Journal of Agricultural Development and Policy, 2025
Volume 35, No. 1, 53-61
https://doi.org/10.63066/23220457.35.1.008

NAAS - 4.34
UGC CARE List Journal

Trend, Instability and Decomposition Analysis of Coconut Crop: Comparative Analysis of Major States

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Abstract

India holds a leading position in global coconut production, contributing 31.45 per cent of the world's output with 19.247 million nuts in the fiscal year 2021-22. This sector significantly impacts the economy, contributing approximately Rs. 30,748 crore to GDP and supporting over 12 million livelihoods. The primary coconut-producing states Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh account for 89.13 per cent of the cultivated area and 90.04 per cent of national production. Karnataka shows the highest growth across area, production, and yield, while Kerala faces challenges with declining area and production. Instability analysis reveals Karnataka as having the highest instability in area, production, and yield, indicating volatility. Decomposition analysis highlights Karnataka's substantial positive area and yield effects, although offset by a negative interaction effect. India's strategic export growth has enhanced its global stature, exporting to over 140 countries. These findings underscore the importance of continued advancements in cultivation techniques, market expansion, and sustainable practices to maintain and enhance India's preeminent position in the global coconut industry.

Keywords: Coconut Production, Productivity, Instability, Decomposition.

JEL Classification: Q10, Q11, Q13

Introduction

India holds a preeminent position in global coconut production, contributing significantly to both its agricultural output and economic prosperity. In the fiscal year 2021-22, India emerged as the largest coconut producer worldwide, accounting for an impressive 31.45 per cent of the total global production. This achievement underscores its pivotal role in the coconut industry, with a total production output reaching 19.247 million nuts during this period. The economic impact of coconut cultivation is substantial, contributing approximately Rs.30,748 crore to the country's gross domestic product and supporting the livelihoods of over 12 million people across various regions (India Trade Portal, 2025). Coconut cultivation in India extends beyond mere economic metrics; it plays a crucial role in ensuring food security and providing employment opportunities (Abeysekera and Waidyarathne, 2020). The crop serves as a vital source of livelihood for approximately 6 lakh individuals engaged in activities ranging from copra processing to coconut oil extraction and coir manufacturing (India Brand Equity Foundation, 2021). These subsidiary industries not only bolster rural economies but also enhance India's export portfolio, reinforcing its global stature in coconut-based products. India's productivity in coconut cultivation is unparalleled, boasting an impressive yield of 9,123 nuts per hectare, (Kalidas *et al,* 2014). This productivity is primarily concentrated in the states of Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh, which collectively account for 89.13 per cent of the total cultivated area and 90.04 per cent of the national coconut production, (Jayasekhar and Jacob 2021). These states have historically been pivotal in driving India's dominance in global coconut trade and play a crucial role in sustaining the country's agricultural resilience.

A comparative analysis with other major coconut-producing nations highlights India's prominent position in coconut production in the global market. While Indonesia leads with a production of 17,100 million nuts in 2021, followed closely by the Philippines with 14,717 million nuts, India stands strong as the third-largest producer with 14,301 million nuts. This ranking underscores India's pivotal role in global coconut supply chains, further reinforced by its extensive cultivation across 2,199 thousand hectares (International Coconut Community Statistical Year Book, 2021).

In terms of international trade, India exports coconut and its derivatives to more than 140 countries worldwide. Key export destinations include Vietnam, UAE, Bangladesh, Malaysia, and the USA (Coconut Development Board). The

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growth trajectory of India's coconut exports has been robust, exhibiting a Compound Annual Growth Rate (CAGR) of 13 per cent from 2015-16 to 2021-22 (India Trade Portal, 2025). This export expansion not only enhances India's foreign exchange earnings but also generates additional employment opportunities through the diversified production of coconut-based products such as coconut chips, coconut milk, coconut sugar, virgin oil, and others. Moreover, India's strategic focus on export markets has further bolstered its position. The country exports a significant portion of its coconut products, including copra, coconut oil, and desiccated coconut, catering to international demand and contributing substantially to the global supply chain.

Within India, the distribution of coconut production is concentrated predominantly in a few key states (Kappil *et al,* 2021). Karnataka emerges as the leading producer with 4,210.87 million nuts and a market share of 30.83 per cent, followed closely by Tamil Nadu with 27.47 per cent of the total production and Kerala with 24.22 per cent share in total national production (Narmada and Karunakaran, 2022). Together, these three states collectively contribute 80 per cent of the national market share, highlighting their critical role in shaping India's coconut industry landscape (National Horticulture Board, 2018).

India has established itself as a global powerhouse in coconut production, driven by unparalleled productivity, expansive cultivation practices, and a strong export orientation. Over the past two decades, the country has witnessed a remarkable surge in coconut plantations, despite fluctuations in acreage and production levels from year-to-year (Narmada *et al,* 2022). The dominance of India in the global coconut market is underscored by several factors. Firstly, the country's coconut productivity is among the highest in the world, owing to favourable agro-climatic conditions and continuous advancements in agricultural techniques. Secondly, India boasts extensive cultivation across various states, accommodating diverse ecological conditions that support robust coconut growth. This geographical diversity not only enhances resilience against adverse climatic events but also ensures a consistent supply throughout the year. Research studies by experts such as (Kappil *et al,* 2021; Narmadha and Karunakaran, 2022) highlight various factors influencing the growth of India's coconut sector. These factors include the expansion of cultivation areas, price dynamics, and improvements in yield per hectare across different regions of the country. India's leadership in coconut production exemplifies its agricultural prowess and its economic significance.

