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**Chinmayee Nanda**

PG Scholar, Department of  
Agriculture Economics and  
Statistics Section, College of  
Agriculture, Nagpur, Maharashtra,  
India

**NT Bagde**

Assistant Professor and Head,  
Department of Agricultural  
Economics, College of Agriculture,  
Nagpur, Maharashtra, India

**SN Suryawanshi**

Assistant Professor, Department of  
Agricultural Economics, College of  
Agriculture, Nagpur, Maharashtra,  
India

**Rohma Azeem**

Assistant Professor, Department of  
Statistics, College of Agriculture,  
Nagpur, Maharashtra, India

**AB Kayarwar**

Assistant Professor, Department of  
Statistics, College of Agriculture,  
Nagpur, Maharashtra, India

**Corresponding Author:**

**Chinmayee Nanda**

PG Scholar, Department of  
Agriculture Economics and  
Statistics Section, College of  
Agriculture, Nagpur, Maharashtra,  
India

## Performance of major fruits in Maharashtra

**Chinmayee Nanda, NT Bagde, SN Suryawanshi, Rohma Azeem and AB Kayarwar**

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### Abstract

The present study examined the growth and instability in the area, production, and productivity of major fruits i.e. citrus and mango in Maharashtra, India, over the period from 2001-02 to 2021-22. Maharashtra, a key agricultural state, is renowned for its diverse agro-climatic zones, which support the cultivation of various fruits that are vital to both domestic consumption and international trade. The secondary data were collected and the study period has been divided into two sub-periods i.e. period I (2001-02 to 2010-11) and period II (2011-12 to 2021-22) and the overall period (2001-02 to 2021-22) to assess the performance of major fruits i.e. mango and citrus. The analysis employed, compound growth rates and instability indices, including the Coefficient of Variation (CV) and Cuddy Della Valle's Instability Index (CDVII), to evaluate the trends and fluctuations in the area, production, and productivity of major fruits. The results revealed that citrus exhibited significant growth in area during period I, but this trend reversed in period II, leading to a marginal overall decrease. Conversely, citrus production improved significantly in period II, despite initial declines, indicating favorable conditions or interventions that enhanced productivity. Mango showed a substantial expansion in area during period I, followed by a sharp decline in period II, leading to an overall decrease. Both fruits displayed considerable instability, particularly in production and productivity, with mango exhibiting more pronounced fluctuations across the study period. The findings highlighted the need for targeted interventions to address the underlying challenges and stabilize the performance of these major fruits in Maharashtra. The study underscored the importance of enhancing productivity while managing the variability and instability in the agricultural sector to ensure sustainable growth and economic stability for farmers in the region.

**Keywords:** Growth rate, cuddy della valle's instability index, mango, citrus

### Introduction

Maharashtra, a state situated in the western part of India, stands as a pivotal hub in the country's agricultural landscape. Blessed with diverse agro-climatic zones ranging from tropical to subtropical and semi-arid regions, Maharashtra boasts a rich variety of fruits and vegetables that play a crucial role in both domestic consumption and international trade. The cultivation of these crops not only contributes significantly to the state's economy but also supports livelihoods of millions of farmers across its diverse geographical terrain. The state is renowned for its production of major fruits such as mangoes, oranges, grapes and bananas.

In Maharashtra area under Citrus is highest (2.13 lakh hectares) with production of 17.97 lakh tonnes followed by Mango (1.64 lakh hectares) with production of 4.49 lakh tonnes (M/o Agriculture and Farmers welfare, Govt of India, First advanced estimates, 2022-23). Citrus fruits belong to the Rutaceae family, which encompasses a wide array of fruits including oranges (*Citrus sinensis*), lemons (*Citrus limon*), limes (*Citrus aurantiifolia*), grapefruits (*Citrus paradisi*), and mandarins (*Citrus reticulata*), each with distinct varieties suited to different climatic conditions. Renowned for their refreshing flavors and nutritional richness, citrus fruits are cultivated across various states, with Maharashtra emerging as a key producer within the country. Maharashtra benefits from its diverse agro-climatic zones, which support the cultivation of multiple citrus varieties throughout the year. Regions such as Nagpur are particularly renowned for their sweet and juicy Nagpur mandarin and earned a tag of "Orange city of India" (Bhattacharyya *et al*, 2024) <sup>[5]</sup>, while other parts of the state excel in producing varieties like Kinnow and sweet lime.

