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Trends in area, production and productivity of major pulses in Maharashtra: An economic analysis

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Abstract

The present study analyses the region-wise growth patterns of area, production, and productivity of major pulse crops-Chickpea, Pigeon Pea, Green Gram and Black Gram-in Maharashtra over the period from 1991-92 to 2020-21. The analysis focuses on four major agro-climatic regions: Konkan, Western Maharashtra, Marathwada and Vidarbha. Compound growth rates were calculated for three sub-periods: Period I (1991-92 to 2000-01), Period II (2001-02 to 2010-11) and Period III (2011-12 to 2020-21), along with the overall study period (1991-92 to 2020-21). The study is based on secondary data obtained from the Socio-Economic Review, District Statistical Abstracts and official reports published by the Directorate of Economics and Statistics and the Department of Agriculture, Government of Maharashtra. Results showed wide regional disparities. Rice and wheat recorded positive growth mainly driven by productivity gains, especially in Western Maharashtra and Vidarbha, due to improved irrigation and technology. Marathwada experienced sharp declines due to drought and poor infrastructure. Pearl millet and sorghum showed a continuous decline in area and production, reflecting crop diversification and agrarian distress. Overall, Maharashtra's cereal growth became yield-driven rather than area-driven, emphasizing the need for better irrigation, high-yielding varieties, and improved market access for sustainable growth.

Keywords: CGR, rice, wheat, pearl millet, sorghum, region, Maharashtra etc

Introduction

Cereals form the backbone of Maharashtra's agricultural economy, serving as the primary source of food, income, and livelihood for a large proportion of the state's rural population. The major cereals grown in the state include rice, wheat, sorghum, and pearl millet, which together account for a substantial share of the total cropped area. These crops not only ensure food security but also support agro-based industries and livestock feeding systems. Maharashtra's diverse agro-climatic regions-Konkan, Western Maharashtra, Marathwada, and Vidarbha-exhibit distinct variations in the cultivation pattern, productivity, and performance of these cereals, largely influenced by differences in rainfall, irrigation, soil type, and technology adoption. Rice is predominantly cultivated in the Konkan and Vidarbha regions, where higher rainfall and favorable climatic conditions support its growth. Wheat is mainly concentrated in Western Maharashtra, benefiting from irrigation facilities and improved crop management practices, resulting in higher productivity levels. Kharif sorghum and pearl millet, typically grown under rainfed conditions, occupy relatively smaller areas, with Western Maharashtra and Marathwada being the key growing regions. Overall, the productivity of cereals is highest in Western Maharashtra due to better irrigation infrastructure, advanced cultivation technologies, and improved seed varieties, whereas Marathwada and Vidarbha show

moderate to low productivity levels owing to erratic rainfall and limited irrigation. The regional disparities in cereal performance highlight the need for targeted interventions such as strengthening irrigation networks, promoting drought-tolerant and high-yielding varieties, and improving soil and water management to enhance cereal productivity and ensure sustainable food grain production across Maharashtra. (Source: Final Advance Estimates, 2022-23, GoM, Maharashtra)

Methodology

The study focused on four purposively selected regions of Maharashtra: Konkan, Western Maharashtra, Marathwada, and Vidarbha. The study was conducted on major pulses crops. The four important major pulses of Maharashtra viz, chick pea, green gram, black gram and pigeon pea were selected for the study. The present study was utilized the time series data (1991-92 to 2020-2021) on area, production and productivity of major pulse for region wise was collected from various publications and websites of Directorate of Economics and Statistics Government of Maharashtra, Agricultural Statistics at a glance and Bureau of Economics and Statistics of Maharashtra state, Statistical Abstract of Maharashtra, etc.

Specification of time periods

The compound growth rates were computed based on time

series data on area, production and productivity of major pulses for regions of Maharashtra as well as a whole for 30 years of study period viz., 1991-92 to 2020-21 using log-linear production function. The compound growth rates of 30 years i.e. from 1991-92 to 2020-21 was subdivided into three sub-periods viz., Period-I (1991-92 to 2000-01), Period-II (2001-02 to 2010-11), Period-III (2011-12 to 2020-21) and entire period (1991-92 to 2020-21).