Data Sources and Methodology

The present study was primarily based on secondary data focusing on the states of Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh. The parameters considered included the area measured in hectares, production in million nuts, and productivity as nuts per hectare. The data was sourced from the Coconut Development Board, the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. To analyze the growth trends in the selected parameters, the compound annual growth rate method was utilized. A semi-logarithmic regression model was applied to examine the acceleration or deceleration in growth. Coppock's Instability Index was used to study deviations from the trend. Additionally, a decomposition analysis model was employed to measure the relative contribution of area and yield to the total output change for coconut cultivation. This comprehensive approach provided a detailed understanding of the growth dynamics and productivity variations in the coconut sector across India and its major coconut-producing states.

Compound growth rate

The compound annual growth rate (CAGR) was employed to analyze the growth rate in the area, production, and yield of the coconut crop among major states and India. The compound annual growth function was specified as a semi-log equation. This method effectively captured the growth trends and helped in understanding the long-term development patterns of coconut cultivation across different regions.

$$Y_t = a\, b^t\, u$$

Model Specification: $lnY_t = ln\ a + t\ (ln\ b) + ln\ \ u$

Where

lnY_t = natural logarithm of the dependent variable (area, production, or productivity).

t = the time period (1, 2, ..., 11 in your case).

a = intercept term (constant).

ln b = associated with t, which measures the instantaneous rate of growth

u = random error term.

Where

*ln b = ln (*1+*r)*

where *r* = CGR

r = [Antilog (*lnb*) - 1]

CGR (%) = *r* x 100

The function was estimated for all the 3 variables for the states and country separately from 2000-01 to 2021-22.

Semi-logarithmic regression model

The semi-logarithmic regression model employed here offered a robust framework to analyse the growth trajectories of area, production, and productivity of a crop over time. By taking the natural logarithm of the dependent variables, the model captured exponential growth patterns, while β_1 and β_2 coefficients quantified the rate of change and acceleration/ deceleration, respectively. Estimating this model separately

for states and the country from 1955-56 to 2021-22 provided insights into regional and national trends, revealing how these agricultural metrics evolved over time. This approach not only elucidated growth dynamics but also facilitated comparisons between geographic entities, highlighting variations and trends in agricultural performance at different scales. Overall, the semi-logarithmic regression was instrumental in understanding and predicting agricultural developments essential for policy-making and agricultural planning.

Model specification: $InY = \alpha + \beta_1 t + \beta_2 t^2 + u$

Where:

lnY = natural logarithm of the dependent variable (area, production, or productivity).

t = the time period (1, 2, ..., 11 in your case).

α = intercept term, a constant.

β_1 = coefficient associated with t, which measures the rate of change over time.

β_2 = coefficient associated with t^2, which measures the rate of acceleration or deceleration over time.

u = random error term.

The function was estimated for all the 3 variables for the states and country separately from 2000-01 to 2021-22.

Coppock Instability Index: CII

The Coppock instability index (CII) provided a measure of deviation from the trend in economic or financial data, complementing measures like the coefficient of variation. Unlike the coefficient of variation, which assessed variation around the trend, CII calculated the average year-to-year percentage variation adjusted for trend. This index captured the volatility in the data series adjusted for trend, offering insights into stability or instability over time. It was computed using the formula.

$$\text{Log V} = \frac{\left[\text{Log}\left(X_{t+1} / X_t\right) - \text{m}\right]}{\text{N}-1}$$

Where,

X_t represents the production area/yield in the year *'t'*

N = Number of years

m = Arithmetic mean of the difference between the logarithms of consecutive years' values

Log V = Logarithmic variance of the series

The logarithmic variance Log V is then converted to CII

$\text{CII} = [\text{Antilog} \sqrt{\text{LogV}} - 1] \times 100]$

Decomposition analysis

Decomposition analysis was a valuable method for measuring the relative contribution of area and yield to the total output change for major crops. The model, initially redeveloped by Sharma and Subramanyam (1984) and later employed by researchers like Kalamkar (2007), was widely used to study the growth performance of crops at the state level.

Base and current year variables

A_0, P_0 and Y_0, respectively area, production and productivity in base year and

A_n, P_n and Y_n are values of the respective variable in nth year item.

