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A Comparative Performance Evaluation of Sugarcane Producing States in India

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Abstract

Present study attempts to examine the comparative performance of sugarcane producing states and identify best performing states in terms of selected performance indicators. The study made use of averages, compound annual growth rates and coefficient of variation to achieve the objectives of the study. Semi log regression has been applied to test the significance of growth rates wherever find necessary. The study of selected 18 sugar producing states reveals that the sugarcane scenario of India is full of diversity in terms of area, production and yield of sugarcane across sugar producing states. At all India level during last 12 years all the three selected variables have registered significant growth in terms of CAGR. However, the large variation in the state wise sugarcane yield is a matter of concern from the point of view of viability of sugar industry. The study of area, production and yield of sugarcane on the basis of averages, growth rates and stability suggest that with some exceptions, it could be concluded that in terms of averages, Maharashtra, Uttar Pradesh, Tamil Nadu, Karnataka and Andhra Pradesh have been top performers. While in terms of growth rate Karnataka and Maharashtra have consistently registered growth. While if we identify top performers in terms of stability, Uttar Pradesh and Gujarat could be marked as top performer as these states have registered least CV for most of the performance indicator.

Keywords: Performance, Sugarcane, Semi log Regression, Coefficient of Variation

Background

The sugar is extracted from two different raw materials sugarcane and beet; both produce identical refined sugar. Beet is grown in temperate climate and accounts for around one third of world sugar production. Sugarcane is grown in semi-tropical region and accounts for around two-third of world sugar production.

In India, sugarcane is the key raw material for the production of sugar. Sugarcane is grown in the tropical and sub-tropical region of the India. In India, there are around 18 states where the sugar is produced on regular basis in an organized setup of vacuum pan sugar mills. These states include, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal and others. Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and Gujarat are the major sugarcane producing states in the tropical regions of India. Subtropical regions include Uttar Pradesh, Bihar, Punjab, Haryana and Madhya Pradesh. Sugarcane yields are substantially higher in the tropical states as compared to the subtropical states. In India, subtropical regions account for around 67% of the cane area and 62% of the sugarcane production. Though the tropical regions account for 33% of the total area in India, it contributes 38% of the production, owing to high productivity.

In this background it would be beneficial to examine the comparative performance of sugarcane producing states in India and identify best performing states in terms of selected performance indicators.

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Review of Literature

F. Schneider Jr (1926)¹ endeavored to study the evolution of sugar industry in the world. The study revealed that sugar cane is known to have been cultivated in India before the start of the Christian era. It is evident from the historical literature that soldiers of Alexander the Great brought back from the banks of the Indus the "honey-bearing reed." The real introduction of sugar into Europe came, however, at a considerably later date. It was India, from where the use of sugar spread worldwide.

Nandini et al. (2017)² attempted to examine the growth path of sugarcane production in India with the help of secondary data and find that there were variations in production and no uniform pattern of growth was observed. The paper concluded that the major reason for low production and low productivity is the unpredictable monsoon conditions. Thus initiatives on proper irrigation management would enable the scope and increase the production of sugarcane in India.

Using time series data consisting of two periods of time from 1970-71 to 1989-90 (Pre – liberalization) and from 1990-91 to 2009-10 (post reform period), **Darvishi et al. (2013)**³ attempted to analyse the trends in area, production and productivity of coffee and tea before and after the introduction of trade liberalization policies in India. The study concluded that there is not much change in the relative share, area under coffee and tea showed an increase during the post liberalization period. Similarly production and productivity of coffee and tea also increased during the post liberalization period and the variability has declined.

Objectives of the Study

The purpose of this study is twofold. First, this study attempts to examine the comparative performance of sugarcane producing states and second to identify best performing states in terms of selected performance indicators.

Methodology of Research

In India, there are around 18 states where the sugar is produced on regular basis in an organized setup of vacuum pan sugar mills. These states include, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal and others. From the point of view of the objectives of the study and the availability of time series- state wise data, ten states have been selected for the analysis and remaining states have been grouped in "other states together". The selected states are Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Tamil Nadu and Uttar Pradesh. To avoid any discrepancy arises from the division of Uttar Pradesh and Madhya Pradesh, the values related to

Uttarakhand and Chhattisgarh have been merged with Uttar Pradesh and Madhya Pradesh respectively. Hence in the study Uttar Pradesh and Madhya Pradesh has been taken undivided. The study is based on state wise data pertaining to the period of 2002-03 to 2013-14. Since, it is obvious that with the passage of time most of the performance indicators would show relatively higher values. Hence the comparison of growth rates over the mean values of selected performance indicators has been given preference in the study. Three performance indicators have been selected to make an interstate comparative analysis of selected sugarcane producing states in India. Semi log regression has been applied to estimate the compound annual growth rate of the selected variable and to assess the level of volatility coefficient of variation has been calculated. These indicators have been illustrated in the table 1 below:

