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TECHNICAL EFFICIENCY OF PADDY FARMERS AND ITS DETERMINANTS: APPLICATION OF TRANSLOG FRONTIER ANALYSIS

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Abstract

The objectives of this study are to estimate the technical efficiency and its determinants of paddy farmers in Kurunegala district. 120 sampled farmers were selected from three villages during the last Maha season in 2019/2020. Translog frontier production function is applied to identify the impact of each input on paddy production and its results showed that log forms of the inputs such as land size, chemical costs, seed costs, expenditure on machinery, labor squared, interactions between land and chemicals, land and seed, labor and seed, fertilizer and chemical, fertilizer and seed were significantly affected on paddy production in the model. Empirical findings of the technical efficiencies indicated that, its mean value was 84% with a wide range from 27% to 99%. It suggested that farmers in the study area still have the room to improve their farming efficiency by 16% from its present level and this variation has arisen from differences in demographic characteristics and farm management practices rather than random variability. An inefficiency effect model was estimated by the maximum likelihood method which shows that male farmers are more efficient than females in the sample. Further, family size, income from farming, availability of non- farm income and farming experience were negatively related to technical inefficiency which means that, they were found to be significantly contributing to the variation in farm specific technical efficiency. Based on the results, the study *recommended that agricultural extension officers should organize to exchange the farm experiences between male and female farmers, and promote them by providing additional income facilities to improve the efficiency in paddy farming and farmers' income in future.*

Keywords: Demographic characteristics, farm management practices, smallholder paddy farmers, technical efficiency, translog frontier production function.

1. Introduction

Agriculture is the dominant sector in the economy of Sri Lanka which plays a major role in the economy and it contributes about 7% of the GDP and employs about 25.5% of Sri Lanka population. (Central bank report, 2018). Among the agriculture sector, paddy sector is in Sri Lanka played a major role in terms of supplying food requirement as well as contributes to the gross domestic product and provides job opportunities of the labour force in the country. To increase the efficiency in agriculture sector including paddy sector is the way to upgrade the sector which enhance the living standards of the rural people in Sri Lanka. In this background, this study aims to identify the technical efficiency and its determinants of paddy cultivation in Kuliyapitiya area in Kurunegala district.

Farrell (1957) defined two types of production efficiency such as technical efficiency and allocative efficiency. Technical efficiency evaluates the ability to obtain a higher level of output from a given set of inputs, while allocative efficiency measures the extent to which farmers make efficient decisions by using inputs up to level at which marginal contribution to production value equal to the factor cost, assuming no risk. Technical efficiency is just one component of overall economic efficiency. However, a firm must obtain technically efficient if it wants to get economic efficiency. Technical efficiency relates to rate of the maximum output from a given of inputs, or uses the minimum amount of inputs to produce a given of output. These two explanations of technical efficiency lead to output-oriented and input-oriented efficiency measures. These two measures of technical efficiency will coincide when the technology displays constant returns to scale (Coelli et al., 2005). Technical efficiency is an important factor that affect the amount of production in paddy and that help to raise the income of the farmers and also improves their living standards. Improving efficiency in production allows farmers to increase their output without additional inputs and changing production technologies resulting in increased productivity. For smallholder farmers, variation in productivity due to the differences in efficiency may be affected by socio economic characters and various regional and farm specific characters. Nowadays, the small holder farmers are facing the problem of inefficiency in cultivating paddy in Kurunegala district and those inefficiencies may depend on factors like socio-economic, farming and farm management practices among the farmers in the study area. By improving their usage of inputs as well as their demographic and farming practices, they can improve their efficiency towards the frontier curve with given inputs and state of technology in future. Thus, in order to identify how a farmer, become as efficient and how the above factors influencing the technical efficiency, there is a need to do a study focusing on these aspects in Sri Lanka.

