

RESEARCH ARTICLE**Economic viability of sugarcane cultivation: A comparative analysis**

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Abstract

Economic viability is one of the keystones of sugarcane sustainability. In today's scenario, this means sugarcane growers who produce sugarcane sustainably must benefit from it. The economics of sugarcane cultivation is about finding logical, reasonable means of balancing individual economic self-interest with ecological and social integrity. Despite the increase in area and production of sugarcane, recently some concerns are emerging regarding farm profitability, sustainable use of farm resources and hike in input prices which have a direct and indirect influence on the cost of cultivation of sugarcane. Therefore, the objective is to analyse and compare the economic viability of sugarcane cultivation in major sugarcane producing states of India. The result indicates that the cultivation of sugarcane is profitable for Maharashtra but it involves more risk in terms of relatively less net income, as compared to other states. Moreover, the return per rupee spent was observed positive in both tropical and sub-tropical regions. The Sugar Trap makes the growers to stick with sugarcane cultivation due to some of the benefits received from the sugarcane crop such as relatively high profit, secure market (guarantee of purchase), less chance of crop failure, subsidized inputs, production system is based on contract farming model, etc. The study reports that, due to the longer duration of the crop, there is a hike in operation cost which warrants a technical solution.

Keywords: Sugarcane; Economic viability; Costs, Returns; Price; Input use; India**Introduction**

India has made a lot of progress in agriculture since independence in terms of area, output and productivity under foodgrains in general and cash crops like sugarcane in particular. Sugarcane is one of the important cash crops grown in India, which provides direct and indirect employment to around 7.5 per cent of the rural population. Over 5 million sugarcane growers, 6 million agricultural and 0.5 million skilled & unskilled industrial workers are engaged in the sugar industry (Directorate of Sugar 2013) and contributing to the growth of the vital rural economy. India's share in the world's total sugar production has increased from 5 per cent in the 1960s to 15 per cent at present (CACP 2018). Though sugarcane is grown only in 3.7 per cent of the net area sown, its contribution to the

total value of agriculture output is 6 per cent in 2017-18 (CACP 2018).

Economic viability is one of the keystones of sugarcane sustainability. Thus, sustainable sugarcane farms must be economically viable without affecting the environment. It is just that profits cannot take priority over everything else. Profitability is not equal to maximum profits. It must be able to cover costs of production and leave enough profit to provide an acceptable living for the sugarcane growers. In today's scenario, this means sugarcane growers who produce sugarcane sustainably must benefit from it. The economics of sugarcane cultivation is about finding logical, reasonable means of balancing individual economic self-interest with environmental and social integrity, to achieve long run economic

viability. It mainly depends on the efficiency of the production system and supports the sources of income of the farming production system. It is also a function of market forces, prices of sugarcane and efficiency of production. The sustainability of sugarcane and its viability is essential for the aggregate welfare of sugarcane growers. Therefore, it has to ensure minimum risk (market risk) and cost of cultivation. Despite the increase in area, production and productivity of sugarcane, recently some concerns are emerging regarding farm profitability, sustainable use of farm resources and hike in input prices which have a direct and indirect influence on the cost of cultivation for sugarcane. It can lead to higher risk in farm income and make sugarcane cultivation further vulnerable to market forces. It not only impacts the household economy of the sugarcane growers, but also the aggregate agricultural development. Therefore, it is always desirable to economise the cost of cultivation of sugarcane with low risk in order to achieve sustainable growth of sugarcane crop. The main purpose of this study is to check what the level is and the structure of economic viability and understand how input use pattern has been changing over a period of time, especially in those states where sugarcane cultivation is intensive. In this context, the cost of cultivation and its relation to price policy is dealt with giving details about how much sugarcane cultivation is profitable.

Objective

To analyse and compare the economic viability of sugarcane cultivation in major sugarcane producing states of India.

Materials and Methods

For this analysis, among the sub-tropical region states, Uttar Pradesh and Haryana were selected and Maharashtra, Tamil Nadu, Andhra Pradesh & Karnataka from the tropical region as all these six states are the leading states in India in terms

of sugarcane production. Gujarat is also one of the major sugarcane producer states, but it is excluded here in analysis due non-availability of Cost of Cultivation data. The estimation of farm level income is the most appropriate measure of farmers' well-being. For the estimation of profitability, cost of cultivation, survey data was compiled from the Directorate of Economics and Statistics (DES), Ministry of Agriculture (GOI), where the latest published data are available for the period 1996-97 to 2016-17. The discussion on Sugar Trap is based on the primary data collected from farmers through field survey during 2017-18.

To calculate per hectare farm income, both output and input data were deflated by the relevant price deflators. A weighted State level income series was constructed by using the area share of sugarcane crop in the total cropped area as weight. For the calculation of profitability in order to examine the economic viability of sugarcane cultivation, this analysis has examined the net income [value of output (main + by-product) – total cost (Cost C2)], farm business income [value of output (main + by-product) – paid out cost (Cost A2)] concepts as per in Sen and Bhatia (2004) and family labour income [value of output (main + by-product) – Cost B2] as per in Singh and Dhillon (2015). Cost concepts were used as per the guidelines of CACP. The prices realized by growers were estimated to examine the actual price received by a grower for his / her produce at the farm gate. Price realized by farmers is the ratio of output values of main product per hectare to the yield per hectare.

Results and Discussion

Cost of cultivation of Sugarcane -A state-wise Comparison

The area under sugarcane cultivation and its production has increased substantially during the last six decades. Maharashtra, Karnataka, Andhra

Pradesh, Tamil Nadu, Uttar Pradesh and Haryana are the major sugarcane producing states in India. There is a chance to get better profits from sugarcane cultivation, because of the following three reasons. First, there is relatively less chance of crop loss due to failure of monsoon because it is cultivated under irrigated conditions. Second, prices are fixed by the CACP and third, a guarantee of purchase of sugarcane by the sugar mills under the model of contract farming (Narayanmoorthy 2013). In this context, one needs to understand whether the sugarcane growers are getting a fair income and at least enough to meet the basic needs from sugarcane cultivation or not.