Table 1: Performance Indicator

Sl.	Indicator	Unit	Description
1	Area	000 Hectatres	The area under sugarcane cultivation.
2	Production of Sugarcane	000 Tonnes	The total quantity of sugarcane produced
3	Yield	Tonnes/Ha	The average sugarcane produced from one hectare of land

Analysis

Area under Sugarcane Cultivation

For the comparative study of states in terms of area under sugarcane arithmetic averages of the same for the period 2002-03 to 2013-14 have been calculated and illustrated by the chart 1. At all India Level the area under sugarcane has reached the level of 4592 thousand hectare during this period. It can easily be observed from the chart that Uttar Pradesh has been ranked first in terms of sugarcane area. The status of Uttar Pradesh has been followed by Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh. These five states have been marked as largest in terms of area under sugarcane cultivation during pre-reform period. The study has observed an increase in the area during study period in these top five states holding largest cane area. Gujarat, Madhya Pradesh and other states together has enjoyed the same trend. However the states like Haryana, Orissa and Punjab has experienced a decline in the average area under sugarcane. During the study period Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh has dominated the largest part of the area under sugarcane.

¹ F. Schneider Jr (1926), Sugar, Foreign Affairs, Vol. 4, No. 2 (Jan., 1926), pp. 311-320

² Nandini et al. (2017), A Study on Sugarcane Production in India, International Journal of Advanced Research in Botany (IJARB) Volume 3, Issue 2, 2017, PP 13-17, Web Link: <https://www.arcjournals.org/pdfs/ijarb/v3-i2/3.pdf> DoA 27/03/2018

³ Darvishi et al. (2013), An Analysis Of Changing Pattern In Area, Production And Productivity Of Coffee And Tea In India, International Journal of Marketing, Financial Services & Management Research, Vol.2, No. 9, September (2013), pp 46-60. Web Link: re.indiaenvironmentportal.org.in/files/file/plantation%20crops%20Kerala.pdf Doa 27/03/2018

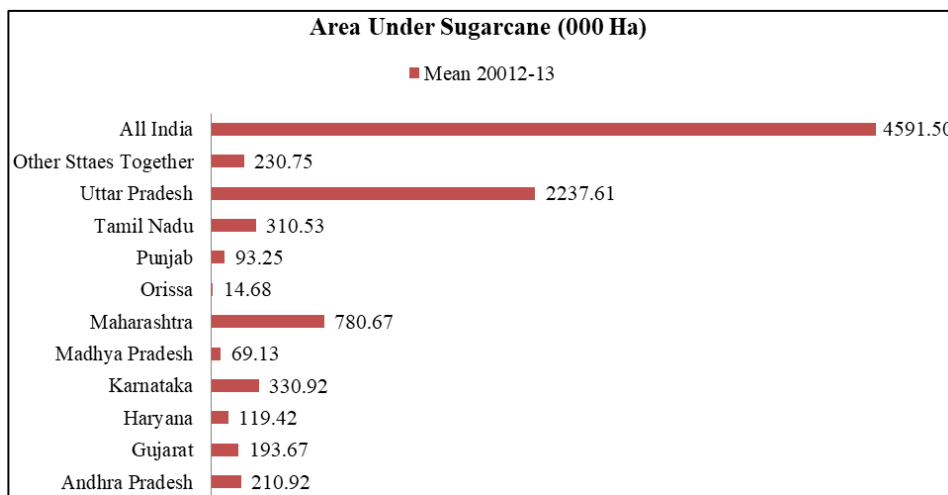


Chart 1: State wise Area under Sugarcane (000 Ha)

Note: Researcher’s illustration, Data Source: Cooperative Sugar (various issues), NFCSFL

To study the growth rate of area under sugarcane, the compound annual growth rate has been calculated for every state with the help of semi log regression model. The state wise growth rates (CAGR) of area have been tabulated in the table 2. The corresponding p and t values have also been given in the two columns next to the CAGR column for the purpose of inference.

