An Economic Efficiency of Sugarcane Cultivation in Erode District of Tamilnadu

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Abstract

The main goals of the study are to find out about the social and economic backgrounds of the sample farmers and to look at how well sugarcane production works economically in the Erode district. A multistage random sampling procedure was used to construct the sample structure for the study's objectives. The Erode district has ten taluks in the first stage, with Sathyamangalam Taluk being picked expressly for its sugarcane-growing potential. Similarly, in the second stage, Sathyamangalam Taluk has 38 revenue villages, of which 5 revenue villages were picked at random. Finally, 150 sugarcane cultivators were picked at random during the 2021–22 agricultural year. The socio-economic variables were analysed with a simple percentage analysis. The stochastic frontier production function has been used to estimate technological efficiency. The study concluded that the cost of labour, fertiliser, seeds, and machine hours were expensive in the area. By using these inputs more effectively, sugarcane production in the research area can be more efficient. Farmers, the government, and research organisations must work together to produce sugar cane efficiently in the region. Farmers must boost sugarcane production, and the government must provide participatory extension services. The government could also make agriculture inputs available on schedule and at lower prices. Research institutes should improve sugarcane types to boost agricultural output quickly.

Keywords: Sugarcane, Efficiency, Stochastic Frontier Production Function, DIRTI-5

1. Introduction

Sugarcane is an important commercial crop of the world and is cultivated in more than 100 countries, the leading countries being Brazil, India, China, Thailand, Pakistan, Mexico and Colombia. The botanical name of sugarcane is *Saccharum officinarum* and for sugar beet, it is Beat *Vulgare*. Both tropical and arctic regions grow sugarcane. It is the second-most significant commercial crop in India and is grown on roughly 5 million hectares, producing about 27 million metric tonnes of sugar, 40 million direct and indirect jobs for farmers, and 3-5 lakh jobs for skilled and unskilled labourers in the production of sugar, gur, and Khandasari. Despite only taking up 2% of the country's total cultivable land, sugarcane production accounts for 7% of the value of all agricultural crops produced there. Additionally, the country's area dedicated to sugarcane farming has increased from 1.18 million hectares (1930–1931) to 5 million hectares (2010–2011), while cane production has increased from 37 million tonnes to 340 million tonnes, with an average productivity of 628.10 quintals per hectare over the same time period.

One of the biggest sugarcane-producing states in India is Tamil Nadu, which contributed 6.41 percent of the country's sugarcane and produced 8.32 percent of the country's sugarcane in 2011–12. Tamil Nadu contributes over 7% of the nation's total sugar production, making it one of the nation's top producersy's sugarcane and produced 8.32 percent of the country's sugarcane in 2011–12. Tamil Nadu contributes over 7% of the nation's total sugar production, making it one of the nation's top producers. As of 31.5.2011, Tamil Nadu had 46 sugar mills, of which 16 were cooperative, 3 were public, and 27 were private. The remaining two mills, Madura Sugars and Arunachalam Sugar Mills Ltd., are not operating at the moment, leaving 44 sugar mills in operation. This suggests that the success of this crop enterprise has a significant impact on both the economy of the farmers and the prosperity of the state. In Tamil Nadu nowadays, sugarcane growing is increasingly becoming commercialised. Securing a reasonable margin between the cost and selling price of his produce is the commercial farmer's first priority. In order to justify continuing to operate, a farm enterprise must generate a net profit that exceeds its total cost. Therefore, it is essential for farmers to be aware of their production expenses. From one region to another, as well as from one group of farmers to another, sugarcane production costs and returns differ. An effort in this direction can be seen in the research, "Economic Efficiency in Sugarcane Production in Sathyamangalam Taluk of Erode District in Tamil Nadu: An Economic Analysis."

