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## Trends in area, production and productivity of sugarcane in Maharashtra

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### Abstract

Maharashtra is one of the leading states in sugarcane and sugar production and it is the second largest agro-based next only to textile industry. The time series data on area, production and productivity of sugarcane from the published sources were used for estimating the districtwise and recovery zone wise annual compound growth rates of area, production and productivity of sugarcane in Maharashtra over a period of 53 years. The area, production and productivity of sugarcane crop have fluctuated widely during the period under consideration in all the districts and State as a whole. 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. The increase in the production was mainly due to the area expansion and slightly due to increase in the productivity of sugarcane. The area, production and productivity of sugarcane in high recovery zone of sugarcane have increased at the rate of 3.18, 3.50 and 0.31 per cent per annum, respectively, during the entire period.

**Keywords:** Time series analysis, recovery zone, sugarcane

### Introduction

Maharashtra is one of the leading states in sugarcane and sugar production and it is the second largest agro-based industry next only to textile industry. This has attracted higher investment and it has brought about desirable changes in social, economical and political life in the rural areas of the state. It has become livelihood of 2.5 crore population and provides employment to 1.65 lakh people directly. Almost 8 lakh people are engaged in the harvesting and transportation of sugarcane to factories from the fields. The sugar industry provides annual revenue of over 2200 crores to the Government. Due to sugar industry, allied business like milk cooperatives, fertilizer supply, irrigation systems have flourished. All this together have led to development of rural places from where the sugarcane is drawn to factories in form of improved road network, transportation facilities, medical facilities, educational facilities and banking etc. ([https://en.wikipedia.org/wiki/cooperative\\_sugar\\_factories\\_and\\_rural\\_development](https://en.wikipedia.org/wiki/cooperative_sugar_factories_and_rural_development)). The sugar industry is amongst the largest tax payers to the central and state exchequers of around 2500 crores annually. The sugar export has the potential to earn Rs. 8767 crores of foreign exchange during the year 2012-13 (CACP report, 2014-15). With such a large expense and wide range of associated economic activities which can transform rural India, the sugar industry has carved for itself an important place in the Indian economy.

### Methodology

In order to estimate district wise and decadal growth rates of area, production and productivity of sugarcane, the time series data on area, production and productivity of sugarcane from the published sources were used for estimating the district wise annual compound growth rates of area, production and productivity of sugarcane in Maharashtra over a period of 53 years (1960-61 to 2012-13). In the present study, the compound growth rates in area, production and productivity of sugarcane were estimated by fitting following exponential function.

$$Y = ab^t$$

Where,

Y = Area/ Production/ Productivity (tones/ha)

a = Constant

b = Regression coefficient

t = Time period (Years)

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

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

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

On the basis of productivity and sugar recovery, the state has been identified with three zones i. e. high recovery zone, medium recovery zone and low recovery zone. Considering these recovery zones, the recovery zonewise compound growth rates were also estimated and presented in the results. However, The districts viz: Mumbai, Thane, Raighad, Ratnagiri, Chandrapur, Gadchiroli and Sindhudurga, etc. were not considered for analysis as they are having very less area under sugarcane.

### Results and Discussion

The area and production of sugarcane have increased since the formation of Maharashtra state. But the rate of increase in area and production of sugarcane was not uniform during different decades in the state as well as in different zones and districts. Also, the productivity of sugarcane not only showed decreasing trend over the period of time but also varied greatly among the recovery zones and different districts. The district wise compound growth rates of these variables have been examined for the period 1960-61 to 2012-13. The district

wise time series data on sugarcane area (A), production (P) and productivity (Y) were divided into five sub periods as period-I (1960-70), period-II (1971-80), period-III (1981-90), period-IV (1991-2000) and period-V (2001-2013). The annual percentage growth rates of area, production and productivity of sugarcane are presented in Table 1 for all the individual districts and state as whole.

The area, production and productivity of sugarcane crop have fluctuated widely during the period under consideration in all the districts and State as a whole. 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. The area and production of sugarcane have increased at the rate of 8.27 per cent and 8.00 per cent per annum, respectively, during entire period. However, the productivity of sugarcane has declined slightly by 0.24 per cent per annum, which is significant at 10 per cent level.

The district wise growth rates in area, production and productivity of sugarcane revealed that the per annum growth rates were positive and significant in all the districts. The area, production and productivity of sugarcane increased at increasing rate while productivity declined in Jalna, Nashik and Thane districts. The annual compound growth rates of productivity of sugarcane in almost all the districts were non-significant or negative except Sangli, Parbhani, Yeotmal and Ahmednagar districts. The sugar industry in the state is likely to face serious shortage of sugarcane supplied in the near future unless appropriate measures are adopted to improve sugarcane productivity.

