iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** XI **Month of publication:** November 2025

DOI: https://doi.org/10.22214/ijraset.2025.76166

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XI Nov 2025- Available at www.ijraset.com

Growth and Instability in Area, Production and Productivity of Selected Kharif Crops in Akola District of Western Vidarbha Region

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Abstract: ***The present study examines the growth performance and instability in area, production and productivity of selected kharif crops namely green gram, kharif jowar and kharif maize in Akola district of the Western Vidarbha region of Maharashtra. Secondary data covering the period from 1985 to 2024 were collected from District Statistical Abstracts and official government publications. To study structural changes, the period was classified into three sub-periods, one overall period and a current period.***

Compound Growth Rate (CGR) was estimated by fitting an exponential growth function, while variability and instability were analysed using the coefficient of variation and the Cuddy–Della Valle instability index, respectively. The results revealed that green gram experienced positive growth during the early period but showed a significant decline in area and production during the recent period. Kharif jowar exhibited a continuous decline in both area and production across all periods, indicating structural displacement. Maize recorded positive growth in production and productivity in the recent period but also showed extremely high instability. The study concludes that growth without stability is unsustainable and emphasizes diversification, climate-resilient technology adoption, irrigation expansion and crop insurance as key interventions for stabilizing farm income in the region.

Keywords: Compound growth rate, Cuddy–Della Valle index, crop instability, rainfed agriculture, Vidarbha.

I. INTRODUCTION

Agriculture in Maharashtra is characterized by considerable spatial and temporal variability owing to its strong dependence on monsoon rainfall, limited irrigation coverage and frequent climatic aberrations. The Vidarbha region, particularly its western part, is among the most drought-prone regions of the state. Akola district represents a typical rainfed farming system where crop performance is highly sensitive to rainfall distribution and variability.

While growth in production reflects agricultural development, instability captures the level of risk and uncertainty faced by farmers. Crops exhibiting high growth may still be unsuitable for farmers if instability is high. Therefore, an integrated analysis of growth and instability is essential for understanding sustainability in rainfed agriculture. The present study aims to examine the growth and instability of selected kharif crops in Akola district and draw policy implications for improving agricultural stability.

II. MATERIALS AND METHODS

A. Study Area

The study covers Akola district of the Western Vidarbha region of Maharashtra.

B. Data Source

The study is based on secondary data collected from District Statistical Abstracts and official publications of the Government of Maharashtra and compiled for the period 1985–2024.

The time series was divided into the following periods: Period I (1985–1995), Period II (1995–2005), Period III (2005–2015), Overall period (1985–2015) and Current period (2015–2024).

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C. Crops Selected

Green gram, kharif jowar and kharif maize.

D. Analytical Tools

1) Growth in area, production and productivity.

The growth in selected crops was measured by using following exponential trend equation to compute the compound growth rates of area, production and productivity of selected crops.

$$Y = ab^t$$

Where,

Y = Area/ Production/ Productivity of selected crops
t = Time period (Years)
a = Intercept
b = Regression coefficient

From the estimated function, the compound growth rate was computed by

$$CGR\ (r) = [Antilog\ (log\ b) - 1] \times 100$$

Where,

r = Compound growth rate in per cent
b = Antilog of log b

2) Variability in area, production, productivity.

The variability in area, production, productivity was measured with the help of coefficient of variation. Coefficient of variation was computed with the help of following formula.

$$C.V. = \frac{\sigma}{\bar{X}} \times 100$$

Where,

C.V. = coefficient of variation (%)
σ = Standard deviation
$\bar{X}$ = Arithmatic mean

