An Assessment of Technical Efficiency of Paddy Production under Major and Minor Irrigation Schemes in Kurunegala District

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ABSTRACT

A study was carried out to investigate the technical efficiency of paddy production under the major and minor irrigation schemes in Kurunegala district. A stochastic frontier production function and a model to explain the technical efficiency were estimated. Technical efficiency was regressed as a function of education level of the farmer, farming experience, level of the farm assets available and the level of involvement in farming. The econometric results revealed that the mean efficiencies of paddy production under major and minor irrigation schemes were 86 percent and 75 percent, respectively. It was evident that the education level of farmers in major irrigation scheme and part time farming in minor irrigation scheme had a significant influence on the technical efficiency.

KEYWORDS: Major Irrigation, Minor Irrigation, Paddy, Technical Efficiency

INTRODUCTION

The agriculture sector plays a vital role in the economy of Sri Lanka. It contributed to 17.6 percent of the total Gross Domestic Product (GDP) in the year 2003. Rice is the predominant crop in Sri Lankan agriculture with an asweddumized extent of 736000 ha which is about 12 percent of country's land and paddy production independently contributed to 2.6 percent of the total GDP in the year 2003(Anon, 2003).

In Sri Lanka, paddy is grown under the three modes of water supply, namely major irrigation (commanding area>100 hectares), minor irrigation (commanding area<100 hectares) and rain fed area. Profitability of paddy cultivation shows significant decline in recent time (Anon, 2000).In order to make the paddy cultivation profitable, with increasing cost of production due to rising prices of inputs, one alternative available is to increase the productivity without increasing the inputs.

The constraints associated with paddy production can be categorized as socio-economic constraints such as high cost of inputs and land fragmentation, and technical constraints such as low fertility of lands and scarcity of water. The high cost of production, especially due to increase in labor wages, has direct impact on the profitability of paddy cultivation. Therefore, analysis of efficiency in paddy production is vital for policy formulation to increase paddy production.

Gunerathne and Thiruchelvam (2002) studied technical efficiency of paddy production in Anuradhapura district. They found that there was a substantial difference in productivity, resource use and technical efficiency in major and minor irrigation schemes. Karunarathne and Herath (1989) studied the technical efficiency at the head end and the tail end of the irrigation schemes of Mahaweli H system. Technical efficiency of potato production has been studied by Amarasinghe and Weerahewa (2001).They found that significant output increases could be secured without adding any inputs.

The objective of this study was to examine the technical efficiency of paddy production under major and minor irrigation schemes in Ibbagamuwa agrarian service areas in Kurunegala district.

METHODOLOGY

Technical efficiency of a firm is defined in terms of the ratio of the observed output(y) on input (x) to the corresponding frontier output(y^*) on input(x^*). Farrel (1957) defined technical efficiency as the ratio of inputs required (x^*) to produce y^*. In other words, any production process is technically efficient if output $y=y^*$ and technically inefficient if $y<y^*$ or $x>x^*$.Thus technical efficiency is $TE=y/y^*$ or $TE=x/x^*$.

Earlier production function analyses assumed that the production function is parametric form along a strict one sided error term (Schmidt, 1976). Such forms take no accounts of the possible influence of measurement errors and other causes of distortions from the estimated frontier are assumed to be the result of technical efficiency. These infirmities are addressed by the stochastic frontier function of the present day.

The stochastic frontier production can be written as,

$$Y_i = f(x_i, \beta) + \epsilon_j$$
$$\epsilon_j = v_i - u_i \qquad i=1, 2, \ldots\ldots.. N$$

Where, Yi, is production, x_i is input level and ϵ_j is the composed error term. The term v_i is symmetric error, which accounts for random variations in output due to factors beyond the control of the farmer. *e.g.*, weather and disease outbreaks, and it is assumed to be independently and identically distributed as N $(0, \sigma^2_v)$. The term u_i is a non negative variable representing inefficiency in production relative to the stochastic frontier. The distribution of u_i is also assumed to be independent and identical as N $(0, \sigma^2_u)$: *i.e.*, the distribution of u_i is half normal. When, $|u_i| = 0$ for a farm whose production lies on the frontier, and $|u_i| > 0$ for one whose production is below the frontier which reflects the technical inefficiency.

According to the Battese and Corra (1977) the variance ratio parameter γ which relates to the variability of u_i to the total variability (σ^2) can be calculated in the following manner.

$$\gamma = \sigma^2 u / \sigma^2$$
$$\sigma^2 = \sigma^2_u / \sigma^2_v$$

Where σ_u and σ_v are standard deviations of u_i and v_i, respectively and the γ parameter has a value in between zero and one. If γ is close to zero, the difference between a farmer's yield and the efficient yield is mainly due to statistical error. On the other hand if γ is close to one, the difference is attributed to the farmer's less than efficient use of the technology *i.e.*, technical inefficiency.

In this study the Cobb-Douglas stochastic frontier production function was used, which is; $\text{Ln } Y_i = \beta_0 + \sum \beta_i \ln x_i + (v_i - u_i)$.

Where, the subscript i refers to the i^{th} farmer, Ln represents the natural logarithm;

V_i is assumed to be independently and identically distributed random errors, having $N(0, \sigma^2_v)$ distribution; and the u_i is non negative random variables, called technical inefficiency effects, associated with technical inefficiency of production of the farmer's involved; The output(Y) is the paddy production in each farmer (kg).

The inputs(x) denote; land(x_1) in acres, labour (x_2) in man days, agrochemicals(x_3) measured in rupees, and seed (x_4) measured in rupees.

