

International Journal of Agriculture Extension and Social Development

Volume 9; Issue 8; August 2026; Page No. 652-655

Received: 02-06-2026
Accepted: 08-07-2026

Indexed Journal
Peer Reviewed Journal

Growth and instability of major food grain crops in Andhra Pradesh

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DOI: <https://www.doi.org/10.33545/26180723.2026.v9.i8i.4078>

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Abstract

Food grains are important for ensuring food and nutritional security and supporting rural livelihoods. This study analyzed the growth and instability in the area, production and productivity of major food grain crops in Andhra Pradesh during 2004-05 to 2023-24. The study covered rice, jowar, ragi, gram, maize, bajra, tur and urad, with the study period divided into Period I (2004-05 to 2013-14), Period II (2014-15 to 2023-24) and the overall period. Compound Annual Growth Rate (CAGR) was used to estimate growth, while the Cuddy-Della Valle Instability Index (CDVI) was employed to measure instability after removing the effect of trend. The results indicated a continuous decline in the area under all selected crops during the overall period. The highest decline was observed in jowar (-8.16%), followed by bajra (-5.99%) and maize (-5.17%). Production also showed a declining trend for most crops, while urad registered a significant increase of 2.55 per cent. Productivity, however, increased significantly in rice (1.23%), jowar (6.14%), maize (3.07%), bajra (4.44%) and urad (4.01%). High instability was observed in the area under maize (37.65%) and jowar (37.03%), while tur recorded the highest instability in production (39.32%). Productivity generally showed low to moderate instability across the crops. Overall, the findings suggest that gains in productivity were not sufficient to compensate for the continuous reduction in cultivated area, emphasizing the need for measures to stabilize food grain acreage while maintaining and strengthening productivity growth.

Keywords: Compound Growth Rate (CAGR), Cuddy-Della Valle (CDVI), area, production, productivity, food grains

Introduction

Food grains form an essential part of India's agricultural economy and play a major role in ensuring food and nutritional security while supporting rural livelihoods. Their production depends largely on changes in cultivated area, productivity and the effective utilization of agricultural resources. Improvements in technology, irrigation facilities, high-yielding varieties and shifts in cropping patterns can influence food grain production. However, variations in cultivated area and yield may lead to instability in production. Therefore, analyzing crop-wise growth and instability helps in understanding changes in the production pattern and identifying crops that need greater policy and development attention.

Andhra Pradesh is an important food grain-producing state, particularly in rice and pulse cultivation. Changes in the area allocated to different crops can influence the availability and stability of food grains in the state. An increase in productivity may not always result in higher production when the cultivated area declines substantially. Likewise, high instability in area or production can increase production risk and create difficulties in farm-level planning and decision-making.

Growth and instability analysis provide useful insights into the changing performance of food grain crops over time. Growth rate analysis measures the direction and extent of changes in area, production and productivity, helping to identify whether the performance of a crop is increasing or declining. It also facilitates comparison among crops and across different periods, thereby highlighting changes in the overall production pattern. However, growth rates alone cannot capture the fluctuations in crop performance.

Hence, the Cuddy-Della Valle Instability Index (CDVI) is used to assess the extent of instability in area, production and productivity after accounting for the existing trend. It helps identify the degree of fluctuations and the associated production risks among different crops. Thus, the combined assessment of growth and instability helps identify crops facing declining area, changing productivity or greater fluctuations and provides useful information for agricultural planning, policy formulation and improving the stability of food grain production.

Objectives

1. To estimate the compound growth rate of area, production and productivity of major food grains in

Andhra Pradesh

- To estimate the Instability of area, production, productivity of major food grains in Andhra Pradesh

Materials and Methodology

Data Source

The study utilized 20 years of secondary time-series data from 2004-05 to 2023-24 for the selected food grain crops in Andhra Pradesh. The required data were collected from different government websites such as IndiaStat, Directorate of Economics and Statistics (DES, India) and the Unified Portal for Agricultural Statistics (UPAg), as provided in the study material. The analysis covered eight major food grain crops, namely rice, jowar, ragi, gram, maize, bajra, tur and urad in Andhra Pradesh.

Methodology

The study relied exclusively on secondary time-series data for Andhra Pradesh for the period 2004-05 to 2023-24. For examining the changes in area, production and productivity over time, the study period was divided into three phases:

Period I (2004-05 to 2013-14)

Period II (2014-15 to 2023-24), and

Overall period (2004-05 to 2023-24).