Coefficient of variation (CV) has been widely used as measure of instability index. It has an easy interpretation. However, CV is suitable when data has no trend as it does not account for the time trend. In time series data, there is always some trend; therefore, one has to be very careful to use CV as measure of instability. The instability index was estimated by the following formula called Cuddy-Della Valle index (Cuddy and Della Valle, 1978);

$$CD = CV \times (1 - R^2)^{1/2}$$

Where,

CD = Cuddy-Della Valle index
CV = Coefficient of variation (%) and is equal to standard deviation/mean
R2 = Coefficient of determination adjusted for number of degree of freedom obtained from trend regression

III. RESULTS AND DISCUSSION

A. Growth Performance of Crops

The compound growth rates of area, production and productivity presented in Table I reveal significant structural changes in cropping pattern across periods. Green gram recorded a significant increase in area and production during the initial period, with area growing at 10.33 per cent and production at 12.88 per cent. However, the trend reversed in later periods, with area declining by 7.95 per cent and production by 13.00 per cent during the current period. Productivity stagnated throughout, indicating declining farmer preference caused by technological stagnation, climatic vulnerability and market uncertainty.

Kharif jowar showed continuous negative growth across all periods. Area declined at 19.80 per cent during the current period, while production declined by 25.60 per cent. This indicates structural displacement due to crop substitution and profitability differences. Productivity improvements witnessed during the initial period were not sustained (Fig. 1).

Maize exhibited positive growth in production and productivity during the overall and current periods. Production grew at 10.56 per cent and productivity at 9.02 per cent during the current period. However, extremely high fluctuations signal instability, classifying it as a high return–high risk crop.

B. Variability and Instability Analysis

Table II reveal Green gram exhibited very high production variability with CV exceeding 77.83 per cent in period III and remaining above 61.94 per cent in the current period. The CDVI values indicated extremely high instability, implying output depends heavily on rainfall distribution. Productivity instability also increased sharply during the later periods, exceeding 45 per cent, indicating weather sensitivity and lack of irrigation coverage.

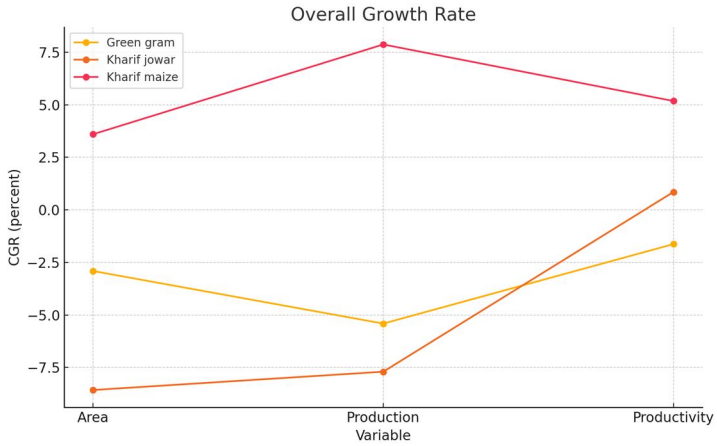


Fig. 1 Overall Growth Rate Comparison

Although Kh. Jowar showed declining trend, its instability remained considerably high. Production CV exceeded 75 per cent, and CDVI remained high even during overall period. The paradox observed is that even though cultivation area is declining, production risk has not declined, implying climate vulnerability has increased.

Maize recorded extremely high variability with production CV reaching 145.24 per cent during the overall period and CDVI crossing 123.20 per cent. This implies that maize is the most unstable crop among those studied. The high instability (Fig. 2) reflects sensitivity to rainfall variability and market price volatility. High growth with high instability classifies maize as a high return–high risk enterprise.

