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

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Abstract

The present study examines growth and instability in area, production and productivity of major Kharif crops namely green gram, Kharif jowar and Kharif maize in the Western Vidarbha Region of Maharashtra. Time-series secondary data were analysed for five reference periods viz., Period I (1985–1995), Period II (1995–2005), Period III (2005–2015), Overall period (1985–2015) and Current period (2015–2024). Growth was measured using compound growth rate (CGR) based on exponential trend function, while variability was assessed using coefficient of variation (CV) and Cuddy–Della Valle instability index (CDVI). The results revealed that maize experienced highly significant expansion in area and production over the overall period, whereas Kharif jowar registered continuous and significant decline in area and production. Green gram showed moderate growth during early periods but exhibited decline in recent years. Variability was extremely high in maize and green gram, whereas jowar showed comparative stability in acreage but higher instability in production. The findings underscore the need for crop diversification, technology diffusion, and climate-resilient interventions in Western Vidarbha.

Keywords: Instability, Variability, Time-series

1. Introduction

Agriculture in the Vidarbha region of Maharashtra is predominantly rainfed and characterised by high variability in rainfall and frequent droughts. Western Vidarbha forms one of the important agricultural sub-regions producing cereals and pulses under monsoon-dependent conditions. Crops such as green gram, Kharif jowar and Kharif maize are important sources of food, fodder and income for farmers. Over the past few decades, changes in rainfall pattern, technological interventions and market dynamics have influenced the performance and acreage of these crops.

Measurement of growth indicates structural changes in agriculture, while variability analysis reflects production risk and instability. Therefore, the present study attempts to estimate the growth and instability in area, production and productivity of selected Kharif crops in Western Vidarbha using standard analytical tools.

2. Materials and methods

2.1 Study area & crops selected

The study covers Akola district of the Western Vidarbha region of Maharashtra. Green gram, Kharif jowar and Kharif maize.

2.2 Data collection & 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).

2.3 Analytical tools

2.3.1 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.

$$\mathbf{Y = ab^t}$$

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

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

Where,

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

2.3.3 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.

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

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);

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

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

3. Results and discussion

3.1 Growth Performance

The compound growth rate results from the Table 1 indicated divergent growth patterns across crops and periods in the Western Vidarbha region, reflecting structural shifts in cropping pattern and productivity performance.

Greengram recorded significant expansion in area and production during Period I and Period II; however, a sharp and significant decline in Period III and the current period resulted in an overall contraction in area (-1.34 per cent) and production (-3.44 per cent), along with a significant fall in productivity (-2.14 per cent), indicated loss of crop importance in recent years.

Kharif jowar exhibited a continuous and severe decline across all periods, with highly significant negative growth in area and production, particularly in Period II, Period III and the current period, while productivity remained almost stagnant over the long run, confirmed a structural shift away from Jowar cultivation.

Kharif maize showed robust and significant growth in area, production and productivity during Period I and Period II, and despite a slowdown during Period III, the overall and current period growth remained positive and significant, reflected its increased dominance and farmer preference in the region.

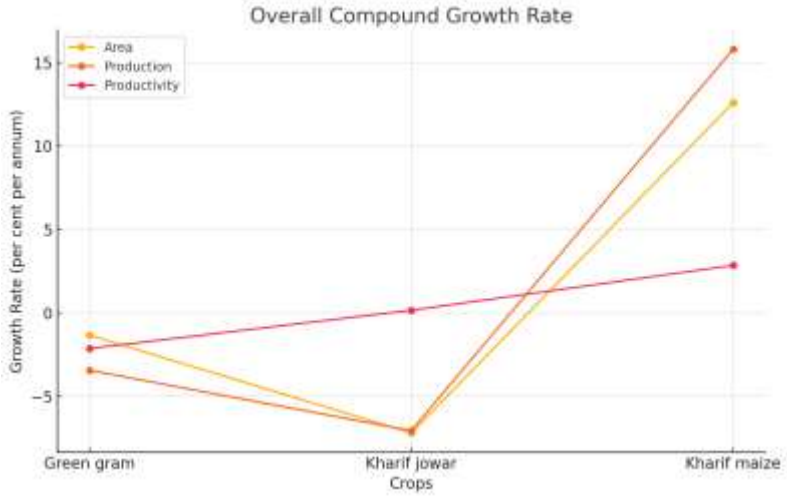
Table 1. Growth Rate of Area, Production and Productivity of Selected Crops in Western Vidarbha Region

