

An Economic Analysis of Technical Efficiency of Paddy Farming: A Case Study in Mahaweli System II

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INTRODUCTION AND RESEARCH PROBLEM

The credit for introducing a formal definition for economic efficiency goes to the study Koopmans (1951). According to this study, a point of production process is efficient, if the output is maximized at given level of inputs. Ferrell (1957)'s study made a great foundation for efficiency and productivity analysis. In this study, overall economic efficiency (EE) divided into two components: technical efficiency (TE) and locative efficiency (AE). It is appeared that Ferrell (1957)'s explanation on efficiency was greatly influenced by Koopmans (1951)'s works. Farrell (1957)'s explanation on efficiency is based on constant returns to scale. According to Farrell (1957)'s study, technical efficiency is achieved at any combination of inputs which is located on the Iso-quant curve and allocative efficiency is achieved if the unit of output is produced by using any combination of inputs which is located on the Iso-cost curve.

It is obvious that technical efficiency analyses are widely used in the world not only in agriculture but also in other various fields. Since rice is the staple food in Sri Lanka, maintaining a satisfactory level of production of rice is very important. Production of rice can be

increased with the technological improvements without increasing in production inputs.

Percentage changes in paddy production of Sri Lanka during 2009 – 2012, are -5.1%, 17.5%, -8.4% and -6% respectively in each year. Very poor growth of paddy production in Sri Lanka is explained by above statistics. Further, values of paddy productivity index of Sri Lanka during 2009-2012, are 137,115,104.1 and 102.8 respectively in each year. Estimated average yield of paddy production of Sri Lanka for 2012 is 3.43 tons per hectare (Central bank reports from 2009 to 2012). This is a very worse value compared with many other countries those who cultivate paddy. Average yield of paddy per hectare estimated for the year 2012 for Australia, Vietnam, China, Indonesia, Japan, United States, India, Bangladesh and Taiwan, are 9.18 tons, 5.66 tons, 6.74 tons, 4.86 tons, 6.74 tons, 8.35 tons, 3.52 tons, 4.38 tons, 5.93 tons respectively (IRRI data base). Average yield of paddy production for Australia was 6.0 tons in year 1960. Therefore, current average yield of paddy in Sri Lanka is even less than the average paddy yield which was acquired by Australia for the year 1960.

All aforementioned evidences prove that the efficiency of paddy farming is not at a satisfactory level in Sri Lanka. Therefore, efficiency of paddy farming should be improved in order to meet domestic rice consumption and for development of the paddy field. However, all the aforementioned issues emphasized the requirement of new methodologies to be applied to increase the paddy harvest in Sri Lanka. Based on these facts, the research problem of this study can be stated in the following manner: How do we improve the productive performance of paddy farmers in Sri Lanka in order to increase paddy production and their incomes.

METHODOLOGY

Analysis of the study has been done based on cross-sectional data collected from household survey conducted in 2013. The sample of the study consists of 285 households from Mahaweli system H. The stochastic frontier approach was used to produce technical efficiency estimates using Frontier 4.1 developed by Coelli (1994). Cobb-Douglas is the selected functional form for the frontier production function and half normal is the distributional assumption made for the inefficiency term.

Frontier production function defined by the study is given below.

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + v_i - u_i$$

Where;

- Y_i = Paddy output in kilo grams
- X_{1i} = Land area under paddy cultivation in acres (Land)
- X_{2i} = Human labor hours (Labor)
- X_{3i} = Machinery hours (Machinery)
- X_{4i} = Amount of fertilizers used in kilo grams (Fertilizer)
- X_{5i} = Amount of seed in kilo grams (Seed)
- X_{6i} = Amount of pesticide/herbicide used in litters (Pesti./herbi.)
- \ln = Natural logarithm
- i = 1,2,...N, N = 285.

The inefficiency model based on Battese and Coelli (1995) specification was

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 + \delta_{10} Z_{10} + \delta_{11} Z_{11} + W_i$$

Where,

Z_1 = Age of the household head.

Z_2 = Number of years of schooling achieved by the household head.

Z_3 = Family size (number of members in the family)

Z_4 = Dummy variable 1, indicating if the farmer is consuming liquor frequently: Yes = 1, No = 0

Z_5 = Dummy variable 2, indicating if the farmer has participated for at agricultural trainings within the year: Yes = 1, No = 0

Z_6 = Dummy variable 3, indicating if the farmer has received agricultural extension services within the year: Yes = 1, No = 0

Z_7 = Dummy variable 4, indicating if the farmer has access to the formal credit facilities: Yes = 1, No = 0

Z_8 = Distance between paddy land and residence in meters

Z_9 = Distance between paddy land main water channel in meters (Bela)

Z_{10} = Commitment 01 (Number of observations in the paddy field by the farmer per day)

Z_{11} = Commitment 02 (Dummy variable 5), indicating whether paddy cultivation has been destroyed more than once due to same reason: Yes = 1, No = 0

Z_{12} = Commitment 03 (Number of times a farmer discuss about his farming activities with family members per day)

Z_{13} = Dummy variable 6, indicating whether main livelihood of the household head is paddy farming: Yes = 1, No = 0

Z_{14} = Attitude (Value of attitude index)

RESULTS AND FINDINGS

The results of this study show that the estimated mean technical efficiency of farmers is 79.98 percent. Land, machineries and labor are the most responsive production factors in paddy farming.

