

International Journal of Agriculture Extension and Social Development

Volume 8; Issue 11; November 2025; Page No. 130-134

Received: 26-08-2025
Accepted: 29-09-2025

Indexed Journal
Peer Reviewed Journal

A study on growth, instability, and decomposition analysis of Bengal gram in YSR Kadapa District, Andhra Pradesh

¹CH Satish Kumar, ²M Rama Krishna, ³H Srinivasa Rao and ⁴G Raghunadha Reddy

¹Cost of Cultivation Scheme, Regional Agricultural Research Station (RARS), Tirupati, Acharya N. G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh, India

²Cost of Cultivation Scheme, Regional Agricultural Research Station (RARS), Nandyal. Acharya N. G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh, India

³Department of Agricultural Economics, Agricultural College, Rajamahendravaram, Acharya N. G. Ranga Agricultural University, Andhra Pradesh, India

⁴Department of Agricultural Economics, MGR Agricultural College, Udayagiri, Acharya N. G. Ranga Agricultural University, Andhra Pradesh, India

DOI: <https://www.doi.org/10.33545/26180723.2025.v8.i11b.2627>

Corresponding Author: CH Satish Kumar

Abstract

The present study analyses the growth performance, instability, and sources of output change in Bengal gram cultivation in YSR Kadapa district of Andhra Pradesh over the period of 1991 to 2023. The study period divided into three sub-periods: Period I (1991- 2001), Period II (2002-2012), and Period III (2013-2023), representing the overall study period (1991-2023). Compound annual growth rate (CAGR), Cuddy-Della Valle Index (CDVI) and Decomposition analysis were opted for the present study. CAGR revealed a significant increase in area (9.37%) and production (9.15%), while productivity growth remained statistically non-significant (-0.19%), indicating stagnation in productivity despite area expansion. CDVI showed high fluctuations were seen in production 47.99 and productivity 41.67, and moderate instability noticed in area 31.90. Decomposition analysis highlighted that productivity effect (122.93%) was the major contributor to changes in production over the long term, while area effect (-2.89%) and interaction effect (-20.64%) had negative impacts. These findings suggest that production growth was primarily driven by productivity improvements in some periods but lacked consistency across decades. The study underscores the need for productivity-enhancing technologies, improved crop management practices, and strategies to reduce productivity and production instability for sustaining Bengal gram cultivation in the region.

Keywords: CAGR, instability, decomposition, Bengal gram and YSR Kadapa

Introduction

Continuous changes occurring in agricultural technology, environmental conditions, agricultural practices may have influence on growing area, production and productivity of agricultural crops. The present study focused on Bengal gram crop which belongs to category of pulses. Pulses are annual leguminous crops, besides serving as an important source of protein for a large portion of the global population, it contributes to healthy soils and climate change mitigation through their nitrogen-fixing properties. India ranked first in area and production with (38%) and (28%) respectively of world area and production of pulses (DPD.gov.in 2022). Major pulses grown in India are Bengal gram (chickpea), red gram (tur), lentil (masoor), green gram (mung), and black gram (urad).

Bengal gram contribute nearly (50%) of India's pulse production. India ranks first in Bengal gram area (73%) and production (75%) at Global level followed by Australia, Turkey and Ethiopia. Among the major producing countries, the highest productivity is observed in Ethiopia (2170

kg/ha), followed by Australia (1725 kg/ha), the Russian Federation (1358 kg/ha), Myanmar (1315 kg/ha), and India (1261 kg/ha) (DPD.gov.in 2022). The major producing states of Bengal gram are Maharashtra (2.63 mha), Madhya Pradesh (2.35 mha), Rajasthan (1.94 mha), Uttar Pradesh (0.68 mha), Karnataka (0.96 mha), and Gujarat (0.63 mha) (ANGRAU Crop Outlook 2023-24) ^[1].

Among the major Bengal gram producing states, Andhra Pradesh ranks 8th in cultivation area with 2.8 lakh hectares and is estimated to produce 3.21 lakh tonnes, contributing (2.8%) to India's total production, with a productivity of 1061 kg/hectare in 2023-24 (3rd AE, DESAP). Across the Bengal gram-growing districts of Andhra Pradesh, YSR Kadapa recorded the highest three-year (2022-2024) average area under cultivation (58,634.67 ha), followed closely by Anantapuram (57,246.33 ha), Nandyal (51,548.33 ha) and Kurnool (46,448.00 ha), respectively. The sharp fluctuation in Bengal gram area in YSR Kadapa district (from 28,621 ha in 2023 to 74,619 ha in 2024) raises questions about the underlying causes of such variations.

