ENERGY USE PATTERN AND ITS EFFICIENCY IN PADDY CULTIVATION IN TAMIL NADU, INDIA

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Abstract

The aim of this study was to analyze the socio-economic characteristics of paddy farmers of different farm sizes in Kancheepuram District, Tamil Nadu. It also sought to examine their resource usage patterns and assess the technical efficiencies at the farm level in paddy production. The research was carried out in Kancheepuram District and focused on 150 paddy farmer households from five different villages within the district. The study utilized a straightforward proportion and the Cobb-Douglas type stochastic production frontier function model to draw its conclusions. The study's findings are significant for policy-making as they provide efficiency indicators to guide farm production planning and identify areas for improving crop production across various farming systems based on efficiency. They also offer insights into long-term techniques for boosting production without the need for additional resources. Moreover, the findings emphasize the importance of providing both formal and informal education to farmers in the region, as education significantly impacts their ability to utilize technology effectively.

Keywords: Cost & Returns, Technical Efficiency, OLS, Stochastic Frontier Function

1. Introduction

All countries continue to place a strong emphasis on research pertaining to the technical, allocative, and economic aspects of efficiency measurement. Measurement of efficiency is important for the simple reason that it is one of the factors that contributes to an increase in productivity. This is particularly true in developing agricultural economies, where resources are scarce and opportunities for developing and implementing improved technologies are limited (Ali and Chaudhry, 1990). These studies aid these economies by identifying the potential increase in productivity through the enhancement of an underutilized resource, namely efficiency, while leveraging existing resources and technology. As a result, they may assist in determining whether it would be more advantageous to begin by enhancing effectiveness or to swiftly develop a new technology. Numerous studies have explored the correlation between farm size and output in Indian agriculture since the late 1950s. The literature pervasively views traditional farmers as "poor but efficient" and consequently emphasizes increased investments in developing new and more productive techniques. Since the 1960s, scholars have considered regional differences, input-output linkages, and the roles of enterprises (Saini, 1969; Sahota, 1968; Hopper, 1965; Saravanan, 2016).

The goal of this research was to evaluate, recommend, and develop suitable productive strategies that lead to greater resource efficiency. Because they put the production processes of the sample farms on a certain input-output space (production function) using a certain technology, they couldn't tell the difference between inefficiencies caused by the biological nature of farming and differences in how each farm used the technology available. This resulted in their inability to distinguish between causes of inefficiency stemming from the biological aspects of agricultural production and farm-specific variations in the utilization of available technology. Indian agriculture has conducted efficiency assessments since the 1970s, despite conceptual issues and analytical differences. Indeed, the latter two estimate relative technical efficiency using a shadow profit function. Some of the most notable examples of available research are the studies conducted by Shanmugam and Palanisami (1993) in the state of Tamil Nadu, Datt and Joshi (1992) in the state of Uttar Pradesh, and Jayaram et al. (1987) in the state of Karnataka. These studies found that paddy fields in the different states had a mean technical efficiency of 75 percent, 66 percent, and 74 percent, respectively, despite being based on deterministic or probabilistic estimations of the frontier production function. Even though these estimates were based on the frontier production function, this is still the case.

However, despite the widespread use of efficiency measures in Indian rice farms, only a handful of these studies have examined the same thing across size groups and agro-ecological regions (zones) at the same time. Despite India's widespread use of efficiency measures, this situation persists. Furthermore, research on the long-standing issue of efficiency gaps between small and large farms has yielded little consensus. In a similar vein, the Kancheepuram district's agricultural industry has been the subject of other research projects. Within the scope of these studies, the research on agricultural production constitutes only a small portion. Empirical investigations are required to determine the resource utilization efficiency of input components in inter-size crop models. Because of this, conducting an empirical and scientific investigative examination of the resource use efficiency of input elements in the rural economy of the kanchipuram district is a significant phenomenon. From an economic standpoint, this study tries to figure out how much technical efficiency there is in paddy production in the kanchipuram District of Tamil Nadu.