Analytical techniques

Compound growth rate

To understand the overall performance of major pulses over the entire period of 30 years, i.e. 1991-92 to 2020-21, it was considered as one period. Compound growth rates were estimated to study the percentage increase or decrease in the selected parameter. The following exponential growth function was used.

$$Y = abte$$

Where,

Y = area, production and productivity

t = time period

b = regression coefficient

a = intercept

The above equation is reduced in the following linear equation, on taking logarithms.

$$\log Y = \log a + X \log b + e$$

Compound growth rate (CGR%) was estimated as

$$\text{CGR (\%)} = [\text{Antilog } b-1] \times 100$$

The growth rates were tested for its significance with the help of students t test as,

$$T_{(cal)} = \frac{|b|}{\text{S.E. (b)}}$$

with appropriate, degrees of freedom at 10 percent, 5 percent and 1 percent level of significance

The simple tabular analysis was done for obtaining the results on changes in area, production and productivity of major cereals in Maharashtra.

Results and Discussion

Growth Pattern of Area, Production and Productivity of Major Cereals and Pulses Across the Region and State

The compound annual growth rate (CAGR) in area, production and productivity of major cereals and pulses including rice, wheat, pearl millet, sorghum, Chickpea, Pigeon pea, green gram and black gram were computed region wise i.e. Konkan, Western Maharashtra, Marathwada, Vidarbha and Maharashtra state. The growth rates were estimated for three sub periods each of 10 years and overall Period of 30 years i.e. from 1991-92 to 2020-21. The region wise time series data on area, production and productivity had been divided into sub periods viz., Period I (1991-92 to 2000-01), Period II (2001-02 to 2010-11) and Period III (2011-12 to 2020-21).

Compound Growth Rates of Area, Production and Productivity of Rice

The region wise compound growth rates of area, production and productivity of rice in Maharashtra from 1991-92 to 2020-21, are presented in Table 1. Significant regional disparities, was observed in area and production grew notably in Period I increasing by 2.07 and 2.66 per cent per annum in Konkan region. The area was declined significantly in Period II, while in Period III, the area, production and productivity showed significant declines. During overall Period the production and productivity were increased significantly by 0.67 and 0.70 per cent per annum whereas area was declined. The growth trends of rice in Konkan region and found that technological advancements have led to improvements in productivity despite a decline in the area under cultivation. The reduction in agricultural land was largely attributed to urbanization. To achieve sustainable agricultural development in the region, the study emphasizes the need to strengthen irrigation infrastructure, encourage the adoption of high yielding rice varieties and improve farmers' market access.

Table 1: Compound Growth Rates of Area, Production and Productivity of Rice

Particulars		Regions				
		Konkan	W. Maharashtra	Marathwada	Vidarbha	Maharashtra
Period I (1991-92 to 2000-01)	A	2.07***	1.19	-2.41**	-2.05**	-0.09
	P	2.66**	2.03	-2.58	-2.24	0.71
	Y	0.59	0.83	-0.17	-0.19	0.80
Period II (2001-02 to 2010-11)	A	-0.24***	0.89***	-15.56***	0.78**	-0.07
	P	0.33	1.28	-17.52***	1.23	0.72
	Y	0.57	0.39	-2.33	0.45	0.80
Period III (2011-12 to 2020-21)	A	-1.49***	0.24	-24.29***	0.33	-0.34
	P	-3.11***	2.60*	-17.08*	2.71	0.75
	Y	-1.64*	2.36	9.52	2.37	1.10
Overall Period (1991-92 to 2020-21)	A	-0.03	0.74***	-10.93***	0.71***	0.20***
	P	0.67**	1.53***	-12.27***	2.16***	1.36***
	Y	0.70***	0.78**	-1.50	1.44***	1.15***

Note: *, ** and *** indicate statistical significance at the 10, 5 and 1 per cent levels, respectively.

A - Area, P-Production, Y- Productivity

Western Maharashtra was exhibited consistent and significant growth among the area, production and productivity across the overall Periods, where production was increased by 1.53 per cent per annum by area expansion (0.74%) and productivity improvement (0.78%) as well as due to better irrigation infrastructure and farming practices. In case of Period I, growth rates of APY were positive but non-significant. In Period II, the area increased significantly by 0.89 per cent per annum, while in Period III, production showed a significant growth of 2.60 per cent per annum. The Marathwada region were recorded continuous and sharp decline in area, production and productivity, during all Period and overall Period except in Period III whereas productivity was increased positively non-significantly. It was primarily due to frequent droughts, poor irrigation infrastructure, rainfall variability, a shift to less water-intensive or more profitable crops, degrading soil health, limited use of modern inputs and technologies and widespread agrarian distress leading to reduced investment and rural migration. In Vidarbha region in period I area was negatively significant but in period II it was positively significant. Vidarbha region showed recovery trend with rising area, productivity and production, particularly in Period II and III, which could be attributed to improved water resource management and adaptive practices. During overall Period the area, production and productivity were increased significantly by 0.71, 2.16 and 1.44 per cent per