Production formula

$P_0 = A_0 \times Y_0$ and

$P_n = A_n \times Y_n$

Change in variable

$\Delta P = P_n - P_0$: Change in production,

$\Delta A = A_n - A_0$: Change in area

$\Delta Y = Y_n - Y_0$: Change in yield

Decomposition of change in production

$P_0 = \Delta P = (A_0 + \Delta A)\ (Y_0 + \Delta Y)$

$\Delta P = A_0 \Delta Y + Y_0\ \Delta A + \Delta A \Delta Y$

ΔP = Yield effect + Area effect + Interaction effect

Thus, the total change in production can be decomposed into three components viz., yield effect, area effect and the interaction effect due to change in yield and area

Results and Discussion

This section presented the results obtained from the analysis of coconut production trends across India and its major states. The analysis evaluated the growth patterns, stability, and contributing factors to coconut production across the major coconut-producing states. The overall growth trend was assessed using CAGR, while trend analysis examined the long-term direction of production. Growth acceleration or deceleration was analysed to identify phases of rapid growth or decline. The instability index captured the extent of fluctuations in production, providing insights into the sector's volatility. Additionally, decomposition analysis broke down the growth into its area, yield, and interaction effects.

Estimates of growth trend of major states and India

Estimating the growth trends of India and major states provides valuable insights into regional disparities, changes in agricultural output over time, technical advancements, identify the significant progress and performance across states, thereby enabling the sector to provide a viable development facilitating efficiency in resource allocation.

Despite variations in the annual growth of the cultivated area among states, significant differences were evident. Tamil Nadu (1.511 %) and Karnataka (2.327 %) showcased higher CAGR as compared to the national average of 0.803 per cent (Singh and Patel, 2020). Conversely, Andhra Pradesh

Table 1: Compound growth rate of major coconut growing states and India

Factors	Andhra Pradesh	Tamil Nadu	Karnataka	Kerala	India
Area	0.2	1.511	2.327	-0.995	0.803
Production	2.02	2.02	6.502	-0.598	3.148
Yield	1.816	0.4	4.081	0.401	2.429

recorded a modest increase of 0.200 per cent, while Kerala experienced a decline with a negative CAGR of -0.995 per cent. Figure 1 showed the trend in the area under cultivation. Despite variations in annual crop production growth among states, notable trends (Figure 2) emerged. Karnataka recorded the highest average annual growth rate (CAGR) at 6.502 per cent, while Andhra Pradesh and Tamil Nadu each exhibited a CAGR of 2.02 per cent. Kerala, however, experienced a decline with a negative LGR of -0.598 per cent, contrasting with the national average of 3.148 per cent. Karnataka led in agricultural productivity growth with a compound growth rate (CAGR) of 4.081 per cent. Andhra Pradesh, with a CAGR of 1.816 per cent, showed slower but more stable productivity growth compared to the national average (CAGR of 2.429%). Kerala and Tamil Nadu both had the lowest CAGR at 0.401 per cent.

The trend in the area, production, and productivity of major states and the nation is represented in Figures 1, 2, and 3 below.

While the total area under coconut cultivation in India increased over the past two decades, individual states exhibited varied trends (Figure 1). Andhra Pradesh (AP) and Tamil Nadu (TN) showed a general increase in the cultivation area, with Tamil Nadu having a more pronounced upward trend. Karnataka (KAR) showed growth but with significant fluctuations, and Kerala (KER) experienced a steady decline in the area under coconut cultivation. These trends reflected the dynamic nature of agricultural practices and regional variations in crop management.

Figure 2 displayed the production trends of coconuts in India and key states from 2000 to 2021. India's coconut production saw fluctuations, with an overall increase, peaking at 2,33,512 lakh nuts in 2011 before dropping to 1,93,099 lakh nuts in 2021. Andhra Pradesh (AP) showed a moderate growth trend, increasing from 10,927 lakh nuts in 2000 to 15,669 lakh nuts in 2021, indicating overall growth. Tamil Nadu (TN) experienced a substantial overall rise and maintained high production levels, reaching 53,518 lakh nuts in 2021. Karnataka (KAR) showed considerable growth with notable year-to-year variations, exhibiting significant variability but overall growth. Kerala (KER) maintained relatively stable production levels, fluctuating between 52,870 lakh nuts and 63,260 lakh nuts, ending at 55,350 lakh nuts in 2021. This data highlighted regional differences in production trends and overall growth in India's coconut industry.

Figure 3 provided coconut productivity (in nuts per hectare) for India and the states Andhra Pradesh (AP), Tamil Nadu (TN), Karnataka (KAR), and Kerala (KER) from 2000 to 2021. Overall, India's productivity showed an upward trend, increasing from 6,951 nuts per hectare in 2000 to a peak of 11,481 in 2016 before slightly declining to 8,966 in 2021. Andhra Pradesh (AP) exhibited significant growth, with productivity rising from 10,646 nuts per hectare in 2000 to 14,500 in 2021. Tamil Nadu (TN) showed varied trends, with productivity increasing from 2000 to a peak in 2011, then stabilizing around 11,692 in 2021. Karnataka

