*Original Research Article*

**Dynamics of Sugarcane Growth and Productivity in Mandya District, Karnataka**

**ABSTRACT:**

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| --- |
| Agriculture plays a crucial role in India's economy by generating employment, ensuring food security, driving economic growth, and supporting environmental sustainability. India, a major agricultural player, contributes over 17 per cent to GDP and employs more than 50 per cent of the workforce. Sugarcane, a key cash crop, is vital for the sugar industry, with Karnataka being a significant producer (70.264 MT). Mandya district plays an essential role in Karnataka’s sugarcane production, contributing substantially to the state’s total cultivated area and output.  This study evaluates sugarcane cultivation in Mandya district from 2000-01 to 2023-24, analyzing growth trends, instability, and production dynamics. The study period is divided into two phases: the first (2000-01 to 2011-12) shows modest growth in area (1.19%) and production (1.32%) with high production instability (38.98%), influenced by climatic variability and market uncertainties. The second period (2012-13 to 2023-24) exhibits significant growth in area (7.94%) and production (7.01%), with reduced instability (27.66%), though productivity declined (-0.74%) due to soil fertility depletion and monocropping.  Decomposition analysis reveals that yield effects (142.29%) were the dominant driver of production growth over the entire period, while area expansion had minimal or negative effects. The study recommends adopting high-yielding, drought-resistant varieties and improving soil management to enhance stability and productivity, ensuring a more resilient and sustainable sugarcane sector in Mandya district.  The study recommends adopting high-yielding, drought-resistant varieties and improved soil management to enhance sustainability. These findings provide valuable insights for policymakers, researchers, and farmers in improving sugarcane production and stabilizing the sector. |

***Keywords****: Sugarcane, trends, compound annual growth rate, cuddy-della valle index production, productivity*

# 1. INTRODUCTION

Agriculture has long been the cornerstone of human civilization, serving as a foundation for employment, food security, economic growth, environmental sustainability, cultural preservation and advancements in science and technology. India's diverse agro-climatic conditions enable the cultivation of a wide variety of crops, including rice, wheat, cotton, sugarcane, fruits, vegetables, spices and plantation crops (Adhale *et al*., 2019). It has also been a source of raw materials for various key agro-industries in India, such as cotton, jute, textiles, sugar, vanaspati and oils (Hanji *et al*., 2024). Additionally, many industries depend indirectly on agriculture for their inputs; for instance, the sugar industry relies heavily on sugarcane as its primary raw material (Singh *et al*., 2010).

India ranks second in sugarcane production after Brazil, with 60.61 lakh ha under cultivation, producing 550 mt at a productivity of 84 tonne ha-1 (Maurya *et al*., 2020). Karnataka plays a vital role in India’s sugarcane industry, covering 6.29 lakh ha, or 11.15 per cent of the country’s total sugarcane area. The state produces 70.264 mt, contributing 15.74 per cent of the nation's total sugarcane output (Hanji *et al*., 2024). This highlights Karnataka's significant position in national sugarcane production, aided by its favorable climate, fertile soils and effective farming techniques.

Mandya district is a key player in Karnataka's sugarcane landscape, contributing notably to the state's total area under sugarcane cultivation. This underlines the district's important role in supporting Karnataka’s agricultural economy, especially in sugarcane farming. Mandya's production performance reflects its high productivity levels and well-established agricultural practices. The district benefits from efficient resource use, suitable climate and a strong emphasis on sugarcane as a primary cash crop, enhancing Karnataka's status as a leading sugarcane producer. These factors make Mandya an integral part of Karnataka’s sugarcane output and broader economic framework.

The study focusing on Mandya district aims to examine the following objectives:

1. To analyze the growth and instability of the area, production and productivity of sugarcane in Mandya district.
2. To estimate the decomposition analysis of sugarcane production in Mandya district.

**2. MATERIAL AND METHODS**

The study was entirely based on secondary data pertaining to the area, production and productivity of sugarcane gathered from the publications of the website of *Indiastat* and Directorate of Economics and Statistics for two decades (24 years) period from 2000-01 to 2023-24. The entire study period was divided into two periods as Period I (2000-01 to 2011-12) and Period-II (2012-13 to 2023-24) to analyse the growth performance of sugarcane production in Mandya district. The collected data were processed and analyzed using growth rates, instability index and decomposition analysis as detailed below.

