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Technical Efficiency Of Paddy Farming Under Major Irrigation Conditions In The Dry-Zone Of Sri Lanka: A Parametric Approach

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Abstract: Available literature suggests that paddy farmers in the developing countries fail to exploit the full potential of a technology and make allocative errors. Thus, increasing the efficiency in paddy production assumes greater significance in attaining potential output at the farm level. However it is an undeniable fact that the majority of dry zone paddy farmers are characterized by poor economic status due to inefficient utilization of available resources. This paper investigates the technical efficiency of rice farming in a major irrigation schemes in Sri Lanka and to suggest some policy recommendation for improving the efficiency of resource use in paddy industry under major irrigation conditions. The experiment site was a Nagadeepa reservoir in Mahiyanganaya. The empirical study was carried based on a sample of 357 paddy farmers under Nagadeepa reservoir. In this study, the technical efficiency of paddy farmers was estimated by using stochastic frontier production function, incorporating technical efficiency effect model. The Traslog production function was found to be an adequate representation of the data. According to the results obtained from the stochastic frontier estimation, the average technical efficiency of selected farmers given by the Traslog model is 72.80 per cent. This indicates that there is scope of farther increasing the output by 27.2 percent without increasing the level of input.

Key words: Paddy Farming, Irrigation, Technical and Managerial Efficiency, Frontier Production Function.

INTRODUCTION

Irrigation is the backbone in Sri Lankan rural economy. Because, 25% of cultivable land and two million farmer families (65% of rural households) are engaging in paddy farming as their main occupation. Highly water-intensive rice cultivation consumes more than 70 percent of the total water allocated for food production in the country (Henegedara, 2002). According to policy makers' irrigation is one of the most important strategic factors in the development of rural sector and it is playing a central a role in poverty alleviation (Hussain & Hanjra, 2004). Hence, economically efficient way of water utilization has become a major challenge in irrigation during last decades.

Sri Lankan irrigation schemes are divided into major, medium and minor on the basis of land extent (command area) by these schemes (Thiruchelvan, 2009 , 9-11 June). Major irrigation schemes are defined those as that have a command area of more than 1,000 ha, while systems between 80 and 1,000 ha are considered to be medium irrigation schemes. Minor irrigation schemes are those with a command area of 80ha or less. The principle irrigated crop, paddy is grown on nearly 730,000 ha of land, and 389,000 ha of this total is grown under major irrigation schemes and 170,000 ha of this total grown under medium and minor irrigation schemes (Department of Agriculture iin Sri Lanka, 2011). Remaining 171,000 ha, which is non-irrigable paddy land sown by small scale paddy farmers under rain fed.

1.1 Literature review and Conceptualization:

In view of the growing competition in world rice market and high production costs, production efficiency will become an important determinant of the future paddy industry in Sri Lanka. Developing and adopting new production technologies could improve production efficiency. In addition the industry could maintain its economic viability by improving the efficiency of existing operation with a given technology. In other words, the industry's total output can be increased without increasing the total cost by making better use of available inputs and technology.

Available literature suggests that farmers in developing countries fail to exploit the full potential of technology and make allocative errors (Taylor and Shonkwiler, 1986; Ali and Flinn, 1989; Kalirajan and Shand,

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1989; Bravo-Ureta and Evenson, 1994; Shanmugan and Palanisami, 1994; Sharma and Datta, 1997; Thomas and Sudaresan, 2000, IWMI, 2002; and IPRI, 2010). Most researches and studies have been discussing the technical inefficiency of irrigated paddy farming around the world. However, in Sri Lanka very little empirical efforts have been made to measure the technical efficiency and has assessed the focal factors on this technical efficiency in irrigated paddy farming.

Efficiency of a production unit is defined as how effectively used available resources for the purpose of profit maximization at given technology, available fixed factor and factor prices (Sadoulet & Janvy, 1995). In 1957 M.J Farrell defined efficiency with three conventional economic concepts such as: technical efficiency, allocative efficiency and economic efficiency. According to Farrell (1957) "*Technical efficiency is defined as the ability to archive a higher level of output given similar level of inputs. Allocative efficiency deals with the extent to which farmers make efficient decisions by using inputs up to the level of which their marginal contribution to production value is equal to the factor costs and technical and allocative efficiencies are component of economic efficiency"* This definition is considered as traditional radial efficiency measures by recent literature (Briec, Cavaignac, & Kerstens, 2010). This radial input efficiency measure is the inverse of the input distance function that itself is dual to cost function (Shephard, 1970).

