

## Analysis of growth and instability of sugarcane production in India

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### ABSTRACT

Sugarcane cultivation plays a key role for creating income and employment avenues to rural workers. Indian economy was open to free global trade with economic liberalization reforms. These reforms have impact on export of crops and commodities such as sugarcane. The objective of the study was to analyse the growth and instability in sugarcane cultivation based on the time series data for the period of 1970-2013. The results reveal that the compound growth rates (CGRs) for Karnataka, A.P., Maharashtra and Tamil Nadu were better than the states of subtropical zone. In India, sugarcane productivity has CGR 0.88% with instability index 0.05. The production growth was mainly due to growth in acreage not supported by the yield at country level during last four decades. The study reveals existence of wide cane productivity gaps in tropical and subtropical zones. The CGRs values during post reform regime, growth in cane acreage, production and yield had sluggish as compare to pre- reform regime. The production performance in Maharashtra was quite impressive as CGRs for area and production was 4.07 and 3.75% respectively. Concerns were raised to maintain yield for sugarcane sustainability in Maharashtra due to irrigation water scarcity during drought years.

**Key words:** *Growth and Instability, Sugarcane production, Trade liberalization reforms,*

Sugarcane cultivation has seen profound changes during last four decades. It had plays the vital role towards socio-economic development of rural areas through mobilization of production resources and have generated better avenues for income and employment generation. Sugarcane is the main source of raw material for the production of white sugar, green bio-fuel (ethanol), jaggery (gur) and khandsari. In India, there are nine states, where sugarcane is grown extensively on the large area. However, year to year fluctuations in sugarcane production continued a matter of severe concern. The fluctuations in sugarcane area and production had serious implication for cane supply management to sugar mills affecting crushing duration, sugar production and ultimately on farmer's income. These fluctuations in sugarcane acreage, production and productivity also depends on input supply, comparative production cost advantage and relative profitability; government price policies, infrastructural facilities, and also climatic conditions.

In India, there are two distinct zones for sugarcane cultivation, tropical-south and subtropical north. Subtropical north while comprising 61 per cent of total sugarcane area contributes only 43 per cent of total sugarcane and 34 per cent of total sugar production. Sugarcane cultivation, especially in sub-tropics had faced serious challenges of sustainability, due to factors such as climate change, escalating cost of cane production, deteriorating soil health, emergence of new diseases and pests, acute labour scarcity, improper cane

marketing etc. severely impede sugarcane productivity and sugar recovery. Therefore, high cost of sugarcane production, less productivity and low sugar recovery in sub-tropical north zone are the foremost causes of overall difference between the two zones. The average sugarcane productivity in subtropical zone was 58.4 tonnes/hectare compared to 87.9 tonnes/hectare in tropical zone during TE ending 2012-13 respectively.

There were more than 550 sugar factories which utilized nearly 70 per cent of the sugarcane produced and manufactured 26.3 million tonnes of sugar, with an average crushing duration of 136 days in 2011-12. The Indian sugar industry supports the rural economy. It also has future growth potential, if it could be exploited for co-generation of power and green bio-fuel /ethanol production. Keeping in view, the potential of sugar industry, Govt of India, has set up an expert committee to review that how best to de-regulate sugar sector to realize and reap benefits it's potential. Indian sugar industry is considered worth of Rs 80,000 crores with huge employment. The sugar industry paid nearly Rs.50000 crores annually to farmers/ growers for the supply of sugarcane and also contributes Rs. 2400 crores to the Central Exchequer, besides contributing over Rs.1200 crores to the State Governments. About 50 million farmers, their dependents and a large number of agricultural labourers are involved in sugarcane cultivation, harvesting and ancillary activities. Besides, it nearly six lakh skilled and semi skilled workers, mostly from rural areas were engaged in sugar industry, probably second largest agro-based industry after textiles/cotton processing in India.

