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An analytical study on the growth, instability and decomposition of area, production and productivity of major oil crops in Theni District, Tamil Nadu

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Abstract

This study analyzed the growth, instability and decomposition of area, production and productivity of major oil crops (Groundnut, Sesamum and Coconut) in Theni district, Tamil Nadu, during 2003–04 to 2022–23 using secondary data. Compound Growth Rate (CGR), Cuddy–Della Valle Instability Index (CDVI) and decomposition analysis were employed. Groundnut recorded a decline in area (–1.65%), while production (1.88%) and productivity (3.70%) increased. Sesamum exhibited positive growth in area (3.07%), production (3.99%) and productivity (0.90%), whereas Coconut showed positive growth in area (2.47%) and production (0.60%) despite declining productivity (–1.82%). Productivity was the major contributor to production growth in Groundnut (343.99%) and Sesamum (82.85%), while area expansion dominated Coconut production (63.19%). Sesamum production exhibited the highest instability, whereas Coconut area remained the most stable. The study highlights the need for crop-specific technologies and improved management practices to enhance productivity and ensure sustainable oilseed production in Theni district.

Keywords: Groundnut, sesamum, coconut, CAGR, Cuddy–Della Valle instability index, decomposition Analysis

Introduction

Agriculture has long been the backbone of the Indian economy. Tamil Nadu is one of the leading agricultural states in India and ranks as the tenth largest state by area and the seventh most populous, accounting for about 6 per cent of the country's population. Theni district is one of the important agricultural districts of Tamil Nadu, where agriculture is the primary occupation. The district has favourable agro-climatic conditions for cultivating major oil crops such as groundnut, sesamum and coconut, which contribute significantly to the agricultural economy.

Oilseeds are an important component of India's agricultural sector, contributing to food and nutritional security as well as farmers' livelihoods. They are a major source of edible oils, dietary fats and energy, while also serving as important cash crops that generate rural income and employment.

India produced 12.18 million tonnes of edible oils during 2023–24, meeting only about 44 per cent of its domestic demand through domestic production. Although the country's dependence on edible oil imports has declined from 63.2 per cent in 2015–16 to 56.25 per cent in 2023–24, rising consumption continues to widen the gap between production and demand, highlighting the need to enhance domestic oilseed productivity ^[1]. Oil crop production in Theni plays a vital economic and agricultural role, utilizing roughly 10% of the district's cultivated land.

Review of Literature

Kalidas *et al.*, (2020) ^[6] analyzed the growth, instability and decomposition of coconut production in India and Tamil Nadu using secondary data for the period 2001–2019. The study employed Compound Annual Growth Rate (CAGR), Coppock's Instability Index and decomposition analysis. The results indicated positive growth in coconut production in India (0.74%), while Tamil Nadu showed a declining trend (–2.48%). The study also found that the area effect contributed more to production changes than the yield effect at both the national and state levels.

Joseph and Karunakaran (2022) ^[5] examined the growth and instability of major oilseed crops in India using data from 1989–90 to 2018–19. The study found that groundnut, rapeseed-mustard and soybean accounted for 86.42 per cent of the total oilseed area and 90.95 per cent of production. The compound growth rates of area, production and yield were positive throughout the study period. However, the instability in yield was highest for groundnut and soybean, indicating the need to improve productivity and stabilize production.

Dash *et al.*, (2023) ^[2] reported that the growth rate of groundnut area in Odisha declined significantly from 8.17% during the pre-liberalization period (1970–71 to 1995–96) to 0.13% in the post-liberalization period (1996–97 to 2019–20). In contrast, productivity growth improved from 1.26%

to 2.94%, indicating enhanced yield performance after liberalization. However, production growth decreased from 7.34% to 3.04%, primarily due to the reduction in cultivated area. The study concluded that improvements in productivity were insufficient to offset the decline in area, resulting in slower growth in overall groundnut production.

Objectives of the Study

- To analyze the growth rate and assess the extent of instability in the area, production and productivity of Major Oil Crops in Theni district, Tamil Nadu.
- To determine the relative contribution of area, yield and their interaction to the changes in Major Oil Crops in Theni district, Tamil Nadu.

Methodology

The present study assessed the growth, instability and production changes of major oil crops in Theni district, Tamil Nadu. The selected crops were Groundnut, Sesamum and Coconut. Secondary time-series data on area, production and yield for the period 2003–04 to 2022–23 were collected from the Area, Production and Yield Reports published by the Department of Economics and Statistics (DES), Government of Tamil Nadu. The data were analyzed using IBM SPSS Statistics.