In order to examine the economic viability of sugarcane cultivation in India, it is important to look into the costs and returns from sugarcane cultivation. Table 1 presents information on the costs and returns from sugarcane cultivation in major States. The sugarcane growers are receiving better profit from sugarcane cultivation after the

introduction of Fair and Remunerative Prices (FRP) in 2009. However, the sugarcane growers have received very fair profit in relation to Cost C_2 in Maharashtra during TE 2001-02, 2004-05 and 2008-09. Despite fair profit, the sugarcane growers are also receiving some profit in terms of family labour use. In relation to Cost A_2 , the profit has been recorded positive.

Among the tropical States, Tamil Nadu and Karnataka farmers realise higher income from sugarcane cultivation as compared to Maharashtra and other States in relation to Costs A_2 and C_2 . Farm business income has been recorded as almost the highest in all tropical region States (in range of Rs. 43270 -Rs. 67360 / ha) during the period TE 2016-17. Despite the higher value of the product in Maharashtra, less profit from sugarcane was recorded due to higher Costs A_2 and C_2 . Among the sub-tropical region States, Haryana has recorded the highest income from sugarcane cultivation when compared to Uttar Pradesh.

Table 1. State-wise cost of cultivation, value of output and income of sugarcane (at 2004- 05 Prices) (in Rs. / ha)

Period	Cost of Cultivation			Income		
	Value of Product (VoP)	Total Cost (Cost C ₂)	Paid Out Cost (Cost A ₂)	Family Labour Income (VoP - Cost B ₂)	Net Income (VoP-Cost C ₂)	Farm Business Income (VoP-Cost A ₂)
Maharashtra						
TE 1998-99	59460	45510	28710	17880	13940	30740
TE 2001-02	62440	58910	38300	8950	3530	24140
TE 2004-05	75510	72380	47900	9380	3130	27610
TE 2008-09	69210	64310	41500	10140	4900	27710
TE 2012-13	131450	89800	54010	49330	41640	77440
TE 2016-17	105270	94620	57740	22210	10830	47530
Karnataka						
TE 1998-99	71360	38650	18800	35860	32700	52550
TE 2001-02	73370	48870	27020	29330	24510	46350
TE 2004-05	86760	58550	31410	33610	28200	55340

Table 1 Contd....,

Period	Cost of Cultivation			Income		
	Value of Product (VoP)	Total Cost (Cost C2)	Paid Out Cost (Cost A2)	Family Labour Income (VoP - Cost B2)	Net Income (VoP-Cost C2)	Farm Business Income (VoP-Cost A2)
TE 2008-09	84350	52300	28590	36580	32050	55760
TE 2012-13	105460	58390	27920	53430	47060	77540
TE 2016-17	91460	62050	31020	36090	29410	60440
Andhra Pradesh						
TE 2001-02	63000	56860	32830	10420	6140	30170
TE 2004-05	58470	50670	27270	11500	7800	31200
TE 2008-09	76620	67020	35610	16260	9590	41010
TE 2012-13	78510	61760	35250	20320	16750	43260
TE 2016-17	82400	70870	39130	17970	11530	43270
Tamil Nadu						
TE 2001-02	104410	75140	44010	34230	29270	60400
TE 2004-05	75430	61800	37890	18270	13620	37530
TE 2008-09	93850	68290	43930	32020	25550	49920
TE 2012-13	120690	76680	51630	52760	44000	69060
TE 2016-17	124120	87960	56760	46850	36160	67360
Uttar Pradesh						
TE 1998-99	48560	30830	12000	22640	17730	36560
TE 2001-02	47760	33780	14900	19610	13980	32850
TE 2004-05	49080	34250	13680	20140	14830	35390
TE 2008-09	52580	34160	13680	23600	18410	38890
TE 2012-13	69580	41730	17530	33940	27850	52050
TE 2016-17	75950	44150	17710	38530	31800	58240
Haryana						
TE 2001-02	76470	53950	18350	28920	22520	58120
TE 2004-05	65150	49810	21590	20940	15330	43560
TE 2008-09	62090	44480	19820	19810	17600	42260
TE 2012-13	81210	54530	24130	29910	26670	57070

Note: 1. Cost of Cultivation data for the years 1996-97 to 1998-99 are not available for Andhra Pradesh, Tamil Nadu and Haryana States.

2. Cost of Cultivation data for the years 2014-15, 2015-16 and 2016-17 are not available for Haryana.

Source: Computed from Cost of Cultivation Survey Data, Directorate of Economics and Statistics (DES), MoAFW,

From Table 2, it can be said that, the return per rupee spent was observed positive in both tropical and sub-tropical regions' States. The ratio of the value of output and Cost A_2 and Cost C_2 should be equal to or greater than 1. The return per rupee spent is more in sub-tropical region States as compared to tropical region States in relation to cost A_2 . From the point of economic viability, all sugarcane producer states have shown better performance. The ratio of value of output to Cost A_2 and C_2 clearly indicates that the cultivation of sugarcane is profitable in Maharashtra, but it involves more risk in terms of relatively less net income (Table 2).

