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Growth and instability in area, production and productivity of Mango in Karnataka and India

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Abstract

Mangoes are extremely important to the Indian economy. Mangoes play a significant role in the nation's agricultural and overall economic growth as a major fruit crop with significant export potential, as well as in terms of livelihoods, earnings in foreign currency and the growth of ancillary industries. Indian mangoes are a truly valuable resource for the country due to their popularity and economic importance, which continue to grow both domestically and on the global market. Karnataka ranks among the top mango-producing states in India. Mango production in Karnataka not only meets domestic demand but also makes a significant contribution to mango exports. The trends in area of mango crop in Karnataka showed an increasing trend by 2.41 percent which is due to increase demand for the fruits crop due to higher nutritional quality and health benefits. The trends in production of mango crop in Karnataka showed an increasing trend by 1.52 percent as it is the function of area and productivity. The productivity of mango crop in Karnataka showed a negative trend by 0.88 percent due to Changes in weather patterns, including irregular rainfall, extreme temperatures, and unseasonal weather events, can negatively impact mango trees' flowering and fruiting patterns. Mango trees can be susceptible to various pests and diseases, such as mango hopper, fruit flies, powdery mildew, anthracnose, and bacterial infections. The instability indices for area, production and productivity for mango in Karnataka were 4.33, 6.02, and 5.91 which indicates less risk in growing mango crop in future. It was found that at the overall period, the area, production and productivity of mango was highly consistent and stable. In India the area under mango crop showed a decreasing trend by 0.13 percent and in case of production and productivity of mango crop showed an increasing trend by 3.03 percent and 3.26 percent respectively during the study period. The instability indices for area, production, productivity for mango crop in India were 4.00, 6.51, and 7.18 respectively. It indicates less fluctuation during overall study period.

Keywords: Trend, indices, area, production and productivity

Introduction

One delectable treat stands out among the rest in a world abound with exotic fruits: the mango. This tropical treasure, dubbed the "king of fruits," has won the hearts and palates of people all over the world. The allure of the mango is undeniable from its seductive aroma to its luscious golden flesh. This delicious fruit is a true treasure of nature because it not only satisfies our taste buds but also has many health advantages. The mango has a lengthy history that dates back thousands of years, with its origins in South Asia. It is one of the oldest fruits in the world to have been cultivated, with roots dating back to 4,000 BCE. Mangoes are revered for their divine flavour and mythological significance and they have been incorporated into numerous historical tales and cultural customs throughout the world.

In addition to its delicious flavour, the mango has an impressive nutritional profile. This fruit is a nutritional powerhouse because it is brimming with vitamins, minerals, and antioxidants. Mangoes improve overall health by supporting a healthy digestive system and the immune system. Additionally, they are high in fibre which helps with weight control and promotes heart health. The mango truly lives up to its reputation as a superfruit with such an abundance of nutrients. The mango holds immense economic importance in India, both as a major fruit crop and a significant contributor to the country's agricultural economy. With nearly 40% of the world's mango production, India is the largest producer in the world. India produces more than 20 million tonnes of mangos each year using a variety of cultivars that are spread out across the nation. India can satisfy domestic demand and export mangoes to a number of foreign markets, which helps the country make significant profits.

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Many people in India's rural areas have access to employment and other sources of income thanks to mango cultivation and related activities. The mango industry employs a sizable workforce across the entire value chain, from farmers and farm labourers to traders, processors, and exporters. Mango exports contribute significantly to India's foreign exchange earnings. The country exports mangoes to over 40 countries, including the United States, the United Kingdom, the Middle East, and Southeast Asia. The demand for Indian mangoes in international markets remains high due to their exceptional taste, quality, and variety. The foreign exchange earnings from mango exports help strengthen India's economy and balance its trade. Mango holds great importance in the state of Karnataka, India, contributing significantly to its economy, agriculture, culture and overall well-being. Karnataka ranks among the top mango-producing states in India. Rich soil, a lot of sunlight and sufficient rainfall are some of the state's favourable agro-climatic characteristics that make it easier to grow high-quality mangoes. Mango production in Karnataka not only meets domestic demand but also makes a significant contribution to mango exports. Mangoes from Karnataka are exported to many different international markets, which increases the state's agricultural exports and generates foreign exchange income.

Mango research is crucial for developing farming methods, enhancing fruit quality, enhancing pest and disease management, promoting sustainability, investigating value-added products, and meeting consumer demands. The growth and sustainability of the mango industry are facilitated by ongoing research, which benefits producers, consumers, and related industries.

Objective of the study

To analyze the growth and instability in area, production and productivity of mango in Karnataka and India.