Table 1: Maximum Likelihood Estimates of the Stochastic Frontier Production Function

Variables	Coefficient	t-ratios
Constant	0.71408764	1.75697010*
Land (X1)	0.81232865	2.71263914***
Labor (X2)	-0.39863931	-1.69538615*
Machineries (X3)	0.28501599	1.99864379**
Fertilizer (X4)	-0.37680319	-0.23974509
Seed (X5)	0.26930652	0.79496416
Pesticide /herbicide (X6)	0.30079203	0.26010334

Source: Data analysis by the author

*Note: ***, ** and * indicate significance at 1%, 5% and 10% levels respectively.*

Table 2: Estimations of Inefficiency Model

Variables	Coefficient	t-ratios
Age (Z ₁)	0.46178367	1.67130782**
Schooling (Z ₂)	-0.2110807	-1.69090023**
Number of members in the family (Z ₃)	0.14690029	0.47506031
Liquor / Dummy variable 01 (Z ₄)	0.82313258	2.37812648***
Training / Dummy variable 02) (Z ₅)	-0.4022378	-1.45535276*
Extension / Dummy variable 03 (Z ₆)	0.88506040	0.13378431
Access to credit facilities / Dummy variable 03 (Z ₇)	0.91806232	0.14295795
Distance 01 (Z ₈)	0.90482735	0.29675879

Distance 02 (Z ₉)	0.33297332	2.53406987***
Commitment 01 (Z ₁₀)	-0.2414728	1.78213211**
Commitment 02 / Dummy variable 04 (Z ₁₁)	-0.6293622	0.62431735
Commitment 03 (Z ₁₂)	-0.1223710	0.44802768
Occupation / Dummy variable 05 (Z ₁₃)	-0.7120034	-2.25413185***
Attitude (Z ₁₄)	-0.4873921	-3.0209498****

Source: Data analysis by the author

Note: ****, ***, ** and * indicate significance at 1%, 5%, 10% and 15% levels respectively.

Table 3: Diagnostic Statistics

Variables	Coefficient	t-ratios
Sigma-squared ($\sigma^2 = \sigma_U^2 + \sigma_V^2$)	0.32279629	1.88096911*
Gamma ($\gamma \equiv \sigma_U^2 / \sigma^2$)	0.84276935	2.436472268**
Log likelihood function	0.18829590	
LR test	0.27232337	

Source: Data analysis by the author

Note: ***, ** and * indicate significance at 1%, 5% and 10% levels respectively.

Table 4: Other Statistics of the Model

Variable	Value
$\chi^2_{0.05,21}$	32.7
No. of observations	285
Mean efficiency	0.79978911

Source: Data analysis by the author

CONCLUSIONS, IMPLICATIONS AND SIGNIFICANCE

The results of the study show that the estimated mean technical efficiency of the farmers is 79.98 percent. Land size is the leading responsive production factor and a hundred percent increase in land size increases paddy harvest by 81.23 percent. The analysis revealed that the sum of partial output elasticities with respect to all inputs is 0.6987 which indicates existing of Decreasing Returns to Scale in paddy production.

Fourteen factors have been considered as determinants of technical efficiency in estimating inefficiency model of the study. Schooling, agricultural training and farmers' positive attitudes are negatively associated with inefficiency of paddy farming. Age, alcohol consumption and distance between land and main water watercourse are positively associated with inefficiency of paddy farming.

Estimated value of overall technical efficiency in the area is 80 percent which implies that farmers in the sample are technically efficient 80 percent or technically inefficient 20 percent. In other words, there is a scope in short run to increase paddy harvest by 20 percent with existing utilization of inputs. This is somewhat different result compared with the studies by Shehu and Mshelia (2007) and Tijani (2006) where technical efficiency of paddy farming exceeds 90 percent. In Sri Lanka, there are many problems regard to increase in production inputs such as land, labor and fertilizer. Especially maximum utilization of land can be seen in Mahaweli development area. 2.5 acres were given for paddy cultivation and 0.5 acres were given for residence per household when Mahaweli development project was established. Even though marginal productivity of land is higher, paddy cultivation is at a difficult position to increase land utilization. All types of fertilizers are provided at maximum concessionary prices by the government. Therefore increase in quantity of fertilizer cannot be done in order to increase paddy harvest in Sri Lanka. A result of the study shows labor input has diminishing marginal returns. With this background utilizing more

labor is also will not be good solution if quantity of land machineries are held constant. Machinery has positive marginal product at current utilization. But doing more mechanization in paddy field is very difficult due to very small scale paddy farming in Sri Lanka.

A new aspect of technical efficiency studies has been introduced by this study through introducing new determinants of technical efficiency. In this study, farmers' attitudes towards paddy cultivation have been included as a new determinant of technical efficiency. Higher efficiency was significantly affected by positive attitudes of farmers and it has been proved through number of dimensions by the study. The study has given criteria to classify attitudes in to three categories; positive, negative and moderate. This classification can be taken as a foundation in analyzing attitudes in future researches. Addiction to liquor is another determinant which has been introduced by this study as a determinant of technical efficiency. This was statistically significant and negatively affected on farmers' efficiency. Farmers' commitment is also considered as a determinant of technical efficiency by the study.

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