Full Length Research Article

© 2025, Centre for Advanced Research in Agricultural Sciences
Research Journal of Agricultural Sciences
Volume 16; Issue 03 (May–Jun 2025); pp 322–326

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Pulses Growth, Instability and Crop Diversification: A Study in Guntur District of Andhra Pradesh

T. Ramadevi[1] and N. R. V. Ramana Reddy*[2]

[1-2] Department of Economics, Vikrama Simhapuri University, SPSR Nellore - 524 324, Andhra Pradesh, India

Received: 19 May 2025; Revised accepted: 26 June 2025

Abstract

Pulses are an essential source of plant-based protein, fiber, vitamins, and minerals, playing a vital role in nutritional security and sustainable agriculture. This study examines the growth, instability, and crop diversification of pulses in Guntur district, Andhra Pradesh, as they are extensively grown and contribute significantly to farmers' incomes. A simple regression growth model, Cuddy Della Valle instability index and Herfindahl index are considered to assess and analyze the growth, instability and crop diversification of pulses. The findings indicate fluctuating growth trends in production, a gradual increase in yield, and moderate instability in area and production, while yield showed low to moderate instability. Crop diversification analysis revealed a shift from moderate to complete diversification in this study period.

Key words: Pulses, Protein, Fiber, Vitamins, Minerals, Instability, Coefficient of variation, Cuddy-Della Valle index, Crop diversification, Herfindahl index

Pulses, the edible seeds of leguminous plants, hold immense nutritional and agricultural importance. These crops include a variety of beans, lentils, chickpeas, peas, and others, and are cultivated extensively across the globe for both human and animal consumption [1]. Pulses are highly valued for their rich nutritional content, offering an excellent source of plant-based protein, dietary fiber, essential vitamins (such as folate and B-complex vitamins), and minerals (like iron, zinc, and magnesium). This makes them a vital component of diets in many regions, particularly in developing and vegetarian-dominant countries like India, where they serve as the primary protein source and help combat malnutrition and protein-energy deficiency [2-3].

Agronomically, pulses play a pivotal role in sustainable farming systems. Being nitrogen-fixing crops, they have the unique ability to convert atmospheric nitrogen into a form usable by plants through symbiotic relationships with rhizobium bacteria in their root nodules. This natural process reduces the need for synthetic nitrogen fertilizers, enhances soil fertility, and supports healthier crop yields in subsequent planting cycles [4]. Consequently, pulses are often integrated into crop rotation systems to maintain soil health and improve agricultural productivity, as they play a vital role in sustainable farming. Being leguminous plants, pulses have the unique ability to fix atmospheric nitrogen through symbiotic relationships with Rhizobium bacteria in their root nodules. This natural process enriches the soil with nitrogen, reducing the need for chemical fertilizers for subsequent crops. Additionally, pulses help break pest and disease cycles. In addition to their environmental and nutritional benefits, pulses contribute to food security and economic stability, particularly for smallholder farmers. Their drought-tolerant nature and adaptability to marginal soils make them suitable for cultivation in arid and semi-arid regions, offering a resilient food source amid climate variability. Overall, pulses are indispensable not only for dietary diversity and human health but also for ecological sustainability and soil conservation in modern agricultural practices [5].

Guntur district plays a crucial role in Andhra Pradesh agricultural sector, making a significant contribution to its overall output of pulses. With fertile soils, diverse cropping patterns, and extensive irrigation infrastructure, Guntur stands as one of the most agriculturally dynamic regions in the state. The district reflects the broader agricultural growth trends of Andhra Pradesh while also showcasing distinct patterns in the cultivation of key crops. Over the years, Guntur has been a leading producer of pulses, primarily cultivating Red Gram, Black Gram, Green Gram, Bengal Gram, and Horse Gram [6].

