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An Analysis of the Factors that Influence on Sugarcane Acreage in Maharashtra

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Abstract: ***Sugarcane is the main cash crop of India. Maharashtra is leading state in average sugarcane production and its recovery. The climatic condition of Maharashtra is suitable for sugarcane production. Over a period of time, area, production and productivity of sugarcane fluctuated considerably from year to year. The different types of factors influence the crops to be grown in the state. The economic factors viz., prices of the various crops, previous acreage as well as climatic factors influences to a great extent in case of sugarcane cultivation consequently the growth in acreage has however not been uniform or steady. Besides, the acreage fluctuations lead to instability in the income of the farmers and also in the production of sugar. These factors differ considerably from region to region. Therefore, acreage response is also expected to vary among regions. The data obtained from secondary sources were analyzed to examine the factors which affect on the sugarcane acreage in Maharashtra state for three different time period i.e. pre- liberalization (19670-71 to 1990-91) post- liberalization (1991-92 to 2010-11) and entire period (1970-71 to 2010-11) by using linear multiple regression based on Nerlovian Partial Adjustment Model. The short run and long run price elasticities of acreages were also estimated. The results of the study revealed that, the price exerted a significant influence on the sugarcane acreage.***

Keywords: Sugarcane, Acreage, Supply, Elasticity, Nerlovian model

1. Introduction

Sugarcane is traditional and relatively more remunerative crop amongst all the non-food and food grains cultivated in the country. As history foretells, India had been connected to sugar for a long time. In fact, it is known as the place of origin of sugar, India maintains this reputation of sugar connection by producing the second largest quantity of sugar in the world and being the largest consumer of sugar. Sugarcane is one of the important crops of commerce and it will be one of key determinant of future Indian agriculture meeting both sugar, and energy demands. The contribution of Indian sugar was nearly 14 per cent of the total sugar production of the world. The sugar industry in India has been a focal point for socio-economic development in rural areas by mobilizing rural resources, generating employment and higher income, transport and communication facilities. Sugarcane is in great demand for various other uses like fodder, paper production and most importantly bio-fuels.

In typical sugar mills 100 tonnes of sugarcane on an average produces 10 tonnes of sugar, 4 tonnes of molasses from which ethanol is produced, 3 tonnes of press mud which is converted into bio-fertilizer, 30 tonnes of bagasses used for co-generation of power to yield1, 500KW electricity and for manufacturing of paper. Besides about 30 tonnes of cane tops and leaves are generally left in the field, which through recycling further add to the economic value of the crop In spite of that, the growth in acreage has however not been uniform or steady. Besides, the average fluctuations lead to instability in the income of the farmers and also in the production of sugar. The fluctuations in sugarcane acreage have always been a matter of concern to sugar policy maker and sugar factory owners. The acreage response to price changes play crucial role for wide range of issues of analytical as well as practical significance. In an economy like India, where production is dependent to a considerable extent on climatic factors and non-climatic variables, the response of which is reflected more directly on acreage.

The sugar production is largely depends on the acreage under sugarcane and policies of government with export and import of sugar .These two factors affect the sugar production and country like India observed “Boom and bust cycle” there was surplus production and during next year of surplus production there was deficit production. Thus, the sugar production is widely fluctuating therefore; it is important and imperative to examine the responsiveness of the farmers to price and non-price variables, which influences the acreage allocation decisions to sugarcane. The problem of area allocation in the subsistence economy assumes importance. Geographically, Maharashtra is situated under most favourable conditions for sugarcane growth and sugar recovery. The productivity of sugarcane remained stagnant in the state during few years. Thus, there is a wide gap between existing and potential levels of sugarcane productivity and sugar recovery Therefore, it was essential to determine the factors which influence the acreage under sugarcane. In view of the above, the present study viz.,"An Analysis of the factors that influence on Sugarcane Acreage” was undertaken in order to understand the acreage response of sugarcane in the state over the period of 41 years beginning from 1970-71 to 2010-11.

1.1 Hypotheses

The fluctuations in acreage under sugarcane are governed mainly by lagged prices, lagged acreage and lagged yield of competing crops.

1.2 Objectives

The specific objectives of the study are,

1) To identify the determinants of the acreage response of sugarcane in Maharashtra.
2) To estimate the short run and long run price elasticities of sugarcane
3) To estimate the projections of sugarcane production in Maharashtra

2. Literature Review

Shinde et al. (2001) studied the determinants of sugarcane acreage in western Maharashtra. The study was based on secondary data for the year 1960-61 to 1996-97 by using distributed lag model. They concluded that the lagged price, lagged acreage, coefficient of gross irrigated area and total rainfall was highly significant and thereby imparted the positive impact on sugar cane acreage.