Technical efficiency on an individual decision making unit is defined in terms of the ratio of the observed output to the corresponding frontier output, conditioned on the level of inputs used by the firm (Russel, 1985). A firm is said to be technically efficient if a firm is producing the maximum output from a minimum quantity of inputs (Ziechang, 1984). Technical efficiency is a necessary condition for allocative efficiency and allocative efficiency is a necessary condition for optimal allocation of resources. Generally, technical efficiency is defined as the ratio of the observed output to the corresponding frontier output, conditional on the levels of inputs used by that firm.

1.2 Background of the Problem:

About one-third of the world's food supply is produced on 250 million hectares of irrigated land or less than one-fifth of the total cultivated area (Stewart & Nielsen, 1990). In developing countries, where two-thirds of farmers depend on irrigation and 50% of additional output during the last four decades produced by irrigated land (Barrow, 1991). However, over the past decades public investment in major, medium and minor irrigation systems has not yielded the expected results and the solution to the growing water crisis lies in the institutional reform of existing social system so as to manage the demand for water (Thiruchelvan, 2009 , 9-11 June). Although irrigation has enhanced agricultural production, most large scale systems have not generated the result expected by project planners, causing a decline in public funding for irrigation projects in recent year (Plusquellec, McPhail, & Polti, 1990). Poor performance has been caused by the failure of public agencies to collect funds from farmers to support operation and maintenance of large-scale irrigation schemes in developing countries (Johnson, 1990)

It is generally believed that resources in rice farming, especially in under-developed countries are being utilized inefficiently (Baten, Abdulbasah, & Fatama, 2009). Most irrigated paddy farmers in the dry zone are below the frontier level and they cannot gain the economies of scale due to isolation operation of those firms and inadequate skills and assests. However, very little literature has focused the technical efficiency of this industry and its determinants. The absence of quantitative research on technical efficiency on rice farming is one of the main problems for policy makers in decision making. Consequently, it seems that there is a gap in the theoretical knowledge and quantitative measurements of technical efficiency of rice industry in Sri Lanka. Therefore, the problem addressed in this study is to measure technical efficiency and identify the main factors behind the technical efficiency of rice farming in Sri Lanka.

1.3 Objectives of the Study:

The main objective of this study is to measure the technical efficiency of rice farming under major irrigation conditions and to identify socio-economic and management practices that influence irrigated rice farming in Sri Lanka. The specific objectives are; (a) To identify the more appropriate functional form for frontier analysis and (b) to identify the most suitable distributional function for inefficiency term.

MATERIALS AND METHODS

2.1 Study Locations:

The Nagdeepa irrigation scheme was selected for the study based on the degree of water risk in the dry season (*Yala Season*). This scheme is located around 13 km from Mahiyanganaya Town ship on the Bibile road, in Budulla District. It was set up in 1969 by Irrigation Department with 2,000 farmer families and approximately 1,765 ha. of irrigable land. At present about 2,400 families are living in the area while authorized farmer families were around 1,440. The distribution network consists of 22.6 km of main channel, 30.6km of distributary channels and 92km of field channels. There are 24 distributaries and 303 field channels in the system. Each farmer was given 1.2 ha. of irrigable extent and 0.4 ha. of high land when they have settled in the project. In wet season (*Maha Season*) around 1300 ha. of irrigable land were cultivated. However, during dry season (*Yala Season*) the irrigable land was uncultivated due to shortage of water.

2.2 Sampling Framework:

The target groups of the field survey were authorized paddy farmers in selected schemes. Their income mainly depend on agriculture and related activities, especially paddy farming. Thus, total sample population was 1,440 settler households in Nagadeepa irrigation scheme. Stratified random sample techniques were used to select the sample under two stages. At the first stage farmers were clustered as head, middle and tail based proximity of water sources to the irrigable land. Because, in practice, farmers whose fields are furthest from the water sources frequently have least secure water supply, while the farmers whose fields are closer to water source receive an unduly large share of channel water. The irrigation engineers and technical officers were involved in the development of head, middle and tail regions of each scheme. In the second stage sample size was determined under the Morgan (2001) approach.

