Indian J. Applied & Pure Bio. Vol. 38(2), 895-900 (2023). **ISSN: 0970-2091**
A web of Science Journal

Technical efficiency of Sesame farms in Kallakurichi District of Tamil Nadu – A frontier production function approach

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Abstract

Sesame is the important oilseeds and also very popular crop among the rural farmers. The current research was conducted to analyse the efficiency of sesame farmers in the study area with the following specific objectives: i) To examine the production efficiency of sesame farms in the study area and ii) To suggest the policy recommendations based on the study's findings. In Tamil Nadu, the Kallakurichi district was selected purposively, then the two top-ranking blocks were selected based on the Sesame area. Afterwards, five top-ranking villages were selected from the selected block and by using probability proportionate sampling, the 120 sample farmers were selected and totally 240 sample famers were selected for the study. Then, the data were analyzed using the stochastic production frontier approach to determine the factors that influence the technical efficiency of sesame farmers in the study area by using R Studio 4.2.2 and Maximum Likelihood test was carried out to test the hypothesis of full technical efficiency. The results showed that the sesame cultivation was found to be technically inefficient and the study recommends to enhance the role of government for educating farmers.

Key words : Technical Efficiency, Stochastic Production Frontier, MLE.

Sesame is one of the important oilseeds and also very popular crop among the rural farmers. It is very drought-tolerant so it called as survivor crop, with an ability to grow where most crops fail. It plays an important role in India as well as global market for its seed and oil. In Tamil Nadu, the maximum area under sesame was in Kallakurichi District (5,915 ha) followed by Thanjavur (5,842 ha) and Erode (4,034 ha). The current research was conducted to analyse the efficiency of sesame farmers in the Kallakurichi District of Tamilnadu with the following specific objectives: i) To examine the production

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efficiency of sesame farms in the study area and ii) To suggest the policy recommendations based on the study's findings. For the preparation of the manuscript relevant literature[1-4] has been consulted.

Sampling :

In Tamil Nadu, Kallakurichi district was selected purposively based on the highest rank in the area and production of sesame crop. From the district, two top-level blocks namely Tirukoilur block and Ulundurpet block were chosen taking into consideration of the concentration of area under Sesame. According to acreage under Sesame cultivation, five top-ranking villages were selected from the selected blocks. From the villages, based on Probability proportionate sampling, sample farmers were selected and in total 120 sample famers from each block and 240 sample farmers for the district were selected for the study.

Tools of analysis:
Technical efficiency :

The Econometric model using the stochastic production frontier approach to determine the factors that influence the technical efficiency of sesame farmers in the study area were analysed by using R Studio 4.2.2. Also, a Maximum Likelihood test was carried out to test the hypothesis of full technical efficiency.

The technical efficiency is defined in terms of observed output (Y_i) to the corresponding frontier output (Y*) using the available technology derived which is defined as follows:

$$TE_i = \frac{Y^*}{Y_i} = \frac{E(^{Y_i}/_{u_i X_i})}{E(^{Y_i}/_{u_i=0, X_i})}$$

$$= E[exp^{(-U_i)}/_{c_i}]$$

The parameter of the stochastic frontier production function is estimated using the Maximum Likelihood Estimation method and the specified sesame production function is given as follows,

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + V_i\text{-}U_i.$$

Where,
ln denotes logarithms to base e,
Y = Yield (in kgs /ac)
X_1 = Seed (Rs. /ac)
X_2 = Organic manures (Rs. /ac)
X_3 = Fertilizer (Rs. /ac)
X_4 = Human Labour (Rs. /ac)
X_5 = Machine Labour (Rs. /ac)
X_6 = Plant Protection Chemicals (Rs. /ac)
β_0 = Intercept
β_0-β_6= Coefficient of independent variable X_1-X_6
v_i = random error team which is assumed to be independent and normally distributed as N $(0, \delta^2)$
u_i = Technical inefficiency which is assumed to be independent and a truncated normal distribution at zero with mean μ_i and variance δ_u^2 , N (μ_i, δ_u^2).

Technical efficiency of Sesame farmers:

The technical efficiency of sesame farmers was worked out by using stochastic frontier analysis.

