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Performance of sunflower in Andhra Pradesh: Growth, instability, and decomposition analysis

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Abstract

The present study examines the growth performance, instability and sources of output change in sunflower cultivation in YSR Kadapa district of Andhra Pradesh over the period 1991–2020. The analysis was carried out across three sub-periods and employed Compound Annual Growth Rate (CAGR), Cuddy–Della Valle Instability Index (CDVI) and decomposition analysis. Positive and significant growth in area (11.29%) and production (10.33%), negative and non-significant growth rate in yield (-0.86%) were recorded. The instability in area experienced relatively lower fluctuations (27.24%) than production (49.66%) and productivity (43.43%), shows that variability in production was mainly influenced by yield instability, it was stabilized through decomposition analysis which revealed that the productivity effect (95.22%) was the major contributor to changes than production than area effect (0.27%). The findings highlight that sustainable growth in sunflower production depends primarily on enhancing productivity attributing factors like developing of Farming System Specific (FSS) varieties and management practices.

Keywords: Growth, instability, decomposition, sunflower and YSR kadapa

Introduction

Sunflower seeds and their oil are highly valued for their adaptability and nutritional richness making them an essential component of the global agricultural supply. The oilseed sector contributes substantially to the agricultural economy of many countries by generating income for millions of farmers and supporting various downstream industries (Narayan 2016; Sharma 2018; Satishkumar *et al.* 2022; Kumar *et al.* 2023) [8, 12, 11, 6]. Growing health consciousness, increased preference for plant-based diets and rising demand for nutritious snacks have collectively driven significant expansion in the global sunflower seed market. Global production and trade dynamics further shape the market with major producing regions influencing supply, demand, and price fluctuations.

Globally, Russia is the leading producer of sunflower, contributing (32%) of the world's output with 16.9 (mt), followed by Ukraine with (25%) (13 mt) and the European Union (16%, 8.53 mt). Together, these regions account for nearly (73%) of global sunflower production, underscoring their dominance in international markets (www.fas.usda.gov). Within India, Karnataka has the largest

sunflower area (75 T ha), followed by Odisha (18.21 T ha) and Haryana (14.76 T ha). Karnataka also leads in production with 72.42 (TT), followed by Haryana (28.66 TT) and Odisha (22.87 TT). The highest productivity (Kg/ha) observed in Punjab (2,022), followed by Haryana (1,942) and Telangana (1,698) in the year of 2023-24 (Indiastat.com) [16].

Sunflower (*Helianthus annuus* L.) is a major oilseed crop (Sunandini and Devi 2020) [13] that plays a crucial role in meeting India's edible oil demand (Ramamurthy *et al.* 2022) [9]. However, its cultivation is not uniformly suitable across India's diverse Agro-climatic zones. High humidity and excessive rainfall predispose the crop to fungal diseases, while water scarcity and extreme temperatures during the flowering stage can cause poor pollination and reduced oil content. Additionally, unsuitable soil types such as waterlogged, overly dry, or saline soils limit its successful cultivation.

In Andhra Pradesh, the three-year average (2019–2021) sunflower area was highest in YSR Kadapa district (6.33 T ha), followed by Anantapur (3.67 T ha) and Kurnool (1.33 T ha), indicating a higher concentration of sunflower

cultivation in YSR Kadapa district (apagrisnet.com) [15]. Here, study was confined to Kadapa district. Notably, sunflower area in YSR Kadapa district increased sharply from 4,000 ha in 2019 to 9,000 ha in 2021, as presented in annexure. Objective of the study is to understand the production and productivity patterns, along with their variability, in the study area. In this context, the present study aims to analyse the growth performance, instability, and decomposition of sunflower cultivation in YSR Kadapa district of Andhra Pradesh.

