



Assessing the dynamics of agricultural and price trends of geographical indication (GI) tagged Guntur Sannam chilli in Andhra Pradesh, India

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Geographical indication (GI) tagging has emerged as a crucial tool for safeguarding the authenticity of region-specific agricultural products and enhancing their market potential. In India, GI-tagged products hold significant cultural and economic value, and one notable example is the Guntur Sannam chilli, native to Andhra Pradesh's Guntur district (Sharma 2019). Renowned for its distinctive flavour, pungency, and versatility, Guntur Sannam chilli plays a vital role in the region's agricultural landscape and economy. It serves as a staple in local cuisine and a major export commodity, contributing substantially to the local agrarian economy. The GI tag for Guntur Sannam chilli, awarded in recognition of its unique qualities and adherence to traditional agricultural practices, also reflects the region's rich cultural heritage and agricultural expertise. Kishore (2018) underscored the importance of public institutions in securing GI tags under the TRIPS Agreement to bolster the market potential of traditional products. GI recognition not only helps protect the product from imitations but also enhances its global visibility, meeting the rising international demand for authentic, region-specific spices.

In the 2022–23 season, Guntur Sannam chilli production reached approximately 160,000 metric tonnes, cultivated over 27,000 ha across key regions such as Guntur, Tenali, Bapatla, Mangalagiri, and Sattenapalli. Of this, around 120,000 metric tonnes were consumed domestically due to the chilli's widespread use in Indian and Asian cuisines, while nearly 30% of the production underwent value-added processing, further boosting its market value. The chilli's production and market dynamics have evolved considerably over the past three decades, influenced by

changing agricultural practices, climate variability, market demand, and policy interventions. These factors have collectively impacted the cultivated area, yield efficiency, and overall production volume. However, price trends for Guntur Sannam chilli have exhibited significant volatility, driven by factors such as domestic and international demand fluctuations, supply chain disruptions, rising production costs, and broader economic conditions. Devi *et al.* (2015) highlighted the escalating costs of cultivation and underscored the importance of analyzing the price spread to understand disparities between farmgate and market prices. Srikala *et al.* (2016) presented findings on chilli cultivation costs per hectare in Andhra Pradesh from 2005–06 to 2010–11, revealing an escalation in operational and total expenses over the period. Given these dynamics, it is essential to assess how GI tagging has affected the area, production, and productivity of Guntur Sannam chilli and to estimate the associated price trends and volatility. Therefore, this study aims to provide a comprehensive analysis of the agricultural and price trends of GI-tagged Guntur Sannam chilli in Andhra Pradesh. It seeks to evaluate the changes in area, production, and productivity following the GI tag, as well as to estimate price trends and volatility to understand the broader market dynamics. These insights are critical for developing strategies to mitigate the effects of price fluctuations, ensure sustainable production, and promote economic viability for farmers.

Present study was carried during 2024 at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu to analyse 30 years of data (1993–94 to 2022–23) regarding Guntur Sannam chilli from the Guntur district of Andhra Pradesh, focusing on area, production, productivity, and pricing. Secondary data on cultivation area, production levels, and productivity were sourced from Acharya N G Ranga Agricultural University, while price information was obtained from the Agricultural Market Committee of Guntur. The methodology involved calculating compound growth rates (CGR) to evaluate changes over the three-decade period. ARCH-GARCH models were utilized to

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assess price volatility, and the VAR model was employed to explore the relationship between historical and current prices, offering insights into price dynamics and market stability.

Compound growth rate: The study examined growth in area, production, and productivity using the exponential growth function: $Y_t = a b^t u_t$, converted to a logarithmic-linear format for analysis. The CGR in percentage was calculated using the formula:

$$\text{CGR} = (\text{Antilog of } b-1) \times 100$$

where Y_t , Area, production, or productivity of Guntur Sannam Chilli; a , Intercept; b , regression coefficient; t , Time variable, taking values 1, 2, ..., n ; u_t , Disturbance term for the year t .