The growth rates of area, production and productivity were calculated by applying the exponential growth model to estimate their respective Compound Annual Growth Rates (CAGR). (Dahima *et al.* 2023) ^[4].

$$Y = a b^t$$

Where,

Y= Trend value (Area, Production, Yield) a = Constant

b = Trend Coefficient

t = Independent Variable (Time in year)

Compound Annual Growth Rate (CAGR)

The compound growth rate (CGR) per annum over the period for all the variables was Calculated from the following formula:

$$C.G.R. (\%) = [\text{Antilog of } b - 1] \times 100$$

Cuddy–Della Valle Instability Index (CDVI)

The instability was estimated by using Cuddy-Della Vella index, with the help of following formula:

$$\text{Cuddy- Della Vella Instability Index (CDVI)} = CV \sqrt{1 - R^2}$$

Where,

CDVI = Cuddy-Della Vella index

CV = Coefficient of variation (in per cent) R² = Coefficient of determination.

Results and Discussion

The Compound Annual Growth Rates (CAGR) and Cuddy-Della Valle Index (CDVI) of area, production and productivity of major food grains (rice, jowar, ragi, gram, maize, bajra, tur and urad) in Andhra Pradesh are presented in Table 1.

Table 1: Compound growth rate (CAGR) of area, production and productivity of major food grains in Andhra Pradesh

Crop	Area			Production			Productivity		
	Period I	Period II	Overall Period	Period I	Period II	Overall Period	Period I	Period II	Overall Period
Compound Annual Growth Rates (CAGR)									
Rice	-5.99**	-0.85	-3.58***	-6.24**	0.42	-2.39***	-0.26	1.28	1.23***
Jowar	-16.03***	-6.39**	-8.16***	-8.37**	1.52	-2.53**	9.12***	8.43***	6.14***
Ragi	-6.58***	-2.06**	-4.40***	-8.49***	-0.81	-4.13***	-2.03*	1.28	0.27
Gram	2.20	-2.05	-1.55*	0.80	-0.96	-2.81**	-1.38	1.11	-1.28
Maize	-11.91**	2.80*	-5.17***	-4.32	2.62	-2.26**	8.62***	-0.18	3.07***
Bajra	-8.79***	-3.53	-5.99***	-0.08	0.26	-1.79	9.61***	3.86	4.44***
Tur	-11.43***	1.41	-3.78***	-12.93***	-3.02	-5.99***	-1.72	-4.34	-2.29**
Urad	-3.42	-2.05	-1.41**	-0.08	1.80	2.55***	3.46*	3.93**	4.01***

Note: ***, ** and * indicates significance at 1, 5 and 10 per cent level of Significance.

Source: (IndiaStat, UPAG).

It was observed from the table 1. That, at (Overall period - 2004-05 to 2023-24), for all the crops the area under cultivation has changed significantly but unfortunately, turned out to be negative. That means for all the crops, the area under cultivation has been significantly declined over the period. On the other hand, for overall period, the productivity has significantly increased for most of the crops like rice (1.23%), jowar (6.14%), maize (3.07%), bajra (4.44%), and urad (4.01%).

Similarly, during the same period the production also declined significantly for all the crops except urad, which increased significantly by 2.55 per cent at one per cent level of significance. It indicates that, at (Overall period - 2004-05 to 2023-24), the increase in production of urad in Andhra Pradesh was attributed due to increase in productivity

enchantment rather than area expansion. Regarding rests of the crops, the significant enhancement in productivity was not enough to increase the production of the selected crops due to significant decrease in area under cultivation. The similar trend in respect of (Period -I 2004-05 to 2013-14) and (Period –II 2014-15 to 2023-24) was noticed far all the selected crops in Andhra Pradesh during the study period. Except positive and significant increase in area under cultivation was noticed only for maize (2.80%) in Period -II. Overall, the findings indicate a clear shift towards productivity-driven food grain production in Andhra Pradesh. While rice, jowar, ragi, gram, maize, bajra and tur experienced overall declines in area and production, several of these crops recorded improvements in productivity. The strongest productivity gains were observed in jowar (6.14%),

bajra (4.44%), urad (4.01%) and maize (3.07%). However, these yield gains were generally insufficient to compensate for the contraction in cultivated area. The relatively improved performance of maize in (Period –II 2014-15 to 2023-24) and

the positive production growth of urad suggest that productivity enhancement combined with better area retention can improve food grain production performance.

Table 2: Cuddy-Della Valle Index (CDVI) of area, production and Productivity of major food grains in Andhra Pradesh

Crop	Area				Production			Productivity	
	Period I	Period II	Overall Period	Period I	Period II	Overall Period	Period I	Period II	Overall Period
Compound Annual Growth Rates (CAGR)									
Rice	16.46	5.64	16.06	18.33	5.64	18.73	5.73	6.04	6.72
Jowar	27.2	22.15	37.03	23.38	21.86	27.72	14.94	20.10	19.59
Ragi	7.49	6.12	10.45	10.03	14.30	18.81	7.70	9.33	9.88
Gram	19.11	16.55	19.74	27.99	25.33	28.94	16.78	21.48	19.27
Maize	29.33	12.60	37.65	28.16	18.51	27.61	19.88	7.92	17.37
Bajra	18.25	23.77	22.88	25.87	32.81	28.81	14.22	19.39	19.30
Tur	17.41	19.79	29.13	30.92	29.91	39.32	21.99	28.05	24.23
Urad	14.80	16.98	16.21	18.17	11.99	15.63	14.78	11.89	13.08

Note: ***, ** and * indicates significance at 1, 5 and 10 per cent level of Significance.

