Growth and Instability of Sugarcane Production in Maharashtra, India

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This study analyses the instability in the area, production and productivity of sugarcane in Maharashtra, using the secondary data for the period1950-51 to2019-20. The analysis periods have been divided into five sub-periods on the basis of various reforms in sugarcane industry. The growth trend, decomposition analysis and the Cuddy Della Instability Index have been used for the analysis. The trend of sugarcane productivity in Maharashtra was found to be stagnant between 1 to 3 percent. The result of decomposition analysis indicates a relatively more important contribution of area rather than increase in the production. The results of the Instability analysis revealed that the level of instability in the area, production and productivity of sugarcane increased drastically in Maharashtra. There is no association found between high instability and low growth rate and vice versa. With these research findings, following paper suggests that the sugarcane yield could to be improved through the use of high yielding varieties of sugarcane, improved cultivation practices and better water and soil management to make it profitable and sustainable.

Introduction

Sugarcane is one of the leading cash crops of Maharashtra. The Sugar industry plays a major role in the socio-economic and educational development in the rural areas of the state. Maharashtra's sugar industry has been growing for the last 68 years without any impediments. During 2017-18, the area under sugarcane is 10.22 lakh ha with the total cane production of 712.45 lakh tons, average productivity is 69.71 t/ha and average sugar recovery is 11.65 % and the sugar production is 94.87 lakh ton (DA&FW, 2018). The decline in area, production, recovery and productivity is because of severe drought situation during 2015-16 and 2016-17 in the state. From the 2000's the Sugarcane productivity is struggling with a stationary phase. Therefore, further emphasis needs to

be given on increasing the productivity while reducing the cost of production without increasing the area.

Even after prevalence of favorable climatic conditions for most recent sixty years the normal sugarcane profitability of Maharashtra was stuck around 75 to 85 t/ha. Maharashtra ranks at 1st position in sugarcane recovery. In 2019-2020 out of 147 mills in Maharashtra about 79are co-operative and 68are private sugar factories which generates employment to a large number of people, electricity, ethanol production, bio- compost and number of other chemicals. Thus, Maharashtra economy relies on the sweetness of this crop.

As the number of sugar factories and distillery plants are increasing on a great pace, there is a great demand for sugarcane with high yield because of which sugarcane production has increased over the years in India, particularly in Maharashtra. Stability in production is of equal prominence along with increase in production. As far as sustainability is concerned, the rate of increase in area, production and yield of sugarcane should be steady or stable. But in real scenario, there are lots of fluctuations/instability in the area, production and productivity of sugarcane that need to be studied along with factors responsible for them. The declining trend of sugarcane productivity can be a serious threat to the future competitiveness of sugarcane growers, and therefore it needs to be investigated.

The instability in sugarcane production is becoming a serious menace to farm income and the supply of sugarcane to the sugar mills. It further increases the risk involved in sugarcane production and affects the price stability (Chand and Raju, 2008) thereby increasing the vulnerability of sugarcane growers. This explains the reason behind the variability in sugarcane production that

influences the prices of sugarcane and it automatically affects the profit level of sugarcane crop and the rate of labour absorption. A greater degree of instability accompanied with greater risk will lead to an unsustainable sugarcane production. These are some of the growing concerns about the increased variability in sugarcane production, productivity, and farm income faced by the sugarcane growers and sugar mills. As a result of rapid investment, some changes have taken place in the sugarcane sector in the country as a whole and Maharashtra in particular, and these changes need to be taken into consideration from the sustainability point of view. This study attempted to examine the growth and instability of sugarcane production in Maharashtra over the years with the following objectives (i) To study the compound annual growth rates in area, production and productivity (ii) To determine the change in production (iii) To examine the extent of instability in area, production and productivity of sugarcane in Maharashtra.

Materials and Methods

Time series data on area, production and productivity of sugarcane from 1950-51 to 2019-2020 was obtained from the Directorate of Economics and Statistics. The entire study period 1950-51 to 2019-2020 was categorized as follows; Period I (1950-51 to 1979-80), Period II (1980-81 to 1990-91), Period III (1991-92 to 2000-01), Period IV (2001-01 to 2019-20), Period V (1950-51 to 2019-20). The methodology used for analysis is described below

Growth rate analysis

In order to examine the trends in the area, production and yield of sugarcane, the growth rate was estimated by using the following semi log form of equation (1).

$\log Yt = a + bt$ ----------- (1)

Where, Yt defines the time series data of the area, production and yield of sugarcane crop, 't' is the trend period (i[th] year), 'a' is the constant coefficient and, 'b' is the slope coefficient.

To examine the relative contribution of area and yield in production

To measure the relative percentage contribution of area and yield towards the total sugarcane output change, decomposition analysis was used. The change in sugarcane production during any time period was decomposed into different components in the following manner which was used by Allauddin and Tisdell (1986) and Devraj (2006):

$$\Delta P = [A_o * \Delta Y] + [Y_o * \Delta A] + [\Delta A * \Delta Y]$$

Change in production = Yield effect + Area effect + Interaction effect

P_o, A_o and Y_o are area, production and yield in the base year and P_n, A_n, and Y_n are area, production and yield in a current year.