**2.1 Growth Rate Analysis**

The compound annual growth rate (CAGR) is a useful measure of growth over multiple time periods. In the present study, the CAGR was used to analyze the growth trends in area, productivity and production of sugarcane in Mandya district of Karnataka State. The compound growth rates were worked out for a period of twenty-four years covering from 2000-01 to 2023-24. The CAGR was estimated by fitting a semi-log trend equation model of the following form for various parameters of sugarcane mentioned below:

**Yt=ABt ut ……… (1)**

Where,

Yt= Area/Production/Productivity of sugarcane during time t

A= Constant / intercept indicating Y in the base period (t=0)

t= Time period

ut=Error term

B = (1+g)

Where,

g = growth rate

The above equation (1) would become linear by taking the logarithm on both the sides of the model.

**ln Yt=ln A +t (ln B) +ln ut ……. (2)**

Where,

ln A and ln B are the parameters of the function obtained by Ordinary Least Square (OLS) method. Then growth rate ‘g’ was computed as follows:

**g = [Antilog (B)-1] x 100 ……... (3)**

Where,

g = Compound annual growth rate

B =Regression coefficient

**2.2 Instability Analysis**

Stability is the quality or characteristic of being stable and lack of stability indicate the situation of instability. The value of any parameter which is not likely to move or change is termed as stable. For example, instability in prices can be defined as the state, in which prices of a commodity subject to change with time in a market. The extent of instability thus, needs to be examined in relation to time and was attempted with respect to area, productivity and production of sugarcane.

Instability analysis represents the uncertainty with the help of indicators like Coefficient of Variation, Standard Deviation, various Instability Indices, etc. In the present study instability in area, production and productivity of sugarcane was analyzed using the Cuddy Della Valle Index (CDVI).

**2.2.1 Cuddy Della Valle Index (CDVI)**

The instability in area, production and productivity of sugarcane was analysed using Cuddy-Della Valle Index with modified coefficient of variation (CV) formula as given below (Cuddy and Valle, 1978).

**Coefficient of Variation (CV)= (S.D/Mean) \*100 ……… (4)**

**CDVI= CV ∗ √1−adjusted R2 ……… (5)**

Where,

S. D. = Standard deviation

R2 = Coefficient of multiple determination

The extent of instability was categorized into three levels based on the value of CDVI i.e.,

Low instability = 0-15 per cent, Moderate instability = 15-30 per cent, High instability = >30 per cent.

**2.3 Decomposition analysis**

To measure the relative contribution of area, yield to the total production of the sugarcane crop (Minhas and Vaidyanath, 1965), Decomposition analysis model was used which is given below:

**Po = Ao x Yo and**

**Pn = An x Yn ……… (6)**

Ao, Po and Yo are area, production and productivity in base year and An, Pn and Yn are values of the respective variable in nth year item respectively.

Where,

Ao and An = Area

Yo and Yn = yield in the base year and nth year respectively.

Pn - Po = ∆P

An - Ao = ∆A

**Yn - Yo = ∆Y……... (7)**

For equation (6) and (7) we can write Po + ∆P = (Ao + ∆A) (Yo + ∆Y)

Hence,

**P= Ao ∆Y/∆P\* 100 + Yo ∆A/∆P\* 100 + ∆Y ∆A/∆P\* 100**

(Production = Yield effect + area effect + interaction effect)

Thus, the total change in production can be decomposed into yield effect, area effect and the interaction effect due to change in yield and area.

1. **RESULTS AND DISCUSSION**

**3.1 Performance of area, production and productivity of sugarcane in Mandya district**

The performance of sugarcane in Mandya district during Period-I (2000-01 to 2011-12) is depicted in Table 1 revealed that average area under sugarcane cultivation was 25,227.02 ha, with a registered growth rate of 1.19 per cent, which shows non-significant. Average production of sugarcane was 29,99,265.80 tonnes with showing slightly a higher growth rate (1.32 %) and is non-significant. Average productivity was 116.44 ha-1, with a meager growth rate (0.14 %), but it showed non-significant. The instability index was observed to be highest in production (38.98 %) followed by area (32.11 %) and productivity (9.35 %). The limited growth indicates that external factors like weather and market conditions likely become constrained in advancements. These figures suggest that, similar results of the overall trends in sugarcane cultivation in the present study period were marked by significant variability and instability observed in the findings of Anjum (2018).