In conclusion, the analysis revealed that, 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. The increase in the production was mainly due to the area expansion and slightly due to increase in the productivity of sugarcane.

**Table 1:** District wise annual compound growth rates of sugarcane in Maharashtra

Sr. No.	Period	Districts								
		Kolhapur			Sangli			Satara		
		Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
1	Period-I (1960-70)	0.37***	4.16***	0.76	8.84***	7.82***	-0.92	3.88***	2.7	-1.13
2	Period-II (1971-80)	2.52***	2.04***	-0.46	6.31***	14.11***	7.33**	4.88***	9.19***	4.11**
3	Period-III (1981-90)	1.03	0.09	-0.92	-1.12	-4.26*	-3.17	3.77***	4.60	0.79
4	Period-IV (1991-2000)	4.46***	5.49***	1.10	4.12*	9.73***	5.42***	-0.64	5.47***	6.15***
5	Period-V (2000-2013)	4.22***	5.30	0.60	5.31***	5.71**	0.37	6.21***	7.67**	1.38
6	Entire Period (1960-2013)	2.84***	2.86***	0.02	3.46***	4.09***	0.51***	3.76***	4.65***	1.23

Sr. No.	Period	Districts								
		Pune			Solapur			Ahmednagar		
		Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
1	Period-I (1960-70)	3.18**	-0.75	(-3.81**)	2.67**	1.31	-1.32	4.30**	-2.27	(-6.31***)
2	Period-II (1971-80)	4.83***	7.84	2.87	4.60***	6.77*	2.05	3.19***	3.87*	0.65
3	Period-III (1981-90)	4.09***	2.78	-1.25	6.67***	4.06**	-3.00	-6.32***	-7.76**	-1.53
4	Period-IV (1991-2000)	0.63	5.90***	5.19**	4.97*	9.97***	4.74***	-1.22	2.06	3.33
5	Period-V (2000-2013)	11.37***	12.76***	1.24*	11.56***	13.24***	1.50	10.46**	13.75**	2.98**
6	Entire Period (1960-2013)	4.11***	4.57***	0.43**	5.35***	5.46***	0.10	1.34***	0.87**	-0.46***

Sr. No.	Period	Districts								
		Beed			Latur			Osmanabad		
		Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
1	Period-I (1960-70)	3.97	11.71*	7.43***	0	0	0	6.06***	20.85***	13.94***
2	Period-II (1971-80)	22.60***	22.34***	-0.20	0	0	0	17.06***	18.11***	0.89
3	Period-III (1981-90)	12.43***	5.82	-5.88	29.99*	-1.47	-4.22	-1.56	-3.25	-1.72
4	Period-IV (1991-2000)	2.09	3.89	1.78	6.79**	6.5	-0.24	0.75	5.29	4.53**
5	Period-V (2000-2013)	6.64*	6.49	-0.12	5.57*	6.82*	1.21	10.95*	14.92**	3.58
6	Entire Period (1960-2013)	7.61***	7.85***	0.58	6.53***	7.16***	0.58	3.49***	4.10***	0.58**

Sr. No.	Period	Districts								
		Dhule			Jalgaon			Nashik		
		Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
1	Period-I (1960-70)	3.74	5.87**	4.91***	-7.49	-0.95	7.06***	2.33	6.45	4.02**
2	Period-II (1971-80)	15.07***	13.53**	-1.33	24.92***	23.80***	-0.89	7.20***	7.84***	0.59
3	Period-III (1981-90)	5.63***	-0.16	-5.49**	5.51**	3.99*	-1.43	1.20	-0.69	-0.09
4	Period-IV (1991-2000)	-8.28*	-4.72	5.58***	-6.31*	-1.31	5.84**	-6.16**	-7.15**	3.08
5	Period-V (2000-2013)	-0.48	0.92	1.44	-3.51*	-2.68	0.86	1.46	1.64	0.17
6	Entire Period (1960-2013)	1.78***	2.05***	0.29	5.59***	5.82***	0.22	1.97***	1.70***	-0.16