annum, respectively. Thus, the growth in rice production was driven by yield improvement rather than area expansion. In some parts of Vidarbha, especially where soybean cultivation faced declining returns, pests or market volatility, farmers are returning to rice, which is less risky and more stable under rain-fed conditions. (Agro-Economic Research Centre, Nagpur, 2021).

For entire state of Maharashtra demonstrated significant moderate growth in area (0.20%), production (1.36%) and productivity (1.15%) at 1 per cent level of significance at overall Period. The production was increased by area expansion and productivity improvement. In Konkan and eastern Vidarbha, high and stable rainfall makes rice is the best-suited crop. In addition to rainfall, minimum support price (MSP) for rice, making more stable and less risky crop as per CACP Reports.

Compound Growth Rates of Area, Production and Productivity of Wheat

The region wise compound annual growth rates of area, production and productivity of wheat are presented in Table 2. The Konkan region of Maharashtra lies primarily in the region's agro-climatic unsuitability, particularly due to the high rainfall, waterlogged lateritic soils and warm humid winter climate, which are unfavourable for wheat, wheat crop requires cool and dry conditions during the *rabi* season.

Table 2: Compound Growth Rates of Area, Production and Productivity of Wheat

Particulars		Regions				
		Konkan	W. Maharashtra	Marathwada	Vidarbha	Maharashtra
Period I (1991-92 to 2000-01)	A	-	2.86*	7.45***	3.75	4.25**
	P	-	3.80	10.01**	3.47	5.23*
	Y	-	0.91	2.38	-0.28	0.94
Period II (2001-02 to 2010-11)	A	-	7.35***	3.62**	10.57***	6.96***
	P	-	11.02***	7.18**	15.97***	10.89***
	Y	-	3.42**	3.43**	4.88**	3.68**
Period III (2011-12 to 2020-21)	A	-	5.24***	-1.99	1.80	2.33
	P	-	6.23**	0.37	3.66	4.20
	Y	-	0.94	2.41	1.83	1.83
Overall Period (1991-92 to 2020-2021)	A	-	0.98**	1.41**	2.99***	1.69***
	P	-	2.41***	1.75*	4.53***	2.85***
	Y	-	1.42***	0.34	1.49***	1.14***

Note: *, ** and *** indicate statistical significance at the 10, 5 and 1 per cent levels, respectively.

A - Area, P-Production, Y- Productivity

In Western Maharashtra, during Period I, area was increased significantly. During Period II, the region underwent substantial growth, with area expanding by 7.35 per cent per annum and production increased by 11.02 per cent per annum, resulting in a considerable productivity enhancement by 3.42 per cent per annum. Period III had decreased growth rates of area (5.24%) and production (6.23%), although productivity experienced small growth by 0.94 per cent per annum. Throughout the Period from 1991-92 to 2020-21, the region saw consistent albeit moderate growth, with area expanding by 0.98 per cent per annum, production by 2.41 per cent per annum and productivity by 1.42 per cent per annum. In Period II and for entire Period the production was increased due to area expansion and productivity improvement. In conclusion it was clear from the above discussion that the area, production and productivity growth in wheat were positively significant

over the entire Period of Western Maharashtra. Marathwada region showed the positive significant growth in area and production in Period I by 7.45 and 10.01 per cent per annum, respectively and for whole study Period it was by 1.41 and 1.75 per cent per annum. In Period II, the area, production and productivity were increased positively significantly by 3.62, 7.18 and 3.43 per cent per annum, respectively. In Vidarbha region, Period II and over the entire study Period, the growth in wheat production was driven by both area expansion and productivity improvement. Period II recorded the highest production growth rate among all regions and periods, with wheat production increasing at an impressive rate of 15.97 per cent per annum.

At the state level, during Period I, the area and production of wheat was increased significantly by 4.25 and 5.23 per cent per annum, respectively and productivity was positive non-

significant. In Period II and during the overall study period, the growth in production was driven by both area expansion and productivity improvement. Notably, in Period II, wheat production was recorded high growth rate of 10.89 per cent, the highest among all periods. APY was remained positive non-significant in Period II. Over the entire study period, the production increased at an average annual rate of 2.85 per cent per annum. Period II and the overall Period reported positively significant growth in area, production and productivity.