2. The Problems

India's post-independence agriculture economy has grown since the mid-1960s. The most notable advances are new HYV seeds, improved irrigation, modern inputs like fertilizer, herbicides, and insecticides, tractors, pump sets, and other crop production technology. Organisational and institutional mechanisms for production, input composition, and distribution of all inputs are another beneficial component of the Indian agricultural system. This is a big improvement. Over the past 20 years, agricultural production has increased primarily due to greater infrastructure use and higher output per acre. This made India's food grain self-sufficient. Technological advances, farmer perspectives on modern inputs, the availability of extension services, and the productivity network effect are the causes of these events. Not all crops, farms, or areas. It has increased regional inequality and distributed advantages unevenly among different-sized farming groups. Agricultural regions with diverse crops have responded to technical and economic developments in different ways, which explains this growth disparity. Agriculture specialists and government officials are interested in a country's agricultural infrastructure because it faces many challenges. In the country's cropping system, modern farms must overcome technological challenges and meet efficiency criteria, two fiercely debated concerns. Due to rising populations and affluence, agricultural products are in high demand, forcing farmers to increase crop yields through better technology and resource management. Due to the trend of diverting agricultural land to non-agricultural uses, farmers can only increase crop production by adopting newer, more advanced technology and using resources more efficiently. Regional agro-climatic variables, technology, and input use have an impact on agricultural production and productivity. This is because cropland has a direct impact on agricultural output. Inefficient resource use can lead to a yield gap. At a time when macro-policy is changing due to India's economic liberalisation, it is crucial to study differences in farm-level yields for a given technology and farmer resource endowment across regions to better understand the productivity gap. A recent study provided an economic analysis of paddy production's technological efficiency in Kancheepuram, Tamil Nadu. This moves in the same direction.

3. Objectives

The study's goals were to find out about the social and economic traits of farmers who grow paddy, look at how farmers of different farm sizes use resources, and find out how technically efficient farms are at growing paddy in Kancheepuram District in Tamil Nadu.

4. Materials and Methods

The study was conducted in Kancheepuram Taluk, which is part of the Kancheepuram district. A multistage random sampling procedure was used to create the sample structure for the study's objectives. The Kancheepuram district has five taluks, and Kancheepuram Taluk was specifically chosen due to its paddy-growing potential. During the second stage, five revenue villages were picked at random from Kancheepuram Taluk. In the third stage, 150 paddy growers were randomly selected during the 2022–23 agricultural year. Totally, 150 farmers from five villages in the Kancheepuram taluk of Kancheepuram district were chosen as part of the overall sample size.

An elementary percentage analysis was utilised in order to ascertain the socioeconomic characteristics as well as the costs and returns associated with paddy cultivation for the farmers that made up the sample group that was chosen. The Stochastic Frontier Production Function, which was developed by Aigner DJ, Lovell CAK, and Schmidt (1997), has become the most widely used method for assessing the effectiveness of technical advancements in recent years. A two-component composite error term has been utilised in order to provide a representation of the stochastic frontier (Bhende and Kalirajan, 2007). A symmetric component allows for random fluctuations between enterprises, which captures the effects of measurement error, statistical noise, and unpredictable shocks that are not under the control of the farms. One-sided components capture firm-specific influences, such as slackness in output due to labour shirking, which are within the control of the firms and influence the degree to which they are technically efficient. One-sided components are also used to measure the degree of technical efficiency. In this particular investigation, the empirical model that served as the basis for the research was split into two sections. In the first step, a stochastic production function of the following type is used to estimate farm-specific technical efficiency ratings:

$$\ln (Y_i) = X_i \alpha + V_i - U_i \quad \text{--} \quad (1)$$

Where Y represents the dependent variable (output), and Xi represents the independent factors, such as the area under crop, the seed, the amount of family labour, the amount of hired labour, the number of machine hours, the cost of chemical fertiliser and pesticide, etc. Within the context of this paradigm, the dependent variable is constrained by the stochastic variable represented by the notation Vi-Ui. Because the random error, Vi, can take either a positive or a negative value, the stochastic outputs can take on a variety of different values with respect to the deterministic component of the frontier model. Vi is the symmetric random error term that is distributed independently and identically [N (o, v2)] and it takes into account errors that are outside the control of the farmers. Ui is the one-sided production, which is distributed independently and may be identified with a non-negative truncation of the normal distribution [N (o, v2)]. If the farm is inefficient, then the actual output produced is lower than (or equal to) the potential output. If the farm is efficient, then the actual output produced is higher than the potential output. As a result, the ratio of actual output to potential output can be regarded as a measure of the efficiency of the technology. By applying the first equation from the previous paragraph, the technical efficiency (TE) of the farm can be calculated as follows: TEi = exp (Ui) The technical efficiency of the ith farmer, denoted by the symbol TEi = I, is calculated using the density function of u and v, which may be expressed as