In this background, this study mainly focused on two objectives such as, **(1)** to estimate the level of technical efficiency scores among smallholder paddy farmers in Kurunegala district and **(2)** to examine the impact of socio-economic characteristics and farm management practices on technical efficiency in paddy production in the study area. Estimation of technical efficiency in paddy farming enables the farmers to evaluate themselves on whether they are technically efficient or not with their given resources. Therefore, this study may help the farmers on better use of farming inputs and the possibilities to improve their efficiency and productivity in future. The study also can contribute for the informed decision to the government, non- government and development partners on the design of policies and programs that will assist the farmers to improve the productivity and enhance their income in farming activities. As in many developing countries, paddy farmers in Sri Lanka often are inefficiency in paddy production due to using non- optimal input combination as well as under the influence of paddy farm household characteristics and poor management practices. Therefore, estimating the technical efficiency and its determinants in paddy production is necessary for policy makers, government to designing and implementing policies in the country.

2. Literature review

There are number of studies done by other researchers on technical efficiency of various crops using different methods in different countries. Most of the studies on determinants of technical efficiency of paddy as well as tea and other vegetable crops done by Sri Lankan researchers using stochastic frontier approach and they is a lack of studies on Translog production frontier method in paddy production. Therefore, this study seeks to estimate the level of technical and its determinants among smallholder paddy farmers at their farm level and fill the research gap using Trans log frontier method in in Kurunegala district. A parametric approach was utilized by Aruna Shantha, Asan Ali, and Bandara (2013) in the study of technical efficiency of paddy farming under major irrigation conditions in the dry zone of Sri Lanka. The empirical study was carried based on a sample of 357 paddy farmers under Nagadeepa reservoir and the results of average technical efficiency of selected farmers given by the Translog model is 72.80 percent. This indicates that there is scope of further increasing the output by 27.2 percent without increasing the level of input. Estimation of technical efficiency in the Translog stochastic production frontier model with an application to oil palm produce mills industry in Nigeria were analysed by Amaechi et al (2014). They used a multi stage sampling method to select 30 mills in the study area and their estimated technical efficiency results showed that, firm level technical efficiency means of 70.62 varies with the range of 37.42% to 93.46%. This wide variation in oil farm output of millers from the frontier model found that those differences management practices of millers than random variability. In addition, their study implies that education, processing experience, membership of cooperative society, credit, fruits petroleum energy and water are the major determinants of technical efficiency. Another study done by Kwabena Nyarko Addai and Victor Owusu (2014) on technical efficiency of maize farmers across various Agro Ecological Zones of Ghana. They done this analysis using Translog stochastic production frontier function and their results showed that, extension, mono cropping, gender, age, land ownership and access to credit positively influence the technical efficiency in maize farming in the study. Nehal Hasnain, Elias Hossain and Khairul Islam (2015) analysed the technical efficiency of rice farms in Meherpur District of Bangladesh and the study in mainly based on primary data that are collected from 126 rice farmers using multistage random sampling technique. The level of technical efficiency of rice farms is estimated by applying Translog production frontier approach and its results proved that the average technical efficiency of aus, aman and boro rice farms in Meherpur district are 87.7%, 86.8% and 8.5% respectively. Estimated results from technical inefficiency found that farm size, labour cost, fertilizer cost and pesticide cost, seed cost, irrigation cost and ploughing cost have significant contribution in changing the level of technical efficiency of rice production. Rudra Bahadur Shrestha et al (2016) examined the determinants of inefficiency in vegetable farms for improving rural household income in Nepal. Translog production function used to analyse the survey data and its results revealed that, the vegetable farms are inefficient and have substantial potential to improve the efficiency levels with greater access to agricultural markets, higher levels of farmers' education, and increased number of trainings to the farmers in Nepal. Umar, H.S., Girei A.A. and Yakubu, D. (2017) have compared the Cobb-Douglas and translog frontier models in the analysis of technical efficiency in dry season tomato production. Data were collected from 60 dry season tomato farmers sampled through three staged random sampling technique. The results showed that the estimated elasticity, efficiency scores and inefficiency effects from Cobb-Douglas and Translog functional forms differ significantly. Dominic Tasila Konjal et al (2019) studied the technical and resource use efficiency among smallholder rice farmers in Northern Ghana. Translog production frontier was analysed to estimate the efficiency scores and technical inefficiency model also employed to identify the factors to factors that determine the technical inefficiency in the study. The results show that, quantity of weedicide, farm size and fertiliser used have positive effects on output of rice and the technical inefficiency of farmers was influenced by age, extension, household size, years of education and credit.