Crop	Particulars	Period I	Period II	Period III	Overall	Current Period
Green gram	Area	7.44***	5.12***	-7.60**	-1.34**	-7.63**
	Production	8.58*	-5.58	-7.69	-3.44**	-10.09
	Productivity	1.06	-10.18**	-0.10	-2.14**	-2.66
Kh. Jowar	Area	-1.94**	-7.43***	-12.41***	-7.20***	-15.38***
	Production	3.57	-9.20***	-17.56***	-7.06***	-20.19**
	Productivity	5.62	-1.91	-5.87	0.15	-5.68
Kh. Maize	Area	23.06***	19.06**	-8.69	12.59***	10.93***
	Production	41.92***	19.17**	-7.11	15.79***	19.75**
	Productivity	15.33*	0.10	1.73	2.84***	7.95

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

The above data is showed in the following graph.

Figure 1: Overall Compound Growth Rate



3.2 Growth Performance

The variability and instability analysis from Table 2 highlighted large inter-crop and inter-period differences in area, production and productivity across Western Vidarbha, indicated uneven performance and risk exposure among selected crops.

Green gram exhibited moderate to high variability in area and production, with CV values generally exceeded the moderate-risk range, and extremely high variability in production and productivity during Period III and the current period. The corresponding CDVI values confirmed that instability in production and productivity intensified over time, reflected increased sensitivity to climatic fluctuations and declining management stability in recent years.

Table 1. Variability and Instability of Area, Production and Productivity of Selected Crops in Western Vidarbha Region

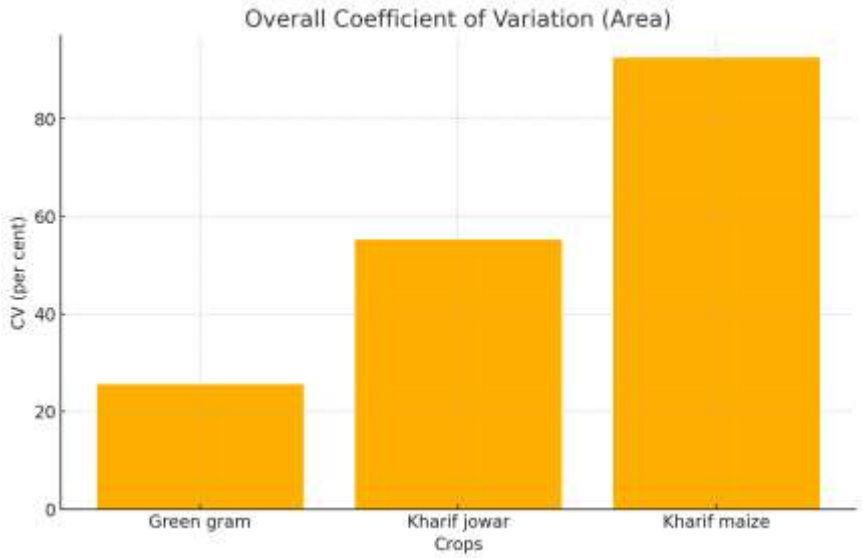
(per cent)

Crop	Particulars		Period I	Period II	Period III	Overall	Current Period
Green gram	Area	CV	23.31	16.77	28.73	25.61	21.20
	Production		38.73	31.78	64.25	48.06	54.44
	Productivity		27.56	41.53	51.85	44.35	38.03
	Area	CDVI	12.05	7.65	20.92	23.53	13.05
	Production		30.48	27.41	61.50	42.72	45.72
	Productivity		27.38	28.12	51.85	41.20	37.31
Kh. Jowar	Area	CV	8.47	27.30	44.53	55.20	36.60
	Production		33.47	36.58	58.53	61.12	59.60
	Productivity		31.78	12.97	29.78	25.16	33.45
	Area	CDVI	6.43	10.75	17.53	15.77	14.36
	Production		31.80	18.13	26.45	32.29	36.71
	Productivity		27.69	11.73	25.10	25.14	30.57
Kh. Maize	Area	CV	100.74	42.75	46.97	92.53	27.50
	Production		125.69	52.64	55.56	112.66	56.71
	Productivity		121.42	33.98	23.01	71.33	41.80
	Area	CDVI	57.87	32.23	41.35	49.60	14.20