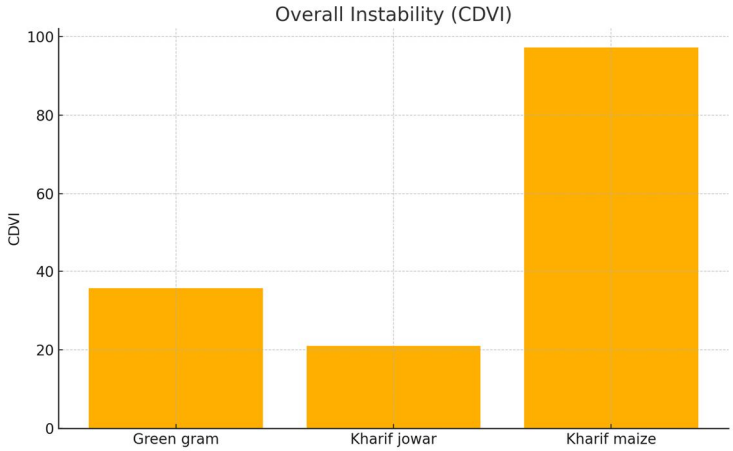


Fig. 1 Overall Instability (CDVI)

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XI Nov 2025- Available at www.ijraset.com

TABLE I

GROWTH RATES OF AREA, PRODUCTION AND PRODUCTIVITY OF SELECTED KHARIF CROPS IN AKOLA DISTRICT

Crop	Particulars	Period I	Period II	Period III	Overall	Current Period
Green gram	Area	10.33***	5.31**	-5.74*	-2.91***	-7.95*
	Production	12.88**	-12.70**	-7.77	-5.41***	-13.00
	Productivity	2.96	-3.39	-1.87	-1.63	-5.49
Kh. Jowar	Area	-2.04**	-12.42***	-14.79***	-8.57***	-19.80**
	Production	5.27	-12.85***	-23.33***	-7.70***	-25.60**
	Productivity	7.47*	-1.19	-10.02*	0.85	0.12***
Kh. Maize	Area	8.16	17.13*	-28.65***	3.60	1.41
	Production	5.45	16.34	-26.98***	7.87***	10.56
	Productivity	-0.84	9.74*	2.35	5.18***	9.02*

Note: ***, **, * denotes level of significance at 1%, 5% and 10% respectively

TABLE III

VARIABILITY AND INSTABILITY OF AREA, PRODUCTION AND PRODUCTIVITY OF SELECTED CROPS IN AKOLA DISTRICT (PER CENT)

Crop	Particulars		Period I	Period II	Period III	Overall	Current Period
Green gram	Area	CV	29.04	21.50	26.20	44.84	24.00
	Production		51.48	54.95	77.83	67.02	61.94
	Productivity		34.67	32.79	64.84	45.00	48.42
	Area	CDVI	10.34	16.19	21.47	35.69	18.11
	Production		38.62	36.99	75.41	55.95	50.77
	Productivity		33.66	31.22	64.68	43.49	45.63
Kh. Jowar	Area	CV	8.82	46.77	46.99	66.12	40.32
	Production		37.07	53.24	75.60	67.24	56.56
	Productivity		33.56	17.20	45.86	36.11	29.38
	Area	CDVI	6.60	20.48	22.86	20.99	24.94
	Production		33.99	27.83	37.82	40.83	31.74
	Productivity		27.40	16.79	37.39	35.48	3.61
Kh. Maize	Area	CV	88.02	61.89	73.74	101.95	39.56
	Production		73.43	64.59	87.87	145.24	59.14
	Productivity		42.82	41.17	22.78	51.43	31.15
	Area	CDVI	83.43	51.07	39.95	97.20	39.41
	Production		71.88	57.40	56.58	123.20	50.96
	Productivity		42.72	32.92	21.81	31.65	24.26

IV. CONCLUSIONS

Maize recorded highest growth but also highest instability, whereas jowar showed negative growth but persistent instability, indicating climatic stress across crops. Green gram showed fluctuating behaviour with moderate growth but high risk. Productivity stagnation is a critical concern across crops. Policy interventions should focus on promotion of drought-tolerant varieties, irrigation expansion and watershed development, minimum support price and procurement for pulses, subsidized crop insurance, crop diversification strategies, subsidise climate-resilient inputs and introduce price stabilization mechanisms for pulses.

