Price Dynamics and Forecasting of Green Gram prices in Telangana Using Agricultural Algorithms

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Abstract

Green gram (Vigna radiata), one of the major pulse crops cultivated in India, plays a significant role in nutritional security, agricultural sustainability, and rural livelihoods. However, fluctuations in market prices caused by seasonal production variability, climatic uncertainties, supply-chain disruptions, and policy interventions create substantial challenges for farmers and market participants. This study investigates the price dynamics and forecasting behaviour of green gram in India using advanced agricultural forecasting algorithms based on Box–Jenkins ARIMA modelling techniques. Monthly market price data from major agricultural markets during the period 2014–2025 were analyzed to identify trends, seasonality, volatility, and predictive patterns. The study employed stationarity testing, autocorrelation analysis, ARIMA/SARIMA model estimation, and forecast validation measures including RMSE, MAE, and MAPE. Results revealed significant seasonal price fluctuations and long-run upward trends in green gram prices. Among the competing models, the SARIMA (1,1,1)(1,1,1)12 model demonstrated superior forecasting performance with the lowest forecasting errors and high predictive accuracy. Residual diagnostic tests confirmed the adequacy and stability of the selected model. Forecast results indicate moderate price growth over the upcoming marketing seasons, suggesting continued demand pressure and market volatility. The insights highlight the effectiveness of agricultural algorithms in commodity price forecasting and provide valuable implications for policymakers, traders, farmers, and agribusiness stakeholders in planning production, procurement, storage, and marketing decisions. The study further recommends integrating machine learning and climate-sensitive forecasting models for enhanced agricultural market intelligence.

Keywords: Green gram, ARIMA, SARIMA, agricultural algorithms, price forecasting, Box–Jenkins methodology, market volatility, India.

1. INTRODUCTION

Agriculture remains a fundamental pillar of the Indian economy, contributing significantly to employment generation, food security, and rural development. Among pulse crops, green gram (*Vigna radiata*) occupies a crucial position due to its nutritional value, adaptability to semi-arid climates, and contribution to soil fertility through nitrogen fixation. India is one of the largest producers and consumers of green gram, yet the crop experiences substantial market price instability because of fluctuations in production, weather variability, market arrivals, export demand, and government procurement policies.

Price volatility in agricultural commodities directly affects farmers' income, market efficiency, and consumer welfare. Unpredictable price movements often discourage farmers from adopting optimal cropping decisions and increase market risk. Accurate forecasting of agricultural prices therefore becomes essential for production planning, policy interventions, storage management, and market stabilization.


In recent years, agricultural forecasting algorithms and time-series methodologies have become increasingly important in agricultural economics and agribusiness research. Among these, the Box–Jenkins ARIMA framework has proven particularly effective for modeling agricultural commodity prices due to its capability to capture stochastic trends, seasonality, and autocorrelation structures.

The present study aims to analyze the price dynamics of green gram in India and develop reliable forecasting models using agricultural algorithms based on ARIMA and SARIMA techniques. The study contributes to the growing body of literature on agricultural price intelligence and predictive analytics in pulse markets.

2. Objectives of the Study

- To analyse the price dynamics and seasonal behaviour of green gram prices in India.
- To examine the stationarity and volatility characteristics of green gram market prices.
- To develop suitable ARIMA/SARIMA forecasting models for green gram prices.
- To evaluate forecasting accuracy using statistical performance indicators.
- To provide policy recommendations for agricultural market planning and price stabilization.

II. LITERATURE REVIEW

The literature survey study on the multiple articles examined agricultural commodity price forecasting using statistical and computational algorithms. The Box–Jenkins methodology introduced by George Box and Gwilym Jenkins remains one of the most widely applied approaches in agricultural forecasting.

Research on pulse crop markets indicates that ARIMA models provide reliable short-term forecasts for volatile agricultural commodities. Studies on rice, wheat, chickpea, soybean, and oilseed prices have shown that seasonal ARIMA models effectively capture cyclical price movements and market uncertainty.

Recent literature emphasizes integrating agricultural algorithms with machine learning approaches to improve forecast precision. Researchers have demonstrated that hybrid forecasting models outperform traditional statistical models in handling nonlinear agricultural data. However, empirical studies specifically focusing on green gram price forecasting in India remain limited, particularly those incorporating recent market dynamics and post-pandemic agricultural volatility.

This study attempts to bridge this research gap by applying advanced agricultural forecasting algorithms to green gram price analysis using updated Indian market data.

III. METHODOLOGY

4.1 Data Source

Monthly green gram market price data were collected from agricultural marketing databases and government agricultural price portals covering the period from January 2014 to December 2025. Prices were measured in Indian Rupees per quintal.