Sr. No.	Period	Districts								
		Aurangabad			Buldhana			Jalna		
		Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
1	Period-I (1960-70)	1.88	9.57***	7.26***	4.29***	19.88***	14.95***	0	0	0
2	Period-II (1971-80)	12.59***	12.62***	0.01	0.10	-1.01	-1.12	0	0	0
3	Period-III (1981-90)	-2.12	-2.62	-0.50	0.92	-1.06	5.11	33.188	3.80	-2.18
4	Period-IV (1991-2000)	-8.99***	-5.96*	3.34	-12.49**	-12.20	0.33	-6.54*	-4.98	1.69
5	Period-V (2000-2013)	6.72*	8.43*	1.59	-7.80	-9.49	-1.83	5.29	4.75	-0.52
6	Entire Period (1960-2013)	1.30***	1.85***	0.91	-1.08	-0.20	1.27	2.20***	1.68**	-0.50

Sr. No.	Period	Districts								
		Nanded			Nagpur			Parbhani		
		Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
1	Period-I (1960-70)	9.07***	18.49***	8.63***	18.74***	32.91***	11.92***	1.67	8.33**	6.54**
2	Period-II (1971-80)	10.13***	13.82***	3.35*	13.60***	17.48***	3.41***	11.99***	10.52***	-1.31
3	Period-III (1981-90)	4.48	2.16	-2.21	19.75***	10.47***	-4.48	7.66***	4.25***	-3.17
4	Period-IV (1991-2000)	-0.14	7.30*	7.44***	1.79	10.64	8.71**	0.06	4.11	4.04
5	Period-V (2000-2013)	2.53	2.63	0.08	-5.88	-7.59	-1.71	2.88	4.55	1.61
6	Entire Period (1960-2013)	4.42***	4.97***	0.53**	5.15***	5.57***	0.38	4.80***	5.54***	0.70***

Sr. No.	Period	Districts								
		Wardha			Yeotmal			Amravati		
		Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
1	Period-I (1960-70)	14.14***	26.81***	11.10***	5.63***	25.01*	18.34*	8.23***	29.03***	19.21***
2	Period-II (1971-80)	6.50**	10.14*	3.41***	16.64***	18.76***	1.81	6.99*	10.16**	2.96*
3	Period-III (1981-90)	37.69***	43.57**	-3.47**	17.36***	15.96*	-1.19	11.20***	8.70***	-2.24*
4	Period-IV (1991-2000)	7.66***	18.37*	9.93	-8.96	-2.88	6.69*	4.17	11.17*	6.72
5	Period-V (2000-2013)	-0.009	0.34	0.32	-2.41	-2.19	0.18	-19.83***	-20.01***	-0.23
6	Entire Period (1960-2013)	10.32***	11.21***	0.96	6.86***	8.08***	1.14***	6.04***	6.97***	1.24*

Sr. No.	Period	Districts					
		Akola			Maharashtra		
		Area	Production	Productivity	Area	Production	Productivity
1	Period-I (1960-70)	14.39***	31.70***	15.12***	4.01**	3.30**	-0.68
2	Period-II (1971-80)	-0.04	0.03	0.07	6.21***	7.21***	0.93
3	Period-III (1981-90)	11.44***	12.58***	1.02	1.69**	-0.47***	-2.13**
4	Period-IV (1991-2000)	-14.85*	-13.19*	9.28	22.01*	23.63**	1.33
5	Period-V (2000-2013)	-13.60	-12.52***	1.46	3.57**	5.44**	1.80**
6	Entire Period (1960-2013)	0.10	1.30	1.47*	8.27***	8.00***	-0.24***

(\*\*\*, \*\* and \* Significant at 1, 5 and 10 per cent, respectively)

### Recovery zone wise trends in area, production and productivity of sugarcane in Maharashtra

The high recovery zone comprises of sugarcane growing areas of Satara (excluding Phaltan tahsil), Sangli and Kolhapur districts. The medium recovery zone covers the sugarcane area of Nashik, Ahmednagar, Solapur, Pune districts and Phaltan tahsil of Satara district. The low recovery zone includes the sugarcane growing areas of Jalgaon, Dhule, Nandurbar, Aurangabad, Jalna, Parbhani, Nanded, Osmanabad, Latur, Amravati, Akola, Wardha, Nagpur and Yeotmal districts of Maharashtra. The recovery zonewise time series data on sugarcane area, production and productivity was divided in to five sub periods as period-I (1960-70), period-II (1971-80), period-III (1981-90), period-IV (1991-2000) and period-V (2001-2013).