2. Review of literature

Elizabeth Ebukiba (2010) researched the economics of cassava farming in the Akwa Ibom state of Nigeria's local government. According to the findings, there is a need to improve resource allocation for farmers in the research region, which might be accomplished through effective resource allocation training and education for farmers to achieve the desired optimality. Tirlapur et al. (2015) evaluated resource use efficiency in the major cultivating crops of the Dharwad district. Chickpea cultivators, according to the research, overused machine hours, seed, plant protection agents, and fertilisers while underusing farmyard manure and human labor. They concluded that inefficient and inefficient resource utilisation was the root cause of the agriculture sector's slow growth. Sowjanya et al. (2016) evaluated the resource efficiency and commercialization of Redgram. The MVP-to-MFC ratio was found to be positive, indicating that these resources were underutilised. Because in order to attain the best results, resources should be used more efficiently. Redgram Manufacturing's logical zone predicts decreasing returns to scale. Akerele EO. et al. (2018) conducted research in the Yewa North Local Government Area of Ogun State, Nigeria. According to the study, cassava farming is generally advantageous regardless of farm size, yet the farmer's gender, household size, and level of education have a significant positive impact on their production. As a result, the government should develop a sufficient number of credit institutions that are well-equipped and motivated to support small farmers by making loans available to them. Ragavi et al. (2019) sought to conduct an economic analysis of tapioca costs and profitability per hectare, as well as the rate of return, in the Namakkal district of Tamil Nadu. According to the study, tapioca output increased considerably as a result of increased productivity and yields. Tapioca resource utilisation differs by size group. The cost of producing tapioca varies according to the size of the land. Small farms had the highest tapioca expenses per hectare, whereas large farms had the lowest. Tapioca producers of varied sizes had varying production costs. Large farms use the most inputs, whereas small farms use the least. Sood et al. (2020) evaluated the performance of pulse growth in Rajasthan. According to the data, there was a positive trend in the area under pulse cultivation, and expanding the area enhanced the output of moong bean, chickpea, and urd bean in the research zone. Saravanan, A. (2022), has found that insight into long-term productivity improvement approaches that do not require more resources. Given that education has a considerable impact on technical efficiency, efforts should be made to popularise both formal and informal education among farmers in the area.

3. Objective

The main goals of the study are to find out about the social and economic backgrounds of the sample farmers and to look at how well sugarcane production works economically in the Erode district.

4. Methodology

4.1. Sample Design and selection of data

The study was conducted in the Sathyamangalam Taluk of Erode district. A multistage random sampling procedure was used to construct the sample structure for the study's objectives. The Erode district has ten taluks in the first stage, with Sathyamangalam Taluk being picked expressly for its sugarcane-growing potential. Similarly, in the second stage, Sathyamangalam Taluk has 38 revenue villages, of which 5 revenue villages were picked at random. In the third step, 150 sugarcane cultivators were picked at random during the 2020–21 agricultural year. As a result, 150 farmers were chosen as part of the overall sample size from five villages in the Sathyamangalam taluk of Erode district.

4.2. Analytical Methodology

The socio-economic variables were analysed with a simple percentage analysis. In recent years, the Stochastic Frontier Production Function (Aigner) has been the most prevalent approach for estimating technological efficiency. The stochastic frontier (Bhende and Kalirajan) has been represented using a two-component composite error term. An asymmetric component allows for random fluctuation in the frontier across businesses, capturing the effects of measurement error, statistical noise, and random shocks outside the farm's control. Firm-specific impacts like slackness in output owing to labour shirking, which is under the control of the businesses and influences their degree of technical efficiency, are captured by a one-sided component. The empirical model utilised for analysis in this study is divided into two parts. The first stage involves estimating farm-specific technical efficiency ratings using a stochastic production function of the following type:

$\ln (Yi) = Xi\, \alpha + Vi - Ui$ -- (1)

Where Y is the dependent variable (output) and Xi are the independent variables viz., area under crop, seed, family labour, hired labour, machine hours, chemical fertiliser and pesticide cost. In this model, the dependent variable is bounded by the stochastic variable, Vi – Ui. The random error, Vi can be positive or negative and so the stochastic outputs vary about the deterministic part of the frontier model.