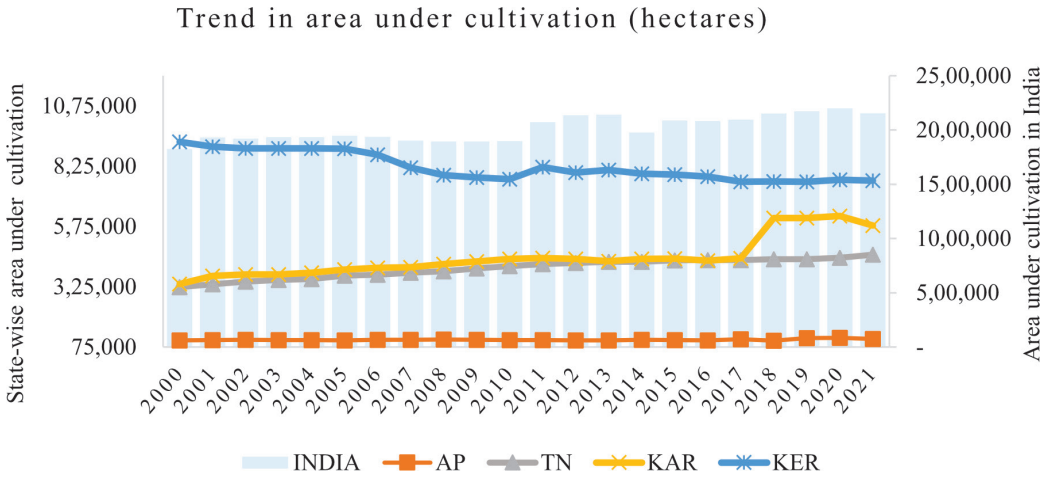

Figure 1: Trend in area under cultivation of coconut crop between 2000 and 2021

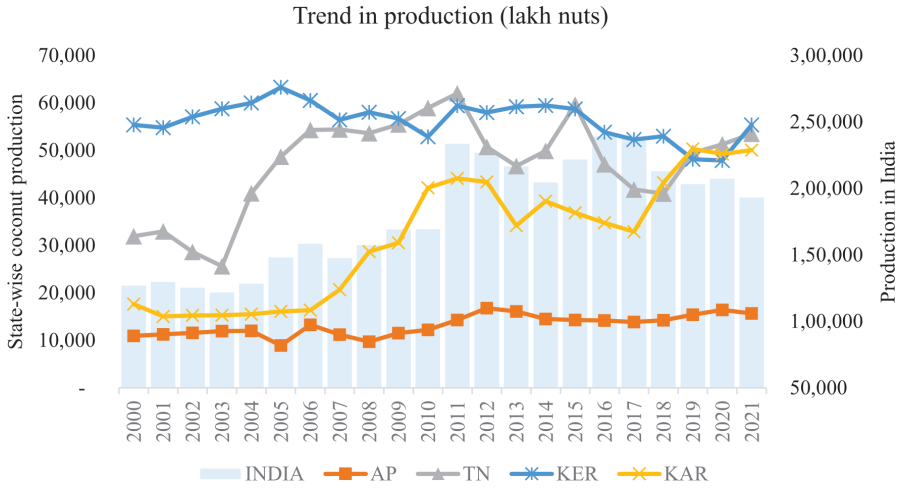

Figure 2: Trend in production of coconut crop between 2000-2021

saw notable increase in productivity, from 5,245 in 2000 to 8,648 in 2021. Kerala, despite some fluctuations, displayed overall stability, with productivity rising from 5,980 in 2000 to 7,231 in 2021. These trends reflected regional differences in agricultural practices and productivity improvements over the years.

Growth acceleration/deceleration

From Table 2, it was observed that the area under cultivation in the country grew by 0.4 per cent, with no signs of acceleration or deceleration. Among major states, Tamil Nadu recorded the highest growth in coconut cultivation at 3.1 per cent, though it experienced a slight deceleration of 0.1 per cent. This trend was consistent with previous studies, which highlighted that Tamil Nadu's promising irrigation infrastructure and policy support contributed to its growth despite minor fluctuations. Conversely, Andhra Pradesh and Kerala showed negative growth rates of -0.4 per cent and -2.1 per cent, respectively, with no signs of acceleration or deceleration. Karnataka exhibited a modest growth of 0.3 per cent, accompanied by a growth acceleration of 0.1 per cent, indicating potential stability and expansion to enhance productivity through sustainable farming practices. These trends highlighted significant regional variations in the expansion of cultivated areas, with Tamil Nadu leading despite slight deceleration, while Andhra Pradesh and Kerala faced declines, and Karnataka showed modest yet accelerating growth.

In national production figures, there was an overall increase of 7.8 per cent, albeit with a slight growth deceleration of 0.2 per cent. Among states, Tamil Nadu and Karnataka led with production growth rates of 10.5 per cent and 10.7 per cent, respectively, experiencing slight decelerations of 0.4 per cent and 0.2 per cent. Prior studies indicated that the higher adoption of hybrid coconut varieties and improved agronomic practices in these states contributed to increased production, despite minor fluctuations in growth rates. Andhra Pradesh showed modest growth at 1.6 per cent, maintaining stability, while Kerala recorded a lower growth