Shende (2002) studied the acreage response for major crops in India viz., rice, wheat, sorghum, maize, cotton, sugarcane, gram and pigeon pea, using farm harvest price as one of the major independent variable and showed that farm harvest price have positive and significant effect on the area under rice, wheat, maize and sugarcane. The coefficient of determination R2 ranged from 0.436 to 0.900 for rice, wheat and sugarcane except gram (0.136). Regression coefficient of both variables was positive, showed a significant effect on the decision of farmers regarding allocation of area, and further revealed that, the short run elasticity for wheat (0.84) is the highest among all selected crops followed by sugarcane (0.900), rice (0.723) and cotton (0.562). It was concluded that the farm harvest price emerged as the strongest factor in determining the acreage of rice, wheat, maize and sugar.

Joshi (2008) studied the acreage response function for wheat crop in Maharashtra. The study revealed that a sizable range of total variation in the current area under wheat in Maharashtra was mainly influenced by lagged price of wheat, lagged area, pre-sowing period rainfall and area under gram. However, these factors influencing the acreage of wheat did differ from region to region.

Mankawade et.al (2015) studied Decomposit analysis and acreage response of soybean. The study revealed that compound growth rates for area, production and productivity of soybean was recorded positive. The growth rate for area, production and productivity was recorded high during period I. The coefficient of variation and coppock's instability index with regards to area (1.08 and 0.62) productivity (2.00 and 1.62) were lowest in Akola and Amavati district, respectively, whereas production was recorded lowest co-efficient of variation and coppock's instability index in Akola district (0.86 and 0.48). At overall period, area effect, yield effect, and interaction effect do not show any influence on one another. The study also reveals that, the short run price elasticity were comparatively higher than the long run price elasticity in soybean, which indicated that the farmers were relatively market oriented in their decision in long run than in the short turn.

Joshi G..G et.al.(2015) in their study entitled Demand and supply projections of wheat for Maharashtra observed that, Over a period of time, there has been a wide fluctuation in both acreages and production of wheat in different regions of Maharashtra state. The gap between the supply of and demand for wheat would be in the range of 56.75 to 58.45 lakh tonnes. Alternative options available for increasing the production or in other words 'supply' is to enhance the adoption of improved production technology from the existing 44 per cent to higher level, thereby, the gap in demand and supply can be minimized.

3. Research Methodology

3.1.1. Nature and sources of Data

To identify the determinants of acreage response, the time series secondary data on sugarcane area and relevant competing crops, rainfall, irrigation etc.for the entire period (1970-71 to 2010-11) were obtained from Season and Crop Reports and Epitomes published by the Department of Agriculture, Government of Maharashtra State. The data on variants was collected from Quarterly Bulletin of Economics and Statistics published by the Directorate of Economics and Statistics, Government of Maharashtra. For this purpose, the year wise data were drawn from various volumes of Indian Sugar, Co-operative Sugar and Agriculture Statistics at a Glance, for the period from 1970-71 to 2010-11.

3.1.2. Selected competing crops

For the present study, major competing crops of sugarcane in Maharashtra i.e. Wheat, Onion, Cotton and Groundnut with respect to area, prices and yield were selected purposively and presented in table no.1

Table 1: Selected competing crops

	Particulars	e competing crops
	ompeting for area	Onion, Groundnut.
	ith price influence	Cotton, Groundnut.
	ith yield influence	Cotton, Groundnut.

3.1.3. Selection of period

Based on the availability of data and to facilitate proper understanding the entire period of 41 years from 1970- 71 to 2010-11 was divided into two sub periods and one entire period as indicated below.
PeriodI:1970-71to1990-91 (Pre-liberalization)
PeriodII:1991-92to2010-11 (Post-liberalization)
Entire period: 1970-71 to 2010-11

3.2 Analysis of data

3.2.1 Acreage response analysis

The model which generally used in supply response analysis based on time series data will be adaptive expectations (or distributed lag) model. In the present study the Nerlovian lagged adjustment model (1958) was used. The acreage response means the change in acreage with the unit change in the variables affecting on during the period of study. The model used in the present study is as follows.