1. Compound Growth Rate

Growth in area, production and yield was estimated using an exponential growth model:

$$Y = ab^t$$

Where,

Y = the area/production/productivity

t = time variable in years

a = constant and b = (1 + r)

Where,

r = Compound Growth Rate

The above equation takes the linear form by taking logarithms of both sides of the equation,

$$\ln y = \ln a + t \ln b.$$

Compound growth rate is computed using the following formula.

$$\text{Compound Growth Rate (CGR)} = (\text{Antilog}(\log_e b) - 1) * 100$$

Growth rates were estimated to assess the trend in area, production and productivity over time. In this study, the Compound Growth Rate (CGR) was used to measure the rate of increase or decrease in the major oil crops (Groundnut, Sesamum and Coconut) during the study period.

2. Instability index

The Cuddy–Della Valle Instability Index (CDVI) was used to measure the instability in area, production and yield of the major oil crops (Groundnut, Sesamum and Coconut) during the study period.

The Cuddy Della Valle index (CDVI) was calculated as follows:

$$\text{CDVI (\%)} = \text{C.V.} * \sqrt{1 - \text{Adj } R^2}$$

$$\text{Adj } R^2 = 1 - \left[\frac{(1 - R^2)(n - 1)}{N - k - 1} \right]$$

Where,

C.V. = Coefficient of Variation

R² = Coefficient of multiple determination

3. Decomposition analysis

The simple decomposition model was used to estimate the relative contribution of area, productivity and their interaction effect to the total change in production of the selected major oil crops (Groundnut, Sesamum and Coconut).

$$\text{Let, } P = A * Y$$

Where: 'P' is the production of major oil crops (Groundnut, Sesamum and Coconut);

'A' is the area under a major oil crops (Groundnut, Sesamum and Coconut);

'Y' is the yield of major oil crops (Groundnut, Sesamum and Coconut).

$$\text{Then, } P_0 = A_0 * Y_0 \text{ and } P_n = A_n * Y_n$$

Accordingly, the simple decomposition model was specified as:

$$P_n - P_0 = (Y_n - Y_0)A_0 + (A_n - A_0)Y_0 + (Y_n - Y_0)(A_n - A_0)$$

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

(ΔY) A_0 = Yield Effect, (ΔA) Y_0 = Area Effect, (ΔY)(ΔA) = Interaction Effect

Where:

'n' refers to current year and 'o' refers to base year of the study period.

Results and Discussion

1. Groundnut

As presented in Table 1, the area under Groundnut cultivation recorded a negative compound growth rate (CGR) of -1.65 per cent, indicating a gradual decline in cultivated area during the study period. However, production and productivity registered positive growth rates of 1.88 per cent and 3.70 per cent, respectively, suggesting that improvements in yield compensated for the reduction in area. The CDVI values further indicate that production (25.31 per cent) was slightly more unstable than productivity (25.07 per cent), while area (16.42 per cent) remained comparatively more stable.

As shown in Table 2, the productivity effect contributed 5,488.17 metric tonnes (343.99 per cent) to the net change in production, highlighting that yield improvement was the major source of production growth. In contrast, the area effect contributed -1,542.00 metric tonnes (-96.70 per cent), indicating that the reduction in cultivated area had a negative influence on production. Likewise, the interaction

effect contributed -2,351.55 metric tonnes (-147.29 per cent), further offsetting production gains. Nevertheless, the positive productivity effect outweighed these adverse effects, resulting in a net increase of 1,594.62 metric tonnes in Groundnut production.

2. Sesamum

Table 1 indicates that Sesamum cultivation experienced

positive growth in all three components during the study period. The compound growth rates for area, production and productivity were 3.07 per cent, 3.99 per cent and 0.90 per cent, respectively. The instability analysis shows that production (67.27 per cent) exhibited the highest variability, followed by area (37.26 per cent) and productivity (32.35 per cent), indicating considerable fluctuations in production over the years.