**Table 1: Performance of area, production and productivity of sugarcane in Mandya district during Period-I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Area (ha)** | **Production (tonne)** | **Productivity (tonne ha-1)** |
| 2000-2001 | 27581 | 3632519 | 129.21 |
| 2001-2002 | 35063 | 4263661 | 121.60 |
| 2002-2003 | 29686 | 3356002 | 113.05 |
| 2003-2004 | 13042 | 1474398 | 113.05 |
| 2004-2005 | 25930 | 3031354 | 115.90 |
| 2005-2006 | 13131 | 1384664 | 105.45 |
| 2006-2007 | 18847 | 2076939 | 110.20 |
| 2007-2008 | 23864 | 2335092 | 97.85 |
| 2008-2009 | 22257 | 2643019 | 118.75 |
| 2009-2010 | 24342 | 2682488 | 110.20 |
| 2010-2011 | 38031 | 5021994 | 132.05 |
| 2011-2012 | 30950 | 4089060 | 130.00 |
| **Average** | 25227.02 | 2999265.80 | 116.44 |
| **CAGR** | 1.19NS | 1.32NS | 0.14NS |
| **CDVI** | 32.11 | 38.98 | 9.35 |

Note: \*\*\*Significant at 1 per cent level; \*\*Significant at 5 per cent level; \*Significant at 10 per cent level; **NS** Non-Significant

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Govt. of India.

The average area under sugarcane cultivation was 31,666.91 ha, showing a highest compound growth rate (7.94 %), and is significant during Period-II (2012-13 to 2023-24) in Mandya district (Table 2). While average production of sugarcane was 3,603,765.66 tonnes, registered a moderate significant growth rate of 7.01 per cent. Average sugarcane productivity was 114.93 tonne ha-1 with a registering significant negative growth rate (-0.74 %). The instability index was observed to be highest in sugarcane production (27.66 %) followed by area (20.70 %) and productivity (5.16 %). Period-II witnessed substantial growth in both area and production, coupled with reduced variability, though productivity showed a slight decline. These findings align with broader trends observed in similar studies across different regions. In addition, farmers need to be addressed with the current excess situation of sugar production in the country and inability to find suitable foreign markets for exports and adversely affecting the domestic (low) prices and compelling factories for irregular payments and assure fair and remunerative prices as observed by Hanji *et al.* (2024).

**Table 2: Performance of area, production and productivity of sugarcane in Mandya district during Period-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Area (ha)** | **Production (tonne)** | **Productivity (tonne ha-1)** |
| 2012-2013 | 28751 | 3468808 | 118.00 |
| 2013-2014 | 19462 | 2496002 | 128.25 |
| 2014-2015 | 21592 | 2543538 | 117.80 |
| 2015-2016 | 27784 | 3061797 | 110.20 |
| 2016-2017 | 17628 | 2193805 | 124.45 |
| 2017-2018 | 20941 | 2347486 | 112.10 |
| 2018-2019 | 34637 | 3718282 | 107.35 |
| 2019-2020 | 37208 | 3984515 | 107.09 |
| 2020-2021 | 39795 | 4328889 | 111.00 |
| 2021-2022 | 40397 | 4766810 | 118.00 |
| 2022-2023 | 44068 | 4872246 | 112.00 |
| 2023-2024 | 47740 | 5463010 | 113.00 |
| **Average** | 31666.91 | 3603765.66 | 114.93 |
| **CAGR (%)** | 7.94\*\*\* | 7.016\*\*\* | -0.74\* |
| **CDVI (%)** | 20.70 | 27.66 | 5.16 |

Note: \*\*\*Significant at 1 per cent level; \*\*Significant at 5 per cent level; \*Significant at 10 per cent level; **NS** Non-Significant

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Govt. of India.

**Table 3: Performance of area, production and productivity of sugarcane in Mandya district during overall Period (2000-2024)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Area  (ha)** | **Production  (tonne)** | **Productivity  (tonne ha-1)** |
| **Average** | 28446.97 | 3301515.73 | 115.69 |
| **CAGR (%)** | 2.53NS | 2.35NS | -0.14NS |
| **CDVI (%)** | 29.77 | 31.36 | 7.47 |

Note: \*\*\*Significant at 1 per cent level; \*\*Significant at 5 per cent level; \*Significant at 10 per cent level; **NS** Non-Significant

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Govt. of India.