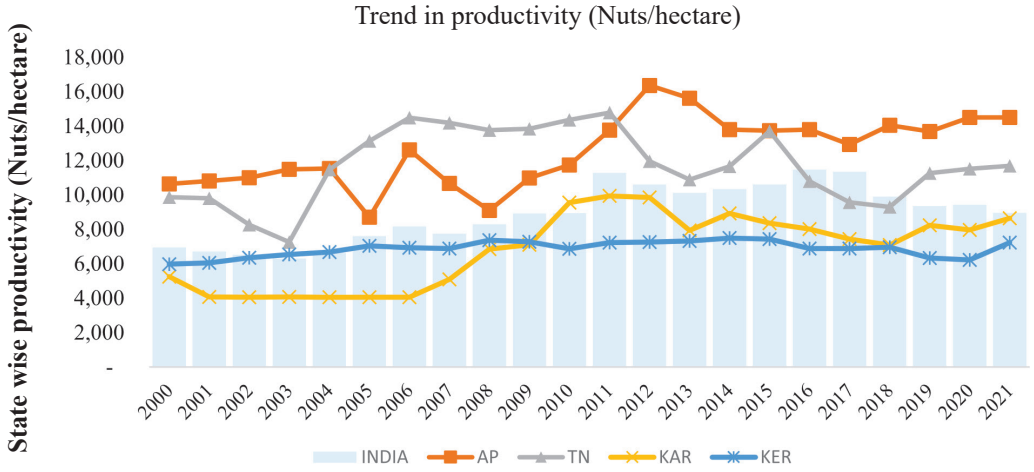

Figure 3: Trend in productivity of coconut crop between 2000-2021

Table 2: Estimates of growth acceleration/ deceleration

Factors	States	Co-efficient								
		Constant		t		t^2		R^2	Adj R^2	F
Area	AP	11.564	(702.789) *	-0.004	(-1.329)	0	(1.978) ***	0.346	0.277	5.023
	TN	12.66	(1826.085) *	0.031	(22.065) *	-0.001	(-11.347) *	0.992	0.991	1134.04
	KAR	12.807	(243.539) *	0.003	-0.316	0.001	(1.947) ***	0.824	0.806	44.581
	KER	13.77	(730.031) *	-0.021	(-5.454) *	0	(3.001) *	0.865	0.851	61.039
	INDIA	7.535	359.511) *	0.004	-0.842	0	-0.991	0.753	0.728	29.036
Production	AP	9.260	(110.708) *	.016	(.943)	.001	(.258)	.568	.523	12.508
	TN	10.168	(88.544) *	.105	(4.577) *	-.004	(-3.833) *	.591	.548	13.752
	KAR	9.359	(66.506) *	.107	(3.784) *	-.002	(-1.579)	.828	.810	45.662
	KER	10.921	(295.557) *	.015	(1.970) **	-.001	(-2.829) **	.495	.442	9.301
	INDIA	9.230	(132.232) *	.078	(5.559) *	-.002	(-3.406) *	.841	.824	50.239
Productivity	AP	9.209	(105.913) *	.020	(1.158)	-9.297	(-.126)	.498	.445	9.410
	TN	9.020	(79.073) *	.075	(3.266) *	-.003	(-3.169) *	.360	.292	5.334
	KAR	8.065	(57.577) *	.103	(3.684) *	-.003	(-2.318) **	.685	.652	20.688
	KER	8.664	(305.811) *	.035	(6.199) *	-.001	(-5.686) *	.680	.646	20.183
	INDIA	8.603	(137.198) *	.074	(5.906) *	-.002	(-4.122) *	.809	.789	40.248

*Notes: Significant *at 1 %, ** at 5% and *** at 10% levels, respectively*

rate of 1.5 per cent with a minor deceleration of 0.1 per cent. These variations underscored the diverse agricultural production dynamics across states, reflecting both growth and stability challenges in different regions.

The national yield growth was 7.4 per cent with a deceleration of 0.2 per cent. Among major states, Karnataka recorded the highest productivity growth at 10.3 per cent, despite a deceleration of 0.3 per cent. Tamil Nadu followed with a 7.5 per cent growth and a similar deceleration. Kerala showed a modest 3 per cent growth, while Andhra Pradesh had the lowest productivity growth among the major states. Both Kerala and Andhra Pradesh experienced a deceleration of 0.1 per cent. This indicated that while Karnataka and Tamil Nadu led in yield growth, they also faced higher deceleration rates. Conversely, Kerala and Andhra Pradesh, though showing lower growth, had relatively stable deceleration rates, highlighting differing agricultural dynamics across these states.

Estimates of instability index

The CII for the nation was 38.96, reflecting the variability in the area under cultivation (Athira and Guledagudda, 2024). Karnataka exhibited the highest CII at 43.6, indicating substantial fluctuation in its annual growth. Tamil Nadu also had a high CII of 40.78, followed by Kerala with a CII of 39.44, both exceeding the national average (Kalidas *et al*, 2020). In contrast, Andhra Pradesh demonstrated stability with the lowest CII of 37.82 among the major producers. These figures highlighted the disparities in agricultural expansion across states, with Karnataka and Tamil Nadu leading in growth yet showing significant variability, while Andhra Pradesh maintained steadiness despite lower growth, and Kerala faced a decline in its cultivated area.

