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ORIGINAL ARTICLE

Decomposition and Instability analysis of Sugarcane Production in Uttar Pradesh

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ABSTRACT
In the present study data were broadly divided into five period in order to analyze the decomposition and instability analysis of sugarcane area production and yield in Uttar Pradesh, for the last 72 year from 1950 to 2022. Data were secondary, collected information from APY Statistic's (www.dac.gov.in). The result revealed that the yield effect has a greater in sugarcane in initial period (period I to III), after that area effect is responsible, while in entire period interaction effect is responsible which means the combined effect of yield and area on sugarcane production. In case of Instability analysis in entire period indicates that variation in sugarcane yield (9.945%) was higher compared with cultivated area and production. It implies that farmer should need to pay adequate attention to the adoption improved production technologies and advance management to address the problem of fluctuation in sugarcane production.
Keywords: Decomposition, Coefficient of variation, instability index

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INTRODUCTION

India is the world's largest producer of sugarcane; the leading states are Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Bihar, Gujarat, Haryana, Punjab, and Andhra Pradesh. India is significantly dependent on sugarcane. A large number of agricultural laborers and about 6 million farmers work in the cane industry. In addition, around half a million skilled and semi-skilled people, the most of whom are from rural regions, are employed in India's largest agro-processing business, the sugar industry. The country's overall cane production is, on average, 60% made up of white sugar production. Approximately 15% to 20% of sugarcane is utilized in the production of gur and khandsari [1].

In Uttar Pradesh, during 2023- 24 sugarcane was cultivated in an area of 2179 thousand hectares and production was 176706 thousand tones with the productivity of 81100 Kg. per hectares [2]. The output per hectare is low when compared to some of the major sugarcane-producing states in the nation. As a result, there is a shortage of sugarcane for sugar mills and a low total output. In an attempt to address this issue, high yielding, early maturing, high sucrose content sugarcane varieties that are resistant to pests and diseases are being developed. In order to fulfill the demands of a growing population and economy, it has developed into a complex scientific study with the goal of producing the greatest amount of agricultural produce in the least amount of time, area, and energy. A greater amount of sugar must be produced in the area that is accessible because of the rapidly growing population and rising per capita sugar consumption. The present study deal with the Decomposition and Instability Analysis of Sugarcane Production in Uttar Pradesh. The result of the study are of great importance to the researcher policy makers, administrator agencies involved in the field of sugarcane and its allied development.

MATERIAL AND METHODS

Secondary data, was collected from www.dac.gov.in (APY statistics), data pertains to period 1950-2022 regarding area, production, and yield of sugarcane for arriving analyzing Instability, and Decomposition with application of time series analysis of data.

The obtained data on area, production and yield were divided into five period as the Period 1 (1950-1967), Period 2 (1968-1985), Period 3 (1986-2003) Period 4 (2004-2022) Overall Period (1950-2022).

Decomposition analysis

Minhas [3]; Nivetha and Uma[4]; Srivastava *et al.,* [5] used the Decomposition analysis model, which is shown below, to determine the relative contribution of area and yield to the overall output of the sugarcane crop. $P_o = A_o \times Y_o$ and

$P_n = A_n \times Y_n$ .....(1)

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

Where,

A_o and A_n = Area Y_o and

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

$P_n - P_o = \Delta P$ $A_n - A_o = \Delta A$ $Y_n - Y_o = \Delta Y$ ---------- (2)

For equations (1) and (2) we can writeP_o $+ \Delta P = (A_o + \Delta A)(Y_o + \Delta Y)$ Hence,

$$P = \frac{A_o \Delta Y}{\Delta P} \times 100 + \frac{Y_o \Delta A}{\Delta P} \times 100 + \frac{\Delta Y \Delta A}{\Delta P} \times 100$$

Production = Yield effect + area effect + interaction effect [6].

As a result, the overall change in production can be broken down into yield effect, area effect, and interaction effect due to yield and area changes.

Instability and It's Measure

For assessing the instability in the area, production, and yield the index certain by Cuddy and Della (1978)[7] and used by Srivastava *et al.,*[8]; Supriya *et al.,* [9]: $CV_t = (CV) \times \sqrt{1 - R^2}$

$$C.V. = \frac{\sigma}{\bar{X}} \times 100$$

Where, σ = Standard Deviation

$\bar{X} = Mean$

R^2 = coefficient of determination of the variable's linear trend model.

CV_t = CV around trend

RESULTS AND DISCUSSION

Sources of change in Sugarcane production

The examination of the expansion of the area, production, and yield of the sugarcane crop reveals the comprehensive pattern of development and the direction of changes. However, this method fails to evaluate the precise influence of the region and crop output on the expansion of sugarcane cultivation. Identifying the origins of variations in sugarcane production is crucial in order to determine the specific aspect that is lagging behind and to ascertain the underlying reasons behind it.

Additionally, it will aid in comprehending the factors that contribute to the improvement of sugarcane production. Therefore, it is necessary to analyse the origins of sugarcane production. In order to analyse the factors contributing to the production of sugarcane, the overall change in production is split into three distinct effects: the area effect, the yield effect, and the interaction effect. Table 1 presents the specific impact of the area, yield, and their interaction on the changes in sugarcane production in Uttar Pradesh.