Table 2: CAGR: State wise Area under Sugarcane

States	CAGR 2002-03 to 2013-14		
	CAGR 2002-2013	P value	t value
Andhra Pradesh	-0.0198	0.086	-1.904
Gujarat	-0.00797	0.395	-0.890
Haryana	-0.05918*	0.003	-3.980
Karnataka	0.055485	0.017	2.858
Madhya Pradesh	0.049171*	0.002	4.155
Maharashtra	0.080043*	0.010	3.143
Orissa	-0.01489	0.498	-0.704
Punjab	-0.044*	0.025	-2.627
Tamil Nadu	0.034585*	0.045	2.295
Uttar Pradesh	0.004008	0.345	0.990
Other States Together	0.071437*	0.000	5.202
All India	0.0202*	0.034	2.457

Source: Researcher’s Calculation, * Significant at 5% Level of Significance

However during the study period nearly half of the states including Andhra Pradesh, Gujarat, Haryana, Orissa and Punjab have experienced negative growth rate in the area under sugarcane. The study has identified that the negative growth rate in area was significant also for Haryana and Punjab at 5% level of significance. While Madhya Pradesh, Maharashtra, Tamil Nadu and other states together have enjoyed a significant positive growth during the post reform period in terms of area under sugarcane. Maharashtra, Karnataka, Madhya Pradesh and Tamil Nadu have been marked as the states those registered a growth rate remarkably high than others including all India average growth rate of area under sugarcane. Hence these states could be identified as better performers of the study period. The same has been illustrated with the help of chart 2.

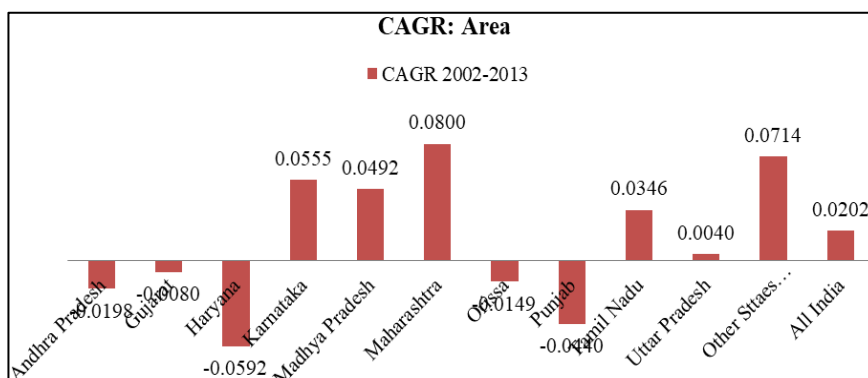


Chart 2: CAGR: State wise Area under Sugarcane

Note: Researcher’s illustration, Data Source: Cooperative Sugar (various issues), NFCSFL

The coefficient of variation in the area has been calculated to assess the instability and the same has been illustrated in the chart 3.

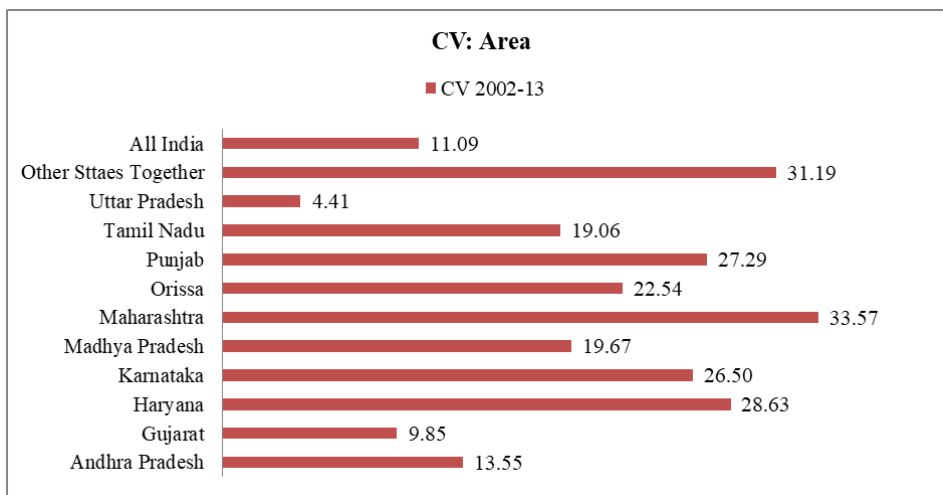


Chart 3: Coefficient of Variation: State wise Area under Sugarcane

Note: Researcher’s Calculation & illustration, Data Source: Cooperative Sugar (various issues), NFCSFL

During the study period Maharashtra has experienced the highest volatility in the growth in area under sugarcane in terms of coefficient of variation. Haryana, Karnataka, Punjab and Madhya Pradesh have also encountered huge variation in the area after Orissa. Among the selected states Uttar Pradesh has shown least variation in the area under sugarcane during both the periods. The stability shown by Uttar Pradesh in terms of area has been found better than the all India also. The greatest variation in area during the study period has been encountered by the Maharashtra, where the CV was calculated to be 33.57. Whereas, the states like Gujarat, Andhra Pradesh, Orissa, and Uttar Pradesh have enjoyed relatively less variations in the area. During the pre reform period the coefficient of variation of area registered by Uttar Pradesh has been found remarkably low than that of all India. Hence in terms of variability in area Uttar Pradesh along with Gujarat could be marked as better performers in terms of variability in area.