Technical efficiency of barley production in the case of Smallholder farmers in Market district done by Getachew Wollie (2018) in Ethiopia. He used the cross sectional data from a sample of 123 barley producers during the 2016/17 production season was collected by applying two stage random sampling and the results indicated that, education level, extension contact and number of barley plots significantly and negatively affected technical inefficiency score in the study. Ouedraogo

Baowendsom Irène, Pam Zahonogo at el (2019) analyzed the determinants of the technical efficiency of maize farmers in Burkina Faso using stochastic frontier of the Translog production function. Their findings revealed that, age of the farmer, gender, the size of the household, the use of improved maize seeds and organic fertilizers have been identified as the major factors that determining the technical efficiency of maize farmers in the area of study. Yadeta Bekele, Guta Regasa (2019) has examined the technical efficiency of smallholder malt barley producers in Tiyo district in Ethiopia and they used the primary data which were obtained from 162 randomly selected malt barley farmers. Estimated results of the stochastic production frontier model shows that experience, education status, number of oxen, land size, and extension contact significantly affected technical inefficiency of malt barley production in the study.

3. Method of Data collection

In Sri Lanka, there are a number of districts more suitable for the production of paddy, even though this study limits to Kurunegala district. The district has 30 DS divisions and out of them Kuliyapitiya west DS division taken as a sample in this study. This DS division consists of many rural villages and out of them three villages namely, Girakathikumbura, Pahala Diyadora and Inguruwaththa taken with randomly selected farmers. Thus, using multi stage sampling method, the above three villages were taken three villages during the last Maha season in 2019/2020 and from each village, 40 farmers who are cultivating paddy were selected in the study. Even in the district, the farmers are producing vegetables and other crops, only paddy farmers considered to measure the efficiency. The relevant data on the amount of paddy yield, size of cultivated land, major costs of paddy production as well as demographic and farming characteristics also collected through a structured questionnaire. The results that obtained from this study might be limited to that particular area focusing only paddy sector which unable to make inference to all paddy districts in Sri Lanka.

4. Analytical tools and Techniques

The following methods of techniques were applied to analyze the data in the study.

4.1 Frequency Analysis

In the beginning, frequency analysis was used to describe the basic features of selected demographic and farming characteristics in the study. Further, to estimate the technical efficiency scores across paddy farmers and to identify the factors which determine the technical inefficiency, the following two methods were applied in the study.

4.2 Cobb – Douglas production function

This measure of the efficiency scores of individual famers, Cobb - Douglas production function was used in the study where the paddy production taken as output and five inputs such as land size, cost of labour, cost of machinery, cost of fertilizer and cost of chemicals defined as production inputs. The empirical model of the Cobb - Douglas production function taken the paddy production as dependent variable and its major inputs taken as independent variables in the model as below:

$$\boldsymbol{l}nyi = \beta 0 + \beta 1lnX1i + \beta 2lnX2i + \beta 3lnX3i + \beta 4lnX4i + \beta 5lnX5i + \beta 6lnX6i + \varepsilon i \text{ .... (1)}$$

Where,
Ln Y_i = Log of paddy production (kg)
Ln X_1 = Log of cultivated land (perches)
Ln X_2 = Log of labour cost
Ln X_3 = Log of machinery cost
Ln X_4 = Log of fertilizer cost
Ln X_5 = Log of chemicals cost
Ln X_6 = Log of seed cost
β_0 = Constant term
β_1, β_2, β_3, β_4, β_5 and β_6 are the coefficients of each independent variable respectively.
ε_i = Error term

4.3 Translog production function

Translog production function is the generalized form of Cobb -Douglas production function that used in the study to estimate the technical efficiency of paddy. The model can be shown as below:

$$\ln y = \alpha + \sum_{k=1}^{K} \beta_k \ln x_k + \tfrac{1}{2} \sum_{k=1}^{K} \sum_{m=1}^{K} \gamma_{km} \ln x_k \ln x_m$$

.... (2)

Where, α is constant, β is the function parameter which to be estimated for each input, X's are the explanatory variables as mentioned in model (1) while Ln *Y* is the quantity of paddy output in logarithm.