Augmented Dickey-Fuller (ADF) test: The ADF test ensured the stationarity of price data, crucial for reliable statistical analyses. Thus, formulated the ADF regression model:

$$\Delta Y_t = \alpha + \beta_t + \gamma Y_{t-1} + \sum \delta_i \Delta Y_{t-1} + \varepsilon_t$$

where Δ , First difference operator; t , Time trend; p , Number of lags; ε_t , Error term.

Then, estimated the regression model. Taken the first difference of the time series data. Later tested the significance of γ .

ARCH-GARCH test: ARCH-GARCH models were employed to capture price volatility, addressing volatility clustering common in financial and commodity time-series datasets. The process commenced with the calculation of log returns from price data as:

$$r_t = \log(P_t / P_{t-1})$$

where P_t , Price at time t . Later, the ARCH model was extended to a GARCH (p, q) model, incorporating past conditional variances formulated as:

$$\sigma_t^2 = \alpha_0 + \sum \alpha_i \varepsilon_{t-i}^2 + \sum \beta_j \varepsilon_{t-j}^2$$

where σ_t^2 , Conditional variance of prices; $\varepsilon_{t-1}^2, \varepsilon_{t-2}^2$, past errors at time $t-1$ and so on.

VAR estimation test: The VAR model examined the relationship between past and current prices, providing insights into price formation and market stability. The general form of the VAR model is:

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + \varepsilon_t$$

where Y_t , Vector of endogenous variables (including prices); A_i , Coefficient matrices; ε_t , Vector of error terms.

Compound growth rate of area, production, and productivity estimation: The CGR analysis of Guntur Sannam chilli provides a detailed understanding of its long-term growth patterns. Over a 30-year period, data on the area, production, and productivity were examined, excluding outlier years (Fig. 1). The results indicated

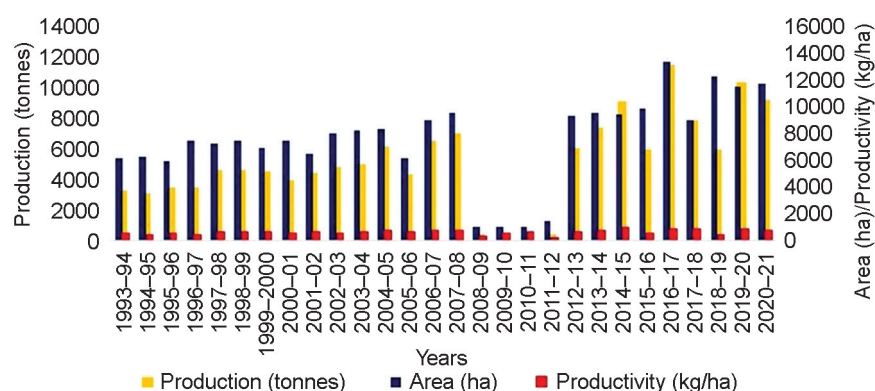


Fig. 1 Trend in area, production and productivity of Guntur Sannam chilli (1993-94 to 2020-21).

significant growth following the GI tag awarded in 2009. The area under cultivation exhibited a CGR of 0.99%, reflecting steady expansion driven by favourable land availability. The production CGR was 2.07%, reflecting increased market demand, while the productivity CGR, at 1.06%, showed slower improvement due to challenges in resource use and environmental factors like pests and diseases. All growth rates were statistically significant at the 1% level. A comparison of pre- and post-GI tagging revealed notable improvements: before GI status, area, production, and productivity grew at 2.28%, 4.87%, and 2.52% per annum, respectively. Post-GI, the growth rates surged to 26.25% for area, 33.27% for production, and 5.56% for productivity, highlighting the GI certification's positive impact on cultivation practices and market demand.

Previous studies by Ashoka *et al.* (2013) and Sathish *et al.* (2017) explored similar trends in chilli cultivation, while Kala *et al.* (2020) observed positive growth in green chilli production in Jaipur, despite declining productivity. At the state level, Rajasthan's green chilli area and production showed significant growth, though productivity slightly decreased. Similarly, Bindu and Nayak (2021) reported positive growth in Bellary's dry chilli cultivation, while other regions experienced declines. Sonnad *et al.* (2011) noted growth in oilseed crops, while Acharya *et al.* (2012) found mixed trends across various crops, including pulses and spices.