Mango (*Mangifera indica*) belonging to the Anacardiaceae family, native to South Asia, popularly known as “King of fruits” (Gunadal *et al*, 2023) [7] holds a cherished status in India's agricultural landscape, contributing significantly to both national and regional fruit production, particularly in states like Maharashtra, being a prominent contributor to the country's mango output. Maharashtra, with its favorable agro-climatic conditions and extensive orchard cultivation, plays a pivotal role in India's mango production. The state Konkan region is renowned for its Alphonso mangoes, famously known as "Hapus" (Burondkar *et al*, 2018) for their exquisite taste, aroma, and vibrant golden color. The Ratnagiri and Devgad regions in Maharashtra are particularly acclaimed for producing some of the finest Alphonso mangoes globally. The contribution of mango cultivation to Maharashtra's agricultural economy is substantial, providing livelihoods to farmers and supporting rural communities across the state. The production of fruits in Maharashtra has witnessed significant fluctuations over the years, influenced by various factors such as climate variability, market demand, technological advancements, and government policies.

### Objectives

To analyze the growth rate and instability of area, production and productivity of major fruits in Maharashtra.

### Period of study

The study was undertaken to analyze the growth rate and to estimate the instability of area, production and productivity of major fruits i.e. citrus and mango pertaining to the period of 20 years i.e. from 2001-02 to 2021-22. The study period was divided into two sub-periods as Period I (2001-02 to 2010-11), Period II (2011-12 to 2021-22) and overall period (2001-02 to 2021-22).

### Selection of crops

Two major fruits were selected on the basis of last five year (2017-18 to 2021-22) contribution of each fruits to total area under horticultural crops.

### Sources of data

The present study was based on secondary data. The crop wise time series data on area, production and productivity of major fruits was collected from various government publications like estimates of National Horticultural Board, Government of India and websites viz. Directorate of economics and statistics, Ministry of Agriculture and Cooperation, New Delhi, Socio Economical statistical information about India (Indiastat.com.)

### Analytical Tools and Techniques

#### A) Compound annual growth Rate

The compound annual growth rates of area, production and productivity of major fruits was estimated for period I (2001-02 to 2010-11), Period II (2011-12 to 2021-22) and overall period (2001-02 to 2021-22) by using exponential model.

$$Y = a.bt$$

$$\text{Log } Y = \log a + t \log b$$

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

Where, CGR = Compound Growth rate

t = Time period in year

Y = Area/Production/Productivity

a = Intercept

b = Regression coefficient.

The significance of regression coefficient was tested using student's t-test.

### B) Instability analysis

To measure the instability in area, production and productivity, an index of instability was used as a measure of variability through Coefficient of Variation (CV) and Cuddy Della Valle's Instability Index (CDVII). The simple coefficient of variation (CV) often contains the trend component and thus over estimates the level of instability in time series data characterized by long-term trends.

#### I. Coefficient of Variation (CV)

$$\text{Coefficient of Variation (CV)} = \frac{\text{standard deviation}}{\text{Mean}} \times 100$$

#### II. Cuddy Della Valle's Instability Index (CDVI)

It was used to measure the exact direction of instability in area, production and productivity of major fruits in long term trend. It is algebraically expressed as,

$$\text{Instability Index} = \text{CV} \sqrt{1 - R^2}$$

Where

CV = coefficient of variation in percentage and R<sup>2</sup> = Coefficient of determination from a time trend regression adjusted by the number of degrees of freedom.

### Results and Discussion

#### Growth rate of area, production and productivity of major fruits in Maharashtra

The growth performance of citrus and mango was presented in Table 1. From table 1, it was found that, area under citrus showed a positive growth rate of 6.29 per cent during period I, whereas during Period II there was a significant declined in the area at 3.10 per cent. However the overall period showed a marginal decrease in area at 0.45 per cent. The production trend showed a different pattern. Despite a slight, declined by 0.42 per cent during Period I, there was a increase in production of 7.47 per cent during Period II. For overall period growth rate of production was 0.73 per cent. The significant declined in productivity of 6.26 per cent during period I and increased in productivity at 10.92 per cent during Period II indicated substantial improvements or interventions that enhanced productivity. The overall period showed a slight increase in productivity by 1.19 per cent. (Similar observations were reported by Doddamani *et al*, 2014) [6].