	Production	68.92	40.64	52.42	60.49	38.72
	Productivity	98.49	33.98	22.50	63.09	38.92

The above CV data of area is pictured in the figure 2.

Figure 2: Coefficient of Variation (Area)



Kharif jowar showed relatively low instability in area during Period I but experienced sharp increases in instability in later periods, especially in Period III and the current period as reflected by rising CV values. Although CDVI values were comparatively lower than CV, production instability remained persistently high across periods, suggested structural decline and vulnerability of the crop under changing agro-climatic and economic conditions.

Kharif maize recorded very high variability and instability in all three indicators during Period I and overall, with CV and CDVI levels indicated extreme risk and expansion-related fluctuations. However, a notable decline in CV and CDVI during Period II, Period III and the current period suggests gradual stabilization as the crop became more established in the region. Despite improvements, production and productivity of maize still remained relatively unstable compared to Green gram and Jowar, showing that the crop, though expanding, is exposed to substantial production risk

4. Conclusions

CGR analysis confirmed a transition from traditional coarse cereals and pulses towards maize, driven by better yield performance, market demand and adaptability under changing climatic and economic conditions. Productivity growth remains weak except maize.

The CV and CDVI results revealed that Kh. Maize was expanded but unstable with high-risk and weather sensitive. Kh. Jowar had consistently declined and losed acreage rapidly i.e. structurally unstable and Green gram was stagnated with high variability with raised production uncertainty. Climate variability and price risk were major constraints.

Policy interventions should focus on crop-specific risk management strategies such as climate-resilient varieties, improved irrigation access and better price support mechanisms to reduce instability in Western Vidarbha agriculture

5. References

1. Abhiram, D. and Soumya Prusty, 2020. Statistical Evaluation of Production Scenario of Kharif Pulse in Odisha, India. International Journal of Current Microbiology and Applied Sciences, Vol. 9 (5) : 845-852.
2. Asha Bisht and A. Kumar, 2018. Growth and Instability Analysis of Pulses Production in India. International Journal of Agriculture Sciences, Vol. 10, (14) : 6722-6724.
3. Birhanu Ayalew and I. Sekar 2016. Trends and Regional Disparity of Maize Production in India. Journal of Development and Agricultural Economics, Vol. 8 (9) : 193-199
4. Birthal, P. S., Negi, D. S., & Jha, A. K. (2015). Risk management in rainfed agriculture. Agricultural Economics Research Review.
5. Cuddy, J. D. A., & Della Valle, P. A. (1978). Measuring instability of time series data. Oxford Bulletin of Economics and Statistics, 40(1), 79–85.
6. FAO (2022). *Climate change and agriculture risk report*.
7. Government of Maharashtra. District statistical abstracts (various years).
8. Jagannath, N. V. Shende, P. M. Tayade, N. S. Nandeshwar, H. Khan and S. N. Vinodakumar, 2013. Growth and Instability in Agriculture: Western Vidarbha of Maharashtra. Ecology, Environment And Conservation, 19 (4) : 1-7.
9. Kaur Ramandeep, M. Malhi and G. Sandhya Kiran, 2015. Analysis of trends in area, production and yield of important crops of India. International Journal of Agronomy and Agricultural Research, Vol. 7 (1) :.86-92.
10. Lobell, D. B. et al. (2021). Climate impacts on crop productivity. *Nature Climate Change*, 11(4), 306–312.
11. Tambe, P. C., Gavali, A. V., & Yadav, D. B. (2021). Growth and instability in soybean in Maharashtra. International Journal of Chemical Studies, 9(1), 3393–3395.