Environment and Ecology 43 (1A) : 195—201, January—March 2025
Article DOI: https://doi.org/10.60151/envec/BFDF6265
ISSN 0970-0420

Trend, Instability and Relative Contribution of Turmeric Production in Andhra Pradesh

Mahima Priyanka Neerugatti, R. R. Kushwaha, Anil Kumar, Supriya, Vishal Mehta

Received 11 December 2024, Accepted 7 February 2025, Published on 26 February 2025

ABSTRACT

This study investigates the trends, instability, and decomposition analysis of the area, production, and yield of turmeric in Andhra Pradesh, over the last 70 years from 1954 to 2023. Using secondary data, collected information from indiastat (www.indiastat.com). From result parametric trend models revealed a quadratic pattern, with an R^2 of 0.748, 0.787, and 0.768 for area, production, and yield, respectively, indicating a diminishing growth rate in recent years. Decomposition analysis showed that during the entire study period, area expansion accounted for 294.31% of production changes, while yield contributions were -450.87%, highlighting the dominant role of land use in shaping production trends. Instability analysis using the modified Cuddy and Della method revealed substantial variability, with coefficients of variation around the trend being highest for production (76.698), followed by area (49.004) and yield (36.609). These findings highlight significant fluctuations in turmeric production, particularly post-2014 bifurcation, driven by land-use changes and inconsistent yield trends. The study underscores the need for targeted strategies to stabilize production, optimize land allocation, and enhance yield sustainability to ensure consistent growth in turmeric cultivation.

Keywords Decomposition, Instability, Trend, Coefficient of variation, Cuddy Della Vella Index.

INTRODUCTION

Turmeric (*Curcuma longa* L.), often referred to as the "Golden Spice," holds a pivotal position in India's agricultural and economic landscape. Celebrated for its vibrant yellow hue and earthy aroma, turmeric is a staple ingredient in Indian cuisine and a vital commodity in international spice markets (Angles *et al.* 2011, Sahu and Sushila 2021). Beyond its culinary uses, turmeric is renowned for its medicinal properties, primarily attributed to curcumin, its active compound. Widely used in Ayurveda, turmeric exhibits potent anti-inflammatory, antioxidant, and antimicrobial qualities, earning its place as a critical ingredient in traditional remedies and modern pharmaceuticals. The spice also gained prominence during

Mahima Priyanka Neerugatti[1], R. R. Kushwaha[2]*, Anil Kumar[3], Supriya[4]

[1]PhD Research Scholar, [2,3]Professor, [4]Associate Professor
Department of Agricultural Economics, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya 224229, UP, India

Vishal Mehta[5]
Assistant Professor, Department of Agricultural Statistics, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya 224229, UP, India

Email: drrkushwaha@nduat.org
*Corresponding author

the COVID-19 pandemic due to its role in boosting immunity. Furthermore, its application in cosmetics and dye production underscores its versatility and economic significance (Anusha *et al*. 2023).

India, known as the "Spice Bowl of the World," is the largest producer, consumer, and exporter of turmeric, accounting for over 80% (Choudhury and Kalita 2018), followed by China (8%), Myanmar (4%), Nigeria (3%), and Bangladesh (3%). India exported 1.70 lakh tonnes of turmeric in 2022-23, up from 1.53 lakh tons the year before. Bangladesh (34,523 tonnes) is the largest importer of turmeric from India, followed by the UAE (18,980 tonnes), Iran (12,223 tonnes), Morocco (10,663 tonnes), the United States (7,009 tonnes), and Malaysia (6,829 tonnes). Due to the reduced price range in the Nizamabad market compared to the previous year, there is currently a strong export demand in the global market, mainly from the United States, United Kingdom, and Malaysia. India's turmeric production in 2022-23 is expected to be 11.7 lakh MT, while the initial preliminary projections for 2023-24 are 10.75 lakh MT. The primary states producing turmeric in India are Telangana, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, and West Bengal (Turmeric outlook 2024).

