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ANALYSIS OF PRODUCTION FUNCTION IN SUGARCANE CULTIVATION OF TAMIL NADU

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Abstract:

This paper analysis the production function in sugarcane cultivation of Tamil Nadu and uses the Cobb-Douglas production function. The primary data was collected through a questionnaire in 2019. The production function result suggested that the sugarcane cultivation in the Kanchipuram Taluk reported that the coefficient of cost of bullock power influenced positively. In contrast, chemical and fertilisers, seed and irrigation are negative and insignificant. The sugarcane cultivation in Uthiramerur Taluk witnessed the high cost of human labour, seed, and irrigation significantly influenced machine power, influencing the farmers' income.

Introduction:

The sugarcane sector plays a significant role in the Indian economy as it provides the raw material for sugar and industries producing alcohol, paper, chemicals and cattle feed. The sugarcane processing network consisting of 762 installed sugar mills has several associated industries and backward and forward linkages. Due to the multi-million-dollar uses of sugarcane and its by-products in several industries, the demand for sugarcane production is growing. With an area of 5 million hectares, sugarcane cultivation in India is carried out on about 2.57 per cent of the total cropped area. It provides employment and livelihood to 60 lakh sugarcane growers and indirect employment to lakhs of people in associated industries.

There has been a steady growth in the area under sugarcane cultivation in India. The area was only 17.07 lakh hectares in 1950-51; it increased to 51.11 lakh hectares in 2018-19. The production of sugarcane was about 123.86 million tonnes by the mid-seventies, which rose to 400.15 million tonnes in 2018-19. The average productivity was 78.23 tonnes/hectare in that year. Uttar Pradesh is the central sugarcane-growing state in the country, allocating about 22 lakh hectares for cane cultivation, followed by Maharashtra with about 8.98 lakh hectares. Karnataka, Tamil Nadu, Gujarat and Andhra Pradesh are other central cane-growing states in the tropical region. Bihar, Haryana, Uttarakhand and Punjab are the key cane-growing states in the sub-tropical region, besides Uttar Pradesh.[1]

The growth over the years (as depicted by compound growth rates or CGRs) in the all-India sugarcane area and yield was positive and around 1 per cent per year from 2001-02 to 2017-18 period. In Uttar Pradesh, the area growth was less than 1 per cent, but the yield growth was 1.249 per cent. There was positive area and yield growth in Maharashtra, with the area growth being much higher than that obtained in Uttar Pradesh. Andhra Pradesh, Haryana, Punjab, Uttarakhand, Tamil Nadu and Gujarat have recorded a significant negative growth rate in the area under sugarcane. In the sub-tropical region, Bihar exhibited a positive CGR of 7.345% in the area, followed by Maharashtra (4.279%) and Karnataka (3.147%).

Bihar and Uttar Pradesh in the sub-tropical region and Maharashtra and Karnataka in the tropical region have exhibited positive growth in area and yield levels during the past 17 years. This points to further expansion of the sugarcane sector in these states. More incentives and development efforts are required in other states to sustain the achieved levels of area coverage under sugarcane.

Review of Earlier Studies:

Azad (1981)[2] studied the determination of sugarcane price made an emphasis while fixing the statutory prices of sugarcane. The Government should consider the cost of production price relationship of different sugarcane production to gather with the cost of production based on bulk line cost and opportunity cost, and prices of competing for crops and inputs based on parity prices.

Joginder and Joginder (1990)[3] studied the resource use productivity in Punjab agriculture and used a linear Cobb-Douglas production function. They found that the use of fertiliser was the most crucial factor for providing inputs to crop productivity in Punjab. Next to fertilisers, the area under high yielding varieties

1. https://www.tribuneindia.com/news/haryana/sugarcane-farming-labour-productivity-the-key-to-sweet-success-168256
2. Azad, M.P. (1981). Determination of Sugarcane Prices – A Case Study, Indian Journal of Agricultural Economics, 36(1)
3. Joginder, S., and Joginder, S. (1990). Resource use Productivity in Punjab Agriculture, Indian Journal of Agricultural Economics, 35(1), 9-14.

contributed significantly to productivity. Though the input use of the tractor showed a positive sign, the same was not statistically significant.

Ahamed et al. (2001)[4] analysed the stands as a proxy for all inputs taken together. The study considered responsible for the variation in it can be conducted that under spaced transplanting method of sugarcane cultivation variation in farm income. However, cost of production is important only concerning the return obtained from the use of various inputs the sugarcane production 'concerning farms within the expected yield group' and below the expected yield group under the sealed transplanting method yield cost and return is maximum within the expected yield group irrespective of different factors responsible for variations.