It is assumed that the inefficiency effects are independently distributed and u_i arises at zero of the normal distribution with mean, μ, and variance, σ^2, where u_i is defined by; $U_i = \sum \delta_i z_i + w_i$.

Where, z_i represents the factors contributing to inefficiency. In this study, farming experience was considered in years, education level was measured in years of schooling, part time farming was taken as a dummy variable and value of farm assets, which composed of sprayers, buffaloes, and two and four wheel tractors were valued in rupees. All the parameters in this study were estimated in a single stage Maximum Likelihood Estimate(MLE) procedure as in the computer software- FRONTIER version 4.1(Colli, 1994).

In this study it was assumed that, there were no differences in resource use, productivity and technical efficiency of paddy production between cultivators in major and minor irrigation schemes and the inefficiency determinants are same for cultivators in both major and minor irrigation schemes. The data used in this study were obtained from a survey carried out during May, 2005 in the Ibbagamuwa agrarian service areas in Kurunegala district. A structured questionnaire was used and a stratified random sampling procedure was adapted. Forty farmers from each major and minor irrigation schemes were interviewed.

The dependent variable, paddy production, was measured in kg. The land variable was the extent of land measured in acres. The labour variable combined family labour, hired labour and exchanged labor. The labour variable was incorporated in terms of man days equivalents by taking 8 hr of work as a day. In computing equivalent man days of work, a woman day and a child day were considered to be 0.75 and 0.5 of man days respectively. The expenditure on agrochemicals which comprised fertilizers, insecticides and weedicides was measured in rupees. The variable, seed was measured in expenditure on seed in rupees.

RESULTS AND DISCUSSION

Table 1 presents the maximum likelihood estimates for the parameter of the stochastic frontier and inefficiency models for both major and minor irrigation schemes.

In the major irrigation schemes land, labour and seed were found to have significant impact while in the minor irrigation scheme land and agrochemicals were found to have significant impact on paddy production. In both areas coefficients of land were found to be positive and showed high input elasticity.

In the minor irrigation scheme the coefficient of labour was estimated to be negative, and had insignificant effect on paddy production. In major irrigation scheme Labor and seed showed significant positive values. Thus, paddy production could be increased by the output elasticity of 0.3963 and 0.4787, respectively. In the minor irrigation schemes agrochemicals showed a significant positive effect which had 0.3628 output elasticity.

The LR test values for major and minor irrigation schemes indicated that model had a good fit and thus, revealed that there were inefficiency effects on paddy production. The average efficiency of the major and minor irrigation schemes were 86 percent and 75 percent, respectively (Table 2). Thus there is a possibility to increase the efficiency of the paddy production in major and minor irrigation schemes by 14 percent and 25 percent, respectively.

In major irrigation scheme, the level of education of the farmers showed a negative significant effect upon the inefficiency. That is, farmers with many years formal education tend to be efficient in paddy production. In minor irrigation scheme the part time farming showed negative significant impact upon the inefficiency.

This implies that, full time involvement in the paddy production increases the efficiency of production. The other variables, farm assets and experience in farming did not significantly affect on the technical efficiency under both major and minor irrigation schemes of paddy production.

Table1. Maximum likelihood estimates for parameters of the stochastic frontier and inefficiency models:

	Parameter	Major		Minor	
		Coefficient	(t-ratio)	Coefficient	(t-ratio)
Stochastic frontier					
Intercept	β_0	2.490*	(2.4692)	3.2132*	(2.4785)
Land(Ac)	β_1	0.8323*	(5.424)	0.5876*	(3.7963)
Labour (manday)	β_2	0.3963*	(5.2452)	-0.0563	(-0.5413)
Seed (Rs)	β_3	0.4787*	(3.1443)	0.2664	(2.2250)
Agrochemicals (Rs)	β_4	0.0511	(0.6873)	0.3628*	(3.206)
Inefficiency model					
Education (years)	δ_1	-0.1294*	(3.1764)	-0.1126	(-1.097)
Farm assets (Rs)	δ_2	0.4796E-5	(1.7522)	-0.7739E-6	(-0.373)
Experience (years)	δ_3	0.1916E-2	(0.4398)	0.5291E-2	(0.4094)
Part time farming (years)	δ_4	-0.2072	(-1.307)	-0.3098*	(-2.7836)
Total variance σ^2		0.0751	(2.6111)	0.1983	(1.307)
Variance ratio γ		0.7458*	(2.893)	0.7803*	(3.7017)
Log likelihood function		-0.2180		-0.9199	
LR test		16.35		18.97	

*Significant at 5 percent level

Table 2. Technical efficiency level among major and minor irrigation schemes in Kurunegala district.

Technical efficiency (%)	Number of Farmers	
	major	minor
<50		2
50-59	2	4
60-69	4	7
70-79	2	8
80-89	7	15
90-100	23	4
Maximum	0.98	0.92
Minimum	0.48	0.29
Average	0.86	0.75

CONCLUSIONS

Stochastic frontier production function was estimated for paddy production in major and minor irrigation schemes in Kurunegala district. Results from the study exhibited a substantial difference in productivity and technical efficiency between these two types of irrigation schemes. The results indicated that land, labour and seed have positive significant effects on paddy production under major irrigation. In minor irrigation scheme land and agrochemicals showed significant effect on paddy production. Major and minor irrigation scheme exhibited 14 percent and 25 percent potentials to increase the paddy production, respectively. The results of the inefficiency indicated that educated farmers were found to be technically efficient in major irrigation schemes while in minor irrigation schemes, full time farmers were found to be more technically efficient. Thus, the study indicates that technical inefficiency can be reduced by encouraging educated farmers to involve in major irrigation schemes of paddy production and by full time participation of in minor irrigation scheme farmers.

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