Among the states producing turmeric Telangana has the highest area under turmeric (50.06 000' ha) followed by Orissa (31.17 000' ha) and Andhra Pradesh (25.59 000' ha). Since Telangana is now the primary producing region, Andhra Pradesh's acreage under turmeric has shrunk since the bifurcation. Telangana is the major producing state of turmeric in India with 0.23 lakh hectare of total area with 1.74 lakh tonnes production and 7565 kg/ha productivity during 2023-24. Andhra Pradesh was left with an area of 0.18 Lakh hectares with 38.03 thousand tonnes of production during 2023-24 (GOI 2022).

Agricultural growth and instability have been widely debated globally. While increasing agricultural production is essential, rising instability in production and growth poses challenges. It impacts farmers' income, adoption of advanced technologies, and investment decisions. Production instability also disrupts price stability, affecting consumers and increasing the vulnerability of low-income households. Furthermore, it has significant implications for food management and macroeconomic stability (Chand and Raju 2009).

Hence the paper has workout the subsequent objective: To assess the trend of area, production and productivity of turmeric in Andhra Pradesh and to measure the instability and the relative contribution of area, and yield to change in the production of turmeric in Andhra Pradesh.

MATERIALS AND METHODS

The collected information are purely secondary. The information on area, production and Yield of turmeric for the period 1954-2023 were collected from www.indiastat.com.

The study period are classified into eight sub-periods as the period I (1954-1963), period II (1964 to 1973), period III (1974 to 1983), period IV (1984 to 1993), period V (1994 to 2003), period VI (2004 to 2013), period VII (2013 to 2023) and period VIII which covers the entire period from 1954 to 2023. To determine instability, and relative contribution of area and yield in production i.e., decomposition analysis of turmeric in Andhra Pradesh.

Trend models

The model may be defined as a way to illustrate a system or process. The process's trajectory, statistical characteristics, and ramifications are often traced using the statistical model. Table 1 briefly summarizes the various models that we are interested in using

Table 1. Different trend models.

Model	Form
Linear model	$Y_t=b_0+(b_1t)$
Exponential model	$Y_t=b_0e^{(b_1t)}$ or, $\ln(Y_t)=\ln(b_0)+(b_1t)$
Cubic model	$Y_t=b_0+(b_1t)+(b_2t^2)+(b_2t^3)$
Quadratic Model	$Y_t=b_0+(b_1t)+(b_2t^2)$
Compound model	$Y_t=b_0(b^t)$ or $\ln(Y_t)=\ln(b_0)+\ln(b_1)$
Logarithmic model	$Y_t=b_0+b_1\ln(t)$
Growth model	$\ln(Y_t)=b_0+b_1t\ Y_t$

Where, Y_t is the value of the series at time t and b_0, b_1, b_2, b_3 are the parameters.

to examine the trajectory and characteristics of the series under our inspection (Srivastava *et al*. 2022).

Decomposition analysis

To ascertain the proportional contributions of area and yield to the total production of the turmeric crop, Minhas and Vaidyanath (1964) employed the decomposition analysis model, which is displayed below.

$P_o = A_0 \times Y_0$ and
$P_n = A_n \times Y_n$ ---------- (i)

Area, production, and yield in the base year are A_o, P_o, and Y_o, respectively, whereas A_n, P_n, and Y_n are the values of the relevant variable in the n^{th} year item.

Where,
A_0 and A_n = Area in the base year and n^{th} year respectively.
Y_0 and Y_n = Yield in the base year and n^{th} year respectively.
$P_n - P_o = \Delta P$, $A_n - A_o = \Delta A$, $Y_n - Y_o = \Delta Y$--------- (iv)
For equations (i) and (ii) we can write
$P_o + \Delta P = (A_o + \Delta A)(Y_o + \Delta Y)$

Hence,

$$P = \frac{A_0 \Delta Y}{\Delta P} \times 100 + \frac{Y_0 \Delta A}{\Delta P} \times 100 + \frac{\Delta Y \Delta A}{\Delta P} \times 100$$

Production = Yield effect + area effect + interaction effect (Gaware *et al*. 2022)

Therefore, because of changes in both yield and area, the total change in production may be divided into three effects: Yield, area, and interaction.