Methodology

The National Horticulture Board and State Department of Horticulture, Karnataka websites, as well as various published and unpublished reports, were used to gather secondary data about the study area. The study uses data from 2008–2009 to 2022-23 to examine the growth and volatility in the area, production, and productivity of mango in Karnataka and India (2022-23 data taken is advanced estimation).

Compound Annual Growth Rate Analysis

The compound annual growth rate of mango area, production and productivity in Karnataka and India is calculated using an exponential function of the form.

$$Y_t = A B^t \quad (1)$$

Where,

Y_t = area, production and productivity of mango in Karnataka and India

t = Year 1,2,.....,n

ut = disturbance term for the year 't'

The equation (1) was transformed into a log linear form and written as

$$\text{Log } Y_t = \text{Log } A + t \text{ log } B + \text{log } ut \quad (2)$$

Compound Annual Growth Rate was calculated as $g^{\wedge} = (b-1)*100$

Where,

g^{\wedge} = Estimated Compound Annual Growth Rate (%)

b = Antilog of B

Cuddy Della Valle Instability Index

Cuddy and Valle (1978) created the Cuddy- Della Valle index to measure the instability in time series data that is characterized by trend. The co-efficient of variation was calculated using the expression to investigate the stability of mango crop area, production and productivity. The Cuddy Della Valle Index is used to measure the instability in this study. The Cuddy Della Valle index de-trends the given series first, indicating the direction of instability. The use of the coefficient of variation as a measure of instability in time series data has significant drawbacks. If the time series data show any trend, the variation assessed by coefficient of variation can be overstated, i.e., if coefficient of variation is used to quantify instability, the region with expanding output at a constant rate will score high in instability. In contrast, the Cuddy-Della Valle index uses coefficient of determination to de-trend the coefficient of variation.

The coefficient of variation (CV) is a statistical measure of data points' dispersion around the mean in a data series. The coefficient of variation is a useful statistic for assessing the degree of variation between two data series, even if the means are radically different. It indicates the ratio of the standard deviation to the mean.

$$\text{Coefficient of variation} = \frac{\text{Standard deviation}}{\text{Mean}} * 100$$

The co-efficient of variation (%) was calculated to determine the extent of fluctuation in mango crop area, production and productivity in terms of area and quantity over time. The instability index was also calculated to look at the volatility of mango crop area, production and productivity in Karnataka and India in terms of area and quantity over time using the following formula:

$$\text{Instability Index (I)} = CV * \sqrt{1 - \text{Adj } R^2}$$

Where,

CV = Coefficient of Variation

Adj R^2 = Coefficient of determination

The ranges of CDVI (Sihmar, 2014) are given as follows:

Low instability = between 0 and 15

Medium instability = greater than 15 and lower than 30

High instability = greater than 30

Results and Discussion

Growth and instability in area, production and productivity of mango crop in Karnataka (2011-12 to 2020-21)

The table 1 depicted the trends in area of mango crop in Karnataka showed a increasing trend by 2.41 percent which is due to increase demand for the fruits and vegetables crop due to higher nutritional quality and health benefits of fruits and vegetables. The trends in production of mango crop in Karnataka showed an increasing trend by 1.52 percent which

is significant at one percent level in the function of area and productivity. The productivity of mango crop in Karnataka showed a negative trend by 0.88 percent which is significant at one percent level, due to Changes in weather patterns, including irregular rainfall, extreme temperatures, and unseasonal weather events, can negatively impact mango trees' flowering and fruiting patterns. Mango trees can be susceptible to various pests and diseases, such as mango hopper, fruit flies, powdery mildew, anthracnose, and bacterial infections. If not adequately managed, these issues can significantly reduce productivity. Inadequate pruning, improper fertilization, and suboptimal irrigation practices can all contribute to reduced mango productivity. The instability indices for area, production and productivity for mango in Karnataka were 4.33, 6.02, and 5.91 which indicates less risk in growing mango crop in future. It was found that at the overall period, the area, production and productivity of mango was highly consistent and stable. The area under mango cultivation is increasing in Karnataka, the productivity and quality of mangoes can vary across regions and farms. Factors such as proper orchard management, pest control, disease management, and market access also play crucial roles in determining the success of mango cultivation.

Table 1: Trends in area, production, productivity of mango crop in Karnataka during 2007-08 to 2019-20.