Vi is the symmetric random error term distributed independently and identically [N (o, σ_v^2)] and captures errors beyond the farmers' control. Ui is the one-sided production, distributed independently and identified with a non-negative truncation of the normal distribution [N (o, σ_v^2)]. If the farm is inefficient (efficient), the actual output produced is less than (or equal to) the potential output. Therefore, the ratios of actual output and potential ouput can be treated as a measure of technical efficiency. Using the above equation I, the technical efficiency (TE) of the i^{th} farm is derived as: $TE_i = \exp(-Ui)$

The technical efficiency of the i-th farmer ($TE_i = \mu_i$) is derived from the density function of u and v, which can be written as

$F_u (u) = 1/ \sqrt{} ½*\pi).\ 1/ \sigma_u .\ \exp.[-u^2/2\ \sigma_u^2]$ for $u \leq 0$ -----------------------------(2)

= 0 otherwise

$F_v (v) = 1/ \sqrt{} ½*\pi).\ 1/ \sigma_v .\ \exp.[-v^2/2\ \sigma_v^2]$ for $- \infty \leq u \leq \infty$ -------------------- (2a)

The density function of y is the joint density function of (u+v) and is given by

$F_v (y) = \pi .1/ \sqrt{} ½*\pi) .\ 1/\sigma .\ \exp.\ \{(u+v)^2 / 2\ \sigma^2 \}$.

$1- f\{((u+v) / \sigma) (\gamma/ 1+ \gamma))]$ --- (3)

Where,

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ --- (4)

$\gamma = \sigma_u^2 / \sigma^2 , 0 \leq \gamma \leq 1$ -- (4a)

Finally, γ is given by

$\sigma^{ui} = - \sigma_u \sigma_v / \sigma [\{\varphi (.\ )/1-\varphi (.) \}-\{((u+v)/\sigma) \sqrt{} (\gamma /1- \gamma))]$ ----------------------- (5)

where φ (.) and φ (.) are standard density and distribution functions, respectively. The variables specified for estimation of Technical Efficiency for the individual farms and crops based on Cobb-Douglas type was;

y = Crop output (sugarcane/in quintal/acre)

X1 = Area under crop (in acres)

X2 = Seed cost (in RS)

X3 = Man-days of labour (male + female) per acre.
X4 = Machine hour cost in rupees per acre
X5 = Quantity of inorganic fertiliser used per acre in kg
X6 = Cost of organic fertiliser used (in rupees per acre).

4.3. Determinants of Technical Efficiency

As crop output is influenced by factors such as rainfall, disease and pest incidence, soil fertility, and other socio-economic factors, the following type of simple linear regression technique was used to identify the factors that influence the technical efficiency of the selected farmer households. The frontier's technical efficiency scores are regressed on the independent variables as follows;

$TE_{ij} = \boldsymbol{\alpha} + \boldsymbol{\alpha}_1 (X_1) + \boldsymbol{\alpha}_2 (X_2) + \boldsymbol{\alpha}_3 (X_3) + \boldsymbol{\alpha}_4 (X_4) + e_i$

Where,
TE_{ij} = level of technical efficiency estimated through MLE
X_1 = Farm size
X_2 = Family Size
X_3 = Age
X_4 = Educational status
$\boldsymbol{\alpha}_1 \ldots\ldots\ldots \boldsymbol{\alpha}_4$ = regression co-efficients
e_i = error term
$\boldsymbol{\alpha}$ = constant

5. Results and Discussion

5.1. Socio-Economic Characteristics of the Sample Farmer Households

This section focuses on the socioeconomic characteristics of the selected sample of sugarcane farmer households in Erode District's Sathyamangalam Taluk. Table 1 shows the major socioeconomic characteristics chosen for investigation in the study.

