

Research Paper

Growth Trend and Instability in Area, Production and Productivity of Sugarcane in Uttar Pradesh: An Overview

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ABSTRACT

The present study was conducted to analyze the growth rates and instability in the area, production, and productivity of sugarcane in Uttar Pradesh for the last 71 years from 1950-51 to 2020-21. A Semi-log regression model was used to assess the growth rates and trend, while instability was determined by an adjusted coefficient of variation and the Cuddy Della Vella Instability Index. The results of the growth analysis revealed that area, production and productivity accounted to be positive and statistically significant, whereas the highest growth rate was registered for sugarcane production i.e. 2.25 percent per annum rather than area (1.19% per annum) and productivity (1.05% per annum). In case of instability for the entire study period, the area, production and productivity of this crop accounted to be 24.01, 44.82 and 23.64 percent respectively. It shows that the variation in sugarcane production is higher compared with crop acreage and productivity. It implies that farmers should need to pay adequate attention to adopting improved production technologies and advanced management to address the problems of fluctuation in sugarcane production. Moreover, the higher stability of productivity and area implies a low risk in the supply of raw sugarcane to the sugar industries.

HIGHLIGHTS

- ① Growth rate of area, production and productivity of sugarcane in Uttar Pradesh were registered significant and showing an increasing trend.
- ① The high instability in sugarcane production could be attributed to the natural phenomenon, dissemination of advanced production technologies or technological changes.
- ① High growth and low instability in area and productivity of sugarcane implies sustainable production and low risk in the supply of raw sugarcane to the sugar industries.

Keywords: Co-efficient of variation, Cuddy Della Vella Index, Exponential trend equation, Sugarcane, Growth and Instability

In India, sugarcane is an important commercial crop and is cultivated in 2.57 percent of the acreage. Of all sugarcane-producing countries in the world, India accounts for about 25 percent of the world's production after Brazil. India is not only a major producer of sugarcane, but also a major exporter of sugarcane with exporting more than 280 thousand tons of sugarcane in the last fiscal year. It provides employment around 7.5 percent of the country's rural population to grow

sugarcane and contributes 1.1 percent to gross domestic product (GDP) (Solomon, 2016). Sugarcane accounted for about 648 billion rupees to the Indian economy during 2019. It accounted for more than 80 percent of the total added value from sugar crops

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in India's agricultural sector in fiscal year 2020 (Statista Research Department, 2021).

The sugar industry of India is the second-largest agro-based industry after textiles and it has successfully contributed toward providing employment and economic development of the country (Ahmed and Rahman, 2014). The sugar industry as a whole has supported 6 million farmers and their families (Verma, 2015). The sugarcane is considered as the crop for the future because of its contribution to production of sugar, jaggery, khandsari and many by-products like molasses, bagasses and press mud and also certain renewable sources of green energy in the form of bioethanol and many bio-based products which is consumed widely across the nation.

In India, the agro-climatic regions of sugarcane cultivation can be divided into two: tropical and sub-tropical. The sub-tropical region constitutes the northern states of Uttar Pradesh, Bihar, Uttarakhand, Punjab; Haryana comprises 55 percent of the total area under sugarcane and contributes 47 percent of the country's sugarcane production. The tropical region constitutes mainly the southern states of Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh (Upreti and Singh, 2017). In case of sugar production, the share of Maharashtra, Uttar Pradesh and Karnataka has increased from 74 percent to 84.6 percent during the corresponding period (2015-17). Among all states in the country, Uttar Pradesh is the primary sugarcane-producing state of the country and occupies first place in both area and production of sugarcane (Adhle *et al.* 2019). In the cultivation of sugarcane, owner farmers used resources more effectively than tenant farmers (Bey *et al.* 2022). The state's share in the total area of sugarcane grown in the country is approximately 48 percent, and it contributes 50 percent of the total sugarcane production followed by Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Bihar, Haryana and Punjab. The sugarcane productivity in the state is currently 79.19 tonnes per hectare, which is 7 percent higher than the national average of 72.38 tonnes per hectare. The present study deals with the Growth Trend and Instability in Area, Production and Productivity of Sugarcane in Uttar Pradesh: An Overview. The results of the study are of great importance to the researcher, policy makers, administrators and agencies involved in the field of sugarcane and its allied developments.

MATERIALS AND METHODS

Data source

The study is merely based on time series data on multiple variables like area, production and productivity of sugarcane for last the 71 years, i.e., from 1950- 51 to 2020-21. The time-series data were obtained from various sources like Co-operative sugar, Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare Government of India.

The obtained time series data on area, production and productivity were divided into seven-sub period as the period I (1950- 51 to 1959-60), period II (1960-61 to 1969-70), period III (1970-71 to 1979-80), period IV (1980-81 to 1989-90) period V (1990-91 to 1999-00) period VI (2000-01 to 2009-10), period IIV (2010-11 to 2020-21) and overall period (1950-51 to 2020-21). To analyze the data we utilized the statistical software STATA.

