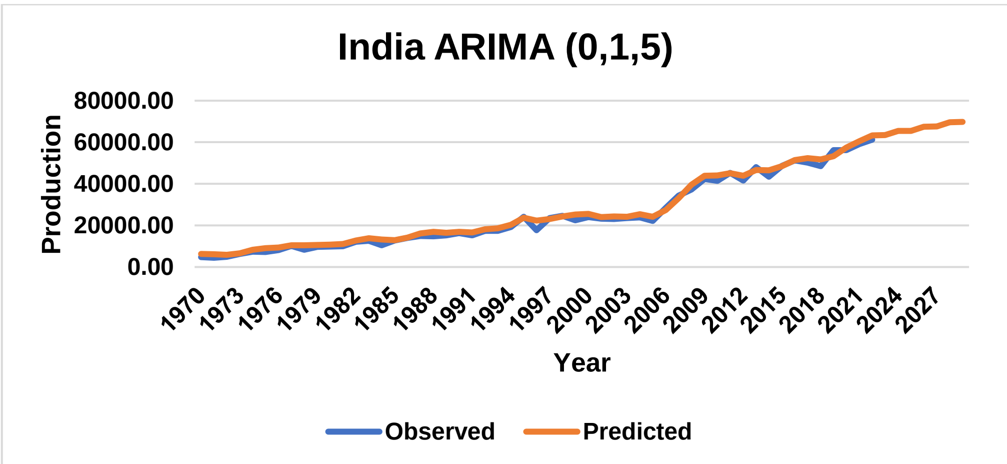




**Fig. 7. Observed and Predicted Area (000'ha) under potato in India and Rajasthan**



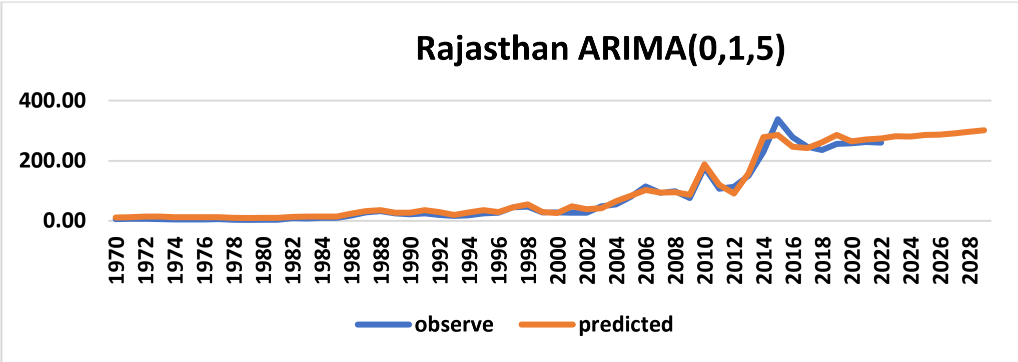



Fig. 8. Observed and Predicted of Production (‘000’ tons)of potato in India and Rajasthan