Input Costs Structure

The level and structure of cost of cultivation have an influence on profitability. Some significant changes have occurred recently in the crop production structure in terms of changes in technology and the relative prices of inputs. The evidence from Table 3 shows the most important input is human labour, which during TE 2016-17, accounted for about 51.5 per cent of the total cost in Tamil Nadu, about 32.3 per cent in Karnataka, 29.6 per cent in Maharashtra and around 31.5 and 26.5 per cent in Uttar Pradesh and Haryana,

respectively. The other important items of cost of cultivation are fertilizers, machine labour, manure, seed and irrigation charges. The relative share of these items varied from State to State and year to year. These variations in cost of cultivation structure are influenced by the proportion of ratoon in the total acreage (Sen and Bhatia 2004). Despite the water intensive sugarcane varieties adopted in Karnataka (CACP 2014), very little portion was spent on irrigation as compared to other States. Due to the low subsidies on irrigation and long duration of sugarcane crop growth, there are bigger charges for irrigation in Maharashtra compared to other sugarcane growing States. Moreover, the cost of fertilizers and manure is higher in Maharashtra and Karnataka (in range 10.5 -12 per cent), whereas it is very low in Haryana. The charges of machine labour recorded in Tamil Nadu are less compared to that of other sugarcane growing States. All these variable cost items are higher and together accounted for about 72.3 per cent of the total cost in Maharashtra during the period TE 2016-17. This may be because of using more amount of fertilizers, labour and irrigation charges (Upreti and Singh 2017). The relatively higher costs are for machines, fertilizers and manure and irrigation. Use of animal power was

Table 2. Ratio of value of output to cost A_2 and C_2 (Return per Rupee Spent)

Period	Maharashtra		Karnataka		Andhra Pradesh		Tamil Nadu		Uttar Pradesh		Haryana	
	VoP/ C_2	VoP/ A_2	VoP/ C_2	VoP/ A_2	VoP/ C_2	VoP/ A_2	VoP/ C_2	VoP/ A_2	VoP/ C_2	VoP/ A_2	VoP/ C_2	VoP/ A_2
TE 1998-99	1.3	1.6	1.8	2.1	NA	NA	NA	NA	1.6	2.6	NA	NA
TE 2001-02	1.1	1.5	1.5	1.8	1.1	1.7	1.4	1.7	1.4	2.3	1.4	2.9
TE 2004-05	1.0	1.5	1.5	1.9	1.2	1.9	1.2	1.6	1.4	2.5	1.3	2.3
TE 2008-09	1.1	1.5	1.6	1.8	1.1	1.9	1.4	1.6	1.5	2.5	1.4	2.2
TE 2012-13	1.5	1.7	1.8	2.1	1.3	1.8	1.6	1.5	1.7	2.4	1.5	2.3
TE 2016-17	1.1	1.6	1.5	2.0	1.2	1.8	1.4	1.5	1.7	2.5	NA	NA

Note: NA - denotes data are not available

Source: Computed from Cost of Cultivation Survey Data, Directorate of Economics and Statistics (DES), MoAFW, GoI. (1996-97 to 2016-17).

not an important cost item of sugarcane cultivation in Haryana, Tamil Nadu and Andhra Pradesh as its share was generally in the range of 0.5 to 1.4 per cent of the total cost. Due to the increment in human labour cost, the proportion of operational cost to total cost has increased in Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Haryana, whereas it declined in Uttar Pradesh (Table 3).

Among the fixed cost items, the share of the rental value of own land was found higher as compared to other items like land revenue, depreciation on implements and interest on fixed capital during TE 2016-17 which accounted for about 44.4 per cent of the total cost in Haryana, about 38 per cent in Uttar Pradesh and 33.5 Andhra Pradesh, 34 per cent in Karnataka, 18.6 per cent in Maharashtra and around 17.3 per cent in Tamil Nadu. To sum up,

Table 3. Share of various input costs in the total cost (in per cent)

Items	Tropical Region								Sub-tropical Region			
	Maharashtra		Karnataka		Andhra Pradesh		Tamil Nadu		Uttar Pradesh		Haryana*	
	TE 1998-99	TE 2016-17	TE 1998-99	TE 2016-17	TE 2001-02	TE 2016-17	TE 2001-02	TE 2016-17	TE 1998-99	TE 2016-17	TE 2001-02	TE 2012-13
Human Labour	27.5	29.6	29.2	32.3	34.4	41.7	39.3	51.5	29.0	31.5	24.7	26.5
Animal Labour	3.3	3.4	2.2	2.5	1.4	1.1	0.3	0.5	1.4	0.8	0.2	0.2
Machine Labour	7.0	11.1	3.3	1.4	2.3	1.2	1.3	2.2	1.8	1.8	3.0	3.7
Seed	6.1	3.7	4.9	3.6	8.5	6.1	6.6	4.0	6.2	6.1	5.6	9.0
Fertilizer & Manure	12.0	11.8	10.5	11.8	6.5	7.5	9.6	8.3	8.2	4.4	4.1	3.7
Insecticides	0.0	0.4	0.1	0.1	1.4	0.6	0.3	0.5	0.2	0.6	1.4	1.3
Irrigation Charges	10.7	8.8	3.0	5.8	5.1	2.0	3.2	5.4	4.5	6.0	4.3	2.7
Interest on Working Capital	3.6	3.5	2.8	2.9	3.3	3.2	3.4	3.8	2.2	2.2	2.0	2.6
Operational Cost	70.1	72.3	56.0	60.5	62.8	63.3	63.9	76.2	53.6	53.2	45.2	49.9
Rental Value of Owned Land	21.8	18.6	40.3	34.0	31.2	33.5	26.3	17.3	39.1	38.0	46.4	44.4
Rent Paid For Leased-in-Land	0	0	0	0	1.6	0.8	0.3	0.1	0	0.3	0	0
Land Revenue, Taxes, Cesses	0.5	0.2	0	0	0	0	0.2	0	0.1	0	0	0
Depreciation on Implements & Farm Building	1.1	0.7	0.8	0.3	0.8	0.2	0.8	0.4	1.2	1.8	0.8	0.3
Interest on Fixed Capital	6.5	8.2	2.9	5.3	3.6	2.2	8.5	6.0	6.0	6.6	7.6	5.4
Fixed Costs	29.9	27.7	44.0	39.5	37.2	36.7	36.1	23.8	46.4	46.8	54.8	50.1

Note: *Cost of Cultivation data for the years 2014-15, 2015-16 and 2016-17 are not available for Haryana State.