Trend and growth rate analysis

The semi-log trend function is commonly used to determine the trend and estimate the growth rate of area, production and productivity in several studies (Kumawat and Meena, 2005; Akhter *et al.* 2016; Singh *et al.* 2021). In the semi-log function, a given's year output depends on the preceding year. The following well-known compound interest formula was applied in this study with equation (Gujarati *et al.* 2003; Rana *et al.* 2021).

$$Y_t = Y_0 (1 + r)^t$$

Where,

Y = Area, production and productivity in the year t ,

Y_0 = Area, production and productivity in the base year

r = Compound growth rate

t = Time in chronological years.

A semi-log growth rate model has been employed instead of a linear model because semi-log model will provide both relative and absolute changes.

$$\text{Compound growth rate } (r) = [\text{Anti ln } \beta_2 e 1] \times 100$$

Therefore, if β_2 is positive and statistically significant, then there is a positive increase in growth rate. If the β_2 is negative and statistically significant, then there is a diminishing growth rate. If the β_2 is not statistically significant, there is stagnation in the growth rate.

Where, r = compound growth rate in percent per annum,

β_2 = estimated coefficient

e = euler's exponential

Estimating instability index

Instability in agricultural crops depends on production technology, improved variety, nature, economic environment, sensitivity to weather, availability to input. To study the instability of sugarcane in Uttar Pradesh in respect to area, production and productivity, the coefficient of variation can be used by following the formula:

Coefficient of Variation (C.V.) =

$$\frac{\text{Standard Deviation } (\sigma) \text{ of } X}{\text{Mean } (\mu) \text{ of } X} \times 100$$

Here,

Standard Deviation of X has been calculated by using the formula;

$$\text{Standard Deviation } (\sigma) \text{ of } X = \sqrt{\frac{1}{N} \sum (X - \bar{X})^2}$$

Where:

X_i = individual observation in time series data,

\bar{X} = arithmetic mean of X .

$X - \bar{X}$ = deviation from the mean,

N = number of observation.

However, a simple coefficient of variation does not explain the variation of time series data properly (Joshi and Singh, 2015). Therefore, in this study, the level of instability is also computed around the trend i.e. coefficient of variation is multiplied by the square root of the difference between the unity and coefficient of multiple determinants (r^2), where r^2 was significant to obtain the instability index. The coefficient of variation around the trend (CV_t) was used proposed by J.D.A. Cuddy and P.A. Della

Valle in 1978 with the following equation (Singh *et al.* 2021) is as follows—

$$\text{Instability index} = \frac{\sigma}{\bar{X}} \times 100 = \sqrt{1 - r^2}$$

Or

$$\text{Cuddy – Dell Valle Instability index } (\%) = \text{C.V} \times \sqrt{(1 - R^2)}$$

Where,

C.V = Coefficient of Variation in per cent,

R^2 = Coefficient of determination from a time trend regression adjusted for its degrees of freedom.

RESULTS AND DISCUSSION

Trend and growth rates in area, production and productivity of sugarcane

The result from the semi-log function for the area, production and productivity of sugarcane in Uttar Pradesh for the period 1950-51 to 2020-21 were estimated and presented in Table 1. Since the 1950s, the area under sugarcane cultivation and productivity in Uttar Pradesh has more than doubled from 1014 to 2180 thousand hectare area and productivity (39.48 t/ha to 81.31 t/ha), however, during the last 15 years there is continues to decline in the area under sugarcane cultivation. The production of sugarcane has increased more than four times, from 400.30 lakh tonnes to 1772.62 tonnes. It was revealed from the table, for the overall period (1950-2021) the growth rates of area, production and productivity were positive and statistically.

The decadal growth in the area under sugarcane, production and productivity for the last seven decades is given in Table1. It was evident from the table that the growth rate in sugarcane production and productivity were the highest in the 2010s despite a decline in area under sugarcane cultivation, the production and productivity have increased mainly due to significant improvement in the adoption of improved production technologies (nutrient, irrigation, weed, resource conservation technologies etc.). The negative growth was witnessed during the 1960s, this was marked by growth in area and production were approximately

Table 1: Growth rates in area, production and productivity of sugarcane in Uttar Pradesh (1950-2021)

Period	Area	Production	Productivity
Period-I (1950- 51 to 1959-60)	1.89	1.88	-0.09
Period-II (1960-61 to 1969-70)	-0.95	-0.43	0.53
Period-III (1970-71 to 1979-80)	1.82	1.66	-1.55
Period-IV (1980-81 to 1989-90)	1.66	3.53	1.84
Period-V (1990-91 to 1999-00)	1.11	1.99	0.87
Period-VI (2000-01 to 2009-10)	0.50	0.67	0.15
Period-VII (2010-11 to 2020-21)	0.13	4.31	4.18
Overall (1950- 51 to 2020-21)	1.19	2.25	1.05

Table 2: Instability in area, production and productivity of sugarcane in Uttar Pradesh (1950-2021)

Period	Area	Production	Productivity
Period-I (1950- 51 to 1959-60)	12.39	12.38	6.04
Period-II (1960-61 to 1969-70)	10.07	14.84	8.10
Period-III (1970-71 to 1979-80)	8.17	12.42	6.92
Period-IV (1980-81 to 1989-90)	8.27	12.13	6.16
Period-V (1990-91 to 1999-00)	5.01	7.76	4.66
Period-VI (2000-01 to 2009-10)	4.79	6.58	4.19
Period-VII (2010-11 to 2020-21)	1.74	14.20	13.43
Overall (1950- 51 to 2020-21)	24.01	44.82	23.64