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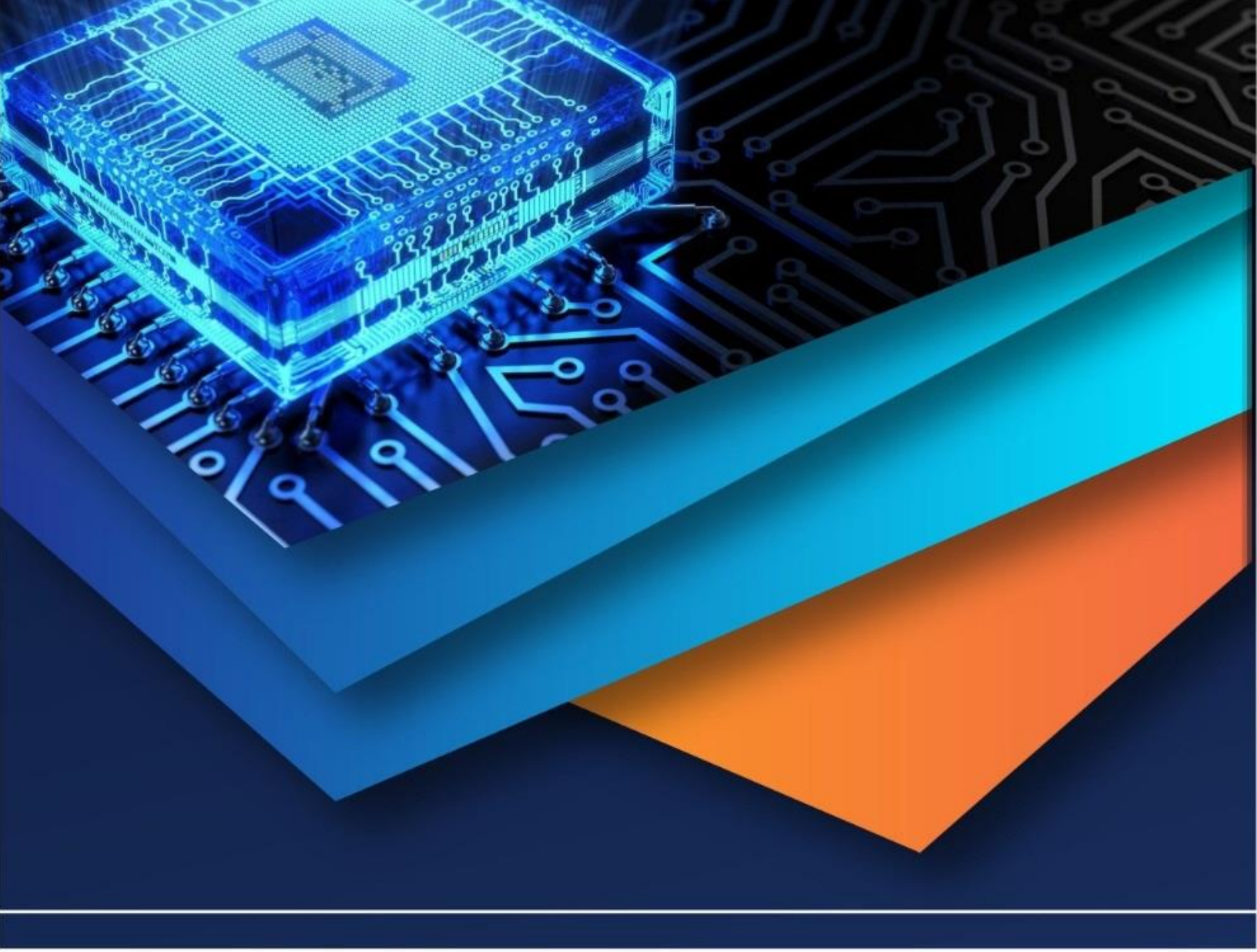
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