Source: Computed from Cost of Cultivation Survey Data, Directorate of Economics and Statistics (DES), MoAFW, GoI. (1996-97 to 2016-17).

the share of operational costs was recorded higher than the fixed cost in all States except Haryana. The rental value of owned land was found high in sub-tropical region States like Uttar Pradesh and Haryana (Table 3). Due to variations in input use, uniform central government policies are also not suitable for sugarcane cultivation for all the States. Therefore, separate State-wise policy formulation is needed to overcome the lacunae as sugarcane cultivation conditions vary from State to State on the line of State Advisory Prices (SAP) announced by major sugarcane growing states to cover up the difference in cost of cultivation.

Prices realized by sugarcane growers

The region-wise and all India level trends in the yield is presented in Figure 1. The yield level of tropical region is higher than the yield levels of sub-tropical region. All India average of yield level of tropical region (83.3 tonnes per hectare) is higher than the yield levels of sub-tropical region (65.3 tonnes per hectare) in 2015-16. It means the average of yield level of sub-tropical region is below the average of national level (74.3 tonnes per hectare). Due to the acute drought situation faced by almost all the states, the yield levels of national, tropical and subtropical regions have

drastically declined during 2003-04. After that it shows that increasing trend of yield level. In 2015-16, among the tropical region states Tamil Nadu (105 tonnes /hectare) has recorded high yield of sugarcane followed by Karnataka (85.5 tonnes / hectare), Maharashtra (76.1 tonnes /hectare), Andhra Pradesh (79.4 tonnes /hectare) and Gujarat (70.5 tonnes /hectare), whereas among the sub-tropical region states, Haryana (76.0 tonnes / hectare) has recorded high yield level followed by Punjab (72.0 tonnes /hectare), Uttar Pradesh (61.7 tonnes / hectare), Uttarakhand (61.7 tonnes / hectare) and, Bihar (55.2 tonnes /hectare). However, the trends of yield level shows that sub-tropical region has stagnant trend, whereas the tropical region has more fluctuations in yield trend due to acute shortage of water and sugarcane infected by diseases especially during 2003-05 and 2008-10. Further, the sugarcane yields are lower in the sub-tropical region due to short growing season, moisture stress, more pest and diseases problems, floods and water logging and very poor rations (Shukla et al. 2017). Moreover, according to the Rangarajan Committee (2012) report, the sugarcane area reservation structure does not seem to have promoted yield.

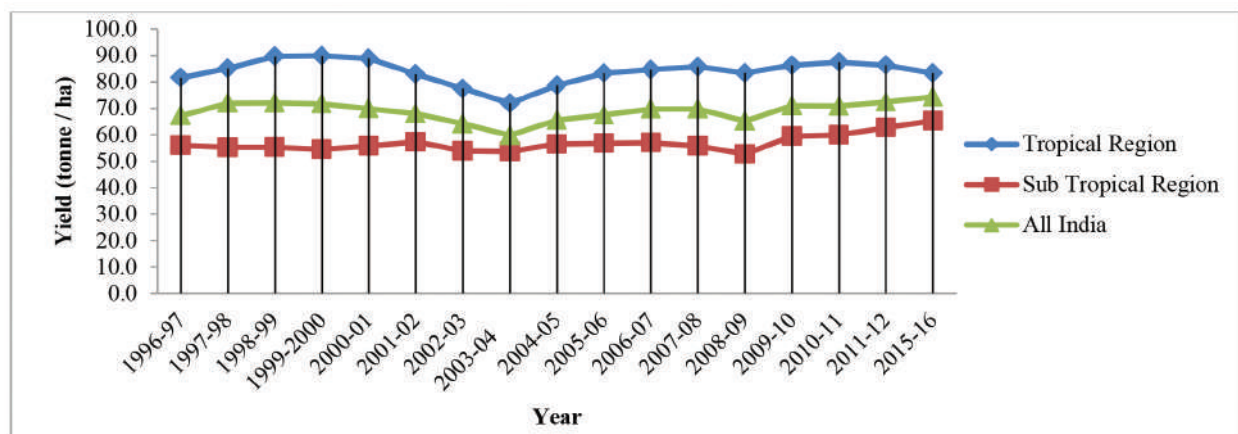


Figure 1. Region-wise yield of sugarcane in India

Source: DES, Ministry of Agriculture & Farmers Welfare, GoI and ICAR-Indian Institute of Sugarcane Research, Lucknow.

Farm profit mainly depends on two components, i.e., price effect and quantity effect. There is the chance to get profit if the cost is constant and output prices increase. Therefore, there is a need to understand the relationship between price policy and price realized by the growers. The central government fixes the Fair Remunerative Price for sugarcane every year. Consequent to this, every State government has the autonomy to decide its own sugarcane prices (State Advisory Price). The government has replaced the concept of MSP by FRP in sugarcane prices in 2009-10 sugar season. The Fair Remunerative Prices for sugarcane has increased from Rs.74.5 per quintal in 2004-05 to Rs. 170 per quintal in 2012-13 and the hike was more since 2008-09. The rising cost of production of sugarcane is a major cause that has led to higher support prices (Dev and Rao 2010).

The ratio of price realized by sugarcane growers to Minimum Statutory Price (MSP) / Fair Remunerative Price (FRP) was almost higher than 1 for all the sugarcane growing States up to 2013-14, except in Maharashtra during the period 2007-08 (Figure 2). A huge stock of sugar was pending in that particular year in Maharashtra which is a

major sugar exporter state in India. After 2010-11, the ratio of the price realized to FRP has been stagnant till 2012-13 due to increasing sugarcane payment arrears over the years. As a result of unpaid arrears, the price realization started declining after 2013-14 for all the states. Among the tropical region States, the prices realized by sugarcane growers were higher in Karnataka followed by Andhra Pradesh, Maharashtra and Tamil Nadu. The prices realized by sugarcane growers in sub-tropical States were higher in Haryana followed by Uttar Pradesh. Moreover, the sub-tropical region States like Haryana and Uttar Pradesh are receiving higher prices at their farm gates as compared to the tropical region States like Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. It may be due to short duration of crop and the widening gap between the sugarcane prices (SAP) decided by State governments and fair remunerative prices decided by the central government. It is clear that the sub-tropical states are comparatively more economically viable than the tropical states in sugarcane cultivation in terms of farm gate price realization.

