

STATISTICAL ANALYSIS OF AREA, PRODUCTION AND YIELD OF SUGARCANE IN INDIA**M. H. Lohagaonkar¹, A. A. Bhagat², D. S. Jadhav³ and B. K. Gayval⁴**¹ Associate Professor and Head, Department of Statistics, Shri. Chhatrapati Shivaji Mahavidyalay, Shrigonda (M.S.)² Assistant Professor of Statistics, ZARS, Ganeshkhind, Pune (M.S.)³ Assistant Professor of Statistics, YCIS, Satara(M.S.)⁴ Assistant Professor of Statistics, S. P. College , Pune (M.S.)**Corresponding author Email - mhlohagaonkar@gmail.com****ABSTRACT**

This research investigates the growth patterns and instability in sugarcane cultivation in India over a span of 72 years, from 1950-51 to 2020-21, utilizing secondary time series data. Descriptive statistics and compound growth rates (CGR) were employed to discern trends in sugarcane cultivation parameters, including area, production, and yield. The mean values for sugarcane cultivation parameters were found to be 3.35 million hectares for area, 204.55 million tonnes for production, and 56,922.75 kg per hectare for yield. Analysis revealed positively skewed distributions for area and production, while yield exhibited a negatively skewed distribution. Moreover, platykurtic curves were observed for all three parameters – area, production, and yield of sugarcane in India. Compound growth rates were computed using exponential functions, with sugarcane area, production, and productivity showing growth rates of 1.58%, 2.81%, and 1.22% per annum respectively. The significance of these growth rates was tested using Student's t-test. Additionally, the instability in sugarcane cultivation parameters was assessed using the Cuddy-Della Valle index.

KEYWORDS: Area, production, yield, CGR and sugarcane.

INTRODUCTION

Sugarcane is the most dominant industrial crops for sugar and bio-energy. It is extremely essential to be aware with the trend of variability in sugarcane production for proper planning and maintaining balanced demand and supply system. Upreti et al (2017) found the positive and significant contribution of human labour, machine, fertilizers, insecticides and size of plot towards productivity of sugarcane and thus efficient management of these inputs can certainly led to increasing the productivity of sugarcane in India. Kamble *et al.* (2020) observed that the growth rates of area and production of sugarcane for Maharashtra as a whole were observed to be positive and significant for the entire period of 53 years. There existed wide variation in the performance of sugarcane crop in terms of changes in area, total production and productivity among the districts over a period of time.

Bhagat et al. (2023) studied the performance of Indian banana with respect to growth in quantity exhibited as positive growth rate of 22.14 per cent annum. The quantum of banana exported exhibited less variability with coefficient of variation at 121.32 per cent while it was highest in the banana value during study period with coefficient of variation at 146.14 per cent. The instability index of banana export and value were 38.85 and 48.53 per cent respectively. Bhagat et al (2021) indicated that there was an upward positive trend of grape export from India during the study period. The performance of Indian grape with respect to growth in quantity exhibited a positive growth rate of 12.81 per cent per annum which was statistically significant at 1 per cent level of significance. The instability index of grape export and value was 29.47 and 23.37 percent respectively.

The instability in sugarcane production and yield are serious problems for sugarcane growers because it affects the price level of sugarcane. Hence, the present investigation has been undertaken to study the growth and instability in area, production and yield of sugarcane in India.

MATERIALS AND METHODS

The secondary time series data on area, production and yield of sugarcane from the published sources were used for estimating the annual compound growth rates of area, production and yield of sugarcane in India over a period of 72 years (1950- 51 to 2020-21). The descriptive statistics of area, production and productivity of sugarcane in India was estimated. The compound growth rates in area, production and yield of sugarcane were estimated by fitting following compound growth rate equation.

$$Y = ab^t$$

Where,

Y = Area/ Production/ yield

a = Constant

b = Regression coefficient

t = Time period (Years)

The compound growth rate 'r' in percentage was worked out by

$$r = (Antilog b-1) \times 100$$

The significance of calculated compound growth rates were tested with the help of student 't' test.

The instability in area, production and yield of sugarcane was tested by Cuddy-Della Valle index that attempts to de-trend the CV by using coefficient of determination.

$$CDVI = C.V. X \sqrt{(1 - R^2)}$$

Where,

CDVI is cuddy della valley index.

C.V. is coefficient of variation

R² is the coefficient of determination.