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Sugarcane as the renewable energy crop for ethanol production, as supplement to fossil fuel had provided avenues for further boost of its production. Because of its potential for renewable energy, sugarcane has become the preferred choice, since the Brazilian venture in early 1980's for ethanol production and its utilization as fuel blend with petrol for running automobiles. In India, molasses, a by-product of sugar processing industries, will remain the main raw material for ethanol production. Similarly, bagasse, a by-product of sugar mill remains raw material for power generation. By year 2030, every Indian sugar mill will have to be modernized as the electricity generating centre in rural areas. It would boost economy and socio-economic transformation of rural population. Keeping in view, the significance of sugar industry an attempt has been made to estimate the growth pattern and instability in sugarcane production during last four decades in India.

### MATERIALS AND METHODS

Growth in area, production and productivity was examined to know the changes take place in sugarcane cultivation in India. The state-wise time series data on area, production and sugarcane productivity pertains to 6 major production states namely (Uttar Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, Bihar and Haryana) and India for the period 1970-71 to 2011-12 were compiled from various published sources such as www.iisr.nic.in., ISMA publications, Co operative Sugar etc. The Indian economy was opened to world market with several economic liberalization reforms in 1990-91. These reforms would have some impact on international trade of agricultural crops and commodities including sugarcane. To capture the impact of liberalization reforms especially on sugarcane cultivation, the time series data period was divided into two sub periods. (i) 1970-71 to 1990-91 – pre liberalization reform period (ii) Post liberalization period (1992-93 to 2011-12) to analyse the growth pattern, identification of sugarcane production potential regions in India based on compound growth rates (CGRs) and instability index. The selected states for sugarcane production from the tropical and subtropical regions, state-wise compound growth rates (CGRs) in area, production and productivity were worked out by using semi-log function, as follows.

$$\ln(Y_{in}) = \alpha + \beta.t \dots\dots (1)$$

Where,

$Y_{in}$  = dependent variable (area/production/yield of sugarcane) in  $i^{th}$  state in  $n^{th}$  year.

$t = 1, 2, \dots\dots$  (Proxy for time trend variable indicating data period in years)

$\alpha$  and  $\beta$  = estimated coefficients of the semi-log equation (1).

Then,  $CGR (\%) = \{ \exp(\beta) - 1 \} * 100$

The variability in sugarcane area/ production and productivity was estimated by using instability index as below:

Instability index = Standard Deviation of  $\ln(Y_{t+1} / Y_t)$

Where,

$Y_t$  = Sugarcane area / production / yield in the current year

$Y_{t+1}$  = Sugarcane area / production / yield for the next year.

This index is unit free and very robust and it measures deviations from the underlying trend (log linear in this case). When there are no deviations from trend the ratio of  $Y_{t+1}/Y_t$  is constant and thus standard deviation is zero. As the series fluctuates more, the ratio of  $Y_{t+1}$  and  $Y_t$  also fluctuates more, and standard deviation increases. Slightly modified formula's of this index has been also available in the literature to study instability in agricultural production and its impact crop productivity (Ray 1983; Rao *et al.*, 1988; Chand and Raju 2008). The above instability measure also indicates risk involved in sugarcane acreage allocation, production and productivity.

### RESULTS AND DISCUSSIONS

#### *Analysis of Compound growth rate and instability in sugarcane*

The compound growth rates (CGRs) and instability in sugarcane area, production and productivity were worked out for 6 major producing states as well as at country level. Sugarcane cultivation in India recognized for the wide yield gaps in tropical and sub-tropical states. There were lot of variations in crop duration, crop production and market management practices, climatic conditions, availability of natural resources, government policies, institutions, infrastructure etc amongst the States. Because of these variations, pattern of growth in sugarcane area, production and yield respond to various incentives, motivational and inducements vary across the tropical and subtropical states. Similarly, instability in sugarcane was expected to illustrate patterns of sugarcane development in different states during two regimes. The estimated CGRs and instability index for in area, production and yield of sugarcane are presented in Table 1. It is evident from table that the area under sugarcane has increased from 2.49 million ha to 5.0 million ha during last four decades, with the CGR of 1.63 per cent and instability index 0.08. In spite of pressure of high acreage allocation to food grain crop to feed ever growing population, the CGR in sugarcane area was quite impressive during last 43 years period. Similarly, sugarcane production in India has also increased substantially with the CGR of 2.52 per cent which was significant at 1 per cent level during reference period. Though, the CGR in production was marginal, the instability index of 0.104 does not suggest wide fluctuations in sugarcane production at national level.