Table 1 Decomposition of Change in Production of Sugarcane in Uttar Pradesh **(in per cent)**

PERIOD	UTTAR PRADESH		
	AREA	YIELD	INTERACTION
Period I (1950 to 1967)	31.40	**69.77**	-1.17
Period II (1968 to 1985)	42.85	**48.27**	8.89
Period III (1986 to 2003)	30.18	**63.48**	6.33
Period IV (2004 to 2022)	**68.71**	23.42	7.87
Period V (1950 to 2022)	30.88	33.65	**35.48**

Note: Sum of all three effect=100

During periods I, II, and III, the growth in sugarcane output in Uttar Pradesh was mostly attributed to an increase in yield, resulting in a productivity contribution of around 6977%, 48.27%, and 63.48% for this crop. However, starting with period IV (2004 to 2022), which is after period III, the area effect became the primary factor driving the development of sugarcane production in Uttar Pradesh. During the whole time, namely period V, the interaction effect had the greatest impact on sugarcane output, followed by the yield effect and the area effect.

In the past, the yield effect was responsible for maximum production in Uttar Pradesh due to factors such as improved agricultural practices, technological advancements, and favorable weather conditions that led to higher yields despite the area under cultivation not being the primary driver of production.

However, after Period III (1986-2003), the area effect became more responsible for maximum production of sugarcane in Uttar Pradesh. This shift can be attributed to changes in land use, expansion of sugarcane cultivation in new areas, and variations in environmental conditions that favored the cultivation area over solely focusing on yield enhancement strategies. Factors such as addressing power shortages, improving irrigation practices, and adopting new technologies, like replacing diesel pumps with solar pumps, played a significant role in increasing the area under sugarcane cultivation and thereby impacting production levels.

In Period V (1950-2022) the interaction effect is responsible which means the combined effect of yield and area on sugarcane production. It suggests that the relationship between yield, and area is not linear but the impact of each factor on production depends on the other factors.

Instability analysis

The Cuddy and Della (1978) approach was employed in Uttar Pradesh to assess the volatility of sugarcane area, production, and yield. The coefficient of variation is a more comprehensive choice, but it should be used appropriately, when dealing with time series that include a trend variable [10]. The approach developed by Cuddy and Della in 1978 relies on the assumption of a linear pattern. However, it is difficult to identify a linear pattern in time series data, that extents a lengthy period of time. In this study, objective was to introduce nonlinearity into the trend model. Next, the coefficient of determination was computed from the well-fitted model in order to determine the CV_t value for various sequences. It has been designated as the modified Cuddy and Della measure. The study employed the Cuddy and Della (1978) metric to assess non-linearity in the trend model, specifically in relation to the linearity assumption of the Cuddy and Della model. The R^2 value in the Cuddy and Della model and the modified Cuddy and Della model may vary. The de trend coefficient of variation is assessed in five periods to analyse instability.

The instability in the area, production and yield of sugarcane in Uttar Pradesh for all five period was worked out, and presented in table 2. The coefficient of variation and cuddy della valley index for the period 1950-2022 have been estimated and showed in table 2. Overall instability reveal that sugarcane yield (9.945%) was highly instable followed by sugarcane cultivated area (6.895%) and production (5.019%). It reveal that the risk associated with cultivating sugarcane crops in Uttar Pradesh is evidently higher and has been steadily growing over time. The sugarcane agriculture in Uttar Pradesh is becoming unsustainable due to the rising risk and decreasing yield of the crop.

In the case of area under sugarcane cultivation a low level instability were evident for period II, III, IV and V. In the case of sugarcane production a low level instability was shown for period III. While in yield a low level instability were shown for period I, II, III. The highest instability in the area was observed I, in production I, II, and IV and in yield during period V. The main cause of instability could be attribute due to severe drought and low technology dissemination.

Table 2 Instability in Area, Production and Yield of Sugarcane in Uttar Pradesh

Field of Measurement	Measurement Statistics	Period I	Period II	Period III	Period IV	Period V
AREA	R^2	0.274	0.479	0.715	0.199	0.919
	CV	14.665	10.500	6.886	3.733	24.226
	CV_t	12.496	7.582	3.680	3.342	6.895
PRODUCTION	R^2	0.212	0.560	0.582	0.778	0.959
	CV	17.178	15.621	11.427	17.308	24.785
	CV_t	15.250	10.362	7.391	8.158	5.019
YIELD	R^2	0.002	0.309	0.232	0.757	0.839
	CV	6.829	7.988	6.526	15.446	24.785
	CV_t	6.829	6.641	5.720	7.619	9.945

CONCLUSION

From above discussion, highlight that the analysis of sugarcane decomposition and instability in Uttar Pradesh for the last 72 year from 1950 to 2022 revealed a shift from yield improvements to area expansion as the primary driver of output growth. Initially, yield enhancements, fuelled by advanced agricultural practices and technology, were crucial. However, from 2004 onwards, expanding cultivation areas, improved irrigation, and new technologies like solar pumps became more influential. Over the entire study period (1950-2022), the combined effect of yield and area was most significant.

In instability analysis indicates substantial volatility in sugarcane yield, followed by area and production. This growing risk suggests increasing unsustainability in sugarcane farming, primarily due to severe droughts and inadequate technological dissemination. Notably, the highest instability in yield was observed in the latest period, underscoring the challenges faced by farmers.

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