Table 1: Population and Sample Framework

Scheme	Clusters	No of Households	*Sample Size α=0.05,t=1.96
Nagadeepa	Head	530	133
	Middle	486	123
	Tail	424	121
Total		1,440	367

2.3 Model specification :

The original specification involved a production function specified for cross-sectional data which had an error term composed into two components: a stochastic random error component and a technical inefficiency component (Lovell, 1993). The model expressed in the following form: $Y = f\left(X_i\beta\right) + \varepsilon_i$ I = 1,………, N. Where Y_i is the production (or the logarithm of the production) of the i-th firm; X_i = Kx1 vector of input quantities of the i-th firm; β = vector of unknown parameters; the essential idea behind the stochastic frontier model is that ε_i term can be written as V_i = the random variable which is assumed to be independently and identically distributed and independent of U_i (Lovell, 1993).

Further, it is two sided (-α < V < α) normally distributed and random error that captures the stochastic effects outside the farmers control (Lovell, 2006). (E.g. weather, natural disaster and lucks). U_1 is non-negative random variables which are assumed to account for technical inefficiency in production and are often assumed to be independently and identically distributed and truncations (at zero) of the normal distribution or half-normal (Kumbhakar, Soumandra, & Thomas, 1991).

U_i is a one sided $(U \geq 0)$ efficiency component that captures the technical efficiency of farmers. It measures the shortfall in output Y from its maximum value given by the stochastic frontier $Y = f\left(X_i\beta\right) + V_i$

2.4 Empirical model:

In previous literature, different types of production functions have been adopted to discuss the frontier analysis. Among empirical literature, the most commonly applied production function is Cobb-Douglas (CD) production function and the transcendental Logarithm (TL) production functions (Baten et al., 2009, Battese & Corra, 1977, Hassan & Ahmad, 2005, Kachroo, Sharma, & Kachroo, 2010). The parameters of inefficiency model were produced with two-step approach. Finally Cob-Douglas and translog production functions can be written with natural logarithms as follows:

The empirical model for Cobb-Douglas function forms is given by; $InY_i = \beta_0 + \sum_{j=1}^{6} \beta_{ij} InX_{ij} + V_i - U_i$,

The empirical model for translog functional form is given by;

$$InY_i = \beta_0 + \sum_{i=1}^{6} \beta i.InXi + \frac{1}{2}\sum_{i=1}^{6}\sum_{j=1}^{6} \beta_{ij}.InX_{ij} InX_{ij} + \sum_{i=1}^{6}\sum_{i \succ j}^{6} \beta_{ij} InX_{ij} InX_{ij} + V_{ij} - U_{ij}$$

Where *ln* denotes logarithms to base e and

Y = Output (Kg/ha),X_1= Extent of land (ha.) ,X_2= Family labour (man days),X_3= Hired labour (days/ha)

X_4= Quantity of Fertilizer (NPK) (kg/ha).,X_5= Cost of machinery (Rs/ha) ,X_6 = Off farm income (Rs./month/household) and β_0 ,β_1……….. β_7 are parameters to be estimated and

V_i = Random error, U_i = Technical inefficiency term (half-normal for Cobb-Douglas and truncate normal for translog production function).

Variables for Inefficiency Model α_1 = Experiences in rice farming (years), α_2 = Education (Years),

α_3 = farmer Trainings (Dummy, 1 =Yes, 0= No) , α_4 = Proximity to water source(s) (Dummy; 1=Head-end, 0= Otherwise), α_5 = Water management practices (Dummy; 1= good, 0=Otherwise), α_6 = Usage of New Equipment (1= Yes, 0 = No), α_7 = Contact with Government Supportive Agencies (Dummy; 1= good, 0= Otherwise), α_8 = Respect to Common schedule (Dummy; Good= 1, Otherwise= 0)

The stochastic frontier model was estimated using the FRONTIER 4.1 and the parameters of inefficiency model were estimated with TOBIT regression with the help of LIMDEP software packages.