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

= 0 otherwise

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

$\gamma = \sigma_u^2 / \sigma^2,\ 0 \le \gamma \le 1$ -- (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 = output of paddy (in quintal / acre)
X_1 = seed rate in kg/acre
X_2 = Area under crop (in acres)
X_3 = Family labour (male + female) man-days/acre.
X_4 = Hired labour used in man-days/acre
X_5 = Cost on machine hours used in Rs. / acre
X_6 = Quantity of chemical fertilizer used in kg/acre
X_7 = Cost on pesticide components (in Rs./acre)

4.3. Determinants of Technical Efficiency

A simple linear regression technique of the following type was used to identify the factors that influence the technical efficiency of the selected farmer households. Because crop output is conditioned by factors such as rainfall, incidence of disease and pest, soil fertility, and other socio-economic factors, this technique was used to identify the factors that influence the technical efficiency of the selected farmer households. Saravanan (2016) says that the frontier's scores of technical efficiency are regressed on the independent variables in the following ways:

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

Where,

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

5. Results and Discussion

The research breaks down its findings into three main categories: (i) the socio-economic characteristics of the sample paddy farmers; (ii) the estimated costs and returns of paddy cultivation; and (iii) the technical efficiency of paddy production in Kancheepuram District.

5.1. Socio-Economic Characteristics of the Sample Farmer Households

This section is focused mostly on the investigation of the socio-economic features of the paddy cultivating farmer households that were chosen at random from Kancheepuram taluk of the Kancheepuram District. The study selected important socio-economic characteristics such as family type, size, age, educational status, and monthly income for analysis. We used the post-stratification method to compare these characteristics between sampled paddy farmer households of different farm size groups.

Table-1: Socio-Economic Characteristics of the Sample Farmer Households

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
Farm Size in acres	Marginal farmer (<2.5 acres)	39	26.00
	Small farmer (2.5-5.0 acres)	47	31.33
	Medium farmer (5.0-7.5 acres)	36	24.00
	Large farmer (Above 7.5 acres)	28	18.67
	Total	150	100.00

Source: Calculated value

The majority of the 150 sample Paddy farmer households selected for the research were members of nuclear families; the size of their families ranged from two to four people; the farmers' ages ranged from forty to sixty years; and the farmers' families had a modest family income that ranged from fifteen thousand to thirty thousand rupees each month. Secondary school was the highest level of education any of the farmers had.

5.2. Estimated Cost and Returns of Paddy Cultivation

Based on the information collected at the farm level from the sample farmers in Kancheepuram District, Table-2 provides facts regarding the expected costs and revenues associated with paddy production.

Table-2: Estimated Cost and Revenue Particulars of Paddy Cultivation

Cost / Revenue particulars	Farm Size in acres				Total
	Marginal farmer (<2.5)	Small farmer (2.5-5.0)	Medium farmer (5.0-7.5)	Large farmer (Above 7.5)	
Average area under crop in acres	1.22	2.96	5.89	10.11	6.73
Cost of Seed	556	418	381	430	359
	(3.90)	(4.07)	(4.06)	(5.31)	(4.85)
Cost of Family Labour	7273	4306	3164	2100	2411
	(50.97)	(41.94)	(33.69)	(25.93)	(32.58)
Cost of Hired Labour	2562	2102	2552	2634	2054
	(17.96)	(20.48)	(27.17)	(32.53)	(27.76)
Cost of Machine hours	1488	1323	1353	1307	1161
	(10.43)	(12.89)	(14.41)	(16.14)	(15.69)
Cost of Chemical Fertilizer	1314	1405	1286	1201	981
	(9.21)	(13.69)	(13.69)	(14.83)	(13.26)
Cost of Pesticide in Rs.	1075	712	655	426	434
	(7.53)	(6.94)	(6.97)	(5.26)	(5.86)
Total Variable Cost (TVC)	14268.00	10266.00	9391.00	8098.00	7400.00
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
DIRTI-5	3510	3600	3710	4210	3710
Total Cost (TC)	17778.00	13866.00	13101.00	12308.00	11110.00
Total Revenue (TR)	12730	11369	14162	12851	11430
Net Revenue (TR-TC)	-5048.00	-2497.00	1061.00	543.00	320.00
Revenue over total Variable cost (TR-TVC)	-1538.00	1103.00	4771.00	4753.00	4030.00
Sample observations (in No's)	39	47	36	28	150