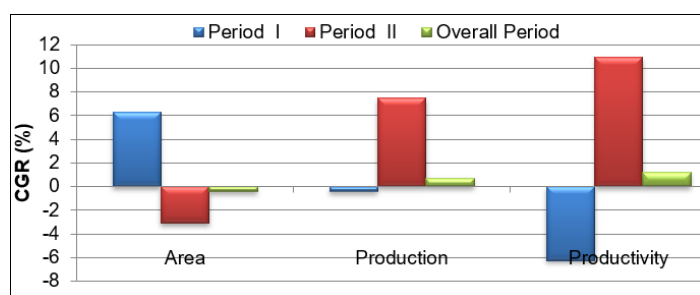
The growth performance of mango was revealed that agricultural land area showed expansion in the area at 10.74 per cent during period I, However, this trend reversed sharply during Period II at -11.14 per cent. The overall decline in the area at -4.33 per cent during entire period suggested that the gains in Period I were not sustained. Both periods, Period I (-2.37 per cent) and Period II (-4.49 per cent) showed a decline in production. Despite fluctuations in the area and productivity, production does not show significant recovery or growth over the entire period (-1.06 per cent). The declined in productivity during Period I (-11.82 per cent), subsequent increased in productivity at 7.75 per cent, during Period II, suggested

improvements and adaptations that overcame earlier hurdles. The overall positive change in productivity (3.41 per cent), indicated that, despite the reductions in the area, efficiency and output per unit area had improved over time.

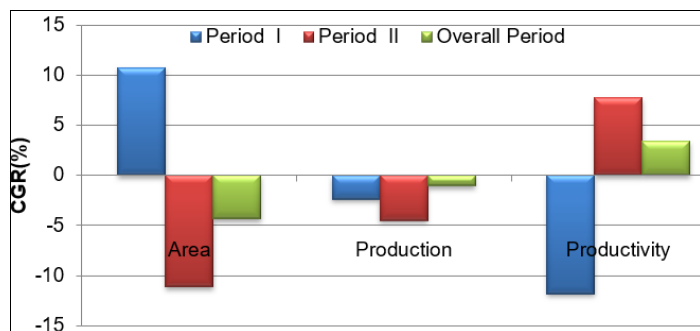
**Table 1:** Growth rate of area, production and productivity of major fruits in Maharashtra

Sr. No.	Crops	Particulars	Period I	Period II	Overall Period
1	Citrus	Area	6.29*** (0.01)	-3.10* (0.01)	-0.45 (0.007)
		Production	-0.42 (0.009)	7.47*** (0.01)	0.73 (0.007)
		Productivity	-6.26*** (0.01)	10.92*** (0.02)	1.19 (0.01)
2	Mango	Area	10.74** (0.03)	-11.14*** (0.03)	-4.33** (0.02)
		Production	-2.37 (0.02)	-4.49 (0.03)	-1.06 (0.009)
		Productivity	-11.82*** (0.03)	7.75* (0.04)	3.41* (0.02)

Note: \*\*\*, \*\* and \* Significant at 1, 5 and 10 per cent respectively  
Figures in parenthesis are standard error



**Fig 1:** Growth rate of area, production and productivity of Citrus



**Fig 2:** Growth rate of area, production and productivity of Mango

**Coefficient of Variation of area, production and productivity of major fruits in Maharashtra**

The variability in area, production and productivity of citrus and mango were studied using coefficient of variation and the results were presented in Table 2. From table 2, it was identified that, the coefficient of variation of area under citrus cultivation suggested that this stability in variation was maintained across the entire timeframe. The coefficient of variation of production and productivity was highest in period II i.e. 25.56 per cent and 34.50 per cent respectively. The overall period coefficient of variation in productivity was 31.99 percent indicates that there has been substantial fluctuation in productivity over the entire period studied.