RESULTS AND DISCUSSION

The descriptive statistics of area, production and yield of sugarcane in India is presented in Table 1. The results revealed that mean area, production and yield of sugarcane was 3.35 million ha., 204.55 million tonnes and 56922.75 kg/ha respectively. The median for area, production and yield was 3.19 million ha., 186.36 million tonnes and 59380 kg/ha respectively. The maximum area (5.15 million hectares), production (405.42 million tonnes) and yield (82205.00 kg/ha) of sugarcane in India were observed during study period. Whereas, minimum area (1.41 million ha.) with production (44.41 million tonnes) and yield (29495.00 kg/ha). The results of skewness of area, production and yield of sugarcane of India indicated that distribution is positively skewed for area and production however, negatively skewed for yield of sugarcane and it was not normally distributed. The platykurtic curves were observed for area, production and productivity of sugarcane in India. The similar results were reported by Bhagat *et al.* (2017) for banana and Singh *et al.* (2021) for Sugarcane production in India.

Table 1. Descriptive Statistics of area, production and yield of sugarcane in India (1950-51 to 2020-21).

Particular	Area (Million ha)	Production (Million Tonnes)	Yield (Kg/ha)
Mean	3.35	204.55	56922.75
Standard Error	0.13	12.31	1646.90
Median	3.19	186.36	59380.00
Mode	2.05	--	--
Standard Deviation	1.06	103.76	13877.01
Kurtosis	-1.16	-1.18	-0.91
Skewness	0.13	0.23	-0.31
Range	3.74	361.01	52710.00
Minimum	1.41	44.41	29495.00
Maximum	5.15	405.42	82205.00

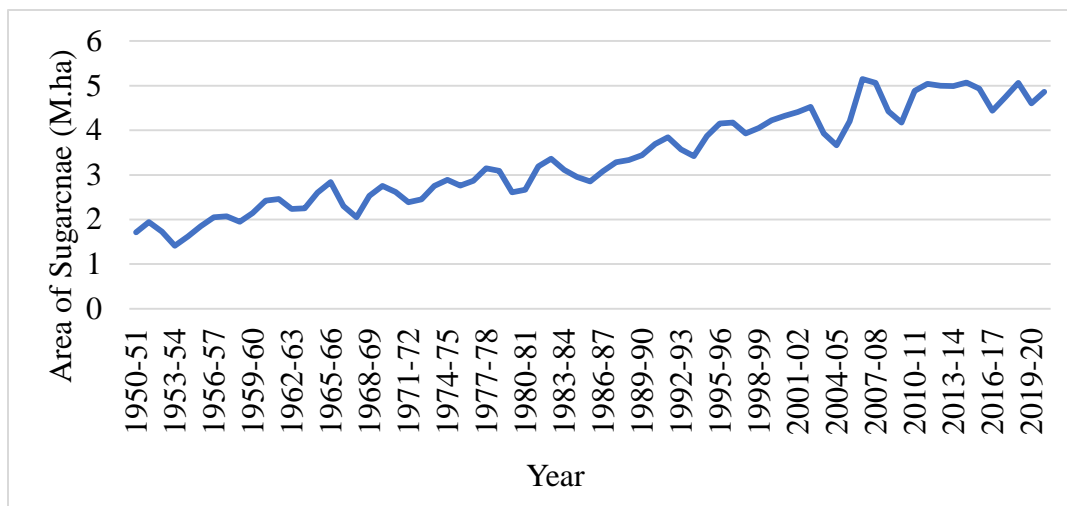


Fig. 1 Time series plot of area of sugarcane in India (1950-51 to 2020-21)