Narayanamoorthy (2005)[5] analysed the economics of drip irrigation in sugarcane cultivation: a case study of a farmer from Tamil Nadu. Though the study results suggested that the drip method of irrigation is economically viable even without subsidy in water-intensive crops like sugarcane, one cannot generalise the study's results, as it is the case of one farmer.

Umanath et al. (2020)[6] In this study, a simultaneous equation model is developed to understand the interrelationship between sugar supply and demand in India using time-series data over 44 years from 1970-1971 to 2013-2014. A three-stage least square regression model was used to estimate the elasticities of supply and demand equations of sugar. Results revealed that the price of sugar affected sugar supply positive relationship with sugar production. Changes in current year area harvested, yield and FRP determine the future area under sugarcane cultivation. Rainfall and technology have supported to increase in the yield. Sugar consumption has a direct relationship with the population rate. These results suggest that technological development, external trade and appropriate sugar policy measures are the primary choice to resolve the sugar complexities in future.

Thomas Felix et al. (2021)[7] results of parameter estimates confirmed that area in a hectare, total fertiliser usage in kilograms and own irrigation machine hours have higher positive production elasticity of sugarcane. The dummy coefficients for farm size reveal that medium and large sugarcane farms are less efficient than small farms. Similarly, the share of own machine-hours has a negative impact on sugarcane production.

Thus, it is evident that most of the earlier studies were conducted at the national level. However, very few studies are available in sugarcane cultivation using production function analysis in general and Taluk level analysis. Therefore, to fill this gap, the present study applies the Cobb-Douglas production function model to study the determinants of sugarcane cultivation in Kanchipuram and Uthiramerur Taluks Kanchipuram Districts in Tamil Nadu.

Data and Methodology:

Data:

Sugarcane cultivation is spread across Tamil Nadu. The Kanchipuram district has contributed significantly to this area under sugarcane cultivation in Tamil Nadu, and it has been purposively selected for this study. The areas under sugarcane cultivation of 13 taluks in the Kanchipuram district has been taken for this study. After selecting the district, the areas were listed under two systems of irrigation. Under the first system, the fields are primarily irrigated by Palar, Cheyyar, Vegavathi Rivers, while under the second system, they are irrigated by the lake, wells and borewells. In the first system, the farmers prepared lands ready for sugarcane cultivation throughout the years.

Hence, farmers who have adequate irrigation facilities plant sugarcane throughout the years. It was found that sugarcane was cultivated in all taluks with varying proportions. Considering the area under sugarcane cultivation, the taluk, which covered 25 per cent of the area under sugarcane, was again purposively selected in each system. They are Kanchipuram taluk in the first system and Uthiramerur taluk in the second system. The sugarcane cultivators were stratified into three size groups based on operational holdings viz from each select taluks. Small, Medium, and Large. From each size group, fifty per cent of farmers were selected at random, giving 300 farmers in all the select taluks. The primary data was collected through a questionnaire in the year 2019.

Methodology:

Functional Analysis:

4. Ahamed, S., Khanam, F., Hossin, A. K. M., & Rahman, S. (2001). Studies on variation in yield, cost and return of sugarcane under the spaced transplanting method and factors responsible for the variations in Bangladesh. Economic Affairs (Calcutta), 46(4), 201.
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7. Thomas Felix, K., Naveen Kumar, P., and Arivarasan, S. (2021). An economic approach to improve the productivity of sugarcane - a stochastic frontier approach, Wesleyan Journal of Research, 14(01), 461-471.

To analyse the resource use-efficiency in the production of Sugarcane Cobb-Douglas, the production function of the following type has been used.

The function in log form is represented as:

$$\ln Y_i = \ln \beta_0 + \beta_1 \ln HL + \beta_2 \ln MP + \beta_3 \ln BP + \beta_4 \ln SD + \beta_5 \ln NPK + \beta_6 \ln IR + e^u$$

Where,

Y = Income of Sugarcane cultivation in Rupees
HL = Human Labour
MP = Machine Power
BP = Bullock Power
SD = Seed
NPK = Chemical and Fertilizers
IR = Irrigation
u = Disturbance term (Error Variable)

α is a constant and β_1, β_2, β_3,……, β_4, are regression coefficients.