The sugarcane production performance as indicated by the CGRs in Karnataka, A.P. Maharashtra and Tamil Nadu which was significant at 1 per cent and much better than the states of subtropical region. The sugarcane yield also registered the annual CGR of 0.88 per cent with instability index 0.05. The study concluded that the growth in sugarcane production was

Table 1 CGRs and instability in sugarcane area, production, yield (1970-71 to 2012-13)

(Area in Million ha, production in Million tonnes, yield tonne/ha)

States	Aver. TE 1973	Aver. TE 2013	CGRs	T- value	Instability index
<b>U.P.</b> (Area)	1.35 (54.4)	2.17 (43.4)	1.208	15.706**	0.068
Production (P)	55.618 (45.7)	126.62 (36.6)	2.266	15.388**	0.097
Yield (Y)	41.1 (84.1)	58.4 (84.4)	1.046	10.456**	0.072
<b>Maharashtra</b> (A)	0.182 (7.3)	0.975 (19.5)	4.066	16.574**	0.199
Production (P)	12.727 (10.5)	76.37 (22.1)	3.753	11.664**	0.236
Yield (Y)	70.9 (145.0)	78.1 (112.7)	-0.300	-2.174*	0.094
<b>A. P.</b> (A)	0.124 (5.0)	0.197 (4.0)	1.335	7.563**	0.136
Production (P)	9.870 (8.1)	15.745 (4.6)	1.549	7.624**	0.158
Yield (Y)	79.6 (162.7)	79.7 (115.1)	0.211	2.251*	0.093
<b>Tamil Nadu</b> (A)	0.132 (5.3)	0.352 (7.1)	2.417	13.348**	0.148
Production (P)	10.729 (8.8)	38.35 (11.1)	2.818	11.952**	0.185
Yield (Y)	81.3 (166.1)	108.9 (157.2)	0.391	4.438**	0.066
<b>Karnataka</b> (A)	0.103 (4.1)	0.419 (8.4)	3.150	11.932**	0.148
Production (P)	8.606 (7.1)	36.90 (10.7)	3.501	10.603**	0.200
Yield (Y)	83.9 (171.5)	87.9 (126.9)	0.340	2.815**	0.105
<b>Haryana</b> (A)	0.135 (5.4)	0.096 (1.9)	-0.719	-3.157**	0.163
Production (P)	6.04 (5.0)	6.83 (2.0)	0.746	2.997**	0.194
Yield (Y)	44.7 (91.5)	71.4 (103.1)	1.475	11.184**	0.126
<b>India</b> (A)	2.49 (100.0)	4.996 (100.0)	1.629	17.827**	0.083
Production (P)	121.60 (100.0)	345.99 (100.0)	2.521	18.475**	0.104
Yield (Y)	48.9 (100.0)	69.3 (100.0)	0.878	11.187**	0.051

Figures in parenthesis are percentage to national level

Source: www.iisr.nic.in. and Cooperative Sugar

\* Significant at 5% and \*\* 1% probability levels

more due to increase in area as compare to yield at country level during last 43 years. The analysis also reveals that there were wide gaps in sugarcane yield in tropical and subtropical states.

#### *Growth pattern and instability in sugarcane during Pre-reform regime*

The estimated CGRs and instability index for sugarcane area, production and yield during pre liberalization regime are presented in Table 2. It is evident from table that the sugarcane area in U.P. has increased from 1.35 to 1.77 million ha during 1970-1990, with CGR of 1.50 per cent and instability index 0.083. Though the Uttar Pradesh had maximum acreage under sugarcane, its share at national has declined marginally. Similarly, sugarcane production in U.P. increased substantially with CGR 3.09 per cent which was significant at 1% level during pre-reform period. Though, CGR in sugarcane production in Uttar Pradesh was slightly higher than CGR at national level. The instability index of 0.119 in U.P. indicates wider fluctuations and comparatively sugarcane production was stable at national level with instability index 0.09 during pre liberalization regime.