Augmented Dickey-Fuller (ADF) test estimation: The ADF test confirmed the stationarity of the second-difference modal price data for Guntur Sannam chilli over 30 years, ensuring reliable statistical modeling. A strong negative correlation between current and lagged price differences supported data stationarity (Fig. 2), and further insights are provided in Table 1.

Similar stationarity assessments were conducted by Chiphang (2017) in evaluating crude oil price impacts on Indian agriculture, and by Saha *et al.* (2019) using the ADF and Phillips-Perron tests, both of which achieved stationarity at the first difference. Paul *et al.* (2016) initially found non-stationarity in their datasets but corrected it through seasonal adjustments and differencing. Kumari *et al.* (2019) also found evidence of a unit root after applying

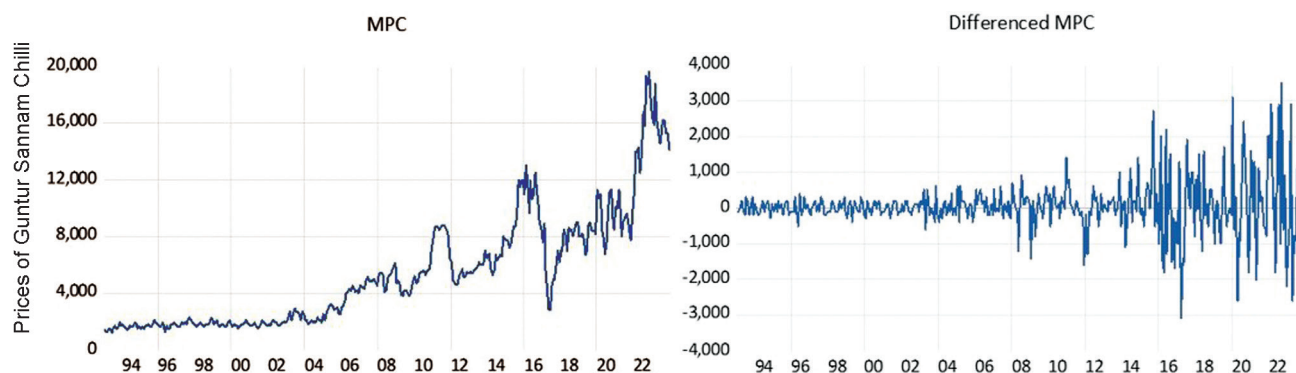


Fig. 2 Non-stationarity and stationarity of prices data of Guntur Sannam chilli (1993–94 to 2022–23).

Table 1 Summary of augmented Dickey-Fuller test of Guntur Sannam chilli prices

Variable	Coefficient	Std. Error	t-statistic	Prob.
D (MPC (-1))	-1.0668	0.0521	-20.4389	0
C	37.1063	39.5825	0.9374	0.3491

differencing at a lag of 1, which corroborates the reliability of ADF testing for various datasets.

ARCH-GARCH Test Estimation: The ARCH-GARCH model revealed significant price volatility for Guntur Sannam Chilli over 30 years, with clear spikes in price post-GI certification (Fig. 3). The model showed that past squared residuals (Table 2) had a significant influence on present price volatility, indicating that volatility dynamics are crucial for risk management. The results highlighted the need for improvements in cold storage and export infrastructure to stabilize prices.

Singh *et al.* (2022) identified the ARCH family model as the most effective for assessing primary market volatility, which showed notable price instability. Shivakumar and

Uma (2020) also applied the GARCH (1, 1) model to examine volatility in green gram markets across India, revealing consistent fluctuations. Nugrahapsari *et al.* (2018) found low volatility in markets driven by stable demand and supply, while Lestari *et al.* (2022) reported high price volatility in red chilli markets due to factors like climate change and seasonal demand surges. Rahman *et al.* (2024) further noted significant price volatility in Big Red and Red Cayenne Chillies, forecasting a downward trend in prices.

Vector Auto-Regression (VAR) estimation: VAR analysis for Guntur Sannam chilli indicated minimal impact of past prices on current prices (Table 3), largely due to high volatility levels.