Regarding variability in production, Karnataka showed the highest coefficient of variation (CII) at 58.23, far exceeding the national average of 46.63. Andhra Pradesh and Tamil Nadu had CIIs of 43.71 and 46.92, respectively, both lower than the national figure. Kerala demonstrated the lowest CII at 39.47, indicating minimal variability in its annual production growth. These statistics highlighted significant disparities in agricultural performance across states. While Karnataka led in growth, it also had considerable variability. Andhra Pradesh and Tamil Nadu exhibited moderate growth with lower variability, whereas Kerala faced a decline but maintained the most stable growth rates.

The highest coppock's index at 51.59 per cent in Karnataka's yield indicated a rapid yet inconsistent growth. However, Kerala's CII of 39.37 per cent, the lowest among the states, reflected very stable productivity (Chand *et al,* 2015). In contrast, Tamil Nadu's CII of 44.62 per cent mirrored the national average, indicating higher variability. Andhra Pradesh's CII stood at 43.44, showing a balanced pattern of yield fluctuations (Kalidas *et al*, 2020). These trends highlighted the diverse agricultural dynamics across states, with Karnataka's rapid but volatile growth, Kerala's stability, Andhra Pradesh's balanced performance, and Tamil Nadu's need for improved stability and growth in productivity.

The comparative analysis highlighted significant disparities in agricultural performance among Andhra

Table 3: Coppock's instability index of major coconut growing states

Factors	Andhra Pradesh	Tamil Nadu	Karnataka	Kerala	India
Area	37.82	40.78	43.6	39.44	38.96
Production	43.71	46.92	58.23	39.47	46.63
Yield	43.44	44.62	51.59	39.37	44.68

Pradesh, Tamil Nadu, Karnataka, and Kerala. While Karnataka showed the most dynamic growth, indicating potential for high returns, Kerala faced challenges with declining area and production but maintained stable productivity (Athira and Guledagudda, 2024). Andhra Pradesh and Tamil Nadu exhibited moderate growth with varying levels of stability. Understanding these trends could inform policy decisions aimed at enhancing agricultural productivity and sustainability across these states (Suresh and Krishnadas, 2021).

Estimates of decomposition analysis

Table 4 provided a decomposition analysis of the contributions of area and yield to the growth of coconut production in major producing states in India, namely Andhra Pradesh, Tamil Nadu, Karnataka, and Kerala, as well as the nation overall. This analysis allowed for a detailed understanding of how changes in area under cultivation and yield per unit area influenced total production.

In Andhra Pradesh, both area and yield positively contributed to coconut production, with the area effect at 27.68 per cent and the yield effect significantly higher at 126.29 per cent. However, the negative interaction effect of -126.29 per cent suggested that the combined influence of area and yield did not synergize well. Despite the positive individual contributions, the interaction between area and yield led to an overall decline in production, highlighting possible inefficiencies or challenges in optimizing both factors simultaneously. Previous studies reported similar findings, attributing such trends to inefficiencies in farm management, fragmented landholdings, and suboptimal resource allocation (Kappil *et al*, 2021). Furthermore, ineffective mechanization and poor irrigation infrastructure may have hindered the state from maximizing its production potential.

Tamil Nadu exhibited a different scenario, where the area effect was substantially high at 655.54 per cent, indicating that an increase in the area under cultivation played a major role in boosting coconut production. The yield effect, though positive at 42.22 per cent, was comparatively lower. This suggested that while yield improvements contributed to production, the primary driver was the expansion of cultivated area. The positive area effect significantly outweighed the yield effect, demonstrating the importance of land use changes in this region's coconut production growth. Earlier research also highlighted the role of land expansion and government initiatives in supporting Tamil Nadu's coconut sector (Jose and Padmanabhan, 2016).

Karnataka showed remarkable growth trends, with an exceptionally high yield effect of 2461.70 per cent, indicating substantial improvements in productivity. The area effect was also positive at 1793.34 per cent, contributing to the increased production. However, the interaction effect was notably negative at -3134.16 per cent, suggesting that the simultaneous changes in area and yield might have led to diminishing returns or other negative synergies. This negative interaction could have reflected issues such as overextension of cultivated areas or challenges in maintaining high productivity levels across expanded areas. Previous studies suggested that Karnataka experienced rapid technological advancements in coconut farming, including hybrid varieties and better farm practices, but excessive land expansion may have led to resource strain and declining marginal returns (Kappil *et al*, 2021).

Kerala faced a unique situation with a positive yield effect of 13.93 per cent amidst a negative area effect of -194.01 per cent. This indicated that while the state experienced a reduction in the area under coconut cultivation, improvements in yield per unit area partially offset this decline. The trend aligned with observed challenges and instability in the region's coconut farming sector. The negative area effect highlighted the decreasing acreage, while the positive yield effect underscored efforts to enhance productivity despite reduced cultivation areas. Previous literature attributed this decline in cultivated area to urbanization, aging plantations, and shifts toward other high-value crops, while productivity improvements were driven by better management practices and disease-resistant varieties (Kumar, 2006).