Rekha Rani *et al*. [7] analyzed the growth performance of mung bean production in Madhya Pradesh, using Compound Annual Growth Rate (CAGR), Cuddy Della Valle Index (CDVI) for instability analysis, and Decomposition Analysis to assess the sources of growth. Sarada and Kumar [8] studied the adoption and spread of ANGRAU-recommended black gram and green gram production technologies in Guntur district, Andhra Pradesh. Singh *et al*. [9] analyzed the production trends of pulses in India using compound annual growth rate (CAGR) based on secondary data. Sadhanala *et al*. [10] calculated the growth trends in area, production, and productivity of major pulses in India using compound growth rate (CGR) and decadal growth rate analysis. Gaur [11] study aims to study the farmers ability to sustain the high growth of pulses production by examining trends, contributing factors, and future opportunities and employed (CAGR) for growth analysis. Kumari and Malik [12] analyzed the growth and instability in mung bean

***Correspondence to:** N. R. V. Ramana Reddy, E-mail: nrvramanareddyvsu@gmail.com; Tel: +91 9848167366

Citation: Ramadevi T, Ramana Reddy NRV. 2025. Pulses growth, instability and crop diversification: A study in Guntur district of Andhra Pradesh. *Res. Jr. Agril. Sci*. 16(3): 322-326.

production in India using compound growth rate (CGR) and Cuddy-Della Valle Index (CDVI) based on long-term trends in area, production, and yield. Pradhan and Dash [13] studied the growth and instability of rabi green gram production in Odisha using secondary data and the study employed compound growth rate (CGR) analysis and the Cuddy-Della Valle Index to assess the trends and fluctuations in area, production, and yield across different districts.

Prioty *et al*. [14] observed the growth and instability of minor pulses in Bangladesh from 1981 to 2020 using an exponential growth function and the Cuddy-Della Valle Index. Mishra *et al*. [15] analyzed the growth and instability of major Kharif pulse crops—pigeon pea, green gram, and black gram—in Madhya Pradesh, employing the exponential trend function to calculate the compound growth rate and Cuddy-Della Valle Index to assess instability. Singh and Bansal [16] have their study with the growth and instability of pulse cultivation in Punjab from 1985-86 to 2017-18 using CGR, Coefficient of Variation, CDI, and CII. Meena *et al*. [17] analyzed crop diversification in Haryana from 2004-05 to 2011-12 and its impact on farmers' income. Kapoor and Tomar [18] conducted a spatial analysis of crop diversification in Indian agriculture using Simpson's Crop Diversification Index. The study examined the status and trends of diversification across different states in India, utilizing secondary data. Tiwari, Choudhary, and Shrey [19] analyzed crop diversification trends in the northern hills of Chhattisgarh, using the Simpson Diversity Index and the Herfindahl Index. Jose, Ponnusamy, and Kamboj [20] evaluated the efficiency of farm diversification in Haryana and assessed diversification efficiency using the Benefit-Cost Ratio (BCR). Ray [21] analyzed crop concentration and crop diversification in Birbhum district, West Bengal, using Bhatia's crop concentration index and Gibbs and Martin's Diversification Index.

Significant advancements in irrigation, fertilizer use, adoption of high-yielding varieties, implementation of modern technology and scientific agricultural practices of pulses (Red Gram, Black Gram, Green Gram, Bengal Gram, and Horse Gram) cultivation boosted in production and productivity in large extent in Andhra Pradesh. The study aims to examine the growth, instability and crop diversification of pulses in Guntur district for the period of twenty-two years, secondary data from 2000-01 to 2021-22 collected from various seasonal and crop reports published by the Government of Andhra Pradesh.

MATERIALS AND METHODS

(i) *Growth model*

To fulfil the aim and objectives of the present research, the following Linear Regression Model has been considered to analyze area, output and yield growth of cereals crops for aggregate data analysis:

$$Y = a + bT$$

Where;

Y = Area / Production / Yield

a is the intercept of the equation

b denotes the coefficient of time (T), the independent variable

T = Independent variable time

The Linear Growth Rate in percent is calculated as:

$$\text{L.G.R} = \left(\frac{\hat{b}}{\bar{Y}}\right) \text{ x } 100$$

$\hat{b}$ represents the estimated value of 'b' and is tested using the student t-test statistic.

$$t = \frac{\hat{\hat{b}}}{S.E\,(\hat{b})}$$

Where;

$$\text{S.E}(\hat{b}) = \sqrt{\frac{\sum(Y-\bar{Y})^2}{N}}D$$

To assess the instability in area, output, and yield of the selected crops, the Coefficient of Variation (CV) was computed using the following formula:

$$\text{C.V.} = \frac{\sigma}{\bar{Y}} \text{ x } 100$$

Where;