To estimate the Instability in Area, Production and Yield of Sugarcane in India

An index of instability was computed for examining the nature and degree of instability in area, production and yield of sugarcane at India and at major producing states levels. A linear trend $y = a + bt + e$ was fitted to the indices of area, production and productivity and trend co-efficient b' was tested. For a better measure of variability, the instability index was adopted which was developed by Cuddy and Della (1978) as follows:

$$Instability\ Index(\%) = CV \times \sqrt{1 - \bar{R}^2}$$

Where, II – Instability Index, CV – Coefficient, variation, $\bar{R}^2$ - coefficient of determination from a time trend regression adjusted by the number of degrees of freedom.

For the purpose of analysis, the degree of instability is divided in three groups which are given below;

S.No.	Instability Index values (in per cent)	Ranges of instability
(a)	Low degree of instability	0 to 10
(b)	Moderate degree of instability	10 to 20
(c)	High degree of instability	Greater than 20

Results and Discussion

Annual compound growth rate of Sugarcane

Results of period wise compound annual growth rate of sugarcane in Table 1 reveals that area, production and productivity had improved consistently over the periods, except after the millennium which can be attributed to the draught which occurred in the year 2015-2016 which led to serious decline in the production and a heavy demand on the water availability. Increase in the area allocation ranged from (1-36 percent) that was the main reason of production rather than any major technological intervention, as indicated by the fluctuating negative trend in productivity which was often less than 4 percent or negative.

These results show that there is always good incentive in continuing sugarcane as the cash crop also expanding the acreage than other crops.

Table.1 Growth Rate of area, production and yield of sugarcane in Maharashtra during 1950-51 to 2019-20 (in per cent)

Period	Maharashtra		
	Area	**Production**	**Productivity**
Period I (1950-51 to 1979-80)	4.3 (12.740) ***	5.2 (13.993) ***	0.9 (3.789) ***
Period II (1980-81 to 1990-91)	2 (1.730) ***	0.6 (0.387)	-1.4 (-3.705)
Period III (1991-92 to 2000-01)	3.5 (2.231) ***	4.4 (2.464) ***	0.9 (1.705) *
Period IV (2001-02 to 2019-20)	4.2 (4.311) ***	3.8 (2.949) ***	0.4 (-1.019)
Period V (1950-51 to 2019-20)	3.9 (36.491) ***	4 (27.360) ***	0.1 (1.120) **

Note: Figures in parenthesis shows 't' values. *** .001 level,* *.01 level.

Table.2 Decomposition of change in production of sugarcane in Maharashtra (1950-51 to 2019-20)

Maharashtra			
Period	**Area Effect**	**Yield Effect**	**Interaction Effect**
PeriodI (1950-51 to 1979-80)	11.380	66.29	22.310
Period II (1980-81 to 1990-91)	6.680	90.090	3.280
Period III (1991-92 to 2000-01)	2.966	96.058	0.975
Period IV (2001-01 to 2019-20)	8.180	85.940	5.875
Period V (1950-51 to 2019-20)	0.33	95.490	4.180

Table.3 Relative contribution of area and yield in production of sugarcane in Maharashtra during (1950-51 to 2019-20)

Period	Maharashtra	
	Area- Production	**Yield-Production**
Period I (1950-51 to 1979-80)	0.946***	0.524
Period II (1980-81 to 1990-91)	0.907***	0.391
Period III (1991-92 to 2000-01)	0.969***	0.707***
Period IV (2001-01 to 2019-20)	0.976***	0.466
Period V (1950-51 to 2019-20)	0.984***	0.139

Note: Figures in parenthesis shows 't' values. *** .001 level.

Table.4 Instability in area, production and yield of sugarcane in
Maharashtra (1950-51 to 2019-20)

Field of Measurement	Measurement Statistics	Period I (1950-1980)	Period II (1980-1990)	Period III (1990-2000)	Period IV (2000-2020)	Period v (1950-2020)
Area	Maharashtra					
	CV	36.18650	11.91666	15.99030	28.5337	75.7874
	t- Value	13.433***	1.746*	2.374**	4.619***	18.738***
	R̄ square	0.861	0.185	0.340	0.517	0.835
	Instability Index (%)	13.49130	10.7580	12.99058	19.8304	30.7849
Production	CV	46.0197	12.94226	19.1154	30.72313	73.34035
	t- Value	12.405***	0.436*	2.686**	2.876**	18.175***
	R̄ square	0.841	0.199	0.408	0.277	0.827
	Instability Index (%)	18.35026	11.58314	14.7076	26.1236	30.50464
Yield	CV	14.06865	5.13223	5.2332	10.72551	13.08193
	t- Value	3.994***	3.729***	1.721*	1.118*	1.041*
	R̄ square	0.340	0.589	0.179	0.013	0.001
	Instability Index (%)	11.429	3.4056	4.7415	10.6556	13.0688