The recovery zone wise annual compound growth rates of area, production and productivity of sugarcane is presented in

Table 2. It is observed from the table that, the area, production and productivity of sugarcane crop have shown wide fluctuations during the period of 53 years in all the recovery zones. The growth rates of area and production of sugarcane were observed to be positive and significant for the period under consideration. The area, production and productivity of sugarcane in high recovery zone of sugarcane have increased at the rate of 3.18, 3.50 and 0.31 per cent per annum, respectively, during the entire period. Similar is the trend in low recovery zone of sugarcane i. e. area, production and productivity is significantly increased by 5.41, 6.82 and 0.50 per cent per annum, respectively. However, in the medium recovery zone of sugarcane, only area and production was found increased by 3.65 and 3.12 per cent per annum, respectively, while productivity was found declined slightly by 0.08 per cent per annum over the entire period.

**Table 2:** Recovery zone wise annual compound growth rates of sugarcane in Maharashtra

Period	Recovery zones								
	High			Medium			Low		
	Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
Period-I (1960-70)	4.68***	4.25***	-0.41	3.60**	-1.37	-4.95***	5.70***	18.01***	11.92***
Period-II (1971-80)	4.00***	6.11***	2.02**	3.91***	5.11**	1.27	17.83***	19.12***	0.60
Period-III (1981-90)	1.15**	-0.16	-1.30	0.65	-2.47	-1.77	2.78	5.25	0.66
Period-IV (1991-2000)	2.91*	6.51***	3.49**	2.12	5.65**	4.36**	2.67	6.54*	3.06
Period-V (2000-2013)	4.94***	5.84**	0.85	11.23***	13.15***	1.83**	7.19*	7.81*	1.61
Entire Period (1960-2013)	3.18***	3.50***	0.31***	3.65***	3.12***	-0.08	5.41***	6.82***	0.50**

(\*\*\*, \*\* and \* Significant at 1, 5 and 10 per cent, respectively)

**Table 3:** Zone wise installed capacity of sugar factories and estimates of additional area and productivity increase in future on the basis of factory season 2012-13

Recovery zone	Installed capacity (lakh tons/day)	Average crushing (days)	Present sugarcane crushed (lakh tons)	Sugarcane requirement for fulfilling installed capacity (lakh tons)	Difference	Present area under sugarcane (lakh ha)	Present productivity of sugarcane (lakh ha)	Need to increase	
								Area (ha)	Productivity (tons/ha)
High	1.62	144	23019592	233.28	3.09	2.54	96.00	3218	91.84
Medium	2.24	148	32106139	331.52	10.46	4.14	87.00	12022	80.27
Low	2.11	134	14921539	282.74	133.53	2.68	64.00	208640	105.50
Maha	5.95	144	50485113	856.80	351.95	9.36	83.00	424036	91.53

Source: Technical Performance of sugar factory in Maharashtra for the year 2012-13 and 2013-14

It is evident from the Table 3 that, for utilizing the installed crushing capacity of 5.95 lakh metric tons to its fullest extent with average crushing period of 144 days, 856.80 lakh tons of sugarcane is needed. However, the total sugarcane production during the year 2012-13 was 504.85 lakh tons. Thus, the difference between these two was 351.95 lakh tons. For obtaining the extra sugarcane production of 351.95 lakh tons, the area has to be increased by 4.24 lakh hectares; or else productivity needs to be increased from 83 to 91.53 tons/ha. The required productivity in high and medium recovery was achieved but for low recovery zone, the average under sugarcane has to be increased by 2.08 lakh hectares or otherwise, the productivity has to be increased from 64 to 105.50 tons/ha.

For ensuring the required sugarcane supply, the production can be increased by increasing the area under sugarcane, increasing sugarcane productivity or by increasing both. However, area expansion under sugarcane seems to be difficult due to limitations on availability of irrigation facility, cultivation of other competing crops like wheat, cotton, groundnut, pulses, fruits and vegetables, etc. under irrigated condition and decrease in the cultivable area as a result of increased urbanization and industrialization. In the context of the difficulty and inappropriateness to increase the area under sugarcane to a sizable extent, the another way left is to improve the productivity. An average cultivator can produce 100 tons of sugarcane per hectare with the use of proper inputs and available irrigation facilities. It is, therefore, imperative on the part of planners, researchers, farmers, extension personal and management boards of the sugar manufacturing units in the state to understand the reasons and consequences of low productivity of sugarcane in all the zones with a view to devise and adopt appropriate measures for improving productivity of sugarcane in the immediate future.

### Conclusion

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. The increase in the production was mainly due to the area expansion and slightly due to increase in the productivity of

sugarcane. Sugarcane was not available in adequate quantity to meet the installed crushing capacity requirement of factories in the state. The only way to fulfill the established crushing capacity of sugar factories in Maharashtra is to increase the productivity of sugarcane.

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