Instability and it's measure

To evaluate instability in the area, production, and yield of turmeric, the indices proposed by Cuddy and Della (1978) and Padmanaban *et al*. (2016) were utilized:

$$CV_t = (CV) \times \sqrt{(1-R^2)}$$

$$\text{Where, } CV = \frac{\sigma}{\overline{X}} \times 100$$

σ = Standard deviation
$\overline{X}$ = Mean
R^2 = Coefficient of determination of the linear trend model of the variable concerned
CV_t = CV around trend

Traditional CV values are a more generic alternative, but they are unable to sufficiently explain the intrinsic trend component in a time series when there is a trend (Hasan *et al.* 2008). Therefore, it is expected that Cuddy and Della's (1978) approach will be better than standard CV. As such, this study obtained for CV around trend i.e. CV_t .

RESULTS AND DISCUSSION

Parametric trend analysis of turmeric in Andhra Pradesh

Knowing, the overall performance path of the series movement was traced to parametric trend using a parametric trend model. To determine the trend in area production and yield various parametric model

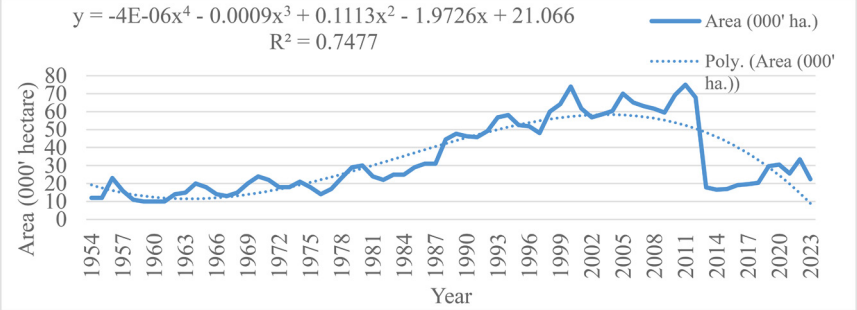

Fig.1. Observed and expected trends of 'area' under turmeric in Andhra Pradesh.

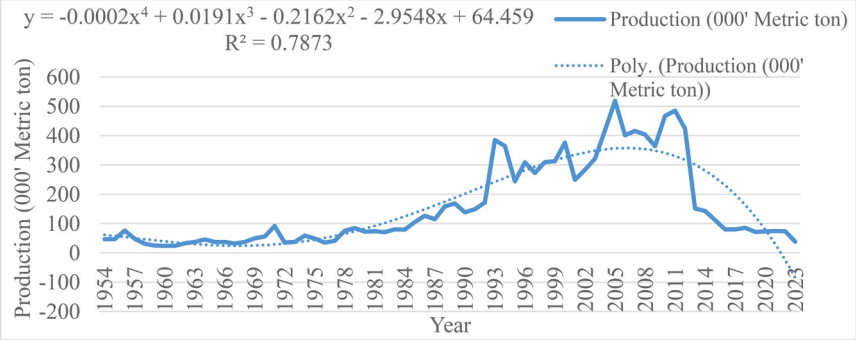

Fig. 2. Observed and expected trends of 'production' under turmeric in Andhra Pradesh.

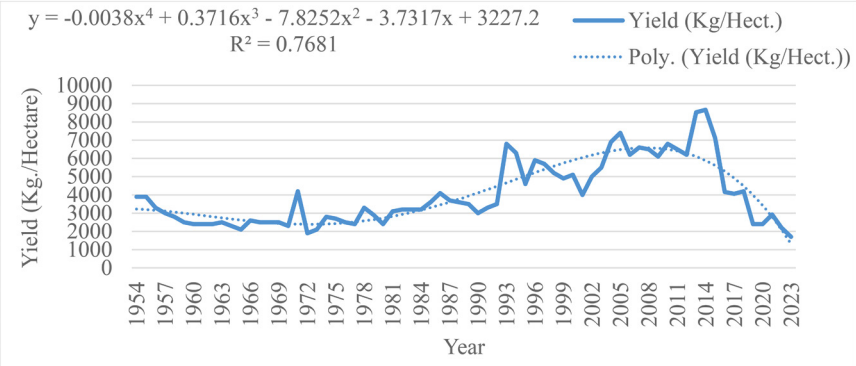

Fig. 3. Observed and expected trends of 'yield' under turmeric in Andhra Pradesh.

such as linear, exponential, logarithmic, quadratic, cubic and compound model were used. The best model is chosen from among the competing models based on its largest R^2 value, model significance, and coefficients.