Materials and Methods

Present study is based on district wise secondary data on area, production, and productivity of Sunflower for the period 1991-2020 was collected from Directorate of Economics and Statistics (DES) Andhra Pradesh. The total period was divided into three sub-period Period I (1991-2000), Period II (2001-2010) and Period III (2011-2020). Data for the study restricted up to the year 2020, as district bifurcation in Andhra Pradesh occurred in 2022. Inclusion of data beyond this period may introduce inconsistencies and uncertainty in the results. The CAGR, CDVI and decomposition analysis were employed to estimates growth rates, instability and area effect and yield effect on changes in production details given at annexure.

Compound Annual Growth Rate (CAGR)

Compound annual growth rates were used to estimate the growth pattern on area, production and productivity of Sunflower in YSR Kadapa district. The growth rate was estimated by using exponential trend model (Gade *et al.*, 2020 and Kaur & Sharma., 2024) [4, 5]. CAGR used to estimate the growth pattern on area, production and productivity of Sunflower were calculated by using log linear function.

$$Y_t = A(1+r)^t$$

where,
Y = the value for which growth rate is to be calculated.
t= time in years.
r= growth rate.

Taking log on both sides of above equation,

$$\text{Log } Y_t = \text{log } A + t \text{ log } (1+r)$$

Putting $\text{Log } Y_t = Y$, $\text{log } A = a$ and $\text{log } (1+r) = b$

$$Y = a + bt$$

$$1 + r = \text{exp}b$$

Finally, the CAGRs is computed by the following equation:
$$r = (\text{exp}b - 1) * 100$$

Cuddy and Della Instability Index

To assess the extent of instability in crop area, production, and productivity, the Cuddy-Della Valle Instability Index (Cuddy and Della Valle, 1978) [1] was used as a measure of variability.

$$CDVI = CV * \sqrt{(1 - \text{Adjusted } R^2)}$$

Where CV = coefficient of variation (in percent)
 R^2 = Coefficient of determination from a time trend regression adjusted by the number of degrees of freedom.

Decomposition Analysis

The initial structured method of breaking down the growth trend was introduced by Minhas and Vaidyanathan (1965) [7]. The decomposition of the growth of Sunflower crop has been investigated to measure the relative contribution of area, productivity and their combined effect to the total output change for the crops under consideration. Several scholars (Rehman and Salam, 2011; Devegowda *et al.*, 2019) [10, 2] have adapted and modified this model, presenting it as follows:

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

Where,
 ΔP = change in production, ΔA = change in area ($A_n - A_0$), ΔY = change in the yield ($Y_n - Y_0$), A_n = area in the current year, Y_n = yield in the current year, Y_0 = yield in the base year, A_0 = Area in base year,
Where, the first term is the productivity contribution, second term is the area contribution, and the last term is the interaction effect.

Results and Discussion

Table 1: Growth in area, production and Productivity of sunflower in YSR Kadapa district

S. No	Aspects	Period -I (1991-2000)	Period -II (2001-2010)	Period -III (2011-2020)	Overall (1991-2020)
1	Area (%)	22.18 **	7.46 *	0.77 NS	11.29 **
2	Production (%)	25.27 **	6.00 NS	5.79 NS	10.33 NS
3	Yield (%)	2.53 NS	-1.35 NS	4.97 NS	-0.86 NS

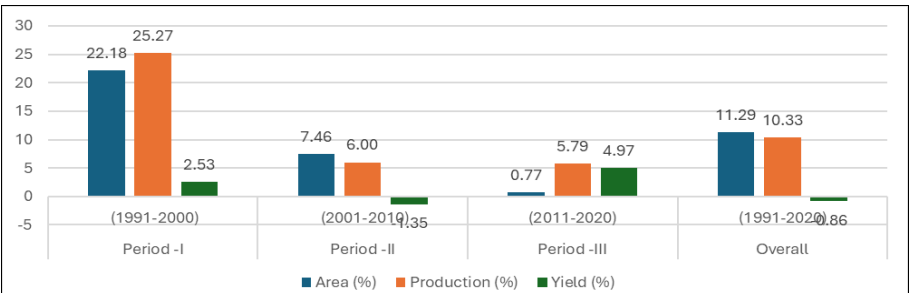


Fig 1: Growth in area, production and Productivity of sunflower in YSR Kadapa district