2.5 Output – Input Elasticities:

However, since first-order coefficients of traslog production functions are not very informative unlike Cobb-Douglas coefficients, it cannot be used directly for as output elasticity of respective factor. Awudu and Eberlin (2001) have applied partial derivative process with the support of estimated coefficients in production function to measure input-output elasticity. In the study, researcher applied Awudu and Eberlin methods which have been established as follows;

$$LnOutput = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_1^2 + \beta_8 X_2^2 + \beta_9 X_3^2 + \beta_{10} X_4^2 + \beta_{11} X_5^2 + \beta_{12} X_6^2$$
$$\beta_{13} X_1 X_2 + \beta_{14} X_1 X_3 + \beta_{15} X_1 X_4 + \beta_{16} X_1 X_5 + \beta_{17} X_1 X_6 + \beta_{18} X_2 X_3 + \beta_{19} X_2 X_4 + \beta_{20} X_2 X_5 + \beta_{21} X_2 X_6 + \beta_{22} X_3 X_4$$
$$\beta_{23} X_3 X_5 + \beta_{24} X_3 X_6 + \beta_{25} X_4 X_5 + \beta_{26} X_4 X_6 + \beta_{27} X_5 X_6 .$$

Elasticity for $X_1 = \frac{1}{Output} * \frac{\partial Output}{\partial X_1} = \frac{\beta_1}{X_1} + \frac{2\beta_7}{X_1} + \frac{\beta_{13}}{X_1} + \frac{\beta_{14}}{X_1} + \frac{\beta_{15}}{X_1} + \frac{\beta_{16}}{X_1} + \frac{\beta_{17}}{X_1}$

The slope is calculated as follows: $\frac{\partial Output}{\partial X_1} = (\beta_1 + 2\beta_7 + \beta_{13} + \beta_{14} + \beta_{15} + \beta_{16} + \beta_{17}) * \frac{Output}{X_1}$

The equation below show the calculation of elasticities evaluated at the mean

$(\beta_1 + 2\beta_7 + \beta_{13} + \beta_{14} + \beta_{15} + \beta_{16} + \beta_{17}) \times \frac{yield}{X_1} \times \frac{X_1}{Yield}$, thus:

$E_{x1} = (\beta_1 + 2\beta_7 + \beta_{13} + \beta_{14} + \beta_{15} + \beta_{16} + \beta_{17})$. Similar approach is applied for measuring input elasticities of other inputs such as: family labour, hired labour, fertilizer, machinery and access to water index. Following table shows the results of the input elasticities for each input in the traslog stochastic frontier production function

2.6 Hypothesis Testing:

Likelihood ratio test (LRTs) have been used to compare two nested models. Asymptotically the test statistics is distributed as a chi-squared random variable with degree of freedom equal to the difference in the number of parameters between the models. Null hypotheses of interest are tested using the generalized likelihood ratio. The generalized likelihood-ratio statistic λ given by:

$$\lambda = -2In\left[L(H_0)/L(H_1)\right] = -2\left[InL(H_0) - InL(H_1)\right]$$

Where $L(H_0)$ is the value of the likelihood function for the frontier model, in which parameters restrictions specified by the null hypotheses, H_0 is imposed; and L (H_1) is the value of the likelihood function for the general frontier model. If the null hypotheses is true , then λ has approximately a chi-square (or mixed square) distribution with degree of freedom equal to the differences between the parameter estimated under H_0 and H_1

RESULTS AND DISCUSSION

3.1 Descriptive Statistics:

Table-2 shows the descriptive statistics of some important variables in paddy farming among selected farmers in Nagadeepa reservoir. Average profit including imputed cost per hectare obtained by paddy farmer was Rs.20, 653 per hectare with variability index of 28.9 percent.

Table 2: Descriptive analysis of the paddy cultivation of selected tanks

Variables	Mean	Std. Deviation
Paddy yield (Kg/ha)	4948.0	1222.3
Extent Cultivated (ha)	0.84	0.34
Fertilizer Cost (Rs/ha)	2,345	525.5
Family Labour (Man days/ha)	18.9	8.3
Hired Labour (Man days /ha)	31.1	16.8
Chemical Cost (Rs/ha)	5428.1	1734.3
Machinery Cost (Rs/ha)	28,545	2997.5
Other cost (Rs/ha)	6,431	3245.6
Total Cost of Production(Rs/ha)[1*]	67,629.1	18,345.6
Total Cost of Production (Rs/ha)[2*]	88,220.1	22.578.0
Gross Income (Rs/ha)	108,856	17.889.8
Profit (Rs/ha)[1*]	41,226.9	8967.9
Profit (Rs/ha)[2*]	20,653.9	5968.8