Same scenario was observed in production aspects of Bengal gram crop in the study area. Researchers are keen to know whether this fluctuation is a random occurrence or part of a continuing trend. Considering this background, the

present study focuses on analysing the growth, instability, and decomposition of Bengal gram cultivation in YSR Kadapa district of Andhra Pradesh.

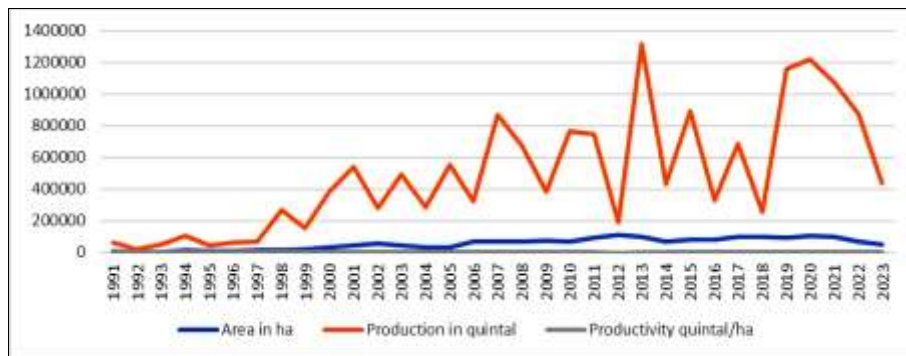


Fig 1: Trends in area, production and productivity of Bengal gram in YSR Kadapa district

Methodology

Data Collection

For the present study secondary data on area, production, and productivity of Bengal gram of YSR district collected from DES Andhra Pradesh. The study period divided into three sub-periods: Period I (1991- 2001), Period II (2002-2012), and Period III (2013-2023), representing the overall study period (1991-2023). It examined trends in the area, production, and productivity of Bengal gram of YSR district to assess growth patterns and variability. The CAGR was employed to evaluate long-term trends, while the CDVI measured fluctuations in these factors. Furthermore, Decomposition Analysis was used to identify key drivers influencing changes in Bengal gram production in YSR district.

Compound Annual Growth Rate (CAGR)

Compound annual growth rates were used to estimate the growth pattern on area, production and productivity of Bengal gram production in YSR district. The growth rate was estimated by using exponential trend model (Gade *et al.*, 2020 and Kaur & Sharma., 2024) [6, 7].

Exponential trend equation: $Y = abt$.

It was converted into log linear function with the help of log arithmetic transformation as under:

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

Where,

Y = Dependent variable (area, production and productivity etc.)

a = Intercept

b = regression coefficient/ (1 + r)

t = Year

r = Compound growth rate/ (Antilog b) -1 The percent compound growth rate (r) will be as,

$$r = [(Anti \log of b) - 1] \times 100$$

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) [2] was used as a measure of variability. The formula suggested by Cuddy and Della Valle (1978) [2] is applied to calculate the degree of variation around the trend as follows:

Cuddy Della Valle Instability Index (CDVI)

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

Where,

CV = Co-efficient of variation

R² = 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) [8]. The decomposition of the growth of Bengal gram 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; Sharma *et al.*, 2017; Devegowda *et al.*, 2019) [9, 10, 3] have adapted and modified this model, presenting it as follows:

$$\Delta p = \frac{A_0 \Delta Y}{\Delta P} * 100 + \frac{Y_0 \Delta A}{\Delta P} * 100 + \frac{Y_0 P_0}{\Delta P} * 100$$

Change in Production = Productivity Effect + Area Effect + Interaction Effect

Where, $\Delta A = A_n - A_0$

$\Delta p = P_n - P_0$

$\Delta Y = Y_n - Y_0$

A₀, Y₀ and P₀ are the values of area, production and productivity of the Bengal gram crop in the base year respectively and A_n, P_n and Y_n are values of area, production and productivity of the Bengal gram crop in the current period respectively. Thus, the total change in production can be decomposed into productivity effect, area effect and their combined interaction, i.e., change in production due to change in area and productivity.