Table-1. Descriptive statistics of variables for irrigated and rainfed Sesame farmers

S. No.	Variables	Sample Mean		Standard Deviation		Minimum Value		Maximum Value	
		Irrigated (Tiruk-oilur)	Rainfed (Ulund-urpet)	Irrigated (Tiruk-oilur)	Rainfed (Ulun-durpet)	Irrigated (Tiruk-oilur)	Rainfed (Ulund-urpet)	Irrigated (Tiruk-oilur)	Rainfed (Ulund-urpet)
1.	Yield of Sesame (in kgs per acre)	431.00	73.14	103.45	15.41	250.00	35.00	645.00	75.00
2.	Seed (Rs. /acre)	592.61	305.92	227.19	102.91	145.00	130.00	1400.00	900.00
3.	Organic manures (Rs. /acre)	1491.53	1028.97	136.07	25.97	1145.00	1000.00	1745.00	1095.00
4.	Fertilizer (Rs. /acre)	2726.12	1174.94	181.11	267.87	2370.00	835.00	3250.00	3000.00
5.	Human Labour (Rs. /acre)	4898.56	2770.52	980.17	535.73	3375.00	1880.00	7260.00	6550.00
6.	Machine labour (Rs. /acre)	4469.10	2842.21	327.26	183.14	3800.00	2540.00	543.00	3400.00
7.	Plant Protection Chemicals (Rs. /acre)	1298.57	1082.95	173.96	47.02	1025.00	1010.00	1870.00	1350.00

1) Descriptive statistics of variables :

The production function for this study was estimated using six input variables. The descriptive analysis of variables of the production function for the Tirukoilur and Ulundurpet blocks were estimated and the results are presented in Table-1.

It could be observed from the table that the mean sample yield of irrigated sesame (431.00 kgs per acre) in the Tirukoilur block was higher than the rainfed sesame (73.14 kgs per acre) in the Ulundurpet block. Similarly, the use of seed was also higher in the Tirukoilur block than in the Ulundurpet block and also the use of other inputs viz., organic manures, fertilizers, human labour, machine labour and plant protection chemicals were higher in the Tirukoilur block than in the Ulundurpet block. The comparative statistics of irrigated sesame in the Tirukoilur block and rainfed sesame in the Ulundurpet block revealed that usage of all productive inputs was higher in the irrigated sesame than rainfed sesame. Hence, the average yield was higher in the Tirukoilur block than in the Ulundurpet block.

2) MLE estimators of Stochastic frontier function for irrigated and rainfed sesame cultivation :

The Maximum likelihood estimates of the Cobb – Douglas model for the irrigated and rainfed sesame farmers in Tirukoilur and Ulundurpet blocks by using stochastic frontier production functions are given in Table-2.

Table-2. MLE estimators of Stochastic frontier function for irrigated and rainfed Sesame farmers

S. No.	Variables	Para-meters	Coefficient		Standard Error		T Value	
			Irrigated (Tiruko-ilur)	Rainfed (Ulund-urpet)	Irrigated (Tiruko-ilur)	Rainfed (Ulund-urpet)	Irrigated (Tiruko-ilur)	Rainfed (Ulund urpet)
A.	Frontier Production Function							
1.	Intercept	β_0	2.1336	3.2205	3.6529	6.0473	0.5841	0.5326
2.	Seed (Rs. /acre)	β_1	0.7159*	0.6096**	0.3286	0.2102	2.1786	2.9000
3.	Organic manures (Rs. /acre)	β_2	0.0345	0.7886**	0.1118	0.2861	0.3086	2.7564
4.	Fertilizer (Rs. /acre)	β_3	0.6505**	0.3532	0.2914	0.3195	2.2323	1.1054
5.	Human labour (Rs. /acre)	β_4	0.7721**	0.2695*	0.2519	0.1313	3.0651	2.0526
6.	Machine labour (Rs. /acre)	β_5	-0.1616	0.0723	0.3513	0.0649	-0.4600	1.1140
7.	Plant protection chemicals (Rs. /acre)	β_6	0.0660	-0.1053NS	0.0595	0.4068	1.1092	-0.0949
B.	Diagnosis statistics							
8.	Sigma- square	σ^2	0.8080	0.9038				
9.	Gamma	Γ	0.6112	0.8924				
10.	Log-likelihood		10.71	20.28				
11.	LR		0.3164	0.4992				
12.	Mean technical efficiency		0.84	0.79				
13.	Number of observations		120	120				