Sugarcane Production

For the comparative study of states in terms of sugarcane production arithmetic averages of the same have been calculated and illustrated by the chart 4. It could easily be observed from the chart that Uttar Pradesh holds the top rank in terms of average sugarcane production. The status of Uttar Pradesh has been followed by Maharashtra, Tamil Nadu, Karnataka and Andhra Pradesh. Among the selected states Andhra Pradesh, Gujarat, Madhya Pradesh, Maharashtra, Tamil Nadu and Uttar Pradesh has produced relatively greater amount of sugarcane during the post reform period. While, Haryana Karnataka, Orissa, Punjab and other states together has experienced a decline in the sugarcane production during the post reform period. Hence, Uttar Pradesh, Maharashtra, Tamil Nadu, Karnataka and Andhra Pradesh could be marked as top performers in terms of sugarcane production.

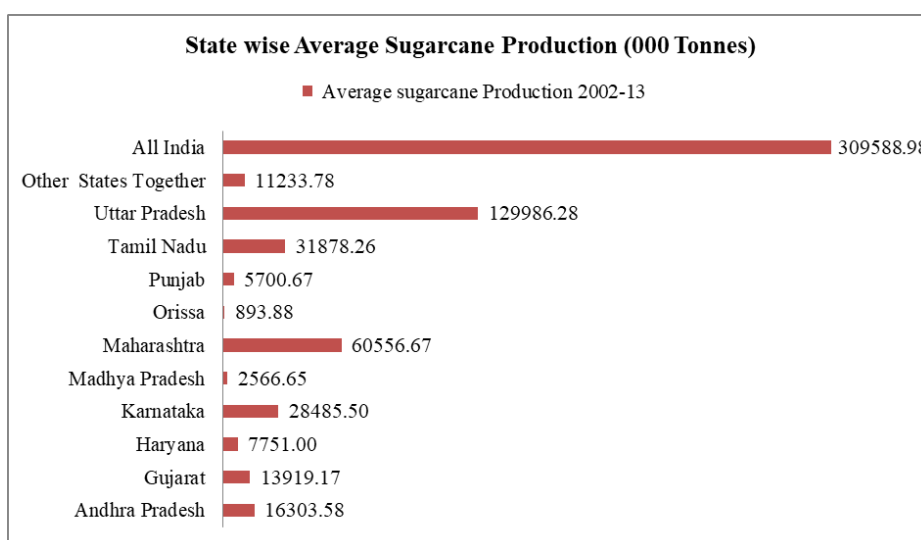


Chart 4: State wise Average Sugarcane Production (000 tonnes)

Note: Researcher’s illustration, Data Source: Cooperative Sugar (various issues), NFCSFL

To study the growth rate of sugarcane production by states, the compound annual growth rate has been calculated with the help of semi log regression model. The state wise growth rates (CAGR) of sugarcane production have been

tabulated in the table 3. The corresponding p and t values have also been given in the two columns next to the CAGR for the purpose of testing the significance of growth rate.

Table 3: CAGR: State Wise Sugarcane Production

State	CAGR 2002-03 to 2013-14		
	CAGR	P value	t value
Andhra Pradesh	-0.00797	0.584	-0.565
Gujarat	-0.00896	0.2	-1.372
Haryana	-0.03632*	0.045	-2.294
Karnataka	0.071437*	0.01	3.162
Madhya Pradesh	0.043938*	0.008	3.309
Maharashtra	0.10076*	0.01	3.164
Orissa	-0.003	0.911	-0.114
Punjab	-0.02858	0.174	-1.463
Tamil Nadu	0.041852*	0.041	2.342
Uttar Pradesh	0.008032	0.154	1.544
Other STATES	0.093081*	0	5.249
All India	0.0305*	0.01	3.171

Note: Researcher’s calculations, Data Source: Cooperative Sugar (various issues), NFCSFL