Result and Discussions:

Production Function Analysis of Sugarcane Cultivation in Small, Medium and Large Farmers Kanchipuram Taluk of Tamil Nadu:

Table 1: OLS Estimates of the Production Function of Sugarcane Cultivation in Kanchipuram District of Tamil Nadu

Variable	Kancipuram Taluk				Uthiramerur Taluk			
	Small Farmers	**Medium Farmers**	**Large Farmers**	**All Farmers**	**Small Farmers**	**Medium Farmers**	**Large Farmers**	**All Farmers**
Const.	4.085*	2.792*	2.058*	3.264*	2.981*	0.557	3.267***	2.061*
	(17.94)	(6.88)	(4.26)	(16.13)	(4.19)	(0.65)	(2.03)	(8.76)
ln HL	0.705*	0.790*	0.684*	0.718*	0.559*	0.815*	0.409	0.600*
	(11.01)	(27.67)	(4.63)	(13.41)	(5.96)	(8.10)	(1.54)	(9.63)
ln BP	-0.026	-0.003	-0.005	0.042	0.024	-0.096	0.267***	-0.034
	(-1.31)	(-0.22)	(-0.27)	(1.67)	(0.26)	(-1.66)	(1.90)	(-0.73)
ln MP	0.049	-0.035	-0.019	0.197*	-0.108	0.220	0.700	0.056
	(1.57)	(-1.07)	(-0.31)	(4.18)	(-0.76)	(1.61)	(0.80)	(0.64)
ln NPK	-0.031	0.003	0.013	-0.019	-0.176	-0.039	0.346	-0.141*
	(-0.51)	(0.05)	(0.32)	(-0.37)	(-0.85)	(-0.56)	(0.42)	(-2.42)
ln SD	0.117*	0.086*	0.244	-0.035	0.601*	-0.031	0.147	0.463*
	(3.99)	(4.88)	(1.53)	(-1.16)	(3.53)	(-0.19)	(0.14)	(4.67)
ln IRI	-0.051	0.032***	0.085	-0.048	0.040	0.236*	-0.912	0.082**
	(-1.53)	(1.71)	(0.86)	(-1.30)	(0.73)	(2.63)	(-1.33)	(1.97)
R^2	**0.98**	**0.98**	**0.97**	**0.97**	**0.79**	**0.86**	**0.95**	**0.96**
F-Value	**347.77***	**393.59***	**261.89***	**780.72***	**47.33***	**43.67***	**38.35***	**623.57***
Total Farmers	**47**	**77**	**26**	**150**	**83**	**48**	**19**	**150**

Notes: (1) The values in parentheses below the coefficients show the t-statistics.
(2) *, **, *** show the 1 per cent 5 per cent, 10 per cent level of significance respectively.
Source: Primary Survey through questionnaire collected in the year 2019.

Kancipuram Taluk:

Small Farmers in Kancipuram Taluk:

The value of R^2 was 0.98 under the small farmers in the irrigated (or river) Kanchipuram Taluk, which indicated 98 per cent variations in sugarcane cultivation. In the small farmers in Kanchipuram, human labour and seed costs significantly contribute to sugarcane cultivation income. The coefficient of machine power is positively influenced, whereas bullock power, irrigation, and chemical and fertiliser are influenced negatively. Furthermore, the sugarcane cultivation of small farmers in Kanchipuram Taluk witnessed a high cost of seed and human labour and machine power, which also influenced the farmers' income.

Medium Farmers in Kancipuram Taluk

The value of R^2 was 0.98 under the medium farmers in the irrigated Kanchipuram Taluk, which indicated 98 per cent variations in sugarcane cultivation. In the medium farmers in Kanchipuram, the cost of human labour, seed and irrigation has significantly contributed to the income of sugarcane cultivation. The coefficient of bullock power and machine power costs is insignificantly negative in the sample farmers. The cost of chemicals and fertilisers are positively influenced. Further, the sugarcane cultivation of medium farmers in Kanchipuram Taluk witnessed a high cost of human labour, seed and irrigation, and chemical and fertilisers also

influenced the farmers' income.

Large Farmers in Kancipuram Taluk:

The value of R^2 was 0.97 under the large farmers in the irrigated Kanchipuram Taluk, which indicated 97 per cent variations in sugarcane cultivation. In the large farmers in Kanchipuram Taluk, the cost of human labour has significantly contributed to the income of sugarcane cultivation. The coefficient of bullock power and machine power is insignificantly negative. The cost of chemical and fertiliser, seed, irrigation is influenced positively. Furthermore, it is indicated that the sugarcane cultivation of large farmers in Kanchipuram Taluk witnessed the high cost of human labour and chemical and fertilisers, seed, and irrigation also influenced the farmers' income.