Results and Discussion

Table 1: Compound annual growth rates in area, production and Productivity of Bengal gram in YSR Kadapa district

S. No	Aspects	Period -I	Period -II	Period -III	Overall
		(1991-2001)	(2002-2012)	(2013-2023)	(1991-2023)
1	Area (%)	23.94**	9.67**	-2.03 ^{NS}	9.37**
2	Production (%)	28.68**	2.37 ^{NS}	0.95 ^{NS}	9.15**
3	Productivity (%)	3.82 ^{NS}	-6.66 ^{NS}	3.02 ^{NS}	-0.19 ^{NS}

Note: ** Statistically significant at 1% level, NS- statistically non-significant

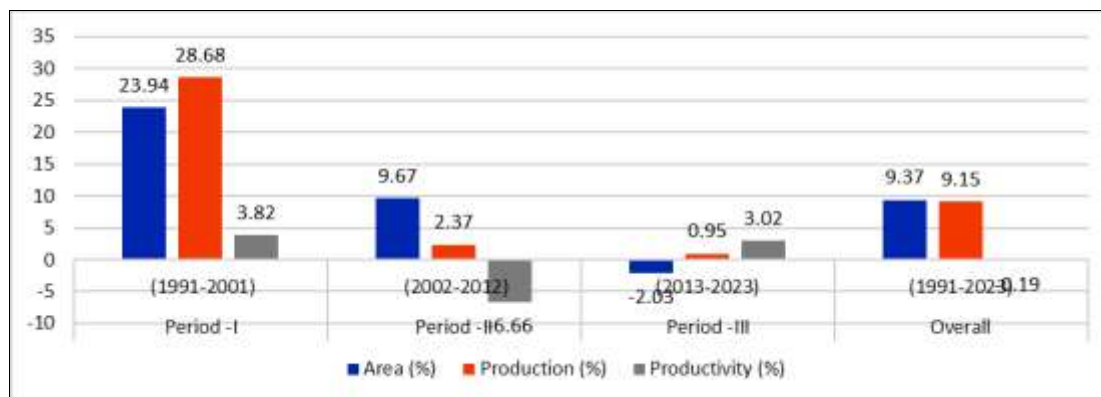


Fig 2: Compound annual growth rates in area, production and Productivity of Bengal gram in YSR Kadapa district

The CAGR provides a consistent rate at which a variable (area, production and productivity) has grown or declined over time shown in Table 1 and Fig 2. The CAGR for the area under Bengal gram cultivation in YSR Kadapa district showed a strong upward trend during the initial decades. During Period-I (1991-2001), the area under Bengal gram cultivation recorded a high CAGR of (23.94%), indicating a phase of rapid expansion. In Period-II (2002-2012), the area growth slowed to (9.67%), suggesting a moderate increase. However, in Period-III (2013-2023), the area declined with a negative CAGR of (-2.02%), pointing to a contraction in sown area. Over the overall period (1991-2023), the area showed a moderate CAGR of (9.37%), driven largely by early growth. The area initially expanded rapidly but saw a decline in recent years, likely due to cropping pattern shifts or unfavourable conditions.

Production witnessed a strong CAGR of (28.67%) in Period-I, likely due to both area expansion and moderate productivity improvements. In Period-II, growth slowed considerably to (2.37%). In Period-III, production growth nearly stagnated with a CAGR of just (0.95%). The overall production CAGR (1991-2023) stood at (9.15%). Early

growth in production was robust, but subsequent periods reflected stagnation, driven by declining area and unstable productivities.

The growth in productivity remained inconsistent and statistically non-significant throughout the study period. In Period-I, productivity rose slightly by (3.82%), but in Period-II, it was declined by (-6.66%), indicating a possible drop in productivity due to unfavourable Agro-climatic or management factors. In Period-III, productivity growth recovered marginally to (3.02%), yet remained non-significant. Over the entire period (1991-2023), the CAGR of productivity was (-0.19%), reflecting a long-term stagnation or slight decline in productivity, which highlights the need for technological interventions, improved crop management strategies and improved high yielding varieties. Over the 33-year study period, Bengal gram cultivation in YSR Kadapa district showed a significant increase in both area and production, while productivity remained stagnant. The growth in production was mainly the result of area expansion rather than improvements in crop productivity.