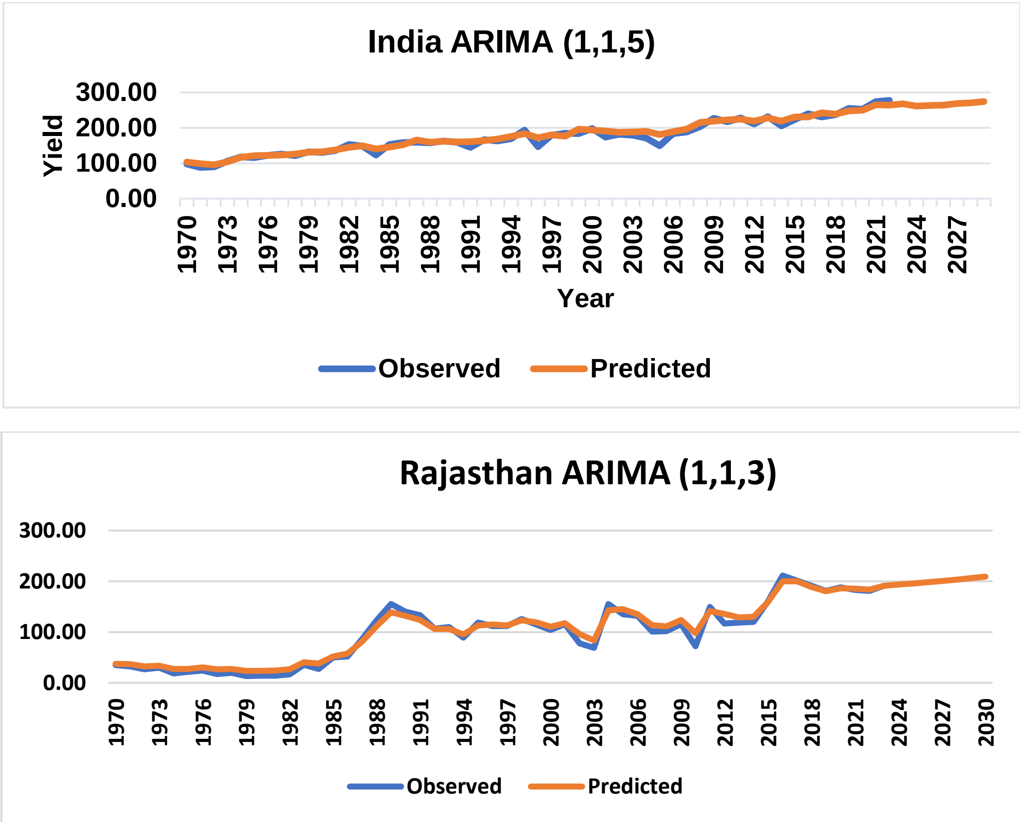
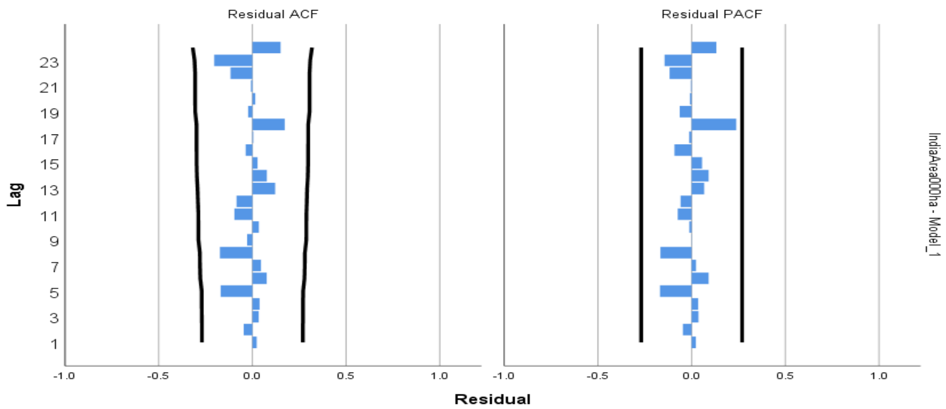



Fig. 9. Observed and Predicted of Yield (q/ha) under potato in India and Rajasthan