Source: Calculated value

(Figures in parentheses indicate percentage)

Table 2 displays the particulars of the costs and revenues incurred by paddy cultivating farmers in Kancheepuram District. These farmers were chosen at random. We determined that the average farm size for marginal farmers was 1.22 acres, for small farmers it was 2.96 acres, for medium farmers it was 5.89 acres, and for larger farmers it was 10.11 acres. Upon considering all the various farm sizes, we determined an average farm size of 6.73 acres. The economics of paddy production in the region were determined by a number of essential factors, including the amount of land devoted to paddy, the cost of seed, the cost of family labour, the cost of hired labour, the cost of machine hours used, the cost of chemical fertiliser, and the cost of pesticide. Family labour costs (imputed) should account for 32.58 percent of total costs for the average paddy producer in the region, with paid labour coming in second (27.76 percent). To put it another way, growing paddy is a job that requires a significant amount of human labour and is highly dependent on this factor. It's conceivable that the larger number of family labourers is due to their excessive reliance on farm operations as well as a lack of available or affordable hired labour in the area. Both of these factors contribute to a high level of family labor. The cost of machine hours used for cultivation, which included modern agricultural machinery in crop production, accounts for 15.69 percent of the total cost. The cost of chemical fertiliser and pesticides are two more important key inputs that have a direct impact on crop productivity.

In other words, a typical farmer cultivating 2.5 acres of paddy spent 9.21 percent of his total expenditure on chemical fertilizer. Farms larger than 7.5 acres, on the other hand, spent 14.83 percent of their total expenditure on chemical fertilizer. This demonstrates that large farmers are required to spend more on fertiliser, whereas smaller farmers are not. When it came to the expense of using pesticides, farms that were smaller than 2.5 acres were responsible for a higher proportion of the cost, whereas businesses that were larger than 2.5 acres were responsible for a smaller proportion of the cost. To put it another way, as the farm's size increased, the proportion of fertilizer expenditures increased, whereas the proportion of pesticide prices declined. We calculated the net revenue for various size groups of high-yield variety paddy farms in the area, which tended to increase with farm size up to 7.5 acres; however, farms larger than 7.5 acres showed a marginal reduction in revenue. This was because larger farms required more labor to cultivate their land. The lower net revenue for farms that are less than 5 acres could be due to a number of factors, including the higher usage of family labour and pesticides in comparison to other farms, as well as the higher authorised capital cost. However, with the exception of the group that farmed 2.5 acres, every other farm had favourable chances in terms of return in comparison to variable costs. To sum up, the average paddy farmer in the area only made Rs.320 net per acre, even though he or she spent 4.85%, 32.76%, 15.69%, 13.26%, 5.86%, and 5.86%, respectively, on seed, family labour, hired labour, machine hours, chemical fertilizer, and pest control.

5.3. Farm level Technical Efficiency in Paddy Production

Prior to the discussion on the technical efficiency of farm groups, Table 3 offers an overview of the input and output characteristics of chosen farmer families of varying sizes in the Kancheepuram District.

Table-3: Average Levels of Input Use and Output per Acre by Farm Size Group

Particulars	**Farm Size in acres**				
	Marginal farmer (<2.5)	**Small farmer (2.5-5.0)**	**Medium farmer (5.0-7.5)**	**Large farmer (Above 7.5)**	**All**
Area under crop (in acres)	1.22	2.96	5.89	10.11	6.73
Seed (in kg)	41	30	29	32	27

Family labour (man-days)	74	76	52	52	59
Hired labour (man-days)	27	30	31	31	31
Machine hours	11	19	13	13	12
Chemicals fertilizer (in kg)	188	193	201	199	175
Pesticide components (in Rs.)	1075	913	897	911	844
Production (quintals)	19	19	20	18	17
Sample size (N)	39	47	36	28	150