(*significant at 1%, **significant at 5% and NS - Non-significant)

In the Irrigated sesame of Tirukoilur block, the estimated coefficient of seed was positive and significant at one per cent with a value of 0.7159, implying that a one per cent increase in the expenditure on seed would increase the irrigated sesame yield by 0.71 per cent. Similarly for the Rainfed sesame of Ulundurpet block, the estimated coefficient of Human labour was positive and significant at one per cent with a value of 0.2695, implying that a one per cent increase in the expenditure on Human labour would increase the rainfed sesame yield by 0.27 per cent respectively.

For the Irrigated sesame, the estimated coefficient of fertilizers and human labour was positive and significant at five per cent with the values 0.6505 and 0.7721, which implied that a one per cent increase in the usage of fertilizers and human labour increased the yield by 0.65 and 0.77 per cent in the Tirukoilur block. Similarly, for the rainfed sesame, the estimated coefficient of Seed and organic manures were positive and significant at five per cent with a value of 0.6096 and 0.7886, which implied that a one per cent increase in the usage of Seed and organic manures increased the yield by 0.61 and 0.79 per cent in the Ulundurpet block.

The variance parameters for γ and δ^2 were 0.6112 and 0.8080 for the irrigated sesame in the Tirukoilur block and the rainfed sesame were 0.8924 and 0.9038 in the

Table-3. Distribution of technical efficiencies in irrigated and rainfed Sesame farmers

Technical Efficiency	Irrigated Sesame (Tirukoilur Block)		Rainfed Sesame (Ulundurpet Block)	
	No. of farmers	Per cent	No. of farmers	Percent
90 - 100	28	23.33	29	24.17
80 - 89	47	39.17	31	25.83
70 - 79	26	21.67	28	23.33
60 - 69	15	12.50	23	19.17
50 - 59	4	3.33	9	7.50
Total	120	100.00	120	100.00

Ulundurpet block. The sigma squared indicated that the goodness fit and correctness of the distribution form assumed for the composite error team while the gamma indicated that the systematic influence was unexplained by the production. The gamma value was high in the Ulundurpet block than in the Tirukoilur block.

The estimated mean technical efficiency (MTE) for irrigated and rainfed sesame was estimated at 84 per cent and 79 per cent indicating that output can be raised by 16 per cent and 21 per cent through efficient crop management practices without actually increasing the level of application of inputs. This revealed that technical inefficiency was attributed as a major reason for lesser productivity in the Ulundurpet block compared to the Tirukoilur block. These values indicated that the difference between observed output and frontier output was due to the technical inefficiency of farms and not due to statistical variability.

Frequency distribution of farmers according to Technical efficiency :

The frequency distribution of sample farmers according to a different technical efficiency rating of Irrigated and Rainfed Sesame Farmers was arranged and the results are presented in Table-3.

It could be observed from the table that the farmers were falling under the range of technical efficiency between 80 - 89 was higher with 39.17 per cent in irrigated sesame and 25.83 per cent in rainfed sesame of Tirukoilur and Ulundurpet blocks respectively followed by the technical efficiency ranging between 90 - 100, with 23.33 per cent in the Ulundurpet block and 24.17 in the Tirukoilur block.

The farmers were falling in the low range between 50 - 59 was high in rainfed sesame (7.50 per cent) when compared to irrigated sesame (3.33 per cent). Hence, it could be understood that the technical efficiency has to be improved a lot in the irrigated and rainfed sesame farms of the Tirukoilur and Ulundurpet blocks respectively.

The results of the technical efficiency showed that the sesame cultivation was found to be profitable and also well technically

efficient, but have opportunity for increasing their efficiency by 16 per cent and 21 per cent for irrigated and rainfed area. The study recommends that to enhance the role of government for educating farmers on new technologies because the sesame farmers did not realize their full production potential and also, they need for sustained improvements on performances.

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