1. Growth in area, production and Productivity of sunflower in YSR Kadapa district

During Period I, area (22.18%) and production (25.27%) were significant, however, productivity growth (2.53%) was non-significant it revealed that production growth was largely driven by area expansion. In Period II, area was declined by 7.46 per cent, production growth (6%) was non-significant, while productivity (-1.35%) was non-significant growth. During Period III, area exhibited very low and non-

significant growth 0.77 per cent, indicating stagnation in acreage. Although production and productivity showed growth rates of 5.79 per cent and 4.97 per cent respectively. Over the overall period, sunflower area recorded a significant growth rate (11.29%), while production (10.33%) and productivity (-0.86%) growth rates were non-significant. This implies that long-term growth in production in the district was predominantly area-led rather than productivity-driven.

Table 2: Instability in area, production and Productivity of Sunflower in YSR Kadapa district

S. No	Aspects	Period -I (1991-2000)	Period -II (2001-2010)	Period -III (2011-2020)	Overall (1991-2020)
1	Area (%)	31.38	21.19	14.25	27.24
2	Production (%)	58.66	35.67	56.18	49.66
3	Yield (%)	38.88	41.26	53.54	43.43

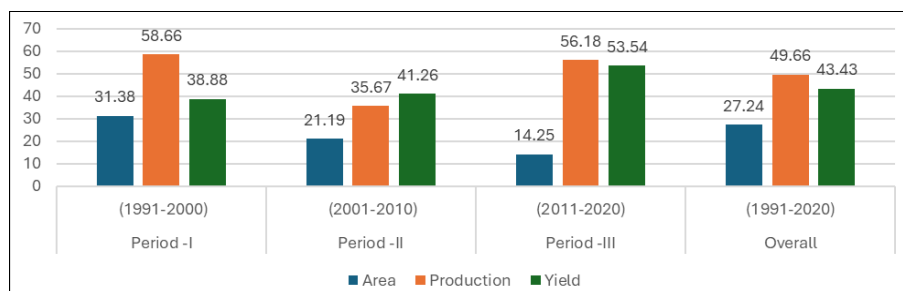


Fig 2: Instability in area, production and Productivity of Sunflower in YSR Kadapa district

2. Instability in Area, Production and Productivity of Sunflower in YSR Kadapa District

The instability in area of sunflower was high during Period I, (31.38%), indicating considerable fluctuations in acreage during the initial phase of sunflower expansion. The instability declined in Period II, (21.19%) and Period III, (14.25%), suggesting relatively better stability in area in recent years. However, the overall instability in area remained high with 27.24 per cent, reflecting long-term variability in farmers' area allocation decisions. The instability in production was very high in all the periods, with the highest instability observed in Period I, (58.66%). Instability declined in Period II, (35.67%), then increased again in Period III, (56.18%). The overall production instability was (49.66%), indicates highly unstable over time. The instability in productivity (yield) showed an

increasing trend over time. Yield instability was moderate during Period I, (38.88%), increased slightly in Period II, (41.26%), and reached a high level in Period III, (53.54%). The overall yield instability about 43.43 per cent, suggests that sunflower productivity was highly sensitive possibly due to rainfall variability, input use, and technological constraints. This result corroborates with the findings of Venkataramanamma *et al.* (2019) [14]. The overall results reveal that sunflower cultivation in YSR Kadapa district was characterized by high instability, particularly in production and productivity. While area instability declined over time, yield and production instability remained persistently high, emphasizing the need for yield-stabilizing technologies, drought-tolerant varieties, and improved crop management practices to ensure sustainable sunflower production.

Table 3: Growth – instability matrix, Overall Period (1991–2020)

S. No	Aspect	Growth (%)	Instability (%)	Category
1	Area	11.29	27.24	High Growth + Low Instability
2	Production	10.33	49.66	High Growth + High Instability
3	Yield	-0.86	43.43	Low Growth + High Instability

Area showed high growth with low instability, indicating stable expansion of sunflower cultivation. Production recorded high growth but high instability, indicating risky

expansion of crop. Yield showed negative growth with high instability, indicating vulnerable condition.