Source: Calculated value

According to the data presented in Table 3, the typical size of paddy farms in the Kancheepuram canal region ranges from 1.22 acres for farms owned by marginal farmers to 2.96 acres for farms owned by small farmers, 5.89 acres for farms owned by medium farmers, and 10.11 acres for farms owned by larger farmers. After combining all farm groups, we determined that the average size of a paddy-growing farm in the region is 6.73 acres. Because the use of family labour seemed to be an important factor in agricultural productivity, in particular for smaller and medium-sized farms, the percentage of family labour used by each category of farm was calculated separately. We took this action because family labour appears to be critical to agricultural productivity. For agricultural output, each farm in the Kancheepuram canal area used 74 days, 76 days, 52 days, and 52 days of family labour, respectively. This demonstrated that family labour was the primary source of agricultural production for all farm sizes in the region. In the area surrounding the Kancheepuram canal, a typical paddy-cultivating farmer employed 59 family members' days of labour to cultivate one acre of land, encompassing all farm size categories. Smaller farms in the region continue to function as family farms due to the fact that they require more family labour per acre of paddy cultivation than larger farms. Consequently, the Kancheepuram region primarily lacks the economic viability of crop production on small farms. We discovered that large paddy farmers had a lower rate of family participation in the labour force compared to small farmers. The table indicates that they used a lot of contracted labour, which may explain why. In other words, the area showed a decrease in the use of family labour per acre for paddy cultivation as farm size increased, while the area saw an increase in the use of hired abor. This was revealed to be the case when comparing family labor with hired labor. The study determined that Kancheepuram's paddy cultivation required an average of 12 machine hours per acre from the time of ploughing to harvesting. Despite small differences in farm size groupings, this determination held true. As farm size increased, the region observed an increase in the quantity of nitrogen, phosphorus, and potassium (NPK) compounded fertilizer applied per acre. To put it another way, a typical farmer used 175 kilogrammes of NPK compounded fertiliser on each acre of paddy that he cultivated. We determined that small farmers in the region incurred a higher share of costs for pesticide components. However, there was a trend for these costs to decrease as farms expanded. Medium-sized farmers in the region produced the highest paddy output per unit of paddy on paddy-producing land.

The purpose of this study was to attempt to estimate the average output response to changes in inputs at the current technological stage. We conducted this before comparing the technical efficiency levels achieved by the sample farms. Researchers in Kancheepuram District, Tamil Nadu, were able to estimate the output elasticities with respect to the primary inputs in paddy production using the Cobb-Douglas Production Function and the Ordinary Least Square (OLS) technique. Researchers employed the Cobb-Douglas Production Function for this task. Table 4 displays the output elasticities for paddy. We calculated these elasticities using OLS estimations of the Cobb-Douglas production function.

Table-4: Ordinary Least Square (OLS) Estimates of the Production Function for Paddy

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Intercept	6.310	1.010	.273	6.249	.000
Area under crop	8.374**	4.323	.607	1.937	.054
Seed	7.002*	1.480	.274	4.730	.000
Family labour	2.589*	.824	.179	3.142	.002
Hired labour	1.110*	.359	.120	3.093	.002
Machine hours used	1.045	.649	.054	1.611	.108
Chemical fertilizer	4.916*	.809	.291	6.075	.000
Cost on Pesticide Components	.669	.733	.045	.913	.362
R^2	0.894				
F	251.034				
N	150				

Source: Calculated value
* Significant at 1% level ** Significant at 5 % level Significant at 10% level

Table 4 displays the estimated regression coefficients of the variables related to the data from the Kancheepuram taluk. These variables clearly explain a large part of the variation in paddy yield. The R2 value of 0.894 for the Kancheepuram taluk of Kancheepuram District in Tamil Nadu was determined. The area under crop, seed, family labour, hired labour, and chemical fertiliser used each had respective output elasticities of 8.374, 7.002, 2.589, and 1.110, 4.916, respectively. These results were statistically significant at both the 1 percent and the 5 percent levels. We conducted an analysis of the technical efficiency of paddy production by applying a stochastic frontier production function to selected farms in the Kancheepuram taluk of the Kancheepuram District in Tamil Nadu. We calculated the maximum likelihood estimate (MLE) for paddy in the Kancheepuram District's Kancheepuram taluk and compared the results.