Bhardwaj *et al.* (2015) found that the VAR model can predict mustard prices based on lagged market arrivals and price data. In contrast, Handique (2020) reported that technological advancements significantly affect agricultural production in the long term, but show minimal influence in the short term. Efendi *et al.* (2024) observed that in Cayenne pepper markets, past prices had a stronger influence on current prices, demonstrating a more direct

Table 2 Summary of Arch-Garch test of Guntur Sannam chilli prices

Variable	Coefficient	Std. Error	z-statistic	Prob.
C	88514.21	49775.24	1.7782	0.0754
RESID (-1) ²	0.8912	0.2566	3.4729	0.0005
GARCH (-1)	0.1507	0.1156	1.3029	0.1926

Table 3 Summary of Vector Auto-regression estimation test of Guntur Sannam chilli prices

Vector Auto-regression estimation test		t-statistic
D (MPC (-1))	-0.0656	-1.2507
D (MPC (-2))	0.0191	0.3659
C	36.7936	0.9160

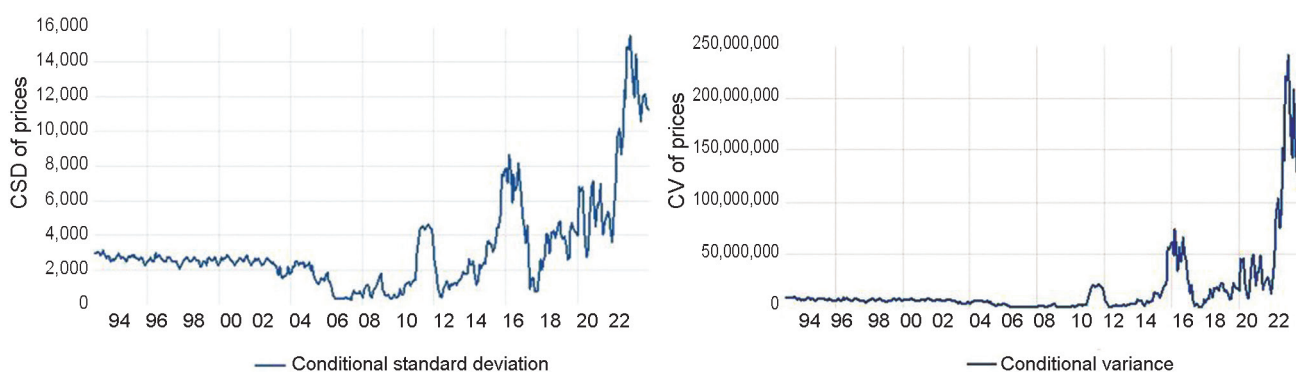


Fig. 3 Volatility of prices of Guntur Sannam chilli under conditional standard.

price relationship than seen in Guntur Sannam chilli markets.

SUMMARY

Present study examines Guntur Sannam chilli, a crucial agricultural product in Andhra Pradesh, revealing notable increases in cultivation area and production based on 30 years of data (1993–94 to 2022–23) attributed to technological advancements and better land management, after GI registration. However, the growth in productivity was slower, potentially due to various limitations. The analysis employed ARCH-GARCH and VAR models to explore price volatility, underscoring the significance of historical price trends, showing hike in prices of Guntur Sannam chilli, after attaining GI tag; for effective risk management. Despite observed fluctuations, the overall market conditions appear relatively stable. Policy recommendations emphasize targeted interventions aimed at enhancing productivity, addressing existing constraints, and stabilizing prices, thereby laying a solid foundation for informed policymaking and future research in this domain.