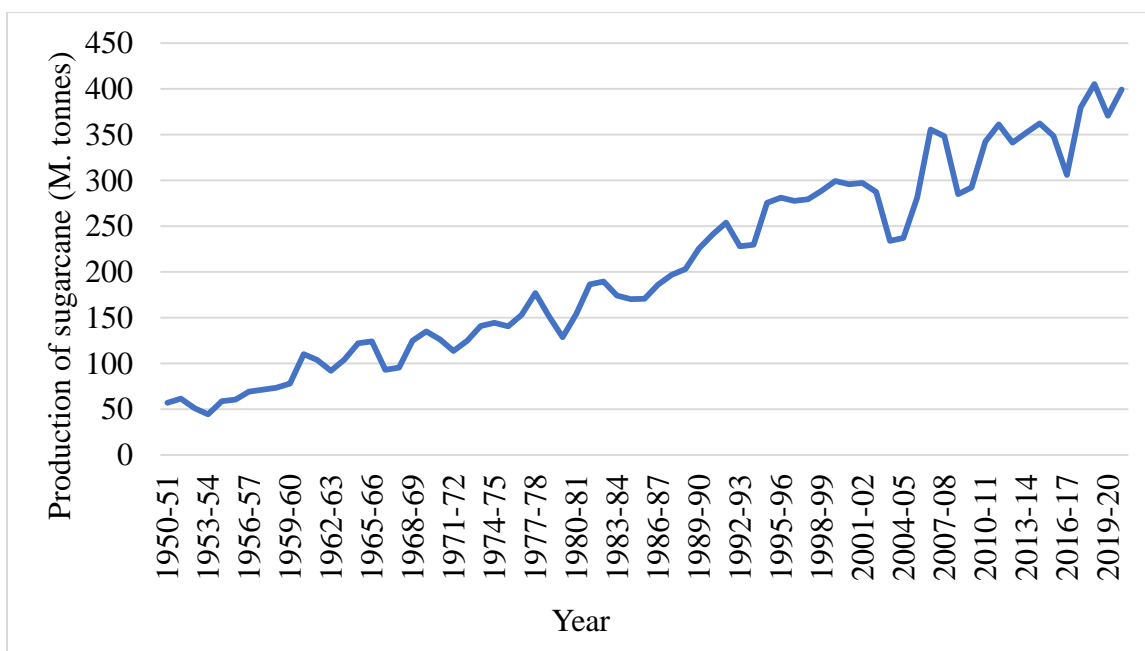


Fig. 2 Time series plot of production of sugarcane in India (1950-51 to 2020-21)

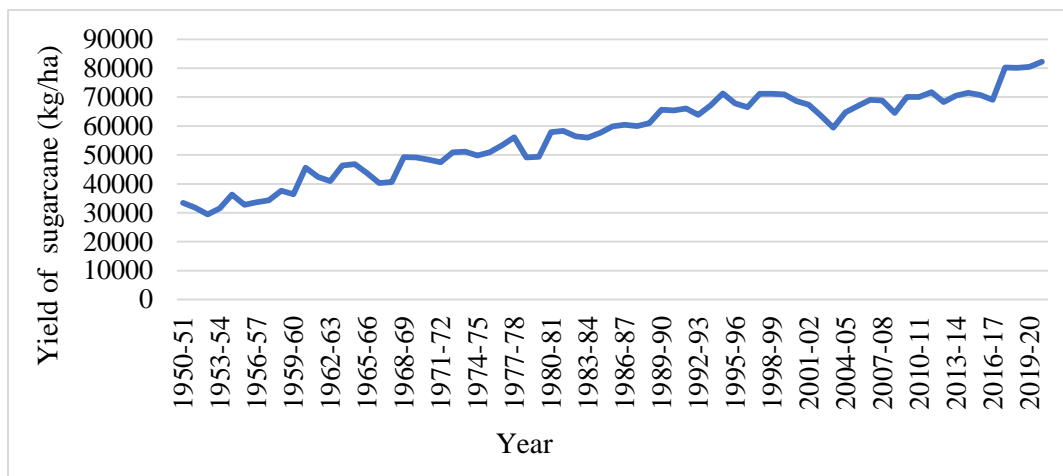


Fig. 3 Time series plot of yield of sugarcane in India (1950-51 to 2020-21)

The results of growth rates in area, production and yield of sugarcane in India are depicted in Table 2. It revealed that the decadal rate of increase in area, production and yield of sugarcane was not uniform in India. The compound growth rates of area, production and yield have been examined for the period 1950-51 to 2020-21. The time series data on sugarcane area (A), production (P) and productivity (Y) were divided into six sub periods as period-I (1950-51 to 1960-61), period-II (1961-62 to 1970-71), period-III (1971-72 to 1980-81), period-IV (1991-92 to 2000-01), period-V (2001-2002 to 2010-11), period-VI (2011-2012 to 2020-21) and overall period (1950-51 to 2020-21).

The growth rates of area, production and yield of sugarcane for India as a whole were observed to be positive and significant for the entire period of 72 years. The area, production and yield of sugarcane have significantly increased at the rate of 1.58, 2.81 and 1.22 per cent per annum, respectively, during entire period. The growth rate of area in period I (3.22) and period V (1.91) has shown significantly increasing growth rate per annum respectively. While in case of production period I (6.00), period IV (2.97) and period V (2.74) have shown significantly increasing positive growth per annum. However, yield has shown non-significant growth of sugarcane for all time periods along with overall period. The similar results were reported by bhagat *et al.* (2017) Bee *et al.* (2020) for sugarcane in India.

Table 2: Period wise Compound growth rate of sugarcane area, production and yield in India (1950-51 to 2020-21).

Particular	Area (Million ha)			Production (Million Tonnes)			Yield (Kg/ha)		
	CGR	S.E.	R ²	CGR	S.E.	R ²	CGR	S.E.	R ²
Period I (1950-51 to 1960-61)	3.22*	0.05	0.50	6.00**	0.06	0.65	2.69**	0.03	0.58
Period II (1961-62 to 1970-71)	1.01	0.04	0.09	2.65	0.05	0.30	1.37	0.03	0.26
Period III (1971-72 to 1980-81)	1.42	0.04	0.22	2.48	0.05	0.35	1.07	0.02	0.27
Period IV (1981-82 to 1990-91)	1.35	0.03	0.28	2.97*	0.03	0.58	1.61**	0.01	0.79
Period V (1991-92 to 2000-01)	1.91**	0.02	0.58	2.74**	0.02	0.70	0.82*	0.01	0.41
Period VI (2001-02 to 2010-11)	1.29	0.05	0.12	2.31	0.06	0.23	1.01	0.02	0.34
Period VII (2011-12 to 2020-21)	-0.69	0.02	0.22	1.34	0.03	0.25	2.05**	0.02	0.70
Overall (1950-51 to 2020-21)	1.58**	0.04	0.92	2.81**	0.07	0.93	1.22**	0.04	0.88