4.4 Inefficiency effect model

After estimating the technical scores using translog production, the inefficiency effect model also employed to identify the impact of farmers' demographic and farming characters on technical inefficiency. For this purpose, variables related to demographic characteristics and farming characteristics among the stakeholder agricultural farmers collected from the respondents in the study area. Thus, the determinants of technical efficiency were modeled in terms of those characters which is specified by the following efficiency model.

$\mu_i = \delta_0 + \delta_1$age $+ \delta_2$gender $+ \delta_3$family size $+ \delta_4$ education $+$
$\delta_5$farm income $+$ δ_6 farming experience $+$ $\delta_7$types of labour $+$
$\delta_8$avialability of creadit accessibility $+$
δ_9 avialable of off farm income
……………………………………………………….... (3)

Where,
μ_i is technical inefficiency and δ_0 is the constant.
From δ_1 to δ_9 represents the coefficients of each variable included in the inefficiency model.

5. Analysis and Discussion

This section describes the estimated results derived from different analytical methods and their discussion illustrated in the study.

5.1 Frequency of the selected variables

The following table describes the basic features of the selected demographic and farming characteristics in terms of frequency and percentage as below.

Table 1. Results of frequency

Variables	Frequency	Percent
Gender		
Male	78	65
Female	42	35
Civil status		
Married	111	92.5
Single	09	7.5
Education		
Primary	60	50
Secondary	60	50
Types of labour		
Family	87	72.5
Hired	33	27.5
Availability of off- farm income		
Yes	78	65
No	42	35
Credit accessibility		
Yes	100	83.3
No	20	16.7

Source: Estimated by authors using SPSS

According to the above table suggests that 65% of the farmers were males, while 35% were females and majority (92.5%) of the farmers were married, while only 7.5% of them were single. In case of both education levels, primary and secondary educated farmers have the same 50% for both education levels and about 72.5% of the farmers managed their paddy farming by family labours and rest of them hired the labours from outside. In addition to the income from farming, 65% of them earning income from non – farm activities whereas 35% of them don't have it. Nearly 83.3% of the farmers have access to financial credit for paddy farming and about 16.7% of them don't have the proper credit facilities in the study. This indicates that, access to financial credit will increase the ability of farmers to purchase the needed inputs to increase the efficiency and productivity of paddy production in their farming.

5.2 Results of Cobb – Douglas production function

The following table shows the estimated results derived from the Cobb – Douglas production function which was used to identify the impact of size of cultivated land and costs of each input on paddy production in the study.

Table 2. Estimated results of Cobb – Douglas production function

Variables	Coefficient	t -ratio	Standardized coefficient
Constant	.193	0.334 (.579)	……..
Ln land size	.933***	15.703 (.059)	.836
Ln labour cost	.030	.659 (.045)	.019
Ln fertilizer cost	-.249**	-2.411 (.103)	-.115
Ln chemical cost	.041	.387 (.106)	.019
Ln seed cost	.232**	2.320 (.100)	.115
Ln machinery cost	.181**	1.909 (.095)	.120

Note: *** and ** represents the statistically significant levels at 1% and 5% respectively Standard errors are in the parentheses