$A_t = a + b_1 + b_2 A_{t-1} + b_3 Y_{t-1} + b_4 R_t + b_5 I_t + b_6 Ac_1t + b_7 Ac_2t + b_8 Ac_3t + b_9 Pc_{1t-1} + b_{10} Pc_{2t-1} + b_{11} Pc_{3t-1} + b_{12} Yc_{1t-1} + b_{13} Yc_{2t-1} + b_{14} Yc_{1t-1} + b_{15} Sfi + ut$

Where,
At = Acreage of sugarcane crop in '00' ha during the current year
A_{t-1} = Acreage of sugarcane crop in '00' ha during the preceding year
P_{t-1} = Price (Rs/qtl) of sugarcane crop during the preceding year

Y_{t-1}=Productivity (t/ha) of sugarcane crop during the preceding year
R_t = Rainfall during preseasonal period (mm)
It = Irrigated area in ('00') hectares during growing season
A_1t =Area under first competing crops during current year in '00'ha
Ac_2t= Area under second competing crops during current year in '00'ha
A_3t= Area under third competing crops during current year in '00'ha
Pc_{1t-1}= Price of first competing crop during the preceding year (Rs/qtl.)
Pc_{2t-1}=Price of second competing crop during the preceding year (Rs/qtl.)
Pc_{3t-1}=Price of third competing crop during the preceding year (Rs/qtl.)
Yc_{1t-1}= Productivity of first competing crop during the preceding year (qtl./ha)
Yc_{2t-1}=Productivity of second competing crop during the preceding year (qtl./ha)
Yc_{3t-1}=Productivity of third competing crop during the preceding year (qtl./ha)
S_{fi} = Number of sugar factories during current year
u = error term
a = Intercept
bi's = Regression coefficient

3.2.2 Short run and long run elasticity:

The elasticity of variables show that the influence of unit change in variable on acreage decisions of crops. In the present study, variable elasticity were estimated for short run as well as for long run period. Moreover, the short run and long run elasticity have been estimated as

Based upon the formulation, both short-run and long run elasticities were estimated. Short-run elasticity can be worked out by,

Short-run elasticity

$$E\,(S.R.) = b_1\,(\overline{Pt\text{-}_1})/A_t)\,\overline{\text{and}}$$

Long run elasticity by

$$E\,(L.R.) = (b_1 / 1 - b_2)\,(\overline{P_{t-1}}/\,\overline{A_t})$$

Since the coefficient of adjustment $\beta = (1-b_2)$ is never greater than unity, it follows that, short-run elasticity can never be greater than long-run elasticity.

3.2.3 Projection of sugarcane production

The supply of most of the agricultural commodities primarily depends on the acreage under these crops. The projection of supply of the sugarcane for 2020 A.D., 2025A.D., and 2030A.D.were then worked out on the basis of the results of the acreage response model under constant productivity and variable productivity conditions.

The future production projections of the sugarcane were made by making use of the projected hectarage and average productivity (81.70 t/ha) and assumed productivity growth rate of 0.28 per cent per annum (1970–71 to 2010–11).

4. Results and Discussion

The results obtained from the present investigation have been presented in the following sub heads:

4.1 Determinants of acreage response of Sugarcane

The current acreage of sugarcane as a dependent variable was regressed on the factors which hypothesized to influence the area under sugarcane in each region. In all, 16 variables were identified which were supposed to influence the area under sugarcane. Finally, using the usual criteria of consistency in signs and statistically significance of regression coefficients, the variables with wrong signs and non–significant levels were dropped and the equations were re-run to estimate the acreage response models. The results obtained from the estimated acreage response models in respect of sugarcane are discussed in Table no.2

Table 2: Results of estimated acreage response function for Sugarcane in Maharashtra for different periods

Sr. No.	Factors	Periods		
		I (Pre-liberalization)	II (Post-liberalization)	Entire period
1.	Intercept	3205.208	-6289.46	-957.09
2.	A_{t-1}	-0.2838 (2.5905)	-4.3839** (1.9377)	0.8667* (1.5844)
3.	P_{t-1}	-63.14** (30.3839)	-45.216*** (12.2587)	-30.67*** (9.1084)
4.	Y_{t-1}	-31.118* (16.917)	150.99*** (34.7529)	15.779* (15.038)
5.	R_{t-1}	0.163*** (0.058)	-0.2238** (0.1223)	-0.1536** (0.00559)
6.	Ac_{3t}	-0.2828* (0.1889)	-1.3216* (0.6488)	-0.1125* (0.2021)
7.	Pc_{2t-1}	-2.011* (1.4088)	-1.490** (0.6488)	0.2613* (0.5219)
8.	Pc_{3t-1}	4.524*** (1.456)	3.3690*** (0.7206)	1.8599*** (0.5654)
9.	Yc_{1t-1}	0.0498 (0.5663)	0.5913 (1.1679)	0.3028 (0.8957)
10.	Yc_{3t-1}	0.8018 (0.6001)	0.5724 (1.015)	0.0596 (0.9346)
11.	S_{fi}	9.012 (12.915)	-10.26 (1.2149)	-13.270* (9.0481)
12.	R2	0.94	0.95	0.91
13.	F Value	19.82***	19.35***	34.44***