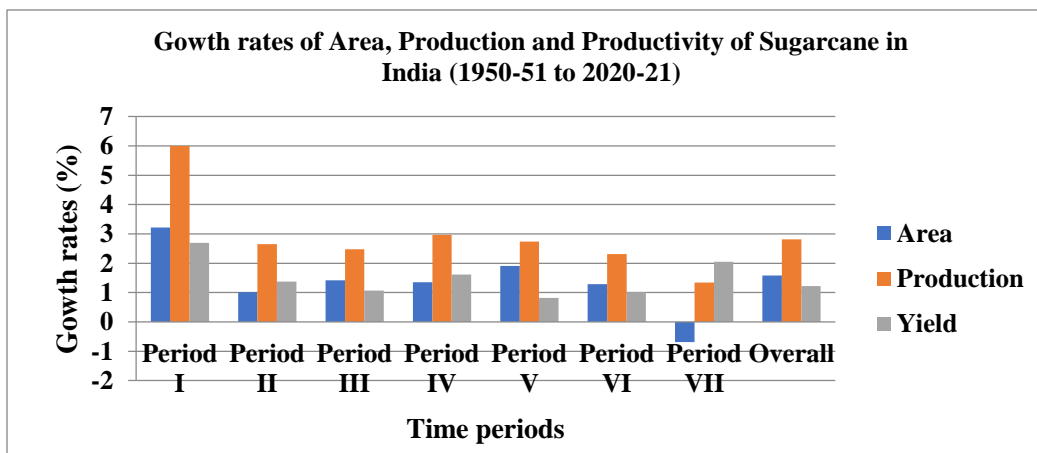


Fig 4. Period wise growth rates of area, production and yield of sugarcane in India

The results of instability index of area, production and yield of sugarcane are presented in Table 3. It revealed that the low degree of instability in area was observed during the period II (1961-62 to 1970-71) (9.70), Period III (1971-72 to 1980-81) (7.93), Period IV (1981-82 to 1990-91) (5.40), Period V (1991-92 to 2000-01) (4.74), Period VII (2001-02 to 2010-11) (3.89) and overall period (1950-51 to 2020-21) (8.96) where moderate instability in area of sugarcane was observed in Period I (15.42), Period II (11.96), Period III (10.06), Period VI (12.57) and in overall period (13.42) respectively. However, the low instability was observed for all periods in yield of sugarcane for India. It was clear from the study that there was a high level risk involved in the sugarcane production. The similar results were reported by Gupta *et al.* (2021) for growth and instability of sugarcane production in Maharashtra.

CONCLUSION:

This study provides insights into the growth patterns and instability in sugarcane cultivation in India over a 72-year period. The findings underscore the need for strategic planning and interventions to mitigate risks and enhance productivity in the sugarcane sector. Significant growth in sugarcane cultivation in India over the study period. Positively skewed distributions were observed for area and production, while yield exhibited a negative skew. Moreover, platykurtic curves were noted for all three parameters. Compound growth rates indicated consistent increases in sugarcane area, production, and yield, with significant differences observed across periods. However, yield showed non-significant growth. The instability index highlighted varying degrees of instability across periods, suggesting a high level of risk associated with sugarcane production.

Table 3. Instability index of area, production and yield of sugarcane in India (1950-51 to 2020-21)

Particular	Measurement	Period I	Period II	Period III	Period IV	Period V	Period VI	Period VII	Overall
Area	CV (%)	14.61	10.17	8.98	7.63	7.31	10.85	4.40	31.68
	R ²	0.50	0.09	0.22	0.58	0.12	0.12	0.22	0.92
	Instability index (%)	10.33	9.70	7.93	5.40	4.74	10.18	3.89	8.96
Production	CV (%)	26.07	14.29	12.48	12.06	9.39	14.32	7.96	0.93
	R ²	0.65	0.30	0.35	0.70	0.23	0.23	0.25	50.73
	Instability index (%)	15.42	11.96	10.06	7.81	5.14	12.57	6.90	13.42
Yield	CV (%)	12.33	8.01	6.30	5.51	3.83	5.12	7.43	24.38
	R ²	0.58	0.26	0.27	0.41	0.34	0.34	0.70	0.88
	Instability index (%)	7.99	6.89	5.38	2.53	2.94	4.16	4.07	8.45

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