The sugarcane production performance as indicated by the CGRs in Karnataka, Maharashtra and Tamil Nadu was ranges from 3.7 to 4.7 per cent and significant at 1 per cent. It was much better than the states of subtropical region where the

CGR in production was only 0.016 per cent in Haryana. The sugarcane yield also registered the annual CGR of 1.46 per cent with instability index 0.054. The study concluded that the area and yield growth contributed equally in sugarcane production in India during per liberalization reform regime. The analysis also reveals that there were wide gaps in sugarcane yield in tropical and subtropical states.

#### *Growth and instability in sugarcane during Post-reform regime*

The estimated CGRs and instability index for sugarcane area, production and yield during post liberalization regime are presented in Table 3. It is evident from table that the sugarcane area and production in Haryana has declined substantially during 1991-2013, with CGR of -1.92 and -0.55 per cent and highly volatile as indicated by instability indices 0.168 and .179 respectively. Though the Uttar Pradesh still had maximum acreage under sugarcane, its share at national has declined from 51.5 to 43 per cent during post reform period. Similarly, The CGRs for production and productivity in U.P. declined substantially as compare to the pre-reform period. The production and yield instability index of 0.069 and 0.059 respectively in U.P. indicates sugarcane production was comparatively stable during post liberalization regimes at national production level instability index 0.11. In majority of sugarcane growing States, there were slight variations/

Table 2 CGRs and instability in sugarcane area, production and yield in Pre reform period

*(Area in Million ha, production in Million tonnes, yield tonne/ha)*

States	Aver. TE 1973	Aver. TE 1990	CGRs	T- value	Instability index
<b>U.P. (Area)</b>	1.35 (54.4)	1.77 (53.0)	1.502	5.899**	0.083
Production (P)	55.618 (45.7)	92.99 (44.6)	3.088	8.292**	0.119
Yield (Y)	41.1 (84.1)	52.4 (84.3)	1.562	6.473**	0.083
<b>Maharashtra (A)</b>	0.182 (7.3)	0.330 (9.8)	3.940	8.271**	0.116
Production (P)	12.727 (10.5)	32.641 (15.7)	4.708	7.644**	0.138
Yield (Y)	70.9 (145.0)	85.5 (137.5)	0.739	2.068	0.082
<b>A. P. (A)</b>	0.124 (5.0)	0.152 (4.5)	0.688	1.366	0.154
Production (P)	9.870 (8.1)	10.46 (5.0)	0.217	0.413	0.169
Yield (Y)	79.6 (162.7)	68.9 (110.8)	-0.467	-1.510	0.114
<b>Tamil Nadu (A)</b>	0.132 (5.3)	0.216 (6.4)	2.564	6.491**	0.136
Production (P)	10.729 (8.8)	22.63 (10.9)	3.719	6.719**	0.180
Yield (Y)	81.3 (166.1)	105.0 (168.9)	1.126	4.152**	0.079
<b>Karnataka (A)</b>	0.103 (4.1)	0.236 (7.0)	4.565	12.719**	0.086
Production (P)	8.606 (7.1)	19.174 (9.2)	4.689	12.860**	0.104
Yield (Y)	83.9 (171.5)	81.6 (131.1)	0.119	0.431	0.082
<b>Haryana (A)</b>	0.135 (5.4)	0.133 (4.0)	-0.844	-1.519	0.162
Production (P)	6.04 (5.0)	6.19 (3.0)	0.016	0.0241	0.212
Yield (Y)	44.7 (91.5)	46.9 (75.4)	0.868	1.754	0.160
<b>India (A)</b>	2.49 (100.0)	3.35 (100.0)	1.486	5.786**	0.078
Production (P)	121.60 (100.0)	208.45 (100.0)	2.972	9.242**	0.099
Yield (Y)	48.9 (100.0)	62.2 (100.0)	1.464	9.792**	0.054