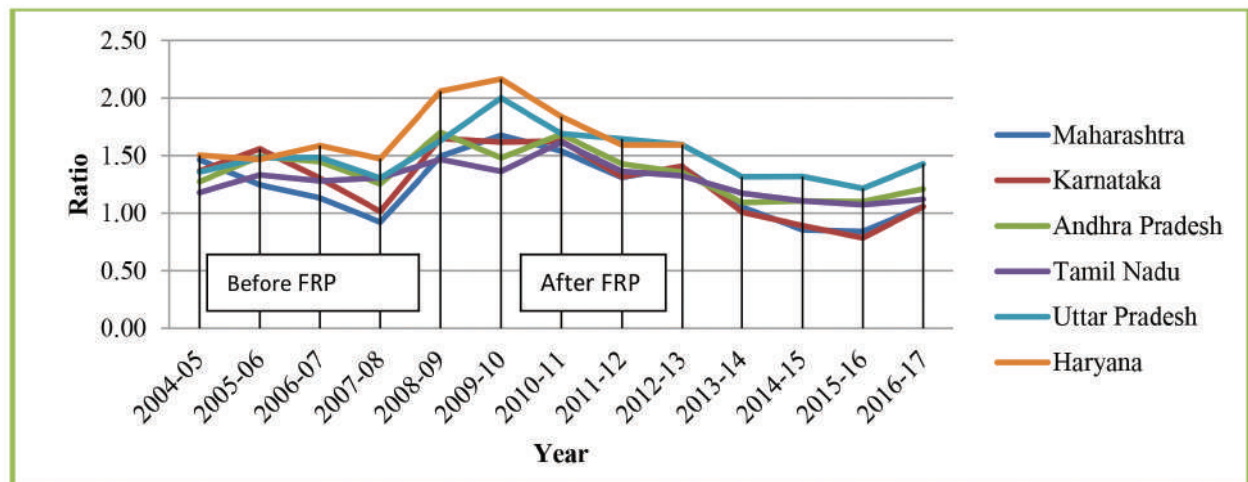


Figure 2. Ratio of Farmers' price realized in relation to FRP of sugarcane

Source: Computed from Cost of Cultivation Survey Data, Directorate of Economics and Statistics (DES), MoAFW, GoI. (1996-97 to 2016-17).

The sugar trap

In Maharashtra, an interesting paradox is observed. Even though, the cultivation of sugarcane crop is not much relatively profitable as compared to other sugar producing states, the area under sugarcane has increased from 578 thousand hectares in 2001-02 to 987 thousand hectares in 2015-16. It appears that the sugarcane growers are caught in a “*sugar trap*”. The growers undertake sugarcane cultivation due to the absence of competing alternative commercial crops, availability of credit at low rate of interest, harvesting is managed and assured purchase by sugar mills (Jugale 2000; Narayanmoorthy 2013). Besides these reasons, while conducting field survey, the sugarcane growers have stated some reasons like sense of security, less chance of being affected by pests and diseases (crop failure), use of modern technology, scope for intercropping, water stress resistance and promoting ancillary activities (jaggery, khandasari, dairy, juice), etc. The sugar mills register the area of the grower after planting and also provide the crop loans through cooperative banks as well as inputs on credit basis to the growers. These loans are deducted at the time of payment and the sugar mills retain a certain portion of the payments to be made some installments to the farmer. These are promised to be given during next season and in the lure of getting back that pending dues from the sugar mill, the farmer grows sugarcane in the next season. That is the “*Sugar Trap*” in which farmer gets entangled, particularly in such regions where the cooperative sugar model is exist. Some states’ sugarcane production system is mainly working on a cooperative model like Maharashtra. Once sugarcane growers are enrolled as shareholders of a sugar mill, they have to compulsorily sell their sugarcane to a particular mill. The sugarcane growers have to supply sugarcane to the sugar mill without fail, else the membership would be automatically get cancelled. Once their

membership is cancelled, they cannot avail benefit receive from the sugar mills like subsidies sugar and inputs, low interest credit including dividend on their shares, educational facilities for children, etc.

Further, the sugarcane growers are getting influenced by fellow farmers who received good profit from sugarcane cultivation. Subsequently, the farmers also venture to grow sugarcane crop in their field. In the initial stage, they have to invest large sums of money in sugarcane cultivation due to the credit-oriented nature of sugarcane crop. To fulfill credit need, the sugarcane growers take loans from co-operative credit societies with automatic repayment arrangements. It is very difficult for growers to repay the loan amount within a year as the sugar mills generally do not make full payment to the sugarcane growers in one installment. As per the Sugarcane (Control) Order (1966), it is mandatory for all sugar mills to release payment of sugarcane in one installment, within 14 days of harvesting. However, the payment delivery system is found to be varying from state to state due to the time taken to complete the production process, reach market and get the return for a mill. This results in a huge accumulation of sugarcane arrears with the sugar mills. Therefore, the sugarcane growers have to grow sugarcane for the next 2-3 years and for that, again they have to borrow some more credit. Moreover, sugarcane is a perennial crop which has comparatively less production cost for ratoon crop as compared to first plantation season crop. This whole process does not allow sugarcane growers to quit sugarcane cultivation easily.