Source: (IndiaStat, UPAG).

According to the table 2. The instability results revealed that the selected food grain crops in Andhra Pradesh generally showed low to moderate variation in area, production and productivity during the study period. During Period I (2004-05 to 2013-14), the selected food grain crops exhibited varying levels of instability in cultivated area. Maize showed the highest instability (29.33%), whereas ragi recorded the lowest (7.49%), with the other crops falling within the moderate instability range. In Period II (2014-15 to 2023-24), bajra recorded the highest area instability (23.77%), while ragi continued to have the lowest instability (6.12%), and the remaining crops showed moderate fluctuations. Over the overall period (2004-05 to 2023-24), maize registered the highest instability (37.65%), followed by jowar (37.03%), whereas ragi had the lowest instability (10.45%). Thus, the overall findings indicate that cultivated area fluctuated more substantially for maize and jowar, while ragi exhibited comparatively greater stability throughout the study period. During Period I (2004-05 to 2013-14), production instability varied across the selected food grain crops, with tur recording the highest instability (30.92%), while rice showed the lowest (18.33%). The remaining crops experienced moderate levels of production instability, indicating comparatively limited fluctuations. In Period II (2014-15 to 2023-24), bajra exhibited the highest production instability (32.81%), whereas urad recorded the lowest (11.99%), with the other crops falling within the moderate range. Over the overall period (2004-05 to 2023-24), tur registered the highest production instability (39.32%), while urad had the lowest (15.63%). Overall, production fluctuations were relatively more pronounced in tur and bajra, whereas urad showed comparatively greater stability throughout the study period. During Period I (2004-05 to 2013-14), productivity instability differed among the selected food grain crops, with tur recording the highest instability (21.99%), while urad had the lowest (14.78%). The other crops showed moderate levels of instability in productivity. In Period II (2014-15 to 2023-24), tur continued to exhibit the highest productivity instability (28.05%), whereas urad recorded the lowest (11.89%). During the overall period (2004-05 to 2023-24), the same pattern was observed, with tur registering the highest instability (24.23%) and urad the lowest (13.08%).

Overall, productivity remained relatively more stable than production for most of the selected crops, while tur experienced greater fluctuations and urad maintained comparatively higher stability throughout the study period.

Discussion

The combined findings of CAGR and CDVI reveal that food grain production in Andhra Pradesh is characterized by rising productivity alongside a decline in cultivated area. Jowar recorded a substantial productivity growth of 6.14 per cent, but its area decreased by 8.16 per cent, leading to negative production growth. A similar situation was observed for bajra and maize, where productivity improvements were not sufficient to offset the reduction in cultivated area. However, the performance of crops such as maize, rice and urad improved during Period II, suggesting some positive changes in the later period. Urad achieved significant overall production growth of 2.55 per cent, mainly supported by a 4.01 per cent increase in productivity despite a fall in area. The high area instability observed in maize and jowar and the high production instability in tur indicate greater uncertainty in their performance. The comparatively stable productivity of several crops offers scope for further production improvement. Hence, efforts should focus on retaining food grain area, enhancing productivity and minimizing production fluctuations through crop-specific strategies to ensure sustainable and stable food grain production in Andhra Pradesh.

Conclusion

The study revealed varied growth and instability patterns among major food grain crops in Andhra Pradesh. During the overall period, the area under all selected crops declined, while productivity increased significantly in rice, jowar, maize, bajra and urad. Jowar recorded the highest productivity growth of 6.14 per cent, but its area declined by 8.16 per cent, leading to negative production growth. Bajra and maize also showed productivity gains, but declining area limited their production growth. In contrast, urad achieved positive production growth of 2.55 per cent due to a 4.01 per cent increase in productivity. Higher area instability in maize and jowar and production instability in tur indicate the need

for crop- specific measures.

Greater emphasis should be placed on improved varieties, efficient water management, balanced fertilizer use and better crop practices. For tur, moisture conservation and timely pest and disease management should be encouraged. Policies should focus on stabilizing food grain area while sustaining productivity gains. Strengthening extension services, access to quality inputs and climate-resilient technologies can further improve production stability. Overall, a combination of area stabilization, productivity enhancement and risk management is essential for sustainable food grain production in Andhra Pradesh.

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