Table 2: Cuddy Della Valle Index in area, production and Productivity of Bengal gram in YSR Kadapa district

S. No	Aspects	Period -I	Period -II	Period -III	Overall
		(1991-2001)	(2002-2012)	(2013-2023)	(1991-2023)
1	Area	31.57	20.80	20.05	31.90
2	Production	55.86	45.33	48.46	47.99
3	Productivity	36.18	47.32	39.92	41.67

The CDVI was used to measure the instability in the area, production, and productivity of Bengal gram in YSR Kadapa district over different periods depicted in table 2 and Fig 3. The instability in area was highest during Period-I (1991-2001) at 31.57, indicating significant fluctuations in the cultivated area of Bengal gram during the early decade. It declined to 20.80 in Period-II and slightly decreased

further to 20.05 in Period-III (2013-2023), suggesting a more stable cropping pattern in recent years. However, the overall instability in area over the entire period (1991-2023) was 31.90, slightly higher than Period-I, indicating that despite short-term stability, long-term fluctuations were considerable.

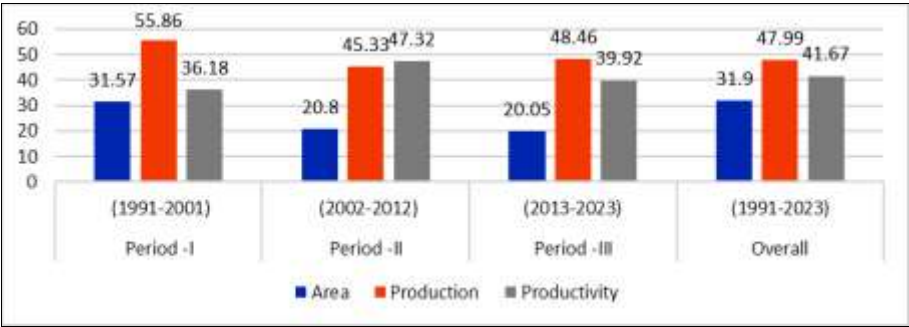


Fig 3: Cuddy Della Valle Index in area, production and Productivity of Bengal gram in YSR Kadapa district

Production exhibited very high instability, with CDVI values of 55.86 in Period-I, 45.33 in Period-II, and 48.46 in Period-III. This reflects consistent volatility in production, likely influenced by variability in area, climatic factors, and productivity performance. The overall production instability for the full period stood at 47.99, indicating that production remained highly unstable throughout, posing a challenge for consistent output levels and planning. Productivity also showed noticeable fluctuations, with 36.18 instability in Period-I, increasing to 47.32 in Period-II, which was the highest among all periods, and then slightly reducing to 39.92 in Period-III. The overall instability in

productivity (1991-2023) was 41.67, suggesting that productivity has remained considerably unstable, which could be attributed to inconsistent input use, climatic risks, or lack of improved technology adoption by opting traditional method of cultivation. The CDVI analysis indicates that production was the most unstable component, followed by productivity and then area. While some decline in area instability was observed over time, productivity and production remained highly volatile, underscoring the need for stabilizing production through improved technology, better risk management practices, and climate-resilient crop strategies.

Table 3: Decomposition analysis in area, production and Productivity of Bengal gram in YSR Kadapa district

S. No	Aspects	Period -I	Period -II	Period -III	Overall
		(1991-2001)	(2002-2012)	(2013-2023)	(1991-2023)
1	Area effect (%)	2.04	205.47	49.19	-2.89
2	Productivity effect (%)	85.14	-326.43	75.93	122.93
3	Interaction effect (%)	12.82	220.97	-24.86	-20.64

To understand the contribution of various components to the change in Bengal gram production, and this approach segregates the total change in production into three effects:

Area Effect, Productivity Effect, and Interaction Effect (combined influence of changes in area and productivity) in YSR Kadapa district shown in Table 3 and Fig 4.

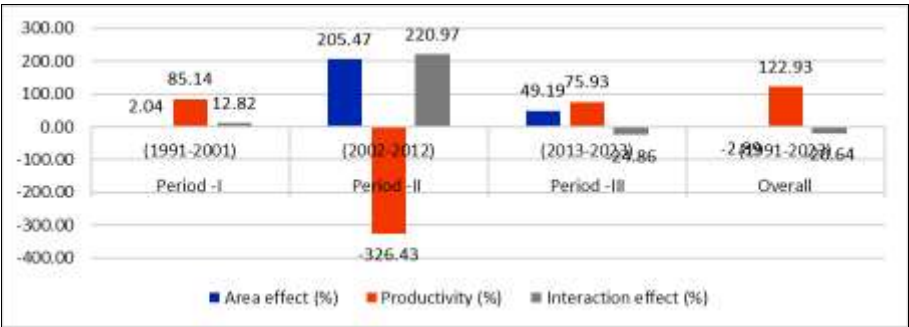


Fig 4: Decomposition analysis in area, production and Productivity of Bengal gram in YSR Kadapa district