Table 4: Area effect, yield effect on changing production of Sunflower in YSR Kadapa district

S. No	Aspects	Period -I (1991-2000)	Period -II (2001-2010)	Period -III (2011-2020)	Overall (1991-2020)
1	Area effect (%)	2.97	-29.39	61.51	0.27
2	Yield effect (%)	84.53	147.66	27.79	95.22
3	Interaction effect (%)	12.49	-18.27	10.70	4.52

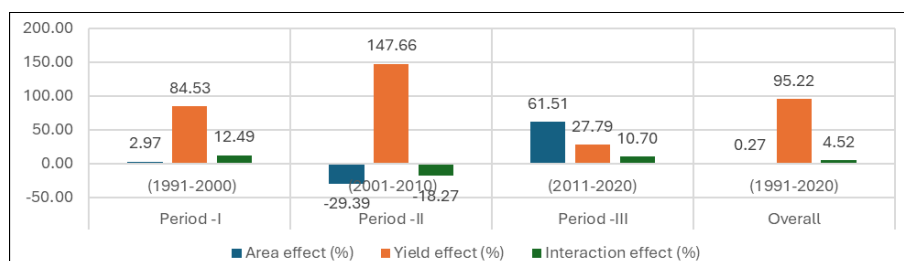


Fig 3: Area effect, yield effect on changing production of Sunflower in YSR Kadapa district

3. Area effect, yield effect on changing production of Sunflower in YSR Kadapa district

During Period I, the yield effect (84.53%) was the dominant contributor for change in Production over area effect (2.97%) and interaction effect (12.49%). This indicates that production growth during the initial period was largely driven by improvements in productivity rather than expansion in area. In period II, the yield effect was (147.66%), while the area effect (-29.39%) and interaction effect (-18.27%) were negative. This shows that the decline in area was offset by the improvements in yield resulting in overall increase in production. During Period III, the area effect emerged as the major contributor (61.51%), followed by the yield effect (27.79%) and the interaction effect (10.70%). This shift indicates that recent changes in sunflower production were mainly influenced by variations in cultivated area rather than yield improvements. For the overall period, the yield effect remained the most significant contributor (95.22%), whereas the area effect (0.27%) and interaction effect (4.52%) were minimal. This shows that long-term changes in production were predominantly driven by productivity changes rather than area expansion.

The decomposition highlights that yield improvements played a crucial role in influencing production over the long run, although short-term variations was influenced by area. Strengthening productivity-enhancing interventions, such as improved hybrids, efficient input management, and climate-resilient practices, is essential for achieving stable and sustainable sunflower production in the district.

Annexure. Area under sunflower in major growing districts of Andhra Pradesh (000 Ha)

District	2019	2020	2021	Average
YSR Kadapa	4	6	9	6.33
Anantapur	2	4	5	3.67
Kurnool	1	1	2	1.33

Conclusion

The results revealed that sunflower cultivation in the YSR district experienced significant expansion in area during the initial period, which largely contributed to production growth. However, in recent years, area expansion stagnated and production growth became inconsistent and statistically non-significant, indicating structural weaknesses in the production system. The instability analysis showed that sunflower production and productivity were highly unstable across all periods, while area instability declined over time. The decomposition analysis confirmed that yield effect was the dominant contributor to changes in production over the long run. Although area played a role in certain sub-periods, productivity improvements were the key driver of

sustainable production growth. This study concludes that the future growth of sunflower cultivation in YSR Kadapa district cannot rely on area expansion alone. Enhancing and stabilizing productivity through improved hybrids, efficient input use, adoption of climate-resilient technologies, and strengthened extension services is crucial for ensuring stable and sustainable sunflower production. Policy interventions should therefore focus on yield-augmenting and risk-mitigating strategies rather than acreage expansion.

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