In recent years, other commercial crops have emerged as a competing crop for sugarcane with their lower water requirement, and also the potential of profitability due to the rising demand. But the problem in this is that there is no assured income and there are fluctuations in production

and prices. Therefore, the gross returns from commercial crops are more uncertain or less than in sugarcane. Moreover, other alternative crops like oilseeds and horticulture crops can be more remunerative, but require more attention. Therefore, we have tried to look of trade-off between sugarcane and other competitive crops. The trade-off between sugarcane and other crops can be solved by calculating comparative advantage from sugarcane farming and alternative crops. Table 4 offers an inter-state comparison of the ratios of per hectare gross value of sugarcane output and per hectare gross value of output of two competing crops. It shows that Maharashtra, Karnataka, Tamil Nadu, Haryana, Uttar Pradesh states have the highest comparative advantage in growing sugarcane. To sum up, a trend has been witnessed in alternative crop production, so that despite the problems being faced by the sugarcane growers, like delays in payment of dues, the growers do not go for alternative crops production. The reason is that sugarcane is the most relatively profitable crop in sugarcane producer states when compared with a combination of any two competing crops.

To sum up, it can be said that the Sugar Trap makes the growers to stick with sugarcane cultivation due to some of the benefits received from the sugarcane crop such as relatively high profit, secure market

Table 4. Ratios of per hectare gross value of sugarcane and competing two cereal crops

States	2004-05	2010-11	2015-16
Haryana	1.08	0.93	1.23
Karnataka	2.09	1.57	1.71
Maharashtra	1.86	1.83	2.84
Tamil Nadu	1.62	1.45	1.62
Uttar Pradesh	1.41	1.22	1.60

Source: Calculated from CSO and Directorate of Economics and Statistics, Ministry of Agriculture & Farmers Welfare, GOI.

(guarantee of purchase), less chance of crop failure, subsidies inputs, production system is based on contract farming model, sugarcane based ancillary activities, etc.

Resources Use in Sugarcane Cultivation

Labour use

With regard to labour use in agriculture, the *Theory of Household Behavior* by Barnum and Saure (1979) suggests that a commercial profit-oriented farm employs only hired labour and produces marketed output, whereas a pure subsistence farm uses only family labour instead of hired labour and does not produce any marketed surplus. In the case of sugarcane, it is only grown for commercial purpose and uses both hired and family labour. However, the proportion of labour use depends on farm size.

The use of labour per unit of land is an important indicator which provides a long run viability of farms in higher wages and declining availability of land (Reddy 2015). As discussed earlier, the proportionate share of human labour is high in the total cost of sugarcane cultivation. However, there are no fixed trends in human labour cost structure among the sugarcane growing states in India. Regional variations have been found in human labour use. Among the tropical states, more human labour was required in Tamil Nadu followed by Andhra Pradesh, Maharashtra and Karnataka. The sub-tropical states Uttar Pradesh and Haryana accounted for less human labour man hours. During 2016-17, the sugarcane crop required 1275 man hours of human labour in Maharashtra, 1105 man hours in Karnataka, 1646 man hours in Tamil Nadu and 1132 man hours in Uttar Pradesh. In Haryana, sugarcane required less human labour, as it accounted for 1053 man hours during 2016-17. Furthermore, due to shortage of labour in peak period, total cost of cultivation is increasing at an alarming rate (Rahman and Bee 2019).

The sugarcane growers benefited by adopting selective mechanization of farm operations to overcome the labour scarcity (Murali and Balakrishnan 2012). In Maharashtra, the machine labour charges were around 11.1 per cent of the total cost in TE 2016-17. It has increased tremendously in almost all sugarcane growing States. It may be due to the growing diffusion of technology in sugarcane that- there has been widespread mechanization of almost all sugarcane farming operations like ploughing, harvesting, weeding and irrigation. In terms of the percentage of higher machine use to total machine labour charges also, Maharashtra tops the position followed by Andhra Pradesh, Tamil Nadu, Karnataka, Uttar Pradesh, and Haryana.

Regional variation exists in animal power use. The hours of human labour used in sugarcane cultivation depend on the extent of animal labour hours use. In almost all sugarcane growing States, the per hectare hours of animal labour use have declined from TE 1998-99 to TE 2016-17. Maharashtra accounted for the highest share in animal labour followed by Karnataka, Haryana, Andhra Pradesh, Uttar Pradesh and Tamil Nadu in TE 2016-17. It is clear that Tamil Nadu has been using a higher proportion of human labour, followed by Andhra Pradesh, Karnataka, Uttar Pradesh, Maharashtra and Haryana. From the social aspect, Tamil Nadu and Andhra Pradesh have a higher ability to provide employment to human and animal labour.

Fertilizers and manure use

The fertilizer charges account for the second largest item in the operational cost of sugarcane cultivation. Being a crucial input contributing to yield, there is a trend among sugarcane growers to go on increasing the application of chemical fertilizers, mainly in Maharashtra, Uttar Pradesh, Andhra Pradesh and Haryana. For example, the sugarcane growers are using chemical fertilizer

doses that hovers around 339 kgs nutrients per hectare in TE 1998-99, to 593 kgs nutrients per hectare in TE 2016-17 in Maharashtra. It has reported the highest level of fertilizer consumption in sugarcane of almost three times more than the average of the sub-tropical States. It was mainly due to the better availability of credit, number of sale points, price of sugarcane, prices of other inputs like micronutrients, manure, etc, high yielding crop varieties, crop duration, prices of fertilizer, etc. The chemical fertilizers consumption in all major sugarcane growing states has increased over the years. The use of manure in sugarcane cultivation was recorded to be very low in Haryana (6.60 Qtl / hectare in TE 2015-16). For appropriate doses of fertilizers and better productivity, the use of water also should be efficient, as too much water or too little water adversely affects the chemical and manure response (Raghavan 2008). In the use of manure, Tamil Nadu has accounted for the highest followed by Karnataka, Maharashtra, Andhra Pradesh and Uttar Pradesh. The evidence shows that the quantity of fertilizers used in sugarcane cultivation in TE 1998-99 was 338.54 kgs nutrient per hectare, 570.92 kgs in TE 2004-05, and 593 in TE 2016-17 in Maharashtra. As against this, the quantity of fertilizers used in sugarcane cultivation of Haryana in TE 2001-02 was 179.21 kgs nutrient per hectare and 241.53 kgs in TE 2015-16. A cursory look at chemical use reveals two important features. First, there are inter-state variations in the fertilizer use, and second, despite the continued increase in absolute terms for all States, the highest application of fertilizers is found in Maharashtra.