Figure.1 Annual compound growth rate of area, production and yield of sugarcane in
Maharashtra during 1950-51 to 2019-20 (in per cent)

Growth Rate of Area, Production and Yield of Sugarcane during 1950-51 to 2019-20 in Maharashtra (in per cent)
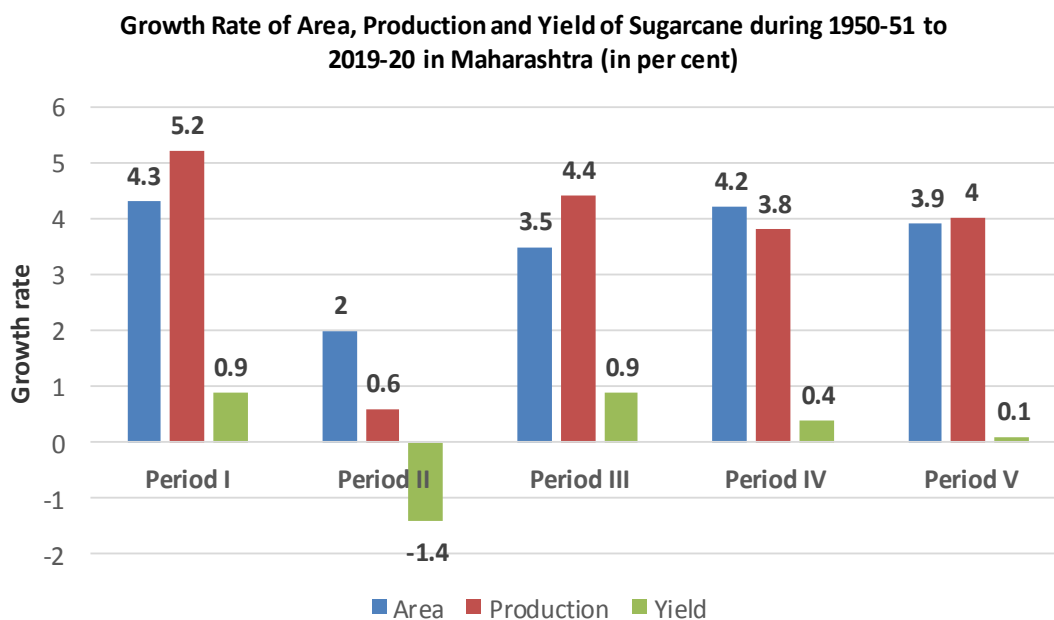
Decomposition analysis of sugarcane production

Total change in the mean production of sugarcane, depicted in the below Table 2 is increasing at an increasing rate in subsequent periods to the previous periods. The fact established in the Table 1 growth rate analysis was that area was the main contributor to the increase in production; however it was supported by the result of the decomposition analysis. At least 90 percent of the production hailed from change in yield while contribution of area was less than 12 percent throughout all the periods. During the period 1950-51 to 1979-80, an increase in output of sugarcane was mainly due to increase in yield with the contribution towards productivity for this crop of around 58 per cent in India. It was found that major output expansion of sugarcane was influenced by the expansion of yield under sugarcane rather the expansion of area in Maharashtra. The major reasons for this stagnant productivity of sugarcane was the draught which was occurring from the past many years, varietal weakening, decline in land productivity, over-exploitation of irrigation, low technology adoption, etc. The low and fluctuating productivity of sugarcane over the years was a major challenge for the sugar sector in Maharashtra.

Relationship of sugarcane production to area and yield

A common method to witness the change in the attitude of area and production and yield and production is to determine the results of the value of correlation (Table 3). The values of correlation for the area and production ranged from (0.907-0.984) for all the sub periods of study at 1 percent level of significance. Whereas, the value of correlation for the yield and production was significant (0.139-0.707) but less than the values of the area and production. This implied that the impact of increment of area

and production strongly affects the sugarcane production in Maharashtra.

Instability measurement of area, production and yield of sugarcane

The instability analysis in Table no 4 depicted a moderate level of instability in the area for Periods (I-IV) and a high level of instability for the overall period of (1950-2020), the same pattern of instability was seen in the case of production where the overall period had a high instability index of 30.50. In the case of yield, a low level of insatiability was observed for the periods II and III and moderate for I, IV and V. The main cause of instability could be attributed to the severe draught and low technological dissemination. It was clear from the results that there was a higher level of risk involved in the sugarcane production and was increasing over the years.

Summary and conclusions are as follows:

The above discussion revealed that although the area and productivity had improved from the previous decades, still sugarcane production is mainly driven by the production allocation. The major reason of the instability was severe draught which the state had witnessed in the past few years which led to heavy dependence on irrigation practices further increasing the cost of cultivation. Also, if the acreage was not allowed to scale up to meet the growing demand, consumer price would increase or export had to be restricted or import had to be resorted, which would entail the loss of the foreign exchange. Hence, in the long-run the utmost need is to bridge the yield gap or increasing the yield potential would be the possible solution

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