Table 1: The Socio Economic Characteristics of sample Famers

Socio-Economic Characteristics		**N**	**%**
Type of family	Nuclear	104	69.33
	Joint	46	30.67
	Total	150	100.00
Family Size Group	Below 2	31	20.67
	2 – 4	75	50.00
	Above 4	44	29.33
	Total	150	100.00
Age group	Below 40	44	29.33
	40 – 60	68	45.33
	Above 60	38	25.33
	Total	150	100.00
Family Monthly Income	Below Rs.15000	56	37.33
	Rs.15000 – Rs.30000	58	38.67
	Above Rs.30000	36	24.00

	Total	150	100.00
Educational status	Illiterate	34	22.67
	Primary Level	39	26.00
	Secondary Level	61	40.67
	Higher Secondary & above level	16	10.67
	Total	150	100.00

Source: Survey data

Table 4.1 shows that most of the 150 sugarcane farmer households included in the study belonged to nuclear families; their family size was 2-4 individuals; their age ranged from 40 to 60 years, and they had a small family monthly income Rs. 15,000 to Rs. 30,000. The farmers' educational attainment was limited to a secondary level.

4.2. Estimated Cost and Returns of Sugarcane Cultivation

The estimated cost and returns of sugarcane cultivation pertaining to the different farms level data collected from the sample farmers of ten villages in Sathyamangalam taluk of Erode District is furnished from table-4.2.

Table-4.2: Estimated Cost and Return of Sugarcane Cultivation (Per Acre) in Sathyamangalam taluk of Erode District

Variables	**Cost in Rs.**	**Percent**
Average area under Sugarcane crop in acre	4.45	
Cost on Seed	6274.85	15.88
Imputed Cost on Family Labour	5103.83	12.92
Cost on Hired Labour	16014.48	40.53
Cost on Machine hours	5759.70	14.58
Cost on Chemical Fertilizer	5735.28	14.51
Cost on Pesticide	625.73	1.58
Total Variable Cost (TVC)	39513.87	100.00
DIRTI-5	1158.03	
Total Cost (TC)	40671.90	
Total Return (TR)	75992.80	
Net Return (TR-TC)	35320.90	
Return over Variable Cost (TR-TVC)	36478.93	
N	150	

Source: Survey Data

From the table-4.2 showed that the cost and return particulars of the selected sample sugarcane cultivating farmers of Sathyamangalam taluk in Erode District. The average sugarcane cultivating farmers in the area spent 15.88 percent, 12.92 percent, 40.53 percent, 14.58 percent, 14.51 percent, and 1.58 percent respectively on cost of seed, family labour, hired labour, machine hours used, chemical fertilizer and pest management; and received a net revenue of Rs. 35320.90/- per acre.

5.2. Resource Use Efficiency of Sugarcane production

5.2.1. Average Production Function

The output elasticities with regard to the primary inputs in the production of sugarcane in Sathyamangalam Taluk of Erode District in Tamil Nadu were estimated using the Cobb-Douglas Production Function utilizing the Ordinary Least Square (OLS) technique. Table 3 shows the output elasticities for sugarcane based on OLS estimates of the Cobb-Douglas production function.

Table–3: OLS Estimates of the Production Function for Sugarcane Cultivation

Variables	Co-efficient	t	Sig.
Intercept	5.212	2.725	0.008
Area under crop	0.426*	3.051	0.001
Seed	0.136**	2.216	0.023
Labour	0.291***	1.509	0.062
Machine Hours used	0.391*	2.764	0.004
Inorganic Fertilizer	0.017	0.228	0.721
Cost on Organic Components	0.122	0.699	0.339
R	0.815		
R^2	0.738		
Adjusted R^2	0.730		
F	113.233*		0.000
N	150		

Source: Survey Data.

Table 3 clearly shows that the computed regression coefficients of the components relevant to the data on Sathyamangalam Taluk explained a significant fraction of the variability in sugarcane output, as measured by the R2 of 0.738 for Sathyamangalam Taluk. The anticipated production elasticities for crop area, seed consumption, labour consumption, and machine hours consumed were 0.426, 0.136, 0.291, and 0.391, respectively, and were statistically significant at the 1%, 5%, and 10% levels.

5.2.2. Technical Efficiency

The technical efficiency of sugarcane production was examined by fitting a Stochastic Frontier Production Function to selected farms involved in sugarcane production from the Sathyamangalam Taluk. The MLE estimates for sugarcane in the Erode District's Sathyamangalam Taluk are shown in Table 4.