It is evident from the table 3 & Chart 5 that during the study period Maharashtra, Karnataka, Madhya Pradesh and Tamil Nadu have enjoyed a significant positive growth rate in terms of sugarcane Production. Uttar Pradesh has also registered a positive growth rate during the same period; however, the growth rate was not significant at 5% level of significance. Andhra Pradesh, Gujarat, Haryana, Orissa and Punjab have experienced negative growth rate. Among them the negative growth rate registered by Haryana has been found significant at 5% level of significance. During the post reform period while other states together have registered a significant positive growth rate in terms of sugarcane production, the growth rate of sugarcane production at all India level has been found significant. During the study period, among the selected states the growth rate registered by Maharashtra, Karnataka, Madhya Pradesh and Tamil Nadu has been found better than that registered by other states and all India as well. Hence these states could be marked as better performers in terms of growth rate of sugarcane production.

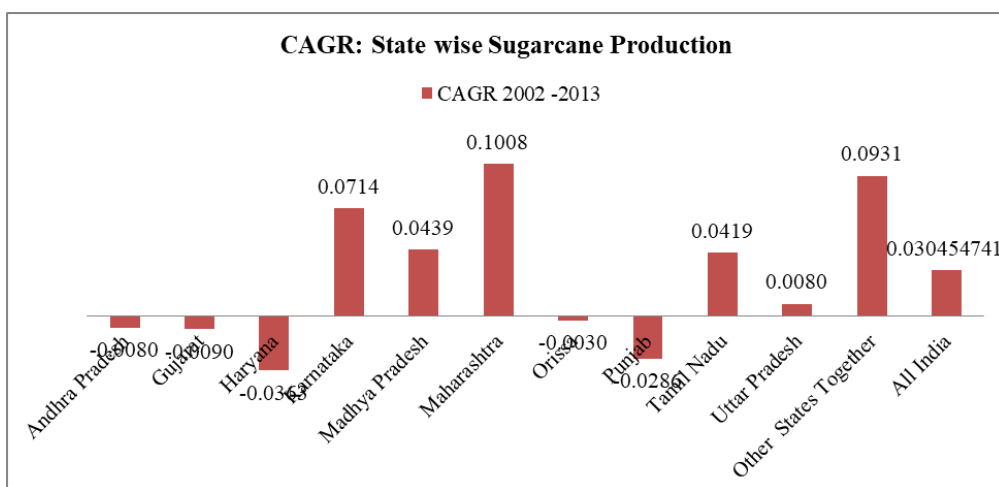


Chart 5: CAGR: State wise Sugarcane Production

Note: Researcher’s Calculation & illustration, Data Source: Cooperative Sugar (various issues)

To assess the variability in sugarcane production during the study period the coefficient of variation has been calculated

for each state. The same has been illustrated in the chart 6.

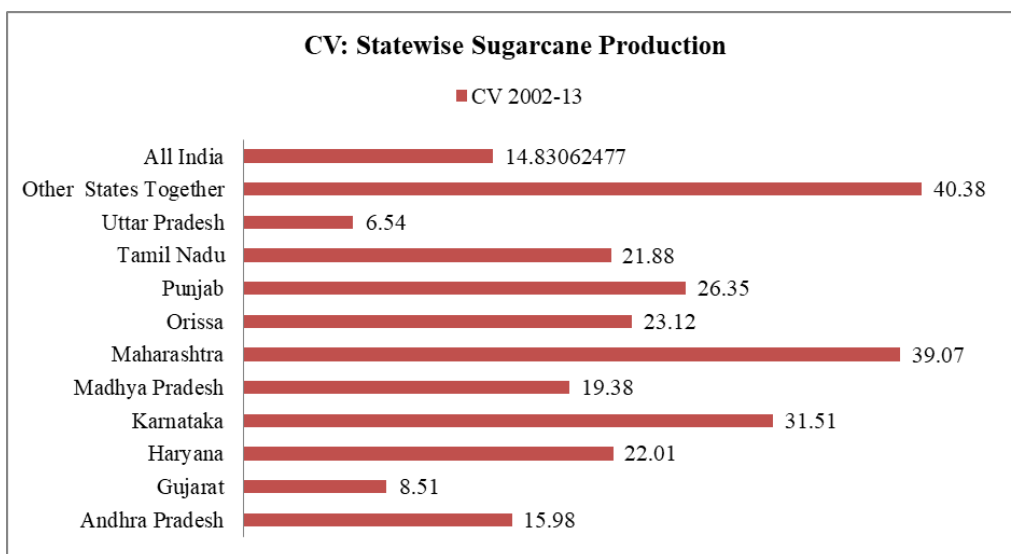


Chart 6: CV: State Wise Sugarcane Production

Note: Researcher’s Calculation & illustration, Data Source: Cooperative Sugar (various issues)

Among the selected states Uttar Pradesh has enjoyed least variation in the sugarcane production during the study period. Maharashtra, Karnataka, Punjab, Orissa, Haryana and Tamil Nadu have faced greatest volatility in sugarcane production.