Source - Indiastat.com. VSI, Pune, APEDA website, Co-operative Sugar.
(Period I-1970-71-1990-91, Period II-1991-92 to 2010-11, Entire period-1970-71 to 2010-11)
(Figures in parentheses are standard errors of respective regression coefficients
*, **, *** = Significant at 10, 5 and 1per cent level of significance, respectively.

The high significance of R^2 value during period I indicated that the form of acreage response function had given a good fit. The ten variables jointly explained about 94 per cent variation in sugarcane acreage. The lagged price, lagged acreage and lagged yield had negative and significant influence, which indicated that, the lagged price, area and yield have played major role in area allocation decisions of sugarcane growers in Maharashtra State. The pre-sowing

rainfall and lagged groundnut prices were also positively significant. The area of competing crop groundnut and the prices of competing crop cotton showed the desired negative sign and significant coefficient. This indicated that, increase in area under groundnut and last year prices of cotton resulted into reducing the area under sugarcane.

During period II, the coefficient of lagged prices and lagged acreage of sugarcane was found to be negatively significant.

The pre-sowing period rainfall was the strongest variable negatively affecting the current sugarcane area. The lagged prices of groundnut also found to be positively significant. The negative and significant impact of the area of competing crop groundnut and lagged cotton prices on current acreage of sugarcane indicated the competitive behaviour of these crops with acreage of sugarcane in the state during this period. The improvement in cotton price had positively influenced the acreages of cotton and hence resulted into decreased area of sugarcane in the state.

For the entire period, the lagged price of sugarcane had played important role in the acreage allocation decision; regression coefficient of lagged price was found to be negative and significant. The lagged yield and lagged area found to be positive and significant this indicated that, the farmer's in the state had given due weightage to the lagged area, lagged price and lagged yield of sugarcane while making area allocation decision for sugarcane during current year.

The negative impact of the pre-sowing period rainfall on the variations in acreages of sugarcane indicated that favorable moisture conditions have also positive impact on the allocation of area under sugarcane. The negative and significant regression coefficient of acreage under competing crop groundnut indicated that it was sole competitor for sugarcane area allocation. Sale et al. (1989) also pointed out that the relative prices and previous year's area under competing crops were found to be the most important determinants of sugarcane acreage fluctuations for the period of 1959-60 to 1982-83.

From the above we can observe that, for the period I, II and entire period prices have negative and significant impact on sugarcane acreage here we can see that, farmers are price conscious because sugarcane is price incentive crop which get FRP(Fair and remunerative prices)so there is no risk in the sugarcane cultivation.

4.2 Short run and long run elasticity

The price elasticity showed the influence of unit change in price on acreage allocation of the crop. In the present study price elasticity were estimated for short run as well as for long run period and presented in Table no.3

Table 3: Estimation of short run and long run price elasticities of acreage

Region	Periods	SRE	LRE
Maharashtra State	I	0.5137*	0.5309*
	II	0.8427***	0.6181**
	Overall	0.8307***	0.6518***

Note- SRE-Short run elasticities ,LRE-Long run elasticities.
Source - Indiastat.com.VSI, Pune, APEDA website, Co-operative Sugar.
(Period I-1970-71-1990-91, Period II-1991-92 to 2010-11, Entire period-1970-71 to 2010-11)
*,**,*** =Significant at 10, 5 and 1per cent level of significance respectively

The estimates of short-run elasticities for sugarcane were found to be positive and significant during all the periods for Maharashtra state, where as at overall period it was 0.8307 which was highly significant at the 1 per cent level of significance. For the I,IIand overall period, the long run elasticities for Maharashtra state were positive and statistically significant. Thus, the farmers from the Maharashtra state responded positively and significantly indicating their conscious behavior about change in price.

In nutshell, it is concluded that the estimated acreage response functions for sugarcane had shown a sizeable range of total variation, in the area to be planted for sugarcane in current season in Maharashtra. The main factors influencing acreages under sugarcane in the state during 1970-71 to 2010-11 were lagged price of sugarcane, lagged area, pre-sowing period rainfall and area under competing crops. However, these factors influencing the acreage of sugarcane did differ from region to region.