Table–4: Estimated Parameters of the Stochastic Frontier Production Function for Sugarcane Cultivation

Variables	β	t	Sig.
Intercept	9.018	3.442	0.003
Area under crop	0.291**	2.667	0.017
Seed	0.256*	5.299	0.000
Labour	0.214*	4.380	0.001

Machine Hours used	0.162***	1.988	0.075
Inorganic Fertilizer	0.130	0.663	0.509
Cost on Organic Components	0.153	1.462	0.637
σ_v	0.145		
σ_u	0.285		
σ^2	0.104		
σ_v^2	0.021		
σ_u^2	0.081		
γ	0.787		
Log Likelihood	75.1347		
N	150		

Source: Survey Data

Based on sample farm-level data from Sathyamangalam Taluk, maximum likelihood estimates of the stochastic frontier production show that four input variables, like area under sugarcane crop, seed, labour, and machine hours used, were registered with a priori signs and statistically significant at 1%, 5%, and 10% levels. In other words, the sugarcane production elasticities were computed as 0.291, 0.256, 0.214, and 0.162 for the area under crop, seed, labour, and machine hours, respectively. Despite the fact that inorganic fertiliser use and the cost of organic fertiliser had a positive effect on sugarcane productivity, the results were not statistically significant. The values of u2 and v2 were calculated to be 0.081 and 0.021, respectively. A high score for the frequency of severe inefficiencies in the sugarcane output of farmers in the Sathyamangalam Taluk indicated the prevalence of severe inefficiencies in sugarcane production (0.787). In other words, the inefficient use of resources under the control of the area's sample farmers accounted for 79 percent of the difference between observed and border production among farms.

4.2.2. Efficiency Scores

Maximum likelihood estimations of the frontier production function were used to determine the magnitude of farm-level inefficiencies identified for sugarcane-growing farmers in Sathyamangalam Taluk. Table 5 depicts the frequency distribution of expected technological efficiencies for sugarcane farming sample farmers in the Erode District.

Table–5: Technical Efficiency by Farm Size Groups for Sugarcane Cultivation

Levels of Technical Efficiency (Per cent)	**N**	**Percent**
<75	32	21.33
75-85	63	42.00
>85	55	36.67
N	150	100
Mean TE	.7912	

Source: Primary data

Table 5 shows that the average level of technical efficiency was 79 percent. It was also discovered that 21.33% of the farmers in the area were less than 75% efficient, 42.00 % were 75–85 % efficient, and 36.67 % were more than 85 % efficient.Farms' average technological efficiency was determined to be 0.7912.

5.2.4. Determinants of Technical Efficiency

The efficiency scores generated by the frontier model were regressed on the variables viz., Farm Size, Family Size, Age and Education as furnished in table-6.

Table–6: Determinants of Technical Efficiency

Variables	B	**t**	**Sig.**
Intercept	0.635	12.898	0.000
Farm size	0.142**	3.4651	0.018
Family Size	0.136*	2.658	0.004
Age	0.178**	3.287	0.009
Educational status	0.123**	2.632	0.027
R^2	0.718		
Adj R^2	0.699		
N	150		

Source: Survey Data

The model described the variation in technical efficiency on the sample farms in terms of R2, which ranged from 72 percent for sugarcane farmers. As expected, all of the variables show positive signals. Sugarcane farming technical efficiency in taluk was significantly associated with farm size, family size, age, and education, and all of the coefficients were statistically significant at the 1% and 5% levels. Because having a large family raises sugarcane production efficiency, it is logical to believe that age influences technical efficiency.

6. Conclusion

This study found that sugarcane farmers in Erode District's Sathyamangalam taluk were inefficient in using farm resources. This may be due to expensive labour, fertiliser, seeds, and machine hours. By using these inputs more effectively, sugarcane production in the research area can be more efficient. Farmers, the government, and research organisations must work together to produce sugar cane efficiently in the region. Farmers must boost sugarcane production, and the government must provide participatory extension services. The government could also make agriculture inputs available on schedule and at lower prices. Research institutes should improve sugarcane types to boost agricultural output quickly.

7. References

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