σ represents the Standard Deviation (SD), and

$\bar{Y}$ denotes the average value of area, production, or yield

(ii) *Instability model*

The Cuddy Della Valle (CDVI) Index is a statistical tool used to assess the instability of time series data, particularly in agricultural studies. While the Coefficient of Variation (CV) is commonly used to measure instability, it has certain limitations, especially when the data exhibit a trend. In such cases, CV alone may overestimate the level of instability. To account for trends in the data, the CDVI Index provides a more accurate measure by adjusting the coefficient of variation (CV) using the square root of (1 - adjusted R-squared) derived from a trend regression analysis. A higher CDVI value indicates greater instability in the series.

To assess instability, this study incorporates the following CDV Index measure.

$$\text{CDV Index} = \text{C.V} * \sqrt{1 - R^2}$$

Where; CV represents the Coefficient of Variation in percentage and R^2 denotes the coefficient of determination obtained from time trend regression, adjusted for the number of degrees of freedom. The CDV Index categorizes instability as follows: less than 15 indicates low instability; 15-30 represents moderate instability, and above 30 signifies high instability.

(iii) *Crop diversification model*

The present study applied the Herfindahl Index to analyze crop diversification, which is calculated by summing the squares of the acreage proportion of each crop within the total cropped area.

$$H.I = \sum_{i=1}^{N} Pi^2$$

Where; N represents the total number of crops, and Pi denotes the acreage proportion of the i-th crop within the total cropped area. The Herfindahl Index decreases as the number of crops increases. This index equals one when there is complete specialization and approaches zero when diversification is perfect. In other words, the Herfindahl Index ranges from 0 (perfect diversification with equal distribution among all crops) to 1 (complete specialization with only one crop cultivated). A higher Herfindahl Index reflects a greater concentration on a single dominant crop, indicating lower crop diversity, while a lower Herfindahl Index signifies a more diverse cropping system. Thus, the present study considered, if the index obtained value ranged between 0 to 0.33 considered being complete diversification. If the value lies between 0.34 to 0.66 it indicates moderate diversification and if the value found between 0.67 and 1.0 then it considered as crop specialization. This Index is also called as inverse index of diversification.

RESULTS AND DISCUSSION

(i) *Growth of area, production and yield of pulses in Guntur district*

In this subsection, the growth trends of pulses cultivated in Guntur district from 2002-03 to 2021-22 have been analyzed across five periods. The 20-year period from 2002-03 to 2021-22 has been divided into four sub-periods: period-1 (from 2002-2007), period-2 (from 2007-2012), period-3 (from 2012-2017) and period - 4 (from 2017-2022). The growth trends in the area, production, and yield for Period 1, Period 2, Period 3, Period 4, and the total period have been examined and presented in (Table 1), linear growth regression function has been used to analyze the growth trends in area, production, and yield of pulses [22].

Table 1 Linear growth regression of area, production and yield of pulses in Guntur district of Andhra Pradesh

Period	Area	Production	Yield
Period – 1	A = 39876304.700-19802.900*t	P = -612592.200+307.200*t	Y = -6013466.200+3059.800t
Period – 2	A = 9113571.000-4477.900t	P = -596076.200+298.500*t	Y = -19534890.800+9762.400*t
Period – 3	A = -36425917.400+18137.800*t	P = 780188.600-384.600*t	Y = -8236805.700+4153.900t
Period – 4	A = 11746577.000-5759.200*t	P = 67740.200-31.100*t	Y = 19521757.400-9597.200*t
Total period	A = 6797376.068-3313.078*t	P = -229662.268+116.278*t	Y = -3421918.200+1759.671*t
Linear growth rates (LGR) of pulses			
Period – 1	0.684*	0.961*	0.157
Period – 2	0.258	0.621*	0.872*
Period – 3	0.804*	0.706*	0.320
Period – 4	0.503	0.370*	0.635*
Total period	0.496*	0.711*	0.355*

*Significance level at a 5% probability level

Period- 1 (2002-2007)

Data in (Table 1) depicts that the estimated value of area is -19,802.90, indicating a declining trend in pulses cultivation in Guntur district. The area under pulses decreased at a growth rate of 0.684% per year, which means an average reduction of 19,802.90 hectares annually during the study period. However, the estimated value of production is 307.20, showing a positive trend with an annual increase of 307.20 tonnes at a growth rate of 0.961% per year. The yield also shows a positive growth, with an estimated value of 3,059.80 and a growth rate of 0.157% per year.