Table 1: Growth rate and instability of major oil crops Cultivation in Theni District during 2003-04 to 2022-23

Crop	Groundnut			Sesamum			Coconut		
	Area (In Hectares)	Production (In Metric tonnes)	Productivity (Metric tonnes / Hectare)	Area (In Hectares)	Production (In Metric tonnes)	Productivity (Metric tonnes / Hectare)	Area (In Hectares)	Production (In Nuts)	Productivity (Nuts / Hectare)
Mean	2119.60	5393.55	2.67	917.60	495.45	0.51	18,845.90	290,005,952.40	15,608.25
SD	398.56	1470.16	0.88	375.76	355.06	0.16	2796.66	67534622.96	3979.58
CGR (%)	-1.65	1.88	3.70	3.07	3.99	0.90	2.47	0.60	-1.82
CV	18.80	27.26	32.84	40.95	71.66	31.97	14.84	23.29	25.50
Adj R ²	0.237	0.138	0.417	0.172	0.119	-0.024	0.907	-0.032	0.137
CDVI (%)	16.42	25.31	25.07	37.26	67.27	32.35	4.53	23.66	23.69

According to Table 2, the productivity effect accounted for 142.02 metric tonnes (82.85 per cent) of the total increase in production, indicating that yield improvement was the principal factor responsible for output growth. The area effect contributed 16.17 metric tonnes (9.43 per cent), while the interaction effect contributed 13.23 metric tonnes (7.72 per cent). Overall, the combined effects resulted in a net increase of 171.42 metric tonnes, with productivity emerging as the dominant contributor.

3. Coconut

It is evident from Table 1 that the area under Coconut

cultivation expanded during the study period with a compound growth rate of 2.47 per cent. Production also registered a positive growth rate of 0.60 per cent, whereas productivity recorded a negative growth rate of -1.82 per cent, indicating a declining trend in yield over time. The instability analysis revealed that area (4.53 per cent) remained highly stable compared with production (23.66 per cent) and productivity (23.69 per cent), which showed relatively higher fluctuations.

Table 2: Relative Contribution of Productivity, Area and Interaction Effects to Output Growth of Major Oil Crops in Theni District during 2003-04 to 2022-23

Crop	Productivity Effect ($A_0 \Delta Y$)	Area Effect ($Y_0 \Delta A$)	Interaction Effect ($\Delta A \Delta Y$)	Net Change in Production
Groundnut (Metric tonnes)	5,488.17 (343.99%)	-1,542.00 (-96.70%)	-2,351.55 (-147.29%)	1,594.62
Sesamum (Metric tonnes)	142.02 (82.85%)	16.17 (9.43%)	13.23 (7.72%)	171.42
Coconut (Nuts)	39,934,711.44 (22.90%)	110,185,723.00 (63.19%)	24,261,061.92 (13.91%)	174,381,496.36

As evident from Table 2, the area effect contributed 110,185,723 nuts (63.19 per cent) of the total increase in production, making it the largest contributor to output growth. The productivity effect contributed 39,934,711.44 nuts (22.90 per cent), while the interaction effect accounted for 24,261,061.92 nuts (13.91 per cent). Thus, the increase in Coconut production was mainly attributed to the expansion of cultivated area, supported by improvements in productivity, resulting in a net increase of 174,381,496.36 nuts during the study period.

Conclusion

The present study examined the growth, instability and decomposition of area, production and productivity of Groundnut, Sesamum and Coconut in Theni district, Tamil Nadu, during 2003-04 to 2022-23. The results revealed contrasting growth patterns among the three crops. Groundnut recorded a decline in cultivated area (CGR: -1.65%), while production (1.88%) and productivity (3.70%) increased, indicating that improvements in yield offset the

reduction in area. Sesamum exhibited positive growth in area (3.07%), production (3.99%) and productivity (0.90%), whereas Coconut showed positive growth in area (2.47%) and production (0.60%), despite a decline in productivity (-1.82%). The decomposition analysis indicated that productivity was the major contributor to production growth in Groundnut (343.99%) and Sesamum (82.85%), while expansion of cultivated area was the dominant factor in Coconut production (63.19%). The instability analysis revealed that Sesamum production (CDVI: 67.27%) was the most unstable, followed by Groundnut production (25.31%), whereas Coconut area (CDVI: 4.53%) was the most stable during the study period.

The findings highlight the need for improved crop varieties, precision nutrient management, efficient irrigation, integrated pest management and climate-smart agricultural practices to enhance productivity in Groundnut and Sesamum. For Coconut, emphasis should be placed on scientific orchard management, balanced fertilization and efficient water management to improve productivity and

sustain production. These crop-specific technological and management interventions will support sustainable oilseed production and improve farm income in Theni district.

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