[1*] excluding imputed cost, [2*] including imputed cost, 1$= 126 SLRS

While without imputed cost the profit per hectare was Rs. 41,226 with 21.7percent variability index. Average yield per hectare was 4948.0 kg with variability index of 24.7 percent. A drastic yield difference between head farmers and tail farmers were observed and it was mainly due to irrigation inequality. The highest yield (6987 kg/ha) was reported by a head- end farmer and lowest (887kg/ha) was reported by a tail-end farmer. A family labour accounts for large portion of labour cost in a selected tank and it was ranged from 11-46 man days in selected tanks. It was revealed that, yet, family members were jointly engaging in paddy farming although they were receiving slimmer profit margin with respective field.

3.2 Hypothesis Testing:

A series of tests were done to test the specification of functional form, distributional pattern of inefficiency term and availability of technical efficiency in the data set and results are summarized in table 2. These were tested through imposing restrictions on the model and using the generalized likelihood ratio statistics. At the first step researcher hypothesized that the average Cobb-Douglas functions adequately represents the production structure of the furniture industry. However this hypothesis ($\gamma = 0,$) was strongly rejected at 0.05 significant level. By second hypothesis researcher attempted to identify the best stochastic frontier among Cobb-Douglas and Traslog functions. According to LR test, frontier traslog function was recommended as best function to represent data set by rejecting null hypothesis at 95% probability. Finally the study tests the distributional pattern of technical inefficient term U_i by imposing the restriction of $\mu = 0$, indicating that the inefficient term is half-normal distribution. While, null hypothesis rejected at 5% significant level and proposed truncated normal distribution for inefficient term. Observing that entire hypothesis this study has selected traslog production stochastic frontier production function with truncated normal distribution for inefficiency term.

Table 3: Log likelihood Ratio Test

Null Hypothesis	Log likelihood	LR Statistics	Critical Value	Decision
$H_0 : \gamma = 0$, Average CD = Frontier CD	56.48 90.94	68.92	7.05** $\chi^2_{(0.05)}$	Reject H_0
H_0 : Frontier CD = Frontier TL	90.94 135.29	88.7	33.92 $\chi^2_{(0.05)}$	Reject H_0
H_0 : $\mu = 0$	119.36 135.29	31.86	10.83 $\chi^2_{(0.001)}$	Reject H_0

Note: **The critical values are taken from table of Kodde and Palm (1986). The null hypothesis which includes the restriction that γ is zero does not have a chi-square distribution, and since the alternative hypothesis is that $0<\gamma>$ the test has asymptotic distribution.

3.3 Stochastic Frontier Production Functions:

The estimated parameters of the traslog production frontier and Cobb-Douglas are presented in table 3. However, since the study used only traslog coefficients for further analysis since Cobb-Douglas were rejected by previous hypothesis testing. The γ is the percentage of the variance of –firm specific technical inefficiency (U_1) to the total variance of output. Since γ is closed to 1 (0.98) suggested that the technical inefficiency is existing with irrigated paddy industry in Sri Lanka. The value is 0.98 means that the variation of the output due to technical inefficiency and frontier output is dominated by technical inefficiency. Further λ is ratio of the variance of firm-specific technical inefficiency (U_1) to the variance of random error (V_1). Besides, the value for σ is positive indicate that the observed output deviate from frontier output and also average response functions were not right production function for studying the structure of paddy farming in Sri Lanka.

3.4 First-order Parameters of Stochastic Translog Function:

The first order parameters of traslog stochastic frontier β_j have the predicted (positive) sign reflecting the conventional direct relationship between inputs and output. Unless recurrent expenditure, all other variables were strongly significant at 99% probability level. The bordered Hessian Matrix of the first and second order partial derivatives is negative semi-definite reflecting that all regularity conditions such as; positive and diminishing marginal product are valid at the point of approximation (i.e., sample mean).