Period -2 (2007-2012)

From (Table 1), the estimated value of area is -4,477.90; indicating a continued decline in pulses cultivation at a growth rate of 0.258% per year, with an average reduction of 4,477.90 hectares annually. The estimated value of production is 298.50, showing an annual increase of 298.50 tonnes, with a growth rate of 0.621% per year. The estimated value of yield is 9,762.40, and its growth rate is 0.872% per year, indicating a significant improvement in productivity.

Period- 3 (2012-2017)

The (Table 1), shows that the estimated value of area is 18,137.80, indicating a positive trend in pulses cultivation at a growth rate of 0.804% per year, with an expansion of 18,137.80 hectares annually. However, the estimated value of production is -384.60, showing a declining trend by 384.60 tonnes at a growth rate of 0.706% per year. The estimated value of yield is 4,153.90, and the yield growth rate is 0.320%per year suggesting moderate improvements in productivity.

Period -4 (2017-2022)

Data in (Table 1), depicts that the estimated value of area is -5,759.20; indicating a declining trend in pulses cultivation at a growth rate of 0.503% per year with reduction of 5,759.20 hectares annually. The estimated value of production is -31.10, showing a negative trend, with production declining by 31.10 tonnes per year at a growth rate of 0.370% per year. Similarly, the estimated value of yield is -9,597.20, with a growth rate of 0.635% per year, indicating a reduction in productivity.

Total period (2002-2022)

For the entire study period, (Table 1) reveals that the estimated value of area is -3,313.08, indicating a marginal decline in pulses cultivation at a growth rate of 0.496% per year. This means an average reduction of 3,313.08 hectares annually. However, the estimated value of production is 116.28, showing a positive trend, with production increasing by 116.28 tonnes per year at a growth rate of 0.711% per year. The estimated value of yield is 1,759.67, with a growth rate of 0.355% per year, confirming that productivity improvements contributed to sustaining pulses production over time.

(ii) *Instability in area, production and yield of pulses in Guntur district*

In this subsection, the variability in area, production, and yield of pulses cultivated in Guntur district from 2002-03 to 2021-22 is analyzed across five periods. The variability in area, production, and yield of pulses for Period 1, Period 2, Period 3, Period 4, and the total period was examined and presented in (Table 2). To analyze this variability, the Coefficient of Variation (CV), Coefficient of Determination (R^2), and CDV Volatility Index were calculated. The instability in the area, production, and yield of pulses over different periods has been assessed using the Coefficient of Determination (R^2), Coefficient of Variation (CV), and CDV Index [23-24].

Period – 1 (2002-2007)

From (Table 2), the coefficient of determination (R^2) values for area, production, and yield are 0.468, 0.924, and

0.025, respectively. The coefficients of variation (CV) for area, production, and yield are 26.69, 15.12, and 25.39, respectively. The CDV Index values indicate moderate instability in area (19.18) and yield (25.07), whereas low instability is observed in production (4.16) during this period.

The analysis of pulses cultivation in Guntur district from 2002 to 2022 reveals fluctuating trends, with a general decline in area over time, while production and yield showed modest improvements, particularly during certain periods. Despite declining land allocation, productivity gains helped sustain output, although recent years (2017–2022) witnessed reductions across all parameters. Instability analysis further indicates moderate to high variability in area and yield, highlighting the need for consistent policy and technological support to stabilize and enhance pulses production.

Period – 2 (2007-2012)

From (Table 2), the R^2 values for area, production, and yield are 0.067, 0.385, and 0.761, respectively, indicating weak predictability in area and production. The CV values for area, production, and yield are 24.28, 19.46, and 20.21, respectively. The CDV Index shows moderate instability in area (23.45) and production (15.26), while low instability is observed in yield (9.88).