Compound Growth Rates of Area, Production and Productivity of Pearl Millet

The region wise growth pattern of area, production and productivity of pearl millet are depicted in Table 4.3. Pearl millet crop is not cultivated in the Konkan region of Maharashtra due to high rainfall, humid climate and heavy soils which are unsuitable for this drought-tolerant crop that requires dry conditions and well-drained soils. It was observed from table that in Western Maharashtra, pearl millet productivity was positively increased by 4.07 per cent per annum in Period II, despite a decline in both area and production. At overall Period, area and production were decreased significantly negatively by 3.94 and 2.91 per cent per annum but productivity increased significantly by 1.07 per cent per annum, likely due to factors such as improved management practices, research and technological

advancements. The decline in the area under pearl millet cultivation in Western Maharashtra could be attributed to increasing crop diversification. Over the years, farmers have shifted their focus toward more remunerative crops such as cash crops, pulses, oilseeds and horticultural crops, leading to a gradual reduction in the area allocated to traditional coarse cereals like pearl millet.

For Marathwada region the area and production were declined negatively by 3.58 and 3.51 per cent per annum, respectively and productivity was little increased by 0.07 per cent per annum observed at overall. In Period I, area was increased significantly while in Period II and III, it was decreased non-significantly. In Vidarbha region, in Period I, area was declined significantly by 6.27 per cent per annum. In Period II, negative growth trend was observed in both area and production, while productivity was increased significantly by 3.61 per cent per annum. In Period III, the Vidarbha region was reported significant decreased in area (5.27%) and production (14.65%), accompanied by a drastic fall in productivity (9.9%), indicating deteriorating agricultural circumstances. At overall Period, Vidarbha had the most alarming trend, with the most significant reduction in area (-10.4%) and production (-12.34%) and decrease in productivity (-2.17%), indicating a crisis in agricultural sustainability at overall Period. Significant long-term decline in area and production across regions.

Table 3: Compound Growth Rates of Area, Production and Productivity of Pearl Millet

Particulars		Regions				
		Konkan	W. Maharashtra	Marathwada	Vidarbha	Maharashtra
Period I (1991-92 to 2000-01)	A	-	-0.92	2.38***	-6.27***	-0.22
	P	-	-0.64	6.07	-3.77	0.85
	Y	-	0.29	3.6 0	2.67	1.08
Period II (2001-02 to 2010-11)	A	-	-4.82**	-4.7***	-13.42***	-4.84**
	P	-	-0.95	-0.67	-10.29***	-0.90
	Y	-	4.07*	4.22**	3.61**	4.14**
Period III (2011-12 to 2020-21)	A	-	-1.65*	-5.25**	-5.27**	-2.54**
	P	-	-0.09	-4.08	-14.65*	-1.08
	Y	-	1.58	1.24	-9.90	1.49
Overall Period (1991-92 to 2020-2021)	A	-	-3.94***	-3.58***	-10.4***	-3.90***
	P	-	-2.91***	-3.51***	-12.34***	-3.13***
	Y	-	1.07**	0.07	-2.17**	0.08

Note: ** and *** indicate statistical significance at the 10, 5 and 1 per cent levels, respectively.

A - Area, P-Production, Y- Productivity

At the state level, during Period II, the area decreased significantly by 4.84 per cent per annum, while productivity was increased by 4.14 per cent per annum significantly. For entire Period, area and production were decreased significantly while productivity growth was negligible. The area under pearl millet cultivation has declined, leading to a reduction in overall production. This occurred despite improvements in productivity driven by enhanced production technologies and the adoption of high yielding varieties. The area under pearl millet was declined in almost all regions and periods, especially in Vidarbha region. Production also fell, especially in Vidarbha and Marathwada, though less severely in Western Maharashtra. Productivity has been seen some improvement in all region and as whole Maharashtra during Period II.

Compound Growth Rates of Area, Production and Productivity of Sorghum

The growth pattern of area, production and productivity of sorghum for Konkan, Western Maharashtra, Marathwada, Vidarbha region and Maharashtra state are presented in Table 4. In Konkan region sorghum is not cultivated because the high rainfall, humid environment and clayey, poorly drained soils are unsuitable for this crop, which prefers dry climates and well-drained, light-textured soils typically found in semi-arid regions.