The variability in area, production and productivity of mango was revealed that, the coefficient of variation in area of Mango was highest in period II (60.27 per cent) but lowest during period I (30.00 per cent). Similarly, the coefficient of variation

for production increases from Period I (17.73 percent) to Period II (37.97 per cent). This suggested that the variability in mango production doubled in the latter period. The coefficient of variation for productivity was highest in Period I (50.54 per cent) and lowest in Period II (39.82 per cent). However, the overall period coefficient of variation of 49.51 per cent suggested that there were still considerable fluctuations in productivity across the entire period.

**Table 2:** Coefficient of Variation of Area, Production and Productivity of Citrus in Maharashtra

Sr. No.	Crops	Particulars	Period I	Period II	Overall Period
1	Citrus	Area	19.08	19.67	19.51
		Production	8.49	25.56	18.93
		Productivity	29.15	34.50	31.99
2	Mango	Area	30.00	60.27	47.80
		Production	17.73	37.97	29.47
		Productivity	50.54	39.82	49.51

**Cuddy Della Valle’s Instability index of area, production and productivity of major fruits in Maharashtra**

The results of Cuddy Della Valle’s Instability Index (CDVI) of area, production and productivity of Citrus crop were presented in Table 3. From table 3, it was concluded that, the instability in area under citrus cultivation was low in period I (9.42 per cent), moderate in period II (16.62 per cent) and overall period (19.72 per cent). The instability analysis of production revealed that the instability in production was low in both period I (8.90 per cent) and period II (13.86 per cent), moderate in overall period (18.60 per cent). The instability analysis of productivity showed that the instability in productivity was moderate in both period I (20.28 per cent) and period II (21.82 per cent), highest in overall period (31.88 per cent).

The results of Cuddy Della Valle’s Instability Index (CDVI) of area, production and productivity of Mango crop were also presented in Table 3. From table 3, it was concluded that, area under Mango showed high rate of instability in overall period (42.64 per cent) and period II (40.58 per cent) but moderate in period I (19.64 per cent). The instability analysis of production revealed that the instability in production was moderate in both period I (18.15 per cent) and overall period (29.79 per cent), highest in period II (35.94 per cent). The instability analysis of productivity showed that the instability in productivity was high in all the periods corresponding to 46.58 per cent, 38.89 per cent and 32.59 per cent respectively during overall period, period II and period I.

**Table 3:** Cuddy Della Valle’s Instability Index of Area, Production and Productivity of major fruits in Maharashtra

Sr. No.	Crops	Particulars	Period I	Period II	Overall Period
1	Citrus	Area	9.42	16.62	19.72
		Production	8.90	13.86	18.60
		Productivity	20.28	21.82	31.88
2	Mango	Area	19.64	40.58	42.64
		Production	18.15	35.94	29.79
		Productivity	32.59	38.89	46.58

**Conclusion**

The analysis of growth rates and instability in the area, production, and productivity of Citrus and Mango in Maharashtra revealed distinct trends and variability across different periods. For Citrus, the initial period showed a significant expansion in the area, but this was followed by a decline in the later period, resulting in an overall marginal

decrease. In contrast, Citrus production saw significant improvement in the second period, despite an initial slight decline, indicating favorable conditions or interventions that boosted productivity. The initial period's decline in productivity was reversed in the second period, leading to a slight overall increase. Mango, on the other hand, experienced significant fluctuations in area, with an initial increase followed by a sharp decline. This instability in the area was accompanied by a consistent decline in production across both periods, suggesting underlying challenges such as inefficiencies or adverse conditions. However, productivity showed a recovery in the second period, indicating improvements that overcame earlier challenges, though the overall trend remained unstable.

The coefficient of variation and Cuddy Della Valle's Instability Index further highlight the instability in both fruits. Citrus showed relative stability in area variation but increased variability in production and productivity, especially in the latter period. Mango exhibited more pronounced instability, particularly in the area and production, with significant fluctuations in productivity across the periods.

In conclusion, while both Citrus and Mango in Maharashtra have shown periods of growth, they have also faced significant instability in terms of area, production, and productivity. The results suggest that while there have been efforts to improve productivity, underlying challenges remain, leading to variability and instability in performance over time. Addressing these issues through targeted interventions could help stabilize and enhance the performance of these major fruits in Maharashtra.

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