Table 2 Instability in area, production and yield of pulses in Guntur district

Period	R^2			CV			CDV index		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Period – 1	0.468	0.924	0.025	26.69	15.12	25.39	19.18**	4.16*	25.07**
Period – 2	0.067	0.385	0.761	24.28	19.46	20.21	23.45**	15.26**	9.88*
Period – 3	0.647	0.499	0.103	29.28	16.50	15.38	17.40**	11.68*	14.57*
Period – 4	0.253	0.137	0.404	16.01	2.70	17.64	13.84*	2.50*	13.62*
Total period	0.246	0.505	0.126	30.42	22.27	24.58	26.41**	15.69**	22.98**

*Low instability, **Moderate instability

Period – 3 (2012-2017)

From (Table 4), the R^2 values for area, production, and yield are 0.647, 0.499, and 0.103, respectively. The CV values are 29.28, 16.50, and 15.38, indicating higher fluctuations in area compared to production and yield. The CDV Index reveals moderate instability in area (17.40) and low instability in production (11.68) and yield (14.57).

Period – 4 (2017-2022)

From (Table 2), the R^2 values for area, production, and yield are 0.253, 0.137, and 0.404, respectively, showing weaker predictability, particularly for production. The CV values for area, production, and yield are 16.01, 2.70, and 17.64, respectively. The CDV Index indicates low instability in area (13.84), production (2.50), and yield (13.62).

Total period (2002-2022)

From (Table 2), over the entire study period, the R^2 values for area, production, and yield are 0.246, 0.505, and 0.126, respectively. The CV values for area, production, and yield are 30.42, 22.27, and 24.58, indicating higher fluctuations in area compared to production and yield. The CDV Index shows moderate instability in area (26.41), production (15.69), and yield (22.98).

(iii) *Crop diversification in area of pulses in Guntur district*

In this subsection, the crop diversification in the area of pulses cultivated in Guntur district from 2002-03 to 2021-22 is analyzed across five periods. The diversification for Period - 1, Period - 2, Period - 3, Period - 4, and the total period was examined and presented in (Table 3). During the period - 1(2002-2007), the Herfindahl Index (HI) was 0.48; indicating moderate crop diversification, reflecting that pulses cultivation in Guntur district was moderately diversified from specialization. The calculated index values are 0.42, 0.34, and 0.27 for Period - 2, Period - 3, and Period - 4, respectively, and for the entire study period is 0.37. These index values indicate that pulses cultivation in Guntur district gradually transitioned from moderate diversification towards complete diversification over time. This trend shows that farmers in Guntur district are adopting diversified cropping, leading to better yield, income, and sustainability in pulses cultivation [25].

Table 3 Crop diversification index for cereals of pulses in Guntur district

Period	Period- 1 (2002-2007)	Period- 2 (2007-2012)	Period- 3 (2012-2017)	Period- 4 (2017-2022)	Total period (2002-2022)
Herfindahl index (HI)	0.48**	0.42**	0.34**	0.27***	0.37**

**Indicates moderate crop diversification

***Indicate complete crop diversification

CONCLUSION

From the above investigation it could be concluded that the study observed fluctuating growth trends in production, while the yield exhibited a gradual increasing trend over the study period. Instability analysis revealed moderate instability in area and production, whereas yield showed low to moderate instability across different periods. The crop diversification analysis indicated a steady shift from moderate to complete diversification, with the Herfindahl Index values gradually declining over time. The study observed that farmers in Guntur District of Andhra Pradesh are progressively adopting diversified cropping patterns, ensuring better yield stability, income generation, and sustainable pulses cultivation.