Year	Area (in ha)	Production (in MT)	Productivity (in MT/ha)
2007-08	134587	1223258	9.09
2008-09	140497	1607595	11.44
2009-10	147554	1629062	11.09
2010-11	154610	1650529	10.74
2011-12	168723	1693462	10.04
2012-13	170308	1656191	9.72
2013-14	173080	1641165	9.48
2014-15	174032	1686209	9.69
2015-16	181697	1725930	9.5
2016-17	180593	1732281	9.59
2017-18	183228	1760598	9.61
2018-19	178956	1694020	9.47
2019-20	176276	1700974	9.65
Mean	166472.38	1646251.84	9.93
SD	15870.84	129134.08	0.67
CAGR	2.41 ^{NS}	1.52**	-0.88**
CV	9.53	7.84	6.83
R2	0.79	0.41	0.25
CDVI	4.33	6.02	5.91

(Source: National Horticulture Board & Horticulture Statistics Division, Department of Agriculture, Coopn & Farmers Welfare website)

**significant at 1 percent level of significance

*significant at 5 percent level of significance

^{NS}- Non significant

Growth and instability in area, production and productivity of mango crop in India during 2008-09 to 2022-23

It is evident from the Table 2 that, the area under mango crop showed a decreasing trend by 0.13 percent. The mango cultivation was negatively impacted by changes in weather patterns, including erratic rainfall, rising temperatures, and an increase in the frequency of extreme weather events. Mango trees require particular climatic conditions, and any unfavorable changes can hinder their development and yield. Crops of mangos can also be harmed by pests, diseases, and

natural disasters and in case of production and productivity of mango crop showed an increase trend by 3.03 percent and 3.26 percent respectively which is significant at one percent level in the study period (2008-09 to 2022-23) concerned to India. It was mainly due to introduction of high yielding varieties during the study period.

The Cuddy- Della Valle index to measure the degree of variation (instability) around the trend. The instability indices for area, production, productivity for mango crop in India were 4.00, 6.51, and 7.18 respectively. It indicates less fluctuation during overall study period. In India area under mango crop production was stable and consistent over a 15 years period (2008-09 to 2022-23); it indicates that the India is more trustworthy producer of mango to importing countries. In case production and productivity also shows the more stable in nature.

Table 2: Trends in area, production and productivity of mango crop in India during 2008-09 to 2022-23.

Year	Area (000 ha)	Production (000 tonnes)	Productivity (MT/ha)
2008-09	2309	12749.77	5.5
2009-10	2312.3	15026.8	6.5
2010-11	2297	15188.38	6.6
2011-12	2378.1	16196.38	6.8
2012-13	2500	18002.37	7.2
2013-14	2516	18431.33	7.3
2014-15	2163	18526.99	8.6
2015-16	2209	18642.55	8
2016-17	2212	19472.62	8.8
2017-18	2258	21787.19	9.7
2018-19	2296	21378.09	9.3
2019-20	2281	20316.58	8.9
2020-21	2317	20386	8.8
2021-22	2370.8	20335.64	8.8
2022-23	2322.93	20346.07	8.83
Mean	2316.14	18452.45	7.97
SD	93.75	2520.72	1.19
CAGR	-0.13 ^{NS}	3.03**	3.26**
CV	4.04	13.66	14.96
R2	0.02	0.77	0.76
CDVI	4.00	6.51	7.18

(Source: National Horticulture Board & Horticulture Statistics Division, Department of Agriculture, Coopn & Farmers Welfare website)

**significant at 1 percent level of significance

*significant at 5 percent level of significance

^{NS}- Non significant

Conclusions

Karnataka is one of the leading states in mango production in India. It is known for its diverse range of mango varieties and favorable agro-climatic conditions that support mango cultivation. Karnataka is known for its premium mango varieties such as Alphonso (Hapus), Totapuri, Badami, and Mallika. These varieties are sought after in both domestic and international markets. The state has witnessed an overall increase in mango production and productivity. This can be attributed to the adoption of improved farming techniques, research and development efforts, access to better inputs and government support. These factors have helped Karnataka's mango farmers enhance their yields and achieve higher productivity levels.

On a national level, the area under mango cultivation in India has also faced challenges, such as urbanization, climate

change, and economic factors. Mango production has, however, steadily increased in the nation; this development can be attributed to the widespread use of contemporary agricultural methods, to research developments, to improved access to inputs, to knowledge sharing, and to government initiatives. The rise in production has also been fueled by the demand for Indian mangoes on both domestic and international markets. The efforts made by farmers, researchers, and policymakers have largely contributed to the upward trajectory of mango production and productivity in Karnataka and India, despite regional variations in the trends. To ensure the long-term growth and stability of the mango industry, it is crucial to keep addressing the difficulties faced by mango farmers, such as sustainable land use, resiliency to climate change, and market fluctuations.

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