During the study period, Uttar Pradesh along with Gujarat has encountered relatively less variation than others and all India as well. Hence, Uttar Pradesh and Gujarat could be termed as best performers in terms of stability in the sugarcane production.

Yield of Sugarcane

For the comparative study of states in terms of sugarcane yield, it could easily be observed from the chart 7 that the states like Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra and Gujarat has enjoyed relatively better yield during the study period as compared to other states and India as well. The average yield registered by Tamil Nadu, Karnataka, Maharashtra, Andhra Pradesh and Gujarat has been calculated to be higher than the all India average yield during both the periods. Hence these states could be termed as best performers in terms of sugarcane yield.

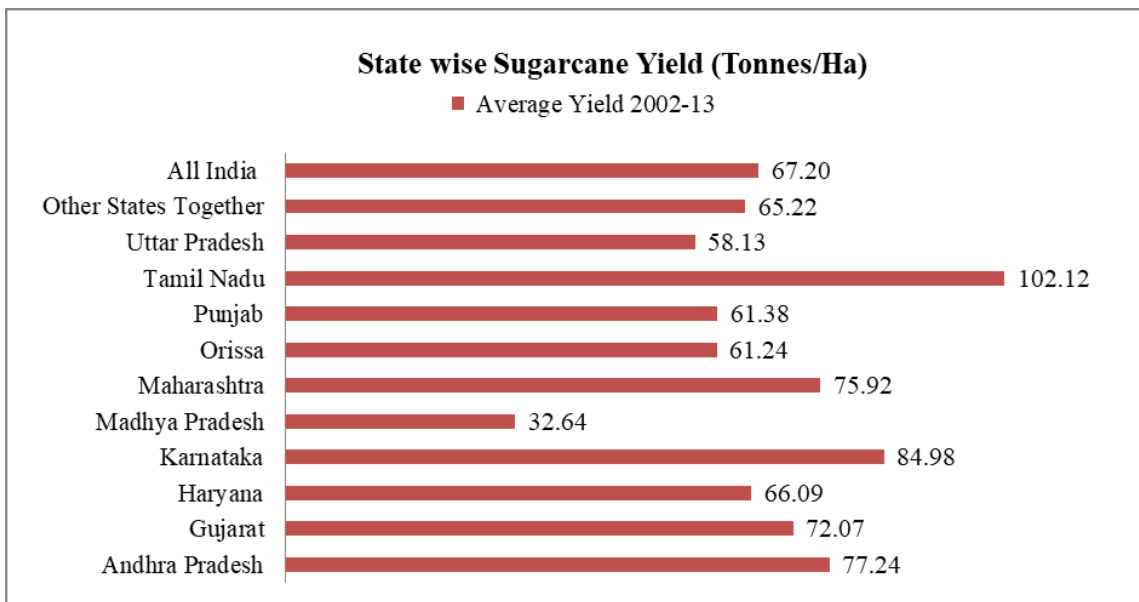


Chart 7: State wise Average Sugarcane Yield (Tonnes/ Ha)

Note: Researcher’s Calculation & illustration, Data Source: Cooperative Sugar (various issues)

The large variation in the state wise sugarcane yield is a matter of concern from the point of view of viability of sugar industry. On the one hand there is states like Tamil Nadu, which produces 102 tonnes of sugarcane per hectare of land and on the other hand there is states like Madhya Pradesh which hardly gets 35 tonnes of sugarcane per hectare. The yield registered by Madhya Pradesh is around one third of the yield enjoyed by Tamil Nadu. Although there are geographical and climatic differences but it is hard to believe that only climatic reasons can cause such huge differences in yield. Efficiency in sugarcane production, status of irrigation facilities, training, research and development could be influential factors and the impact of the same should be assessed. Uttar Pradesh, The largest producer of sugarcane has also performed unsatisfactory in terms of sugarcane yield during both the period.

To study the growth rate of sugarcane yield, the compound annual growth rate has been calculated for every state with the help of semi log regression model. The state wise growth rates (CAGR) of sugarcane yield have been tabulated in the table 4 and chart 8. The corresponding p and t values have also been given in the two columns next to the CAGR for the purpose of inference.