All Farmers in Kancipuram Taluk:

The value of R^2 was 0.97 under all farmers in the irrigated Kanchipuram Taluk, which indicated 97 per cent variations in sugarcane cultivation. In all farmers in Kanchipuram Taluk, the cost of human labour and machine power has significantly contributed to the income of sugarcane cultivation. The coefficient of seed, chemical and fertilisers and irrigation is negative and insignificant. The cost of bullock power influenced positively. Further, it shows that the sugarcane cultivation of all farmers in Kanchipuram witnessed a high cost of human labour and machine power, and bullock power also influenced the farmers' income.

Production Function Analysis of Sugarcane Cultivation in Small, Medium and Large Farmers Uthiramerur:

Small Farmers in Uthiramerur Taluk:

The value of R^2 was 0.79 under the small farmers in the unirrigated (or lake) Uthiramerur Taluk, which indicated 79 per cent variations in sugarcane cultivation. For the small farmers in Uthiramerur Taluk, the cost of human labour and seed has significantly contributed to the income of sugarcane cultivation. The coefficient of machine power and chemical and fertilisers is insignificantly negative. The cost of bullock labour and irrigations are influenced positively. Further, it is inferred that the sugarcane cultivation of small farmers in Uthiramerur Taluk witnessed a high cost of human labour. Seed and bullock power and irrigation also influenced the farmers' income.

Medium Farmers in Uthiramerur Taluk:

The value of R^2 was 0.86 under the medium farmers in the unirrigated Uthiramerur Taluk, which indicated 86 per cent variations in sugarcane cultivation. In the medium farmers in Uthiramerur Taluk, the cost of human labour and irrigation has significantly contributed to the income of sugarcane cultivation. The coefficient of bullock power, seed and chemical and fertiliser costs has been insignificantly negative in the sample farmers. The cost of machine power is positively influenced though insignificant. Furthermore, it is indicated that the sugarcane cultivation of medium farmers in Uthiramerur Taluk witnessed a high cost of human labour and irrigation and machine power also influenced the farmers' income.

Large Farmers in Uthiramerur Taluk:

The value of R^2 was 0.95 under the large farmers in the unirrigated Uthiramerur Taluk, which indicated 95 per cent variations in sugarcane cultivation. In the large farmers in Uthiramerur Taluk, the cost of bullock power has significantly contributed to the income of sugarcane cultivation. The coefficient of irrigation is insignificant negative. In human labour, machine power, chemical and fertilisers and seed influenced positively. Furthermore, it is indicated that the sugarcane cultivation of large farmers in Uthiramerur Taluk witnessed the high cost of bullock power and human labour, machine power chemical and fertilisers and seed influenced the farmers' income. In other words, irrigation costs are lower when compared to small and medium farmers.

All Farmers in Uthiramerur Taluk:

The value of R^2 was 0.96 under all farmers in the unirrigated Uthiramerur Taluk, which indicated 96 per cent variations in sugarcane cultivation. In all farmers in Uthiramerur Taluk, the cost of human labour, seed and irrigation has significantly contributed to the income of sugarcane cultivation. The coefficient of bullock power and chemical and fertilisers is negative and chemical, and fertilisers are influenced significantly at 1 per cent level. The cost of machine power influenced positively. Furthermore, it reveals that the sugarcane cultivation of all farmers in Uthiramerur Taluk witnessed the high cost of human labour, seed and irrigation, and machine power also influenced the farmers' income.

Conclusion:

The production function results (OLS estimation) suggest that the sugarcane cultivation in the Kanchipuram Taluk reported that the coefficient of chemical and fertilisers, seed and irrigation is negative and insignificant. In the cost of the bullock, power influenced positively. Further, the sugarcane cultivation of all farmers in Kanchipuram Taluk witnessed the high cost of human labour and machine power are influenced significantly at 1 per cent level, and bullock power influenced insignificantly to the farmers' income.

In Uthiramerur Taluk, the coefficient of bullock power contributes insignificantly negatively, and chemical and fertilisers are negatively significant at 1 per cent level. The cost of machine power is influenced positively. Further, it is evident that the sugarcane cultivation of all farmers in Uthiramerur Taluk witnessed the

high cost of human labour, seed, and irrigation significantly influenced machine power, which influenced insignificantly to the income of the farmers.

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