Figures in parenthesis are percentage to national level

Source: www.iisr.nic.in. and Co operative Sugar

\* Significant at 5% and \*\* 1% probability levels

Table 3 CGRs of sugarcane area, production and yield during Post reform period

*(Area in Million ha, production in Million tonnes, yield tonne/ha)*

States	Aver. TE 1993	Aver. TE 2013	CGRs	T- value	Instability index
<b>U.P. (Area)</b>	1.88 (51.5)	2.17 (43.4)	0.728	4.953**	0.052
Production (P)	105.87 (44.5)	126.62 (36.6)	0.620	2.854**	0.069
Yield (Y)	56.2 (86.2)	58.4 (84.4)	-0.106	-0.704	0.059
<b>Maharashtra (A)</b>	0.434 (11.9)	0.975 (19.5)	4.099	4.782**	0.260
Production (P)	35.152 (14.8)	76.37 (22.1)	3.697	3.329**	0.308
Yield (Y)	80.9 (124.1)	78.1 (112.7)	-0.385	-1.048	0.106
<b>A. P. (A)</b>	0.185 (5.1)	0.197 (4.0)	0.236	0.587	0.118
Production (P)	133.58 (5.6)	15.745 (4.6)	0.563	1.164	0.149
Yield (Y)	72.1 (110.6)	79.7 (115.1)	0.326	1.798	0.069
<b>Tamil Nadu (A)</b>	0.234 (6.4)	0.352 (7.1)	1.345	2.434*	0.162
Production (P)	23.80 (10.0)	38.35 (11.1)	1.463	2.139*	0.193
Yield (Y)	101.7 (156.0)	108.9 (157.2)	0.116	0.666	0.051
<b>Karnataka (A)</b>	0.269 (7.4)	0.419 (8.4)	0.822	1.073	0.191
Production (P)	22.23 (9.3)	36.90 (10.7)	0.610	0.601	0.265
Yield (Y)	82.6 (126.6)	87.9 (126.9)	-0.210	-0.565	0.127
<b>Haryana (A)</b>	0.148 (4.0)	0.096 (1.9)	-1.934	-2.912**	0.168
Production (P)	7.78 (3.3)	6.83 (2.0)	-0.552	-0.865	0.179
Yield (Y)	52.5 (80.5)	71.4 (103.1)	1.409	6.726**	0.083
<b>India (A)</b>	3.65 (100.0)	4.996 (100.0)	1.365	5.248**	0.089
Production (P)	237.85 (100.0)	345.99 (100.0)	1.404	3.982**	0.110
Yield (Y)	65.2 (100.0)	69.3 (100.0)	0.039	0.247	0.048

Figures in parenthesis are percentage to national level

Source: www.iisr.nic.in. and Co operative Sugar

\* Significant at 5% and \*\* 1% probability levels

changes in yield of sugarcane during the post reform regime, as evident from the values of instability indices. The fluctuations were relatively higher in Karnataka and Maharashtra. The CGRs values indicated that during the post reform regime 1990-2013, the growth in sugarcane area, production and yield had sluggish as compare to the pre-reform regime. The sugarcane production performance in Maharashtra was quite impressive as the CGR in area and production were 4.01 and 3.7 per annum. However, concerns were raised due to decline in yield CGR which put a question mark on sustainability of sugarcane production particularly in Maharashtra and states of tropical region in due to severe water scarcity during deficiency rainfall years.

Amongst, 6 major sugarcane producing states in the country, 3 states U.P., Maharashtra, and Karnataka had showed declining trend in yield during post reform period. The comparative CGRs for sugarcane area, production and yield during pre and post liberalization reform period, observed that the number of states registered decreasing growth trend were more during post liberalization reform period. However, the instability index at India level showed that the sugarcane production was more stable in post reform period as compare to pre-reform regime

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