Appropriate doses of fertilizers could get good productivity leading to economic as well as environmental sustainability for the long run in sugarcane production. Figure 3 indicates that Maharashtra and Andhra Pradesh show excess use of fertilizers in sugarcane cultivation, whereas

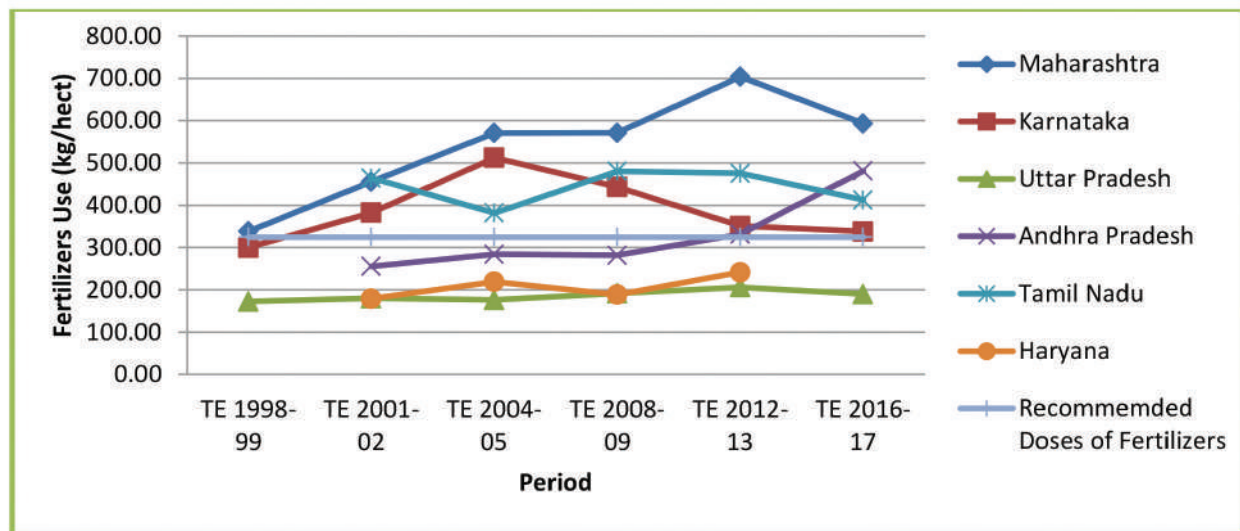


Figure 3. Divergence between Recommended Doses of Fertilizers and Actual Used (Kg Nutrient / Hect)

Note: 1. Doses of chemical fertilizers are recommended by the Ministry of Agriculture and Farmers' Welfare (325 kg nutrient chemical fertilizers per hectare)

2. Cost of cultivation data for the years 1996-97 to 1998-99 are not available for Andhra Pradesh, Tamil Nadu and Haryana.

Source: Based on CoC and Ministry of Agriculture and Farmers' Welfare data

Uttar Pradesh and Haryana show less use of fertilizers against the recommended doses of fertilizers³. In Karnataka, it was found less than the recommended during TE 1998-99, and thereafter it has increased. Tamil Nadu has less divergence in recommended and actually used doses of manure compared to other sugarcane growing states along with chemical fertilizers. This also contributes to higher productivity in Tamil Nadu. The highest divergence was found in Haryana in relation to manure use. Maharashtra showed proximity in the use of recommended doses of chemical fertilizers in TE 1998-99. However, it led to over-consumption of chemical fertilizers in TE 2016-17. Maharashtra has not shown much progress in the use of manure also, whereas Tamil Nadu has a smaller gap between recommended and actually used doses of manure as compared

to other states. Over-use of chemical fertilizers will lead to the problem of decline in margin and productivity due to less response from the soil and inputs combination. Therefore, appropriate use of chemical fertilizers as well as manure needs to be made for sugarcane cultivation in India, especially in Maharashtra where more chemical fertilizers are used.

Water use

The cost of irrigation mainly depends on the sources of irrigation, prices of irrigation pumpsets, electricity charges and government taxes on irrigation for canal or river irrigation. Irrigation charges have a greater influence on profitability and on the areas where fertilizer usage per hectare is also higher. The growers who do not have access to irrigation are the ones who get a lesser subsidy

³ Doses of fertilizers and manure are recommended by the Ministry of Agriculture and Farmer Welfare (325 kg nutrient chemical fertilizers and 6.25 tonnes manure per hectare).