Hence, the hypothesis stating that variations in acreages under sugarcane are governed by lagged price, lagged acreages, yield of sugarcane, seasonal condition and competing crops has been partially proved

4.3 Projections for Sugarcane Production

One of the objectives of the study was to estimate the supply of sugarcane in Maharashtra in 2020, 2025 and 2030 AD. Accordingly, supply for sugarcane has been estimated. Supply of sugarcane has been assumed to be directly dependent upon the magnitude of the changes in area under sugarcane and the yield per hectare. For estimating the supply for sugarcane, acreages under sugarcane were estimated and the same were multiplied by their present and expected yields per hectare. The production being dependent on acreage, the projected production of sugarcane in 2020, 2025 and 2030 A.D. were estimated with the help of supply response function for Maharashtra that was estimated in Table 2.

The function was supply response function for Maharashtra given as below;

$A=-957.09+0.8667^{*}(At\text{-}_1)+30.62(Pt_1)^{***}$ (1.5844)(9.1084)
$+15.779^{*}(Yt\text{-}1)+0.1536^{**}(R_t)$ (15.038) (0.0055)
$-0.1125(Ac_3t)+0.2613^{*}(Pc_2t1)$
(0.2021) (0.5219)
$+1.8599^{***}(Pc3t\text{-}_1)+0.3028(Yc1t\text{-}_1)$ (0.5654) (0.8957)
+0.0596(Yc3t-1)-13.270(Sfi) (0.9346) (9.0481)

With the help of above estimated acreage response function, the projections for future acreage were carried out, supply of sugarcane was estimated, and the same are presented in Table 4.

The area under sugarcane would be 13.69, 16.64and 20.23 lakh hectares during 2020, 2025 and 2030 AD, respectively. The present (2010-11) productivity of sugarcane was about 81.70t/ha and by assuming that the productivity would remain constant during the next two decades, the estimated production of sugarcane in the State would be 1119.04, 1360.17, and 1653.27 lakh tonnes during 2020, 2025 and 2030 AD, respectively.

Table 4: Estimation of supply of Sugarcane in Maharashtra State

Sr.	Year	Area ('000'ha)	Productivity	Production (lakhtonnes)
Situation I (Constant productivity)				
1	2010-11	964.00	81.70	787.58
2	2019-20	1369.70	81.70	1119.04
3	2024-25	1664.84	81.70	1360.17
4	2029-30	2023.69	81.70	1653.27
Situation II (changing productivity @ -0.28% per annum)				
1	2010-11	964.00	81.70	787.58
2	2019-20	1369.70	79.66	1091.10
3	2024-25	1664.84	78.55	1307.73
4	2029-30	2023.69	77.47	1567.47

The supply of sugarcane was also estimated by considering productivity growth rate of -0.28 per cent per annum for next two decades (based on 'r' actually observed during the period of 41 years). The productivity of sugarcane would be 79.66, 78.55 and 77.47 t/ha during 2020, 2025 and 2030 AD, respectively. The estimated production of sugarcane in the state would be 1091.10, 1307.73 and 1567, 47 lakh tonnes during 2020, 2025 and 2030 AD, respectively. Takalkar et al. (2012) also recorded the similar result.

5. Conclusion

Sugarcane had been traditional and relatively more remunerative crop amongst all the non-food and food grains cultivated in the country. The farmers acreage allocation decision were determined by lagged price of sugarcane, rainfall during pre-sowing period and lagged prices of competing crops i.e. groundnut and cotton and area under groundnut in the state. The long-run price elasticities with respect to acreage of sugarcane were found to be positive and significant and indicated that the farmer's were conscious about the price change. The supply of sugarcane in Maharashtra would be decline due to the productivity declined. The acreage response analysis indicated that the price exerted a significant influence on variation in the area under sugarcane. This suggests that the price incentive is important determinant in sugarcane acreages. Hence, a positive price policy in tune with rising trend be continued, so as to increase the supply of sugarcane crop in future too.

6. Future Scope

The study on acreage is helpful to determine the factors, which influences the acreage under crop; it is also helpful to policy makers for proper planning and policy formulating. Therefore, the findings of the study will be useful to the researchers in order to know the past performance, present potentials and future view of sugarcane in Maharashtra. The projections derived from the analysis could also be helpful to determining the probable requirement of sugarcane in future. The study would be useful to the policy makers in planning, formulating and implementing sugarcane development policy in Maharashtra State. The study will be useful to sugarcane growers, sugar factories, exporters and also to the researchers and academicians in carrying out further research.

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