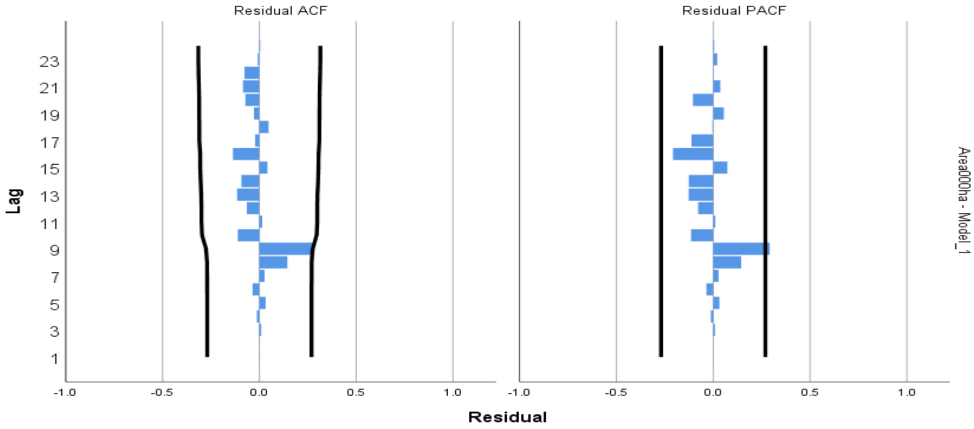



**Fig. 10. ACF and PACF graphs of residuals for the best-fitted models of Area under Potato in India and Rajasthan**

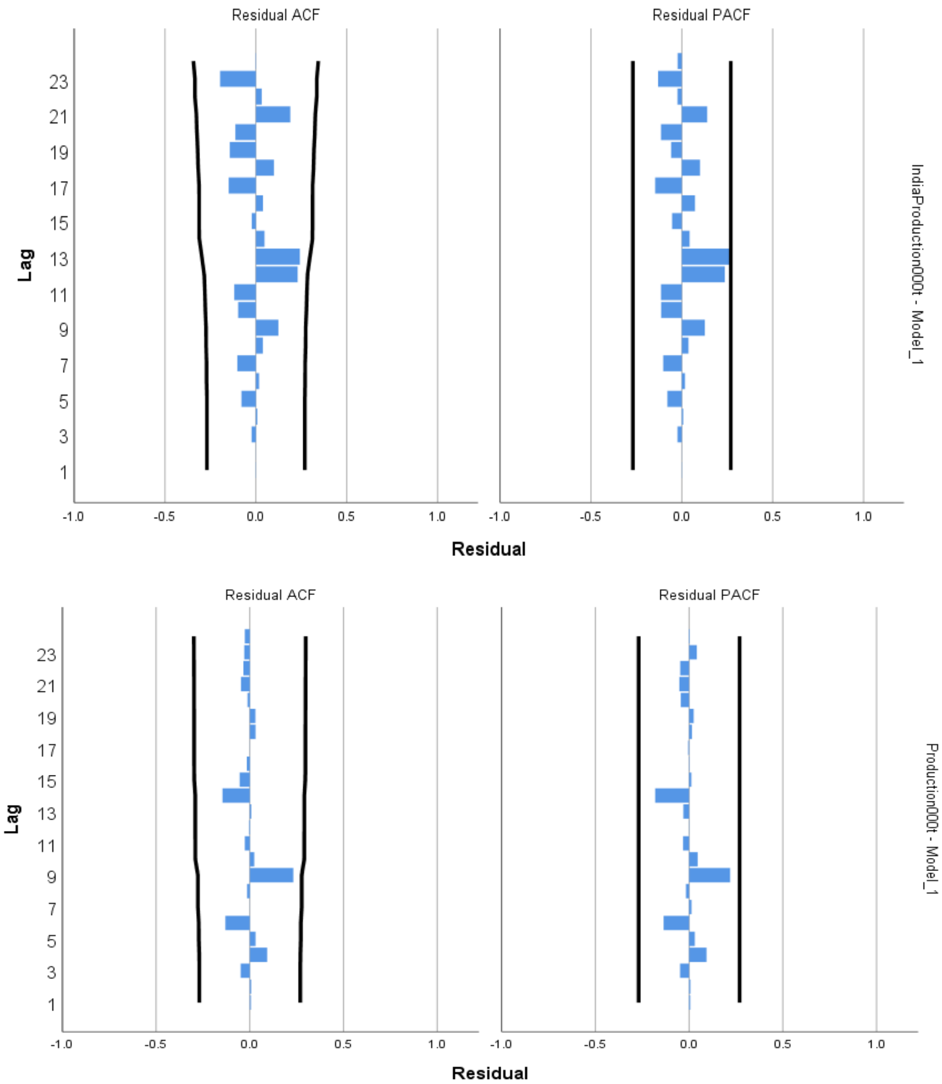



**Fig. 11.ACF and PACF graphs of residuals for the best-fitted models of Production under potato in India and Rajasthan**