In Western Maharashtra, positive and significant growth in production and productivity were observed by 5.17 and 5.50 per cent per annum during Period II; however, for entire study period, the area, production and productivity of sorghum declined. Western Maharashtra showed mixed agricultural trends over time. At overall Period, Marathwada saw a consistent decrease in area (2.34%), production

(3.56%) and productivity (1.25%). Vidarbha demonstrated the most erratic and severe agricultural decline trend in all period, marked by consistent reductions in cultivated area,

production and eventually productivity across all three periods, reflecting deep-rooted and worsening agrarian distress over time.

Table 4: Compound Growth Rates of Area, Production and Productivity of Sorghum

Particulars		Regions				
		Konkan	W. Maharashtra	Marathwada	Vidarbha	Maharashtra
Period I (1991-92 to 2000-01)	A	-	-0.97	0.97	-6.23***	-1.41**
	P	-	-0.88	1.78	-5.16*	-1.24
	Y	-	0.09	0.81	1.14	0.17
Period II (2001-02 to 2010-11)	A	-	-0.31	-2.87***	-10.75***	-2.38***
	P	-	5.17*	-1.92	-11.23***	-0.39
	Y	-	5.50**	0.98	-0.55	2.03*
Period III (2011-12 to 2020-21)	A	-	-1.85	-6.62**	-12.45***	-4.11**
	P	-	0.51	-5.24	-18.46***	-3.41
	Y	-	2.41	1.47	-6.87*	0.72
Overall Period (1991-92 to 2020-21)	A	-	-1.76***	-2.34***	-9.60***	-2.79***
	P	-	-2.05***	-3.56***	-11.29***	-3.87***
	Y	-	-0.30	-1.25**	-1.87***	-1.11**

Note: *, ** and *** indicate statistical significance at the 10, 5 and 1 per cent levels, respectively.

A - Area, P-Production, Y- Productivity

The overall Period showed declining trends in area, production and productivity across all regions and in whole Maharashtra. Vidarbha witnessed the most severe and erratic declines across all periods, with substantial drops in area (-9.60%), production (-11.29%) and productivity (-1.87%), reflecting deepening agrarian distress. At the state level, Maharashtra showed a steady contraction in area (-2.79%) and production (-3.87%), with productivity declining by 1.11 per cent per annum, indicating a gradual weakening of agricultural performance. The growth of sorghum in Maharashtra has shown a declining trend over the years, marked by reductions in cultivated area, production and productivity. While certain regions, such as Western Maharashtra, exhibited short-term improvements in productivity during specific periods, the overall pattern across the state reflects a gradual weakening of sorghum cultivation. Factors such as shifting cropping patterns, declining rainfall, soil degradation and lack of market incentives have contributed to this decline. The most severe contraction was observed in Vidarbha, pointing to broader agrarian distress, while Marathwada and the state as a whole also experienced steady declines in all key indicators. The declining area of *kharif* sorghum was the main reason for decreased production coupled with productivity. Charyulu *et al.* (2016) reported that, Maharashtra state recorded negative trend in sorghum yield during the period (1993-2014). The yield reduction in sorghum was due to diversion of good quality lands from sorghum to more remunerative crops such as cotton and soybean and relegating sorghum to only marginal lands.

Conclusions

The analysis of compound annual growth rates of area, production, and productivity of major cereals in Maharashtra from 1991-92 to 2020-21 revealed wide regional disparities and crop-specific trends. Rice showed productivity-led growth in the Konkan and Vidarbha regions despite a decline in area, mainly due to technological advancement, irrigation improvement, and MSP support, whereas Marathwada experienced a continuous fall in all parameters owing to drought and poor infrastructure. Wheat

recorded significant and consistent growth in Western Maharashtra, Marathwada, and Vidarbha due to irrigation expansion, improved varieties, and better farming practices, with Period II (2001-2011) showing the highest growth across all regions. Pearl millet and sorghum showed declining trends in area and production across all regions, particularly in Marathwada and Vidarbha, due to crop diversification, reduced rainfall, and soil degradation, although moderate productivity improvements were observed in some regions through better technology and management. Overall, Maharashtra's cereal growth during the three decades was driven more by productivity gains than by area expansion, with Western Maharashtra performing best and dryland regions showing distress, highlighting the need for climate-resilient crops, improved irrigation, and technological interventions for sustainable cereal production.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during the writing or editing of this manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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