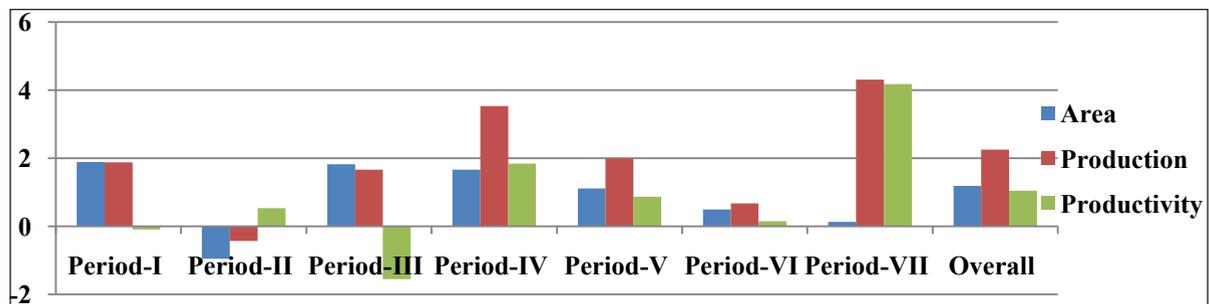


Fig. 1: Decadal growth trend in area, production and productivity of sugarcane in Uttar Pradesh in 1950-2021

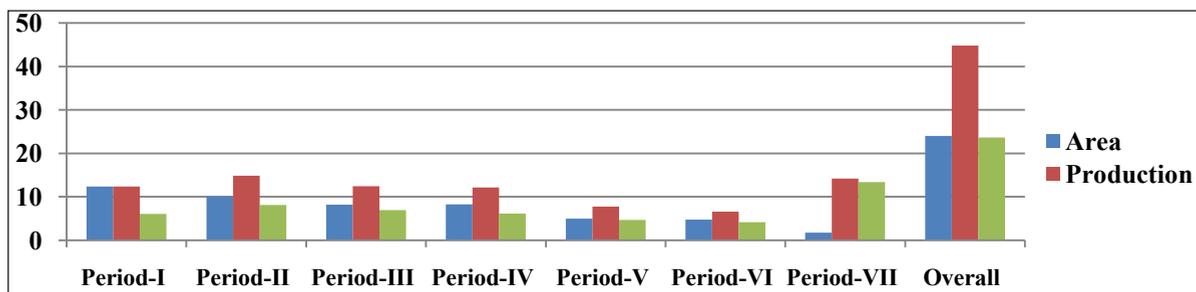


Fig. 2: Decadal instability trend in area, production and productivity of sugarcane in Uttar Pradesh in 1950-2021

(-0.95) and (-0.43) percent per annum. The highest decline in productivity of sugarcane recorded (-) 1.55 percent per annum during the 1970s due to successive drought years.

Instability in area, production and productivity of sugarcane

The instability is one of the major bottlenecks to affecting the cropping pattern, selection of crops for

cultivation and consistent growth. The instability in the area, production and productivity of sugarcane in Uttar Pradesh for all seven periods is worked out and presented in Table 2. The coefficient of variation and Cuddy Della Vella Instability index of sugarcane for the period 1951-2021 have been estimated and presented in Table 2. Overall instability analysis reveals that sugarcane production was highly unstable (44.82%), followed by sugarcane cultivated

area (24.01%) and productivity (23.64%). It revealed the low risks in the expansion of area under sugarcane cultivation, future supply raw sugarcane to the sugar industries and farmers net return. But, farmers still need to pay more attention to sugarcane cultivation by adopting the advanced package of practices and improved varieties. Results depicted that the decadal instability in the area, production and productivity of sugarcane. In the case of area under sugarcane cultivated, a low level instability was observed for period's III, IV, V, VI and VII. In the case of sugarcane production, a low-level of instability was observed for period's V and VI. Eventually, in case of sugarcane productivity, a low-level instability was observed for period's I, II, III, IV, V and VI. The highest instability in the area was observed during period's I, in production during periods II and VII and in productivity during period VII. The main cause of instability could be attributed to the severe drought and low technological dissemination. The result implies that there was a higher level of risk involved in sugarcane production and fluctuated over a decade.

CONCLUSION

The growth rate of area, production and productivity of sugarcane in Uttar Pradesh for the last 71 years were witnessed to be positive, significant and showing an increasing trend over time. It revealed that the production of sugarcane increases mainly due to expansion of the area under sugarcane cultivation and slight improvement of productivity by the adoption of advanced cultivation practices and diversification of cultivated variety. The variability in the production of sugarcane is mainly due to an increase and decrease in area and productivity. The variation in sugarcane production is higher compared with acreage and productivity. It implies that farmers should need to pay adequate attention to adopt improved production technologies and advanced management to address the problems of fluctuation in sugarcane production.

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