The non-linear patterns are visible in Andhra Pradesh (Figs. 1–3). Thus, from Table 2 clearly depicted that quadratic trends are noticeable in the area, yield and production of turmeric, indicating that in the recent past most likely series have reached maximum values and then either remained constant or decreased, which is cause for concern. From figure one can see that area of turmeric has been increased

Table 2. Parametric trends in area, production, and yield of turmeric in Andhra Pradesh.

Equation	Model summary		Parameter estimates			
	R^2	Significance	Constant (b)	b_1	b_2	b_3
			Area ('000'ha)			
Quadratic	0.748	0.00	21.07	-1.97	0.11	-0.0009
			Production ('000'tons)			
Quadratic	0.787	0.00	64.46	-2.95	-0.22	0.0191
			Yield (kg/ha)			
Quadratic	0.768	0.00	3227.20	-3.73	-7.85	0.3716

during and after the eighties. The impact of the expansion of region can be seen in the turmeric production scenario, which has increased from 138.70 thousand tons in 1990 to 485.00 thousand tons in 2011, after which it began to decline from 2011 to 2023 before rising throughout the year. The yield trend for turmeric showed a modest increase, with the lowest trend yield of 1900 kg/ha in 1972, then a major fluctuation in trend to 3300 kg/ha in 1978, then start decreasing from 1978 to 1980, and then start rising from the year 1981. As a result of the study, it is clear that changes in area, per hectare yield, as well as management and other practices, have affected the production process under consideration.

The negative nature of the b_2 coefficient indicates that the production and yield of turmeric in Andhra Pradesh have diminishing rate of change (concave relationship) in recent years. Farmers' interest in turmeric area is decreasing trend moderates and starts increasing as the independent variable grows further. During the study period, overall production in Andhra Pradesh declined, possibly due to bifurcation of Andhra Pradesh in 2014, which resulted in a reduction of turmeric-cultivated area.

Sources of change in turmeric production in Andhra Pradesh

The analysis of the expansion of the area, production and yield of turmeric disclose the overall pattern of growth and direction of changes. However, this approach does not assess the specific impact of the area and yield on the growth of turmeric. It is a necessity to identify sources of changes in turmeric output is essential for determining which factor is relatively falling behind and to identify the reasons for it.

It will also help in understanding the elements that lead to the enhancement of turmeric output. Consequently, an analysis of turmeric's origins is required. The overall change in production is divided into three separate effects—the area effect, the yield effect, and the interaction effect—in order to analyze the variables influencing turmeric output. The precise effects of yield, area, and their interplay on variations in Andhra Pradesh's turmeric output are shown in Table 3.

Table 3. Source of relative change in production of turmeric in Andhra Pradesh (in per cent).

Period	Area effect	Yield effect	Interaction
Period-I (1954-1963)	**168.00**	-116.00	48.00
Period-II (1964-1973)	45.44	**59.00**	-4.44
Period-III (1974-1983)	39.00	**53.33**	7.62
Period-IV (1984-1993)	29.42	33.27	**37.42**
Period-V (1994-2003)	**104.00**	-4.28	0.54
Period-VI (2004-2013)	-36.80	**110.50**	25.94
Period-VII (2014-2023)	109.36	-48.07	38.64
Period-VIII (1954-2023)	**294.31**	-450.87	256.34

Note: Sum of all three effect=100.

In Andhra Pradesh, during the period I an increase in production of turmeric was mainly due to increase in the effect of area of around 168.00%. But in Period II and III this trend shifts from area to yield effect emerging as key growth drivers: During the Period IV an increase in the production was due to the interaction of both area and yield effect of around 37.54%, area expansion contributed significantly in Period V (104.00%) and in Period VI yield contributed to the increase in production and lastly Period VII, area effect again became dominant (109.36%).