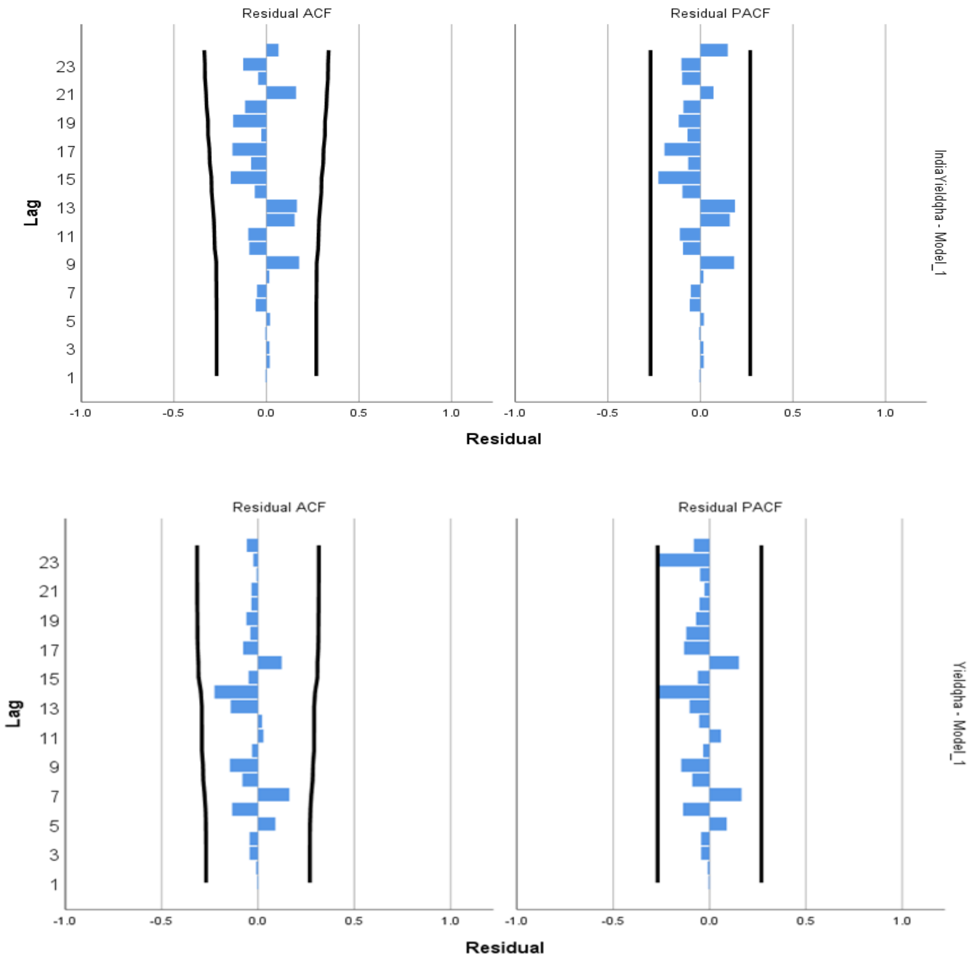



**Fig. 12. ACF and PACF graphs of residuals for the best-fitted models of Area under potato in India and Rajasthan**

## 4. CONCLUSION

The potato is the preeminent horticultural crop, yielding the most nutritional and dry matter output per unit area and time. It is the fundamental crop globally for sustenance. This study, spanning from 1970 to 2023, has examined potato acreage, output, and productivity in Rajasthan and India using a forecasting-based Box-Jenkins methodology after assessing the trend for each individual series. The trend of potato production indicates substantial increases in area, output, and productivity. The analysis reveals a cubic trend in the acreage, output, and productivity of potatoes in India and Rajasthan.Sustainability analysis is employed for future crop enhancement planning. The ARIMA models best appropriate for potato yield in Rajasthan would increase. anticipated to receive 209.25q/ha, while India would be expected to receive 274.09 q/ha in 2030.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

Devi, M., Kumar, J., Malik, D. P., & Mishra, P. (2021). An inter-district analysis of instability and sustainability for major crops in Haryana. *Economic Affairs, 66*(2), 217–223.

Kumari, P., Vekariya, P., Kujur, S. N., Macwan, J., & Mishra, P. (2024). Predicting potato prices in Agra, UP, India: An H2O AutoML approach. *Potato Research*, 1–16. https://doi.org/10.1007/s11540-024-09726-z

Mishra, P., Alhussan, A. A., Khafaga, D. S., Lal, P., Ray, S., Abotaleb, M., ... & El-Kenawy, E. S. M. (2024). Forecasting production of potato for a sustainable future: Global market analysis. *Potato Research*, 1–20. https://doi.org/10.1007/s11540-024-09717-0

Mishra, P., Ghazi Al Khatib, A. M., Lal, P., Anwar, A., Nganvongpanit, K., Abotaleb, M., Ray, S., &Punyapornwithaya, Y. (2023). An overview of pulses production in India: Retrospect and prospects of the future food with an application of hybrid models. *National Academy Science Letters, 10*(2), 1267–1276.