During Period-I (1991-2001), the productivity effect contributed the most to production growth at (85.14%), indicating that improvements in productivity were the primary driver of increased output. The area effect contributed (2.04%), while the interaction effect (which captures the combined influence of simultaneous changes in area and productivity) accounted for (12.82%). This shows that productivity improvements were significant in driving production gains during the early decade. In Period-II (2002-2012), there was a shift in contribution patterns. The area effect increased substantially to (205.47%), showing that production growth was mainly due

to expansion in cultivated area. However, the productivity effect turned highly negative at (-326.43%), indicating a strong decline in productivity, which significantly offset gains from area expansion. The interaction effect, at (220.97%), was also strongly positive, reflecting the combined influence of area and minor productivity variations. The negative productivity effect shows serious inefficiencies or unfavourable conditions affecting crop productivity during this time. In Period-III (2013-2023), the productivity effect (75.93%) again became the dominant contributor to production growth, while the area effect (49.19%) played a moderate

role. However, the interaction effect (-24.86%) was negative, suggesting that the combined change in area and productivity had an adverse influence on overall production. Considering the Overall Period (1991-2023), the productivity effect remained the dominant contributor to production change, accounting for (122.93%) of the variation, emphasizing the importance of productivity gains over the long term. In contrast, the area effect (-2.89%) had a slightly negative impact overall, indicating that area expansion did not consistently support production increases. The interaction effect (-20.64%) was also negative, implying that the simultaneous changes in area and productivity often worked against each other.

Conclusion

Results of the study revealed that, area and production showed significant growth over the overall period. However, productivity growth remained statistically non-significant, highlighting stagnation in productivity improvements. Bengal gram production exhibited high instability followed by productivity and area. While area instability declined in recent decades, productivity and production fluctuations remained high, indicating vulnerability to external factors such as climate, technology gaps, or input variation. The productivity effect was the major contributor to production change across the overall period. In contrast, the area effect was slightly negative, and the interaction effect also contributed negatively. This implies that productivity improvements had a strong positive impact, while area expansion was inconsistent and at times ineffective. Despite notable growth in area and production, Bengal gram cultivation in YSR Kadapa district continues to face challenges due to unstable productivity performance and high production volatility. The findings emphasize the need for targeted interventions to enhance productivity stability, promote climate-resilient practices, and improve input efficiency to ensure sustainable production in the long run.

References

1. ANGRAU. Bengal gram outlook report: June to May (2023-24). Andhra Pradesh: Acharya N.G. Ranga Agricultural University; 2024.
2. Cuddy JD, Della Valle PA. Measuring the instability of time series data. *Oxf Bull Econ Stat.* 1978;40(1).
3. Devegowda SR, Singh OP, Yazarari SP, Kushwaha S. Effect of area and yield on the production of pulses in India. *Pharma Innov J.* 2019;8(4):436-439.
4. Directorate of Economics and Statistics, Andhra Pradesh. Statistical report 2023-2024. Government of Andhra Pradesh; 2024.
5. Directorate of Pulses Development (DPD). Pulses development data and reports. 2022 <https://dpd.gov.in>
6. Gade PA, More SS, Shelke RD, Nalegaonkar AR. Growth and instability in area, production and yield of chilli in India. *Int J Curr Microbiol Appl Sci.* 2020;9(11):2647-2654.
7. Kaur K, Sharma S. Analysis of growth rate and instability index of potato crop in Punjab. *J Agric Dev Policy.* 2024;34(1):132-139.
8. Minhas B, Vaidyanathan A. Growth of crop output in India, 1951-54 to 1958-61: An analysis by component elements. *J Indian Soc Agric Stat.* 1965;27(2):230-252.
9. Rehman F, Saeed I, Salam A. Estimating growth rates and decomposition analysis of agricultural production in Pakistan: Pre and post SAP analysis. *Sarhad J Agric.* 2011;27(1):125-131.
10. Sharma A, Dey A, Devegowda SR, Gautam Y, Kumareswaran T. Growth, instability and decomposition in area, production, and productivity of horticultural crops in North-East India. *J Hortic Sci.* 2022.
11. Chan SKY, Aparna B, Rao IVYR, Prakash KK. Farmer preferences for Bengal gram varietal attributes: A conjoint analysis in Kurnool District of Andhra Pradesh. *Int J Agric Ext Soc Dev.* 2025;8(6):175-179.