Table-5: Estimated Parameters of the Stochastic Frontier Production Function for paddy Cultivation

Variables	Co-efficient	't'	Sig.
Intercept	5.370	2.388	0.018
Area under crop	0.551**	2.528	0.013
Seed	0.122***	1.696	0.092
Family labour	0.099*	2.666	0.009
Hired labour	0.479**	2.331	0.021

Machine hours	0.006	0.181	0.857
Chemical fertilizer	0.917*	9.732	0.000
Pesticide components	0.041	0.814	0.417
σ^2	0.096		
σ_u^2	0.074		
σ_v^2	0.022		
γ	0.780		
log likelihood	13.305		
N	150		

Source: Calculated value
* Significant at 1% level ** Significant at 5 % level Significant at 10% level

The estimated regression coefficients of the variables related to the data in Table 5 clearly show that these variables explained a large part of the variation in paddy yield, as shown by the R2 value of 0.894 for the Kancheepuram District in Tamil Nadu. The areas under crop, seed, family labour, hired labour, and chemical fertiliser used each had output elasticities of 8.374, 7.002, 2.589, and 1.110, respectively, and were statistically significant at the 1 percent and 5 percent levels. We determined the technical efficiency of paddy production by applying a stochastic frontier production function to selected farms in the Kancheepuram District of Tamil Nadu that participated in paddy output. Table 6 presents the results of the Maximum Likelihood Estimation (MLE) for paddy. These results are from Kancheepuram District.

Table-6: Level of Technical Efficiency by Farm Groups for Paddy

Levels of Technical Efficiency (percent)	Farm size group				Total
	Marginal farmer (<2.5)	Small farmer (2.5-5.0)	Medium farmer (5.0-7.5)	Large farmer (Above 7.5)	
<60	3	3	6	3	15
	(7.69)	(6.38)	(16.67)	(10.71)	(10.00)
60-70	2	6	4	6	18
	(5.13)	(12.77)	(11.11)	(21.43)	(12.00)
70-80	15	17	15	8	55
	(38.46)	(36.17)	(41.67)	(28.57)	(36.67)
80-90	16	20	10	8	54
	(41.03)	(42.55)	(27.78)	(28.57)	(36.00)
>90	3	1	1	3	8
	(7.69)	(2.13)	(2.78)	(10.71)	(5.33)
Mean TE	0.78	0.81	0.85	0.83	0.81
N	39	47	36	28	150

Source: Calculated value
(Figures in parentheses indicate percentage)

Table 6 reveals an average technical efficiency of 81 percent for the farms. This means that adhering to better crop management practices can increase paddy output by 10% without

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increasing the level of input application. We also discovered that ten percent of the farmers in the region had efficiency levels below sixty percent, twelve percent had efficiency levels between sixty and seventy percent, thirty-six point seven percent had efficiency levels between eighty and ninety percent, and five point three percent had efficiency levels between ninety and one hundred percent. The study determined that the mean technical efficiency levels for marginal farmers, small farmers, medium farmers, and big farmers were, respectively, 0.78, 0.81, 0.85, and 0.83, with medium farmers demonstrating a higher level of efficiency than the other groups. It's possible that this is due to the fact that the authors' observation of the ideal farm size falls under this category.

Table 7 displays the regression of the frontier model's efficiency scores on the variables education level, farm size, age, and family size.

Table-7: Determinants of Technical Efficiency among Farms

Variables	Paddy	t	Sig.
Intercept	7.659	4.646	0.000
Farm size	0.880*	4.141	0.000
Age	0.322*	4.734	0.000
Education	0.706*	4.817	0.000
Family size	0.159*	3.835	0.000
R^2	0.996		
N	150		

Source: Calculated value * Significant at 5% level

In terms of R2, the model explained the 73% technical efficiency level among paddy-growing farmer households on the sample rice fields. As expected, all of the variables are displaying encouraging results. There was a positive correlation between the size of the farm, the farmer's age, the farmer's education level, the number of people living in the family in Kancheepuram taluk, and the technical efficiency of paddy cultivation. Each of the coefficients was statistically significant. The presence of an educated adult in the family enhances the efficiency of paddy output, implying that the size of the farm influences technical efficiency to some extent.

6. Conclusions

According to the research findings, input variables such as crop acreage, seed, family labor, hired labor, and chemical fertilizer all have positive influences on the level of technical efficiency achieved at the farm level. The average degree of technical efficiency across the several farm groups in the area under study ranged from 0.78 to 0.85, with 0.81 being the overall mean value. The size of the farm, the age of the farmers, the number of years they had spent in school, and the number of people living in each household were the factors that had a significant impact on the technical efficiency of paddy production.

7. Recommendations

The study's findings suggest that we should implement a policy at the farm level to motivate extension workers to work harder and provide essential farm management training to rural farm households, thereby boosting agricultural output. In order to enhance the utilisation of credit programmes for rice farmers, it is crucial to adopt a participatory approach in the development and implementation of these programmes, involving all relevant stakeholders.

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