Source: Estimated by authors using SPSS

The estimated coefficients of the model suggest that out of six explanatory variables, all are significant except log of labour costs and log of machinery costs in the model. The coefficients of each variable represent the elasticity of paddy yield with respective inputs which refers to that percentage change in output as a result of 1% change in the input. The coefficient of land size has 0.93 reflects that, as the cultivated land increases by 1% it will lead to producing 93% of more output of paddy keeping all other inputs held constant. Fertilizer cost has negative sign while seed cost has positive indicates that, as farmers spent on more money on the uses of fertilizer and seed by 1%, on average the paddy production will decrease by nearly 25% and it will increase by 23% respectively. The cost for machinery has the lower value of 0.181 shows that, as the machinery cost increases by 1% will lead to enhance the production of paddy by 18% keeping all others variables were constant. The standardize coefficients for the parameters were implied that size of cultivated land is the most effective factor followed by other factors such as, costs for machinery, fertilizer and seed costs to determine the paddy production in the study area.

5.3 Estimation of Translog production frontier

Before preceding the estimation of technical efficiency and its determinants, it is necessary to identify the presence of inefficiency in the production of paddy among paddy farmers in the study area.

Table 3. Estimation of variance parameters using translog production frontier

Variables	Coefficient	Standard error
Sigma- squared (σ^2)	0.119	0.0346***
Gamma (γ)	0.99	0.0045***
Log -likelihood	86.05	
Log –likelihood Ratio (LR) test	66.17***	

Note: *** represents 1% level of significant

Source: Estimated by author using Frontier 4.1

The variance parameters sigma - squared and gamma were found to be highly significant at 1% level and the coefficient of gamma (γ) was 0.99, revealed that more than half of the inefficiencies in paddy farms were attributed by the technical inefficiency and rest of the inefficiencies due to the random error accounted for specified other characters. Thus, this indicates that the explanatory variables specified in the model make a significant contribution in explaining the inefficiency effect associated with paddy production in the study area. Translog production frontier model is employed to estimate the level of technical efficiency of paddy using maximum likelihood estimates of the translog production function and its results were presented in Table 2. According to the estimated maximum likelihood coefficients for the above first six inputs in single terms, size of land was positive whereas costs of chemical, seed cost and machinery cost were negative and found to have significant impact on paddy production. Among the significant inputs, costs of seed showed high input elasticity followed by costs for chemical and machinery.

Table 4. Maximum likelihood estimates of Translog production function

Variables	Coefficient	Standard error	t -ratio
Constant	20.64***	2.95	6.97
Ln land	3.80***	0.80	4.74
Ln labour cost	0.79	0.87	0.911
Ln fertilizer cost	-1.06	1.544	-0.69
Ln chemical cost	10.10***	1.70	5.91
Ln seed cost	-11.78***	2.50	-4.71
Ln machinery cost	-4.78**	1.76	-2.7
(Ln land)^2	-0.014	0.077	-0.17
(Ln labour cost)^2	-0.140**	0.062	-2.251
(Ln fertilizer cost)^2	0.069	0.386	0.180
(Ln chemical cost)^2	-0.066	0.280	-0.237
(Ln seed cost)^2	-0.023	0.267	-0.088
(Ln machinery cost)^2	0.086	0.353	0.244
Ln (Land * labour cost)	-0.027	0.103	-0.270
Ln (Land * fertilizer cost)	-0.247	0.155	-1.583
Ln (Land* chemicals cost)	0.718***	0.223	3.210
Ln (Land * seed cost)	-1.090***	0.356	-3.055
Ln (Land * machinery cost)	0.184	0.346	0.530
Ln (Labour cost * fertilizer cost)	-0.064	0.244	-0.262
Ln (Labour cost * chemical cost)	0.116	0.241	0.483
Ln (Labour cost * seed cost)	0.353**	0.146	2.418
Ln (Labour cost * machinery cost)	-0.186	0.178	-1.04
Ln (Fertilizer cost * chemical cost)	-1.413**	0.518	-2.72
Ln (Fertilizer cost * seed cost)	1.41**	0.536	2.63
Ln (Fertilizer cost*	0.265	0.448	0.591
machinery cost)	-0.096	0.466	-0.207
Ln (Chemical cost * seed	-0.126	0.464	-0.272
cost)	0.426	0.417	1