Overall, spanning the entire study period (1954-2023), the area effect was the principal source of production variability, underscoring its critical role in shaping turmeric output trends in Andhra Pradesh. This pattern suggests that while yield improvements were initially crucial, the expansion of cultivated area has been pivotal in sustaining long-term production growth.

Instability analysis

The Cuddy and Della (1978) approach was applied in Andhra Pradesh to analyze volatility in turmeric area, production, and yield. While the coefficient of variation (CV) is a robust metric, its use with time series data featuring trends requires caution (Hasan *et al*. 2008). The Cuddy and Della method assumes

Table 4. Instability in area, production and yield of turmeric in Andhra Pradesh.

Field of measurement	Measurement statistics	Period I	Period II	Period III	Period IV	Period V	Period VI	Period VII	Period VIII
Area	R^2	0.0384	0.0995	0.3301	0.8977	0.1711	0.1467	0.5418	0.3092
	CV	30.294	19.174	22.773	26.25	12.378	26.11	25.689	58.962
	CV_t	29.132	18.195	18.639	8.3979	11.27	24.118	17.389	49.004
Production	R^2	0.3602	0.0741	0.4697	0.5505	0.0019	0.2162	0.7132	0.2924
	CV	41.025	38.925	26.774	52.801	14.374	24.638	33.354	91.177
	CV_t	32.815	37.455	19.498	35.387	14.36	21.812	17.862	76.698
Yield	R^2	0.8227	0.0146	0.2677	0.1859	0.1951	0.0396	0.7924	0.303
	CV	20.647	25.508	12.07	28.337	12.733	10.728	56.976	43.849
	CV_t	8.6935	25.321	10.329	25.568	11.424	10.514	25.962	36.609

linearity, which is challenging with long-term time series. This study introduced nonlinearity into the trend model, deriving a modified CV (CV_l) using the coefficient of determination from the adjusted model. The decadal coefficient of variation was calculated for eight periods: 1954–1963, 1964–1973, 1974–1983, 1984–1993, 1994–2003, 2004–2013, 2014–2023, and the overall period (1954–2023), to assess instability trends

Instability of turmeric in Andhra Pradesh

The instability is one of the major bottlenecks to affecting the cropping pattern, selection of crop for cultivation and consistency growth. The instability in the area, production and yield of turmeric in Andhra Pradesh for all eight period in workout and present in Table 4. The coefficient of variation around trend in turmeric for the period 1954-2023 have been shown in Table 4 and depicted in Fig. 4.

Overall instability analysis (Period VIII) reveals that turmeric production was highly unstable (76.698), followed by area (49.004) and yield (36.609). It reveals that low risk in the expansion of turmeric cultivation in Andhra Pradesh. Result depicted that decadal instability in the area, production and yield of turmeric. In the case of area under cultivation high variability in Period I indicating considerable variability from the outset, likely due to initial adjustments in land use. This instability was observed low in the Period II, III, IV, V, VI and VII which suggests a temporary stabilization in land allocation and utilization due to the continued effects of land redistribution and administrative restructuring following the bifurcation.

For production, CV_t shows substantial initial variability, particularly in Period I, II, and IV with temporary stabilization observed in Period III, V, VI and VII, suggesting an improvement in production

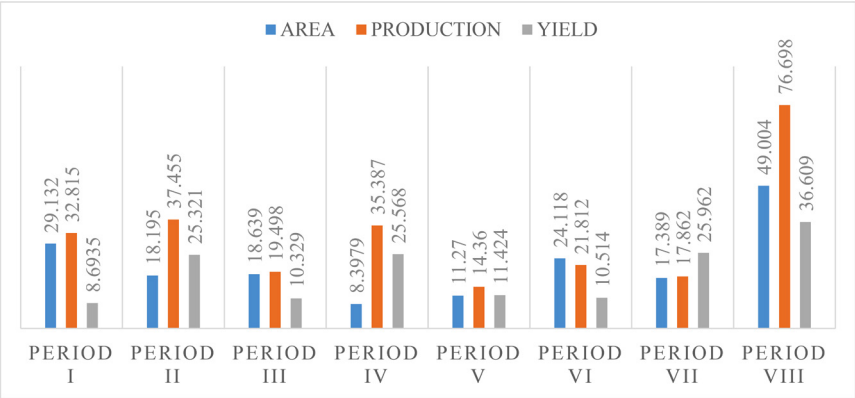

Fig. 4. Instability in area, production and yield of turmeric in Andhra Pradesh.