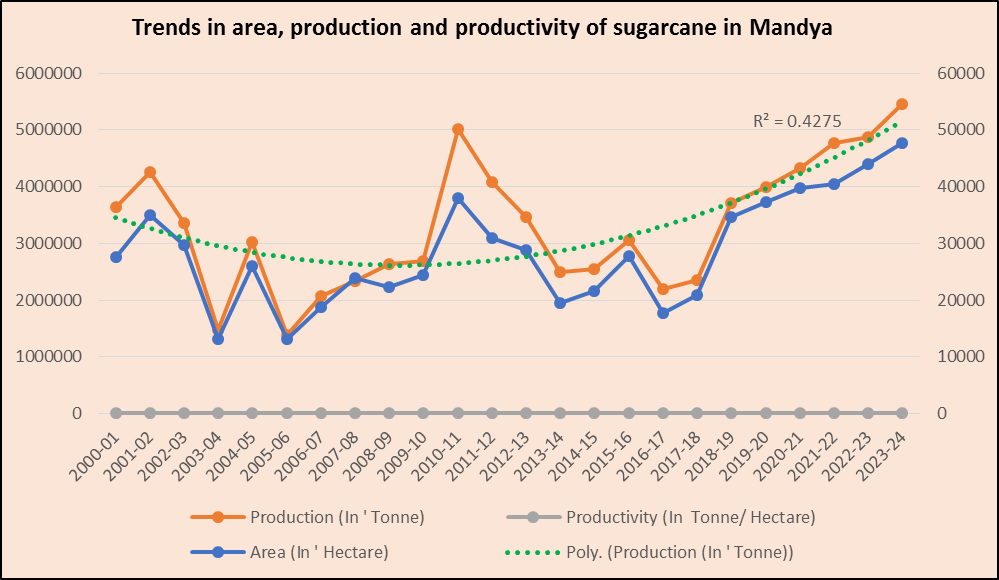
**Table 4: Contribution of area, yield and their interaction for change in production of sugarcane in Mandya district**

**(Percent)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Contribution of** | | | |
| **Period** | **Yield effect** | **Area effect** | **Interaction effect** |
| **Period I** | 95.35 | 4.77 | 0.58 |
| **Period II** | 112.36 | -7.20 | -4.76 |
| **Overall** | 142.29 | -24.42 | -17.85 |

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Govt. of India.

The average area under sugarcane cultivation in Mandya district was 28,446.97 ha during overall study period (2000-01 to 2023-24), it registered a highest growth rate (2.53 %), but non-significant (Table 3). Average production of sugarcane was 3,301,515.73 tonnes, showing a positive and non-significant compound growth rate (2.35 %). Average productivity was 115.69 tonne ha-1 representing non-significant negative growth rate (-0.14 %). A highest variability was observed in production (31.36 %) followed by area (29.77 %) and productivity (7.47 %). Figure 1 representing polynomial trendline of sugarcane production with an R2 value of 0.42. The trend shown in Fig 1 further illustrates consistent yet modest growth with moderate fluctuations and the same trend as observed by Hanji *et al.*, (2024).



**Fig. 01: Trends in area, production and productivity of sugarcane in Mandya during Overall Period (2000-2024)**

It could be observed from Table 4 that decomposition analysis of sugarcane production in Mandya district revealed that during Period I, the yield contributed a highest per cent change (95.35 %) in sugarcane production, followed by area (4.77 %) and interaction effects (0.58 %). In Period II, yield contribution was also found to be highest (112.36 %), while the per cent change in area (-7.20 %) and the interaction effect (-4.76 %) were observed to be negative. During overall study period, the yield contribution increased to 142.29 per cent, emphasizing its primary role in driving change in production, despite negative contributions from area (-24.42 %) and interaction effects (-17.85 %). Thus, yield improvements were the key driver of change in sugarcane production, while area and interaction effects had negative impacts, especially during the overall study period. This reflects broader trends wherein yield, but not area, increasingly drives production growth. This indicates that overall sugarcane production increases were primarily driven by improvements in cane yield levels, while changes in sugarcane area had a minimal or slightly negative impact and the similar results were observed by Maurya *et al*., (2020).

1. **Conclusion**

The study concludes that sugarcane cultivation in Mandya district has exhibited notable growth trends over the study periods. While the area under sugarcane cultivation expanded, it experienced variability and fluctuating growth rates. Sugarcane production also demonstrated significant growth, particularly during Period II, primarily driven by yield improvements. However, production fluctuations indicate some level of instability in the sector.

Decomposition analysis revealed that yield improvements were the primary driver of increased sugarcane production, while changes in area had a minimal or negative impact. The decline in productivity during Period II suggests challenges such as soil fertility depletion and the use of low-yielding varieties. To enhance stability and sustain sugarcane production, the adoption of high-yielding and climate-resilient varieties, along with improved soil management practices, is recommended. This approach would help mitigate risks, sustain yields, and ensure a more stable and productive sugarcane sector in Mandya district.

The present study primarily focuses on the growth and instability of area, production, and productivity in sugarcane cultivation. Future research could explore economic aspects, including market dynamics and price trends, to provide insights that would help farmers achieve better income and financial stability.

**Disclaimer (Artificial intelligence)**

Option 1:

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.

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