Mishra, P., Sahu, P. K., Dhekale, B. S., & Vishwajith, K. P. (2015). Modelling and forecasting of wheat in India and their yield sustainability. *Indian Journal of Economic Development, 11*(3), 637–647.

Mishra, P., Sahu, P. K., Padmanaban, K., Vishwajith, K. P., &Dhekale, B. S. (2015). Study of instability and forecasting of food grain production in India. *International Journal of Agriculture Sciences, 7*(3), 474–481.

Pal, S., & Sahu, P. K. (2007). On assessment of sustainability of crops and cropping system—Some new measures. *Journal of Sustainable Agriculture, 31*(3), 43–54.

Sahu, P. K., Das, M., Sarkar, B., VS, A., Dey, S., Narasimhaiah, L., ... & Raghav, Y. S. (2024). Potato production in India: A critical appraisal on sustainability, forecasting, price, and export behaviour. *Potato Research*, 1–37. https://doi.org/10.1007/s11540-023-09682-0

Sahu, P. K., Kundu, A. L., Mani, P. K., &Pramanicl, M. (2005). Sustainability of different nutrient combinations in a long-term rice-wheat cropping system. *Journal of New Seeds, 7*(3), 91–101.

Singh, R. P., Das, S. K., Bhaskara, R. U. M., & Reddy, N. M. (1990). Towards sustainable dryland agricultural practices. *Technical Bulletin, Central Institute for Dryland Agriculture*, Hyderabad, India, 1–81.

Vishwajith, K. P., Sahu, P. K., Mishra, P., Dhekale, B. S., & Upadhyay, N. (2018). Crop yield sustainability: A few measures. *Journal of Pharmacognosy and Phytochemistry, Special Issue*(2), 247–253.

Yadav, S., Al Khatib, A. M. G., Alshaib, B. M., Ranjan, S., Kumari, B., Alkader, N. A., ... & Kapoor, P. (2024). Decoding potato power: A global forecast of production with machine learning and state-of-the-art techniques. *Potato Research*, 1–22. https://doi.org/10.1007/s11540-024-09705-4



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