3.5 Input Elasticities:

Table 3 shows results of the input elasticities for each input in the traslog stochastic production function. A one percent increase in the family labour, gross value of output increase by 3.44 (t=3.2) ceteris paribus. While, as hired labour increase by one percent value of output increase only by 0.86 (t=2.6) ceteris paribus. Among selected variables, highest response variable to gross output was extent cultivated since its input elasticity is 3.6 (t=3.5). A one percent increase in fertilizer applied and expenditure on machinery, the value of gross output increase by 1.82 (t=2.4) and 0.95 (0.026) respectively subject to other variables keeping constant.

Table 4: Input Elasticity

Variables	Input Elasticity
Extent Cultivated(X1)	3.62
Family Labour Employed (X2)	3.44
Hired Labour Employed (X3)	0.866
Fertilizer applied (X4)	1.82
Expenditure on machineries (X5)	0.965
Off farm income (X6)	2.784

3.6 Frequency Distribution of technical efficiency:

The results of the frequency distribution of technical efficiency of selected furniture producers are presented in Table 5. The study reveals technical efficiency (TE) of selected firms ranging from 23.7 percent to 99.9 percent, with an average 0f 69.5 percent. The results suggested that, on average the industry output can further increase by 30.5 percent without increasing the level of input. Beside it indicates that the average farmer in the sample could save 30..5 percent (i.e., 1-{69.5/99.97}) of cost and the most technically inefficient firm can achieve 76.3% cost saving compared with the TE level of his most efficient counterpart. In addition, around 4.8 percent firms are reflecting very poor TE and 38% firms are keeping an excellent record in TE (more than 80%).

Table 5: Frequency Distribution of Technical Efficiency

Range of Technical Efficiency	No of Farmers	Percentage (%)
Below 30	16	4.8
31-50	131	39.0
51-70	10	3.0
71-80	49	15.0
81-90	81	24.0
91-100	48	14.0
Maximum TE = 89.97% Minimum TE = 23.67% Mean TE = 72.80%		

Source: Author's Computation.

Table 6: Translog and Cobb – Douglas Stochastic Frontier Production Functions

Variables	Parameters	Traslog		Cobb-Douglas	
		Coefficients	T-Ratio	Coefficients	T-Ratio
Constant	β_0	5.776 †	5.693	0.609	2.827 †
Extent cultivated (X1)	β_1	3.369 †	3.554	0.403	9.755 †
Family Labour (X2)	β_2	3.217 †	3.225	0.463	4.396 †
Hired Labour (X3)	β_3	1.303 †	2.623	0.067	2.664 †
Quantity of fertilizer (X4)	β_4	2.181 †	2.424	0.396	8.268 †
Expenditure on Machinery (X5)	β_5	0.739	0.026	0.012	1.597
Off-farm Income (X6)	β_6	3.207 †	3.272	0.406	6.540 †
Ln-$(X1)^2$	β_7	0.347 †	3.068		
Ln-$(X2)^2$	β_8	0.350 †	3.124		
Ln-$(X3)^2$	β_9	-0.073	-1.359		

Ln-(X4)^2	β_{10}	0.282	1.510		
Ln-(X5)^2	β_{11}	0.193 †	3.203 †		
Ln-(X6)^2	β_{12}	-0.065	0.959		
(X1)*(X2)	β_{13}	-0.379	-2.077		
(X1)*(X3)	β_{14}	-0.142	0.952		
(X1)*(X4)	β_{15}	-0.089	-0.428		
(X1)*(X5)	β_{16}	0.132	-0.797		
(X1)*(X6)	β_{17}	0.036	0.260		
(X2)*(X3)	β_{18}	0.318 †	2.826 †		
(X2)*(X4)	β_{19}	-0.391	2.255		
(X2)*(X5)	β_{20}	-0.089	-0.621		
(X2)*(X6)	β_{21}	0.064	0.338		
(X3)*(X4)	β_{22}	0.083	0.588		
(X3)*(X5)	β_{23}	-0.294 †	-2.961 †		
(X3)*(X6)	β_{24}	-0.256	-1.795		
(X4)*(X5)	β_{25}	-0.151	-0.619		
(X4)*(X6)	β_{26}	-0.379	-1.807		
(X5)*(X6)	β_{27}	0.242	1.840		
Sigma Square	σ^2	0.213 †	6.257 †	0.077	8.583
Log Likelihood Function		135.288		90.94	
Sigma	σ	0.461		0.277	
Sigma-Squared (u)	σ_u^2	0.212		0.074	
Sigma-Squared (v)	σ_v^2	0.001		0.003	
Lamda (σ_u / σ_v)	λ	14.569		4.945	
Gamma	γ	0.994 †	277.196 †	0.963	61.912
Mu	μ	-0.929 †	-6.384 †	68.916	
LR test of the one-sided error		123.678		83.77%	
Mean Efficiency		72.80%		-	

Note: † , † † , Significant at 1% and 5% respectively.