consistency at that stage. However, variability signaling long-term challenges in stabilizing production under regional restructuring impacts.

Yield variability is comparatively lower, starting high (8.6935 in Period I) and then fluctuating from Period II to VII. The trends indicate that while efforts may have been made to stabilize yield initially, ongoing adjustments in land and resource allocations in Andhra Pradesh continue to impact consistency.

CONCLUSION

The study highlights the critical dynamics influencing turmeric cultivation in Andhra Pradesh over the period 1954–2023. The findings reveal that while area expansion has historically driven production growth, yield stability remains a significant challenge, as reflected in the negative contribution of yield to overall production change and high instability in production. The quadratic trend patterns indicate that turmeric cultivation may have reached saturation levels in recent years, with declining growth rates being a cause for concern. Regional restructuring, such as the bifurcation of Andhra Pradesh in 2014, has further worsened instability in turmeric production. To ensure sustainable growth in turmeric cultivation, there is an urgent need to focus on yield improvement strategies, adopt modern agricultural practices, and promote technological interventions that enhance productivity and reduce variability. These efforts will not only address the challenges of declining growth rates but also strengthen the resilience of turmeric production in the face of changing socio-economic and environmental conditions.

REFERENCES

Angles S, Sundar A, Chinnadurai M (2011) Production and export performance of turmeric in India – An economic analysis. *Agricultural Economics Research Review* 24(2): 301-308.

Anusha J, Lavanya T, Kumari VR, Radhika P, Supriya K (2023) Growth and instability of turmeric in Telangana. *International Journal of Statistics and Applied Mathematics* 8(5): 120-124.

Chand R, Raju SS (2009) Instability in Indian Agriculture during different phases of technology and policy. *Indian Journal of Agricultural Economic*s 64(2): 283-288.

Choudhury K, Kalita DC (2018) Trends of area, production and productivity of turmeric in Assam. *Journal of Hill Agriculture* 9(3): 322-324.

Cuddy JDA, Della PA (1978) Measuring the instability of time series data. *Oxford Bulletin of Economics Statistics* 40(1): 79-85.

Gaware UP, Mishra RR, Baviskar PP, Pavithra S, Lakshmipriya P, Kumari K, Ahmad N (2022) Growth and decomposition analysis of sugarcane in India. *The Pharma Innovation Journal* 11(1): 232-235.

GOI (2022) Ministry of Agriculture and Farmers Welfare. Agricultural Statistics at a Glance.

Hasan MN, Monayem MMA, Islam MS, Alam QM, Hossain MI (2008) Change and instability in area and production of wheat and maize in Bangladesh. *Bangladesh Journal of Agricultural Research* 33(3): 409-417.

Minhas BS, Vaidyanath A (1964) Growth of crop output in India 1951-54 to 1956-61: An analysis by component elements. *Journal of Indian Society of Agricultural Statistics* 17: 230-252.

Padmanaban K, Sahu PK, Lakshmi N (2016) Instability and forecasting of area, production and productivity of turmeric in major states of India. *Trends in Biosciences* 9(10): 605-616.

Sahu S , Sushila LS (2021) Trend in growth rate in area, production and productivity of turmeric in Bemetara district and in Chhattisgarh state. *The Pharma Innovation Journal* 10(8): 1148-1151.

Srivastava AB, Kushwaha RR, Yadav S, Verma SK, Mishra P (2022) Source of growth for wheat in Uttar Pradesh: Decomposition analysis. *Indian Journal of Economics and Development* 18(4) : 976-980.