Table 4: Percentage decompositions of area, yield and their interaction towards increasing coconut production

Co-efficient	Andhra Pradesh	Tamil Nadu	Karnataka	Kerala	India
Area Effect	27.68	655.54	1916.56	-194.01	91.94
Yield Effect	126.29	42.22	2267.67	13.93	-290.28
Interaction Effect	-126.29	-149.17	-3134.16	155.41	- 126.35

On a national level, the overall performance of coconut production showed a negative area effect of -99.83 per cent, implying a reduction in the total cultivated area. However, this was counterbalanced by a positive productivity effect of 567.79 per cent, indicating significant improvements in yield. The overall interaction effect remained negative at -451.74 per cent, suggesting that the combined influence of area and yield changes did not result in optimal production outcomes. The decomposition analysis revealed varied contributions of area and yield effects across different states. While some regions like Tamil Nadu and Karnataka benefited from increased area and yield, others like Andhra Pradesh and Kerala faced challenges with negative interaction effects and declining cultivated areas. Nationally, productivity improvements were crucial in sustaining coconut production despite reductions in cultivation areas. These findings aligned with national-level studies emphasizing the importance of yield-enhancing technologies and modern agronomic practices in offsetting the declining trend in cultivated area (Kappil *et al*, 2021).

The findings from the analysis provided a detailed view of coconut production dynamics in major states of India. Karnataka showed the highest growth across all parameters: area, production, and yield, indicating robust agricultural development. Andhra Pradesh, on the other hand, had minimal growth in area but showed moderate to significant growth in production and yield, reflecting stability in production despite slower area expansion. Tamil Nadu demonstrated moderate growth in area and production but minimal growth in yield. This suggested that while the state expanded its coconut area, it faced challenges in increasing productivity. Kerala, on the other hand, experienced a decline in both area and production with only minimal growth in yield, indicating challenges in agricultural expansion and productivity. On a national level, India showed moderate growth in all three parameters, serving as a benchmark for state comparisons. The national average reflected a balanced performance, though significant regional variations remained.

The analysis of instability in the area under cultivation showed that Karnataka had the highest instability in the area under coconut cultivation at 43.6 per cent, followed by Tamil Nadu with an instability index of 40.78 per cent. Kerala and Andhra Pradesh had moderate instability levels at 39.44 per cent and 37.82 per cent, respectively, with India overall reflecting a national instability index of 38.96 per cent (India Trade Portal, 2022). In terms of production instability, Karnataka exhibited the highest instability with an index of 58.23 per cent, followed by Tamil Nadu at 46.92 per cent. India's instability index for production was 46.63 per cent, indicating significant instability at the national level. Andhra Pradesh and Kerala showed lower production instability with indices of 43.71 per cent and 39.47 per cent, respectively, with Kerala demonstrating the lowest instability among the states. Regarding yield instability, Karnataka also exhibited the highest instability with an index of 51.59 per cent, followed by Tamil Nadu at 44.62 per cent. India's national yield instability index stood at 44.68 per cent, reflecting considerable instability at the national level. Andhra Pradesh and Kerala showed indices of 43.44 per cent and 39.37 per cent, respectively, with Kerala again having the lowest instability in yield.

The analysis of the area effect revealed that Karnataka had a substantial positive area effect (1793.34%), indicating that area expansion significantly contributed to increased coconut production. Tamil Nadu also showed a high positive area effect (655.54%), but it was less pronounced than Karnataka's. Andhra Pradesh showed a moderate positive area effect (27.68%), while Kerala and India showed negative area effects (-194.01% and -99.83%, respectively), suggesting that area reductions negatively impacted coconut production in these regions. Karnataka also exhibited an exceptionally high positive yield effect (2461.70%), highlighting the major role of yield improvements in boosting production. This high yield effect could be attributed to technological advancements in coconut farming, including the introduction of high-yielding varieties and improved farming practices. India showed a significant positive yield effect (567.79%), reflecting that yield improvements contributed strongly to production at the national level. Andhra Pradesh showed a moderate positive yield effect (126.29%), while Tamil Nadu and Kerala showed smaller positive yield effects (42.22R and 13.93R, respectively). Kerala's minimal yield effect further emphasized the challenges it faced in improving productivity. The interaction effect analysis showed that Karnataka had a large negative interaction effect (-3134.16%), indicating that the combined effect of area and yield changes negatively impacted overall production despite high individual contributions. India also showed a significant negative interaction effect (-451.74%), while Tamil Nadu and Andhra Pradesh also displayed negative interaction effects (-149.17% and -126.29%, respectively). Kerala, however, showed a positive interaction effect (155.41%), suggesting a beneficial combined effect of area and yield changes on production. This was indicative of Kerala's strategy of improving yield despite a reduction in area.

Conclusions and Policy Implications

The study revealed significant regional disparities in coconut production across India. Karnataka demonstrated impressive growth in area, production, and yield, driven by both area expansion and yield improvements. Tamil Nadu showed moderate growth, with area expansion being the key driver, while Andhra Pradesh and Kerala faced challenges with declining areas and production. Despite these regional differences, productivity improvements at the national level helped sustain overall coconut production. The findings highlighted the need for targeted strategies to rejuvenate aging plantations, enhance yield through better farming practices,

and address challenges like pests and climate impacts to ensure the long-term sustainability of the coconut sector.