3.7 Factors effecting technical Efficiency:

The censored regression or Tobit model was applied to determine the impact of socio-economic and managerial capabilities on technical efficiency in furniture industry in Sri Lanka. For this model, TE of each firm considered as dependent variable and 8 explanatory variables which were reflecting the managerial capabilities and socio-economic status of producers were selected. The results of the Tobit function was performed in table 6. All selected variables are positively associated with TE and unless α_7 all other variables were significant at 0.01 level. Among education and Experiences, the experience in rice farming has acquired the big share of Tobit function indicating that experience can exert more influence on TE rather than education. Since all other variables are Dummy variable, researcher measured exponentiated value of respective parameter for better interpretation. The exponentiated coefficients are the best means of interpreting the impact of the dummy variable (Joseph F, Black, Barry, & Rolph E, 2010). The exponentiated coefficient of α_3 is 1.22 means that, head-end producers have 22 percent higher TE score than untrained producers (1.22-1*100). Similarly, those producers who have applied better water management practices, their level of TE is 49% more than the producers who haven't such effort. Some producers have applied new technology for their farming and such producers reflected 11% greater technical efficiency of paddy industry than the producers who did not apply such technology. Contact with supportive agencies directing marginal impact on TE compare to other variables.

Producer's attitudes towards government supportive agencies did not reach a satisfactory level and it did not exert influence on TE of rice farming in Sri Lanka. Finally, the study found two important variables which have had greater impact on technical efficiency in rice farming such as: usage of new equipment and respect a common schedule. The producers, those who have perfectly followed the common cultivation schedule gained 65% more benefit on technical efficiency than others. Besides, any producer who may use new equipment in this industry can enhance their technical efficiency by 53 percent from current level.

Table 7: Inefficiency Model – Censored Regression

Variable	Parameter	Coefficient	T-Ratio	Exp(α)
Experiences in Rice Industry (Years)	α_1	0.3042	5.712	1.35
Education (Years)	α_2	0.1383	2.510	1.15
Attended Training Courses (Yes=1, No=0)	α_3	0.1992	4.793	1.22
Proximity to Water Source (1=Head,0=Tail)	α_4	0.3996	12.145	1.49
Water Management Practices(Good=1, OW=0)	α_5	0.1053	2.995	1.11
Usage of New Equipment's (Yes=1, No=0)	α_6	0.4262	2.768	1.53
Contact with Supportive Agencies (Good=1, OW=0)	α_7	0.0653	1.450	1.07
Respect to Common Schedule (good =1, OW =0)	α_8	0.5033	10.318	1.65
Log Likelihood Function		71.904		

Source: Author's computation

Conclusion And Recommendations:

This study mainly attempted to estimate technical efficiency of irrigated paddy farmers under major irrigation conditions in Sri Lanka and identify its determinants. The average technical efficiency of this industry was 72.8% or 27.2% below the potential. Further it was indicated that on average, the firm's output can further increase by 30.5% or cost can be reduced by 27.2% without changing existing input level and technology.

The study also examined the relationship between producer's managerial capabilities and socio-economics attributes with technical efficiency of irrigated paddy farmers under major irrigation conditions in Sri Lanka. The results revealed that all selected variables had a significant impact on technical efficiency except contact with supportive agencies. If producers can use new equipment and better water management practices they would be able to upgrade their TE more than 50%. Further, by usage of new technologies and following a common cultivation schedule may further enhance their efficiency around 50%. Education, experiences and training were also key determinants behind the technical efficiency in irrigated paddy farming under major tanks. However, contact with government supportive agencies is only the factor that has found insignificant impact on TE. Another possible interpretation is that policies are not sufficiently strong or effective to helping in produce more efficiently. Although the government has established number of supportive agencies to support rice industry during last decades, still they are functioning below the frontier level due to mismanagement of resources and technology.

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