Table 4: CAGR: State wise Sugarcane yield

State	CAGR 2002-03 to 2013-14		
	CAGR 2002 -2013	P value	t value
Andhra Pradesh	0.0121*	0.019	2.80
Gujarat	-0.0020	0.729	-0.36

Haryana	0.0243*	0.001	4.62
Karnataka	0.0151*	0.039	2.37
Madhya Pradesh	-0.0149	0.112	-1.74
Maharashtra	0.0182	0.084	1.92
Orissa	0.0141*	0.023	2.68
Punjab	0.0161*	0.026	2.61
Tamil Nadu	0.0070	0.221	1.31
Uttar Pradesh	0.0040	0.363	0.95
Other States Together	0.0111*	0.019	2.79
All India	0.0110*	0.008	3.33

Note: Researcher’s Calculation, Data Source: Cooperative Sugar (various issues)

It is evident from the table 4 and the chart 8 that all the states except Gujarat and Madhya Pradesh have registered positive growth rate of sugarcane yield during the study period. The positive growth rate registered by Andhra Pradesh, Haryana, Karnataka, Orissa, and have been found significant at 5% level of significance. The positive growth rate registered by other states together and at all India level has also been found significant.

All the selected states except Tamil Nadu, Uttar Pradesh, Gujarat and Madhya Pradesh have registered a growth rate of yield greater than the all India level. Hence, Haryana, Maharashtra, Punjab, Karnataka, Orissa and Andhra Pradesh could be marked as better performers than the other states as these states has enjoyed relatively better growth rate of sugarcane yield.

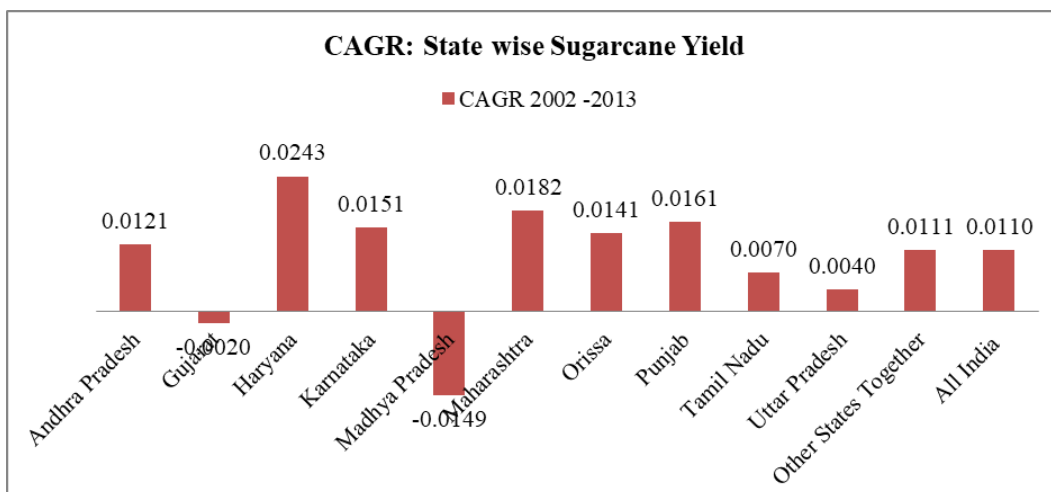


Chart 8: CAGR: State Wise Sugarcane Yield

Note: Researcher’s Calculation & illustration, Data Source: Cooperative Sugar (various issues)