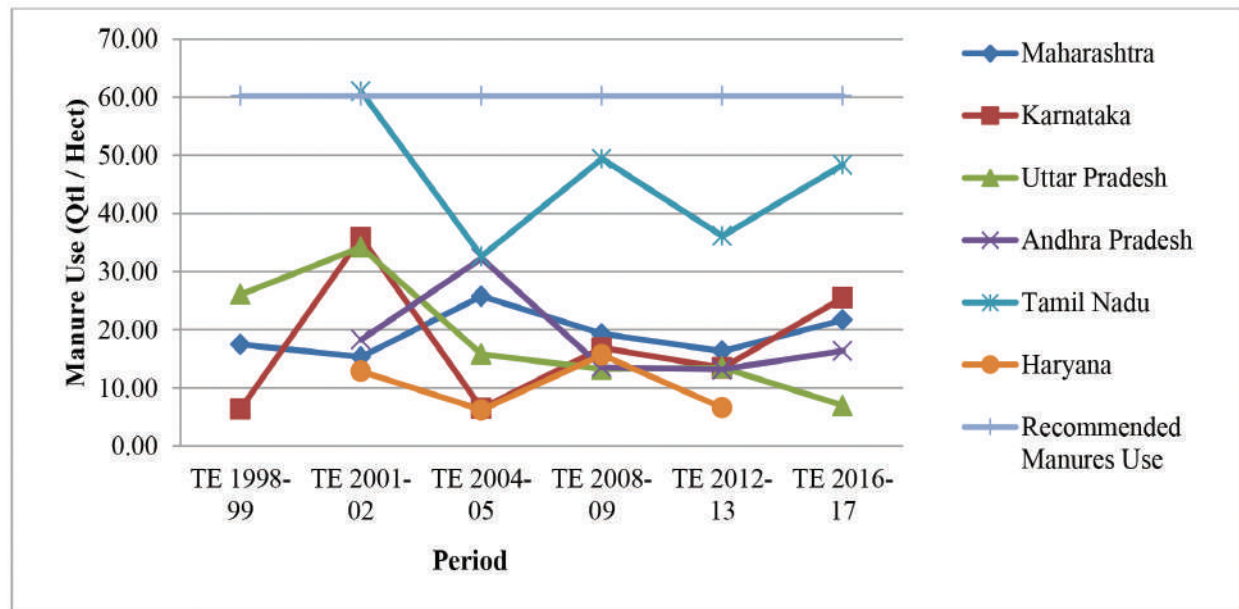


Figure 4. Divergence between Recommended Quantity of Manure and Actual Used

- Note:** 1. Manure per hectare recommended by the Ministry of Agriculture and Farmers' Welfare (6.25 tonnes per hectare)
 2. Cost of cultivation data for the years 1996-97 to 1998-99 are not available for Andhra Pradesh, Tamil Nadu and Haryana.

Source: Based on CoC and Ministry of Agriculture and Farmers' Welfare data

on fertilizers on per hectare basis (Vishandass and Lukka 2013). Maharashtra has three times higher irrigation charges compared to the other sugarcane growing states. The high use of chemical fertilizers in Maharashtra, which consumes large quantities of water, can be one of the reasons for high irrigation charges in Maharashtra. Moreover, the comparatively less subsidies on irrigation and long growing duration of sugarcane crop in Maharashtra are also responsible for high irrigation charges that have made sugarcane cultivation uneconomic with surge in cost of cultivation. The irrigation charges declined only in Andhra Pradesh, even though in the short duration period, the irrigation charges account for the second position in Uttar Pradesh, after Maharashtra.

Generally, in any crop production system, productivity is measured in terms of land productivity rather than water productivity. The

water productivity is also a major determinant of productivity wherein water is used as a major input for sugarcane crop. In terms of land productivity, Tamil Nadu, Karnataka and Maharashtra States are more efficient in sugarcane production. However, they are inefficient in terms of water productivity, whereas, Uttar Pradesh has less land productivity. The number of standard irrigation per hectare required for sugarcane is 34, 27 and 40 in Karnataka, Maharashtra and Tamil Nadu respectively. The crop duration in Uttar Pradesh and Tamil Nadu are more or less the same, but the water requirement per hectare is higher in Tamil Nadu. The sugarcane growing duration in Maharashtra is also higher as compared to Karnataka, but the water consumption is less than Karnataka. Water productivity was found higher in Bihar followed by Uttar Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu and Karnataka

Table 5. State-wise comparison in land and water productivity in relation to sugarcane production (TE 2013-14)(wt. average)

State	Crop Duration* (months)	No. of standard irrigations of 7.5 cms per ha	Water Requirement (Lakh L/ ha * 7.5 times no. of standard irrigations)	Land Productivity (Qtl / ha)*	Water Productivity (Qtl / Lakh L water) (col.5 / col.4)
Maharashtra	13.5	26.2	196.1	801.4	4.08
Karnataka	13.1	34.1	256.0	866.3	3.38
Andhra Pradesh	10.9	27.0	202.5	801.0	3.95
Tamil Nadu	10.8	39.6	296.6	1020.9	3.44
Uttar Pradesh	9.6	7.6	57.2	599.5	10.48
Bihar	12.0	5.0	37.5	512.1	13.65

Note: The recent data are not available on cost of water and the exact quantity of water used. This calculation is based on the approximate quantity of water required for sugarcane cultivation.

Source: Author's calculation based on data taken from CACP report : 2015-16 sugar season

(Table 5). In Bihar, rainfall is also higher during monsoon, so, the water demand was less rather than water management. It is clear that the use of water in sugarcane cultivation not only increased the burden of cost but also increased the problems of low land productivity and low response to input combinations.

Conclusion

From the above discussion, it can be concluded that the cultivation of sugarcane is profitable for sugarcane cultivating states but it involves more risk. Moreover, the return per rupee spent was positive in both tropical and sub-tropical regions' sugarcane producing states. The 'Sugar Trap' makes the growers to stick with sugarcane cultivation due to some of the benefits received from sugarcane crop. However, sugarcane cultivation is facing a major concern that there is

a hike in operation cost due to the longer duration of sugarcane crop, which needs to be technically solved. In order to reduce the operational cost of sugarcane cultivation, the sugarcane growers need proper management of timely sugarcane harvest which is the need of the hour. Due to variations in input use, uniform central government policies may not be suitable for sugarcane cultivation for all the states. Therefore, separate state-wise policy formulation is needed to overcome the lacunae as sugarcane cultivation conditions vary from state to state on the line of State Advisory Prices (SAP) announces by major sugarcane growing states to cover up the difference in cost of cultivation.

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