LITERATURE CITED

1. Zhang J, Wang J, Zhu C, Singh RP, Chen W. 2024. Chickpea: Its origin, distribution, nutrition, benefits, breeding, and symbiotic relationship with *Mesorhizobium* species. *Plants* 13(3): 429.
2. Gurusamy S, Vidhya CS, Khasherao BY, Shanmugam A. 2022. Pulses for health and their varied ways of processing and consumption in India - A review. *Applied Food Research* 2(2): 100171.
3. Jukanti AK, Gaur PM, Gowda CL, Chibbar RN. 2012. Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.): A review. *Br. Jr. Nutrition* 108(Suppl. 1): S11.
4. Zahran HH. 1999. Rhizobium-legume symbiosis and nitrogen fixation under severe conditions and in an arid climate. *Microbiol. Mol. Biol. Rev*. 63(4): 968-989.
5. Ngigi PB, Mouquet-Rivier C, Amiot M-J, Termote C, Pallet D. 2022. Increasing pulse agrobiodiversity to improve food security and sustainable agriculture in Sub-Saharan Africa. *Front. Sustain. Food Systems* 6: 948808.
6. Reddy AA. 2011. Dynamics of the agricultural economy of Andhra Pradesh, India since the last five decades (January 25, 2010). *Journal of Development and Agricultural Economics* 3(8): 394-410.
7. Rani R, Sah U, Kumar H, Bishnoi R, Udgata AR. 2024. Multilevel growth assessment of mung bean production in Madhya Pradesh. *Journal of Food Legumes* 37(2): 190-195.
8. Sarada O, Kumar GVS. 2022. Extent adoption and spread of ANGRAU black gram and green gram production technology by the farmers of Guntur District. *The Andhra Agric. Journal* 69(3): 443-448.
9. Singh JM, Kaur A, Chopra S, Kumar R, Sidhu MS, Kataria P. 2022. Dynamics of production profile of pulses in India. *Legume Research - An International Journal* 45(5): 565-572.
10. Sadhanala S, Mehta VP, Bhatia JK, Kumar R. 2021. Trends in area, production and productivity of major pulses in India. *Agricultural Mechanization in Asia, Africa and Latin America* 51(3): 1449-1455.
11. Gaur P. 2021. Can India sustain high growth of pulses production? *Journal of Food Legumes* 34(1): 1-3.
12. Kumari N, Malik D. 2024. Growth and instability in mung bean production in India. *Journal of Food Legumes* 37(2): 224-231.
13. Pradhan SK, Dash A. 2024. Growth and instability of rabi green gram production in Odisha. *Environment and Ecology* 42(3): 1006-1015.
14. Prioty JK, Rahman KS, Miah MAM. 2024. Growth and instability analysis of minor pulses in Bangladesh. *Food Science and Engineering* 48(2): 30-38.
15. Mishra S, Balai HK, Malviya PK. 2022. Growth and instability of major Kharif pulse crops in Madhya Pradesh State of India. *Agro Economist - An International Journal, AE*: 9(4): 251-257.
16. Singh L, Bansal S. 2020. Growth and instability in area, production and yield of Pulses in Punjab. *Agriculture Situations in India* 77(7): 36-42.
17. Meena VS, Singh S, Sharma S, Meena S, Verma D. 2024. An analysis of doubling income from crop diversification in Haryana. *International Journal of Statistics and Applied Mathematics* SP-9(1): 232-237.
18. Kapoor S, Tomar TS. 2024. Spatial analysis of crop diversification in Indian agriculture. *Journal of Indian Economy and Business* 1(1): 15-26.
19. Tiwari A, Choudhary VK, Shrey R. 2024. Nature and extent of the crop diversification kharif season in northern hills of Chhattisgarh. *International Journal of Advanced Biochemistry Research* SP-8(5): 398-402.
20. Jose E, Ponnusamy K, Kamboj ML. 2024. Efficiency of farm diversification in Haryana. *Journal of Community Mobilization for Sustainable Development* 19(S): 66-73.
21. Ray P. 2022. Crop concentration and crop diversification in Birbhum district of West Bengal: Recent situations. *Agricultural Reviews* 43(2): 255-259.
22. Narayan P, Kumar S. 2015. Constraints of growth in area production and yield of pulses in India: An analytical approach to major pulses. *Indian Journal of Agricultural Research* 49(2): 114-124.
23. Bhagat AA, Shivagaje AJ. 2016. Growth and instability in area, production and productivity of major pulses in Maharashtra. *International Journal of Scientific Research* 5(12): 8177-8179.
24. Bisht A, Kumar A. 2018. Growth and instability analysis of pulses production in India. *International Journal of Agriculture Sciences* 10(14): 6722-6724.
25. Chavan R, Patil SS, Jainuddin SM, Yasmeen. 2017. Growth, demand and supply of quality seeds of pulses in India. *Indian Journal of Economics and Development* 13(2): 676-679.