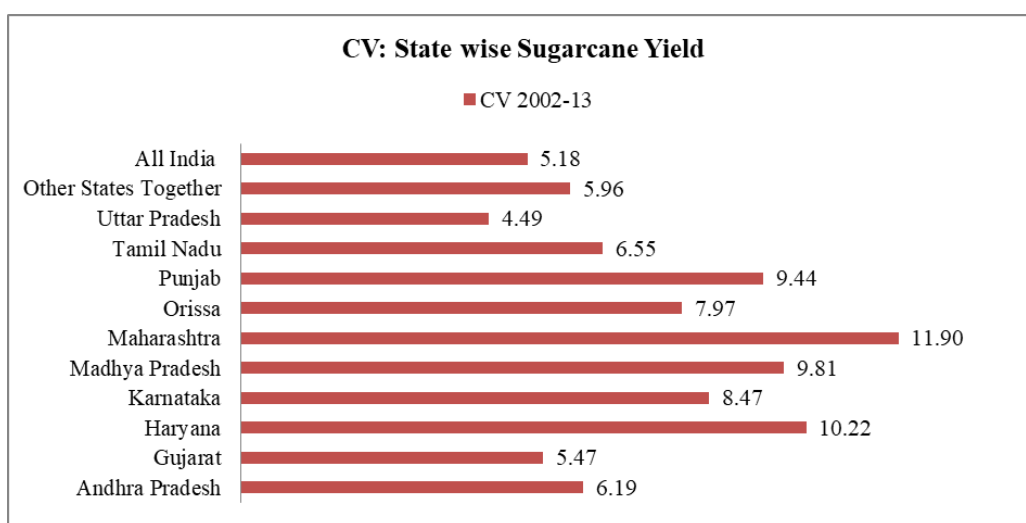


Chart 9: CV: State Wise Sugarcane Yield

Note: Researcher’s Calculation & illustration, Data Source: Cooperative Sugar (various issues)

It can easily be observed from chart 9 that besides Maharashtra, Haryana, Madhya Pradesh, Punjab and Karnataka has also faced relatively greater variation as compared to Orissa, Tamil Nadu, Andhra Pradesh, Gujarat and Uttar Pradesh. Uttar Pradesh has enjoyed relatively smoothed growth in sugarcane yield during the study period. When compared the variability in sugarcane yield at all India level, it has been revealed that among the selected

states only Uttar Pradesh has enjoyed relatively less variation in terms of coefficient of variation.

In the present paper effort has been made to evaluate the comparative performance of sugarcane producing states in terms of averages, growth rates and stability in area, production and yield of sugarcane. A gist of interstate analysis and identification of top Performer for each category has been provided in the table 5.

Table 5: Gist of Interstate Analysis and Top Performer

Performance Indicator	Top Performer in terms of Average Value*	Top Performer in terms of Growth Rate**	Top Performer in terms of Stability***
Area	UP, MH,KA, TN, AP	MH, KA, MP, TN	UP, GJ
Sugarcane Production	UP, MH, TN, KA, AP	MH, KA, MP, TN	UP, GJ
Sugarcane yield	TN, KA, AP,MH,GJ	HR,MH,PB,KA,OR,AP	UP

*Top Five States or average better than all India, ** CAGR greater than all India CAGR, *** CV less than all India CV
 Where:
 AP: Andhra Pradesh, GJ: Gujarat, Hr: Haryana, KA: Karnataka, MH: Maharashtra, MP: Madhya Pradesh, OR: Orissa, PB: Punjab, TN: Tamil Nadu, UP: Uttar Pradesh

Note: Researcher’s Calculation & illustration, Data Source: Cooperative Sugar (various issues)

On the basis of above mentioned rules the study has identified more than one state for each performance

indicator and it is difficult to conclude which state has been all round performer on every indicator and for each period.

However, with some exceptions, generally it could be concluded that in terms of averages, Maharashtra, Uttar Pradesh, Tamil Nadu, Karnataka and Andhra Pradesh have been top performers. While in terms of growth rate Karnataka and Maharashtra have consistently registered growth. While if we identify top performers in terms of stability, Uttar Pradesh and Gujarat could be marked as top performer as these states have registered least CV for most of the performance indicator.

Conclusion

The present study of selected 18 sugar producing states reveals that the sugarcane scenario of India is full of diversity in terms of area, production and yield of sugarcane across sugar producing states. At all India level during last 12 years all the three selected variables have registered significant growth in terms of CAGR. However, the large variation in the state wise sugarcane yield is a matter of concern from the point of view of viability of sugar industry. On the one hand there are states like Tamil Nadu, which produces 102 tonnes of sugarcane per hectare of land and on the other hand there is states like Madhya Pradesh which hardly gets 35 tonnes of sugarcane per hectare. The yield registered by Madhya Pradesh is around one third of the yield enjoyed by Tamil Nadu. Although there are geographical and climatic differences but it is hard to believe that only climatic reasons can cause such huge differences in yield. Efficiency in sugarcane production, status of irrigation facilities, training, research and development could be influential factors and the impact of the same should be assessed. Uttar Pradesh, The largest producer of sugarcane has also performed unsatisfactory in terms of sugarcane yield during both the period.

The study of area, production and yield of sugarcane on the basis of averages, growth rates and stability suggest that with some exceptions, it could be concluded that in terms of averages, Maharashtra, Uttar Pradesh, Tamil Nadu, Karnataka and Andhra Pradesh have been top performers. While in terms of growth rate Karnataka and Maharashtra have consistently registered growth. While if we identify top performers in terms of stability, Uttar Pradesh and Gujarat could be marked as top performer as these states have registered least CV for most of the performance indicator.

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