REFERENCES

- Acharya S P, Basavaraja H, Kunjal L, Mahajanashetti S and Bhat A. 2012. Growth in area, production and productivity of major crops in Karnataka. *Karnataka Journal of Agricultural Sciences* **25**(4): 431–36.
- Ashoka N, Kuldeep C, Ramachandra V and Yeledhalli R. 2013. A study on growth, instability and direction of chilli trade in India. *Journal of Spices and Aromatic Crops* **22**(1): 76–80.
- Bhardwaj S, Paul R K and Singh K. 2015. Price forecast an instrument for improvement in agricultural production and marketing in rajasthan-a case study of rape and mustard seeds. *Indian Journal of Agricultural Marketing* **29**(2): 155–63.
- Bindu H and Nayak M. 2021. Growth and instability in area, production and productivity of dry chilli in Karnataka. *The Pharma Innovation Journal* **SP-10**(10): 43–48.
- Chiphang S. 2017. Does Crude oil price effects Indian agriculture? A Co-integration Test. *Indian Journal of Economics and Development* **13**(3): 586–89.
- Devi I B, Srikala M and Ananda T. 2015. Price volatility in major chilli markets of India. *Indian Journal of Economics and Development* **3**(3): 194–98.
- Efendi A, Mursityo Y T, Hidajati N W, Andajani N, Zuraidah Z and Handoyo S. 2024. Multiple time series modeling of autoregressive distributed lags with forward variable selection for prediction. *WSEAS Transactions on Business and Economics* **21**: 1012–26.
- Handique C. 2020. Relationship between technological advancement and agricultural production: Evidence from India. *International Journal of Recent Technology and Engineering* **8**(6): 2088–94.
- Kala S, Jain S and Shekhawat P. 2020. Growth trends of green chilli in Jaipur district and state of Rajasthan. *Economic Affairs* **65**(3): 459–63.
- Kishore K. 2018. Geographical indications in horticulture: An Indian perspective. *Journal of Intellectual Property Rights* **23**: 159–66.
- Kumari R V, Venkatesh P, Ramakrishna G and Sreenivas A. 2019. Chilli price forecasting using auto regressive integrated moving average (ARIMA). *International Research Journal of Agricultural Economics and Statistics* **10**(2): 290–95.
- Lestari E P, Prajanti S D W, Wibawanto W and Adzim F. 2022. ARCH-GARCH analysis: An approach to determine the price volatility of red chili. *AGRARIS: Journal of Agribusiness and Rural Development Research* **8**(1): 90–105.
- Nugrahapsari R and Arsanti I. 2018. Analyzing curly chili price volatility in Indonesia using the ARCH GARCH approach. *Jurnal Agro Ekonomi* **36**(1): 25–37.
- Paul R K, Rana S and Saxena R. 2016. Effectiveness of price forecasting techniques for capturing asymmetric volatility for onion in selected markets of Delhi. *The Indian Journal of Agricultural Sciences* **86**(3): 303–09.
- Rahman I A, Siregar P S G and Suharsih S. 2024. Analysis of the potential and volatility of big chili and cayenne chili after covid-19 in Yogyakarta city. *International Journal of Multidisciplinary Innovation and Research Methodology* **3**(3): 64–79.
- Saha N, Kar A, Jha G K, Kumar P and Venkatesh P. 2019. A study of market integration of tomato in four major markets in India. *Indian Journal of Extension Education* **55**(4): 128–32.
- Sathish G, Supriya K, Bhawe M and Laha S. 2017. An analysis of growth rate and trend of chilli in Telangana. *International Journal of Research in Applied, Natural and Social Sciences* **5**(7): 113–20.
- Sharma S. 2019. Geographical indication in India: Current scenario and their product distribution. *International Journal of Social Science and Economic Research* **4**(4): 2792–2806.
- Shivakumar K M and Uma G M. 2020. An econometric analysis of markets for pulses: A case study of greengram. *Indian Journal of Economics and Development* **16**(4): 559–64.
- Singh P, Guleria C and Vaidya M. 2022. Market integration and price volatility in tea market of India. *Indian Journal of Ecology* **49**(6): 2364–69.
- Sonnad J, Raveendaran N, Ajjan N and Selvaraj K. 2011. Growth analysis of oilseed crops in India during pre and post-WTO periods. *Karnataka Journal of Agricultural Sciences* **24**(2): 184–87.
- Srikala M, Devi I B, Subramanyam V and Ananda T. 2016. Cost of cultivation and price spread of chillies in Guntur district of Andhra Pradesh. *International Journal of Agriculture, Environment and Biotechnology* **9**(2): 299–303.