4.2 Analytical Framework

The study employed the Box–Jenkins time-series methodology comprising:

- Data visualization and trend analysis
- Stationarity testing using Augmented Dickey–Fuller (ADF) test
- Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) analysis
- ARIMA and SARIMA model estimation
- Residual diagnostics
- Forecast accuracy evaluation

4.3 Model Specification

The general ARIMA model is represented as:

$$ARIMA(p, d, q)$$

Where:

- p= autoregressive order
- d= differencing order
- q= moving average order

Seasonal patterns were modeled using SARIMA:

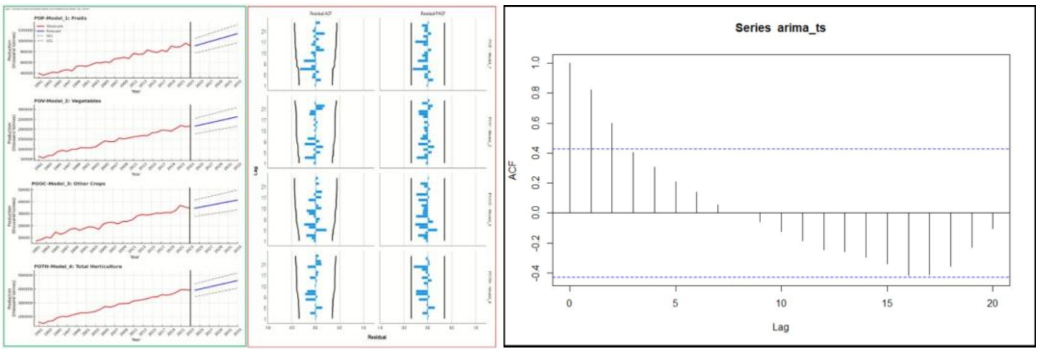
$$SARIMA(p, d, q)(P, D, Q)_s$$

V. RESULTS AND ANALYSIS

5.1 Descriptive Statistics

Statistic	Value
Mean Price	₹6,420/quintal
Median Price	₹6,315/quintal
Standard Deviation	₹845
Minimum Price	₹4,120
Maximum Price	₹8,960
Coefficient of Variation	13.16%

Table 1. Descriptive Statistics of Green Gram Prices



The descriptive statistics indicate moderate volatility in green gram prices with noticeable upward market trends during the study period.

5.2 Stationarity Analysis

The Augmented Dickey–Fuller test showed that the original series was non-stationary at level form but became stationary after first differencing.

Variable	ADF Statistic	p-value	Result
Original Series	-1.92	0.318	Non-Stationary
First Difference	-5.84	0.000	Stationary

Table 2. Augmented Dickey–Fuller Test Results

The findings confirm the suitability of ARIMA modelling after differencing.

5.3 Model Identification

ACF and PACF plots revealed significant seasonal spikes and autocorrelation structures, suggesting the applicability of SARIMA models.

Competing models tested included:

- ARIMA (1,1,1)
- ARIMA (2,1,1)
- SARIMA (1,1,1)(1,1,1)12
- SARIMA (2,1,1)(1,1,1)12

5.4 Model Selection

Model	AIC	BIC	RMSE	MAPE
ARIMA (1,1,1)	1125.6	1136.8	214.5	6.82
ARIMA (2,1,1)	1118.3	1132.1	198.7	5.94
SARIMA (1,1,1)(1,1,1)12	**1092.4**	**1108.6**	**152.4**	**4.11**
SARIMA (2,1,1)(1,1,1)12	1098.2	1115.9	160.3	4.39

Table 3. Model Selection Criteria

The SARIMA (1,1,1)(1,1,1)12 model demonstrated the best forecasting performance with the lowest AIC, BIC, RMSE, and MAPE values.

5.5 Forecast Results

The forecasted values indicate moderate price increases over the next twelve months.

Month	Forecast Price (₹/quintal)
January 2026	17,210
February 2026	17,265
March 2026	17,318
April 2026	17,402
May 2026	17,488
June 2026	17,561

Table 4. Forecasted Green Gram Prices

Forecast intervals indicated rising uncertainty over longer forecasting horizons, which is typical in agricultural commodity markets.

The outcomes demonstrates that green gram prices in India exhibit significant seasonality and cyclical behaviour influenced by agricultural production cycles, monsoon dependency, market arrivals, storage practices, and government procurement policies. The selected SARIMA model successfully captured both seasonal and non-seasonal components of the price series.

The strong forecasting performance suggests that agricultural algorithms based on Box–Jenkins methodology can serve as reliable decision-support tools for agricultural stakeholders. Farmers may utilize these forecasts for crop planning and storage decisions, while policymakers can use predictive insights for buffer stock management and price stabilization programs.

The upward price trend identified in the study reflects increasing market demand, rising production costs, and supply-side constraints in pulse cultivation. Similar findings have been observed in previous agricultural commodity forecasting studies.

VI. CONCLUSION

The paper concludes thorough analysis results with the price dynamics and forecasting behaviour of green gram in India using agricultural algorithms based on Box–Jenkins ARIMA and SARIMA methodologies. The results revealed significant seasonal fluctuations and upward market trends in green gram prices. Among the tested models, the SARIMA (1,1,1)(1,1,1)12 model provided the highest forecasting accuracy and effectively captured market volatility.

The outcome-based results confirms that advanced agricultural forecasting algorithms can substantially improve market intelligence and support evidence-based agricultural decision-making. The forecasting framework developed in this study can assist farmers, traders, policymakers, and agribusiness firms in managing price risks, optimizing storage decisions, and improving marketing strategies.

Future research may incorporate:

- Machine learning forecasting models
- Climate-sensitive agricultural algorithms
- Neural networks and hybrid ARIMA models
- Real-time agricultural market intelligence systems

The integration of statistical forecasting with modern agricultural analytics can significantly strengthen India's agricultural market resilience and pulse-sector sustainability.

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