A careful balance must be maintained between increasing agricultural output and preserving environmental resources by encouraging practices that minimize land degradation and supporting strategic land expansion in areas with low ecological impact. This approach enables the implementation of sustainable land use and expansion strategies. Governments should prioritize funding in advanced agricultural technologies, improved infrastructure, and farmer training to boost yields on existing farmland. This reduces the pressure to convert natural habitats into agricultural land, ensuring an appropriate investment strategy that enhances productivity and promotes modernization.

References

Abeysekara M G D and Waidyarathne K P 2020. The coconut industry: A review of price forecasting modelling in major coconut-producing countries. *CORD* **36**:17–26. https://doi.org/10.37833/cord.v36i.422.

Athira S and Guledagudda S S 2024. Growth and instability analysis of coconut in Kerala and India. *Asian Journal of Agricultural Extension, Economics and Sociology,* **42:**61-67. https://journalajaees.com/index.php/AJAEES/article/view/2414.

Chand R, Saxena R and Rana S 2015. Estimates and analysis of farm income in India, 1983–84 to 2011–12. *Economic and Political Weekly* **50**:139–145. https://www.epw.in/journal/2015/22/special-articles/estimates-and-analysis-farm-income-india-1983-84-2011-12.html.

Coconut Development Board. Coconut export statistics. Government of India. Retrieved 15 February 2025, from https://coconutboard.gov.in/Statistics.aspx

India Brand Equity Foundation 2021. Coconut production and trade in India. *India Brand Equity Foundation.* https://www.ibef.org/exports/coconut-industry-india.

India Trade Portal 2022. India's coconut production and trade statistics. *India Trade Portal.* https://www.indiantradeportal.in/vs.jsp?lang=0&id=0,31,24100,29378#:~:text=India%20plays%20a%20prominent%20role,41%25%20from%20the%20previous%20year.

India Trade Portal 2025. Coconut industry overview. Retrieved 15 February 15 2025 from https://www.indiantradeportal.in/vs.jsp?id=0%2C31%2C24100%2C29378&lang=0

International Coconut Community Statistical Year Book 2021. https://coconutcommunity.org/page-publication/7/4.

Jayasekhar S and Jacob N 2021. Coconut sector in India at the crossroads: A brief narrative. *Indian Coconut Journal* **LXIII**:12–16. https://krishi.icar.gov.in/jspui/handle/123456789/51345.

Jose M and Padmanabhan M 2016. Dynamics of agricultural land use change in Kerala: A policy and social-ecological perspective. *International Journal of Agricultural Sustainability* **14:**307-324. https://doi.org/10.1080/14735903.2015.1107338

Kalamkar S, 2007. Agricultural Development and Sources of Output Growth in Maharashtra State, Working Papers id:860, eSocialSciences. https://ideas.repec.org/p/ess/wpaper/id860.html.

Kalidas K, Darthiya M, Malathi, P, and Thomas L 2014. Organic coconut cultivation in India—Problems and prospects. *International Journal of Scientific Research* **3**:14–15. https://www.researchgate.net/publication/272508945_Organic_Coconut_Cultivation_in_India_-_Problems_Prospects.

Kalidas K, Mahendran K and Akila K 2020. Growth, instability and decomposition analysis of coconut in India and Tamil Nadu, India: A time series comparative approach. *Journal of Economics, Management and Trade,* **26**: 59-66. DOI: 10.9734/jemt/2020/v26i330238

Kappil S R, Aneja, R and Rani P 2021. Decomposing the performance metrics of coconut cultivation in the South Indian states. *Humanities and Social Sciences Communications* **8:**114. https://doi.org/10.1057/s41599-021-00783-0.

Kumar B M 2006. Land use in Kerala: Changing scenarios and shifting paradigms. *Journal of Tropical Agriculture* **43:**1–12. https://jtropag.kau.in/index.php/ojs2/article/view/125.

Narmadha N and Karunakaran K R 2022. Growth performance of coconut production in global scenario: A quin-decadal analysis. *Journal of Experimental Agriculture International* **44:**7–15. DOI: 10.9734/jeai/2022/v44i1130902.

Narmadha N, Karunakaran K R, Anjugam M, Palanisamy N V and Vasanthi R 2022. An economic analysis on Indian scenario of coconut production: Trends and prospects. *Economic Affairs* **67:**263–269. https://economicaffairs.co.in/Journal/abstract/id/NTMyOQ==.

National Horticulture Board 2018. Horticultural statistics at a glance 2018. *Ministry of Agriculture and Farmers Welfare, Government of India.* Retrieved from https://nhb.gov.in/statistics/Publication/Horticulture%20Statistics%20at%20a%20Glance-2018.pdf

Sharma H R and Subramanyam P 1984. Sources of output growth in major crops in semi-arid tropical India. *Indian Journal of Agricultural Economics* **39:**465–474. DOI:10.63040/25827510.2023.01.002.

Singh A and Patel S 2020. State-wise analysis of agricultural growth in India: Challenges and opportunities. *Asian Journal of Agricultural Research* **15:**89-102. https://www.scialert.net/jindex.php?issn=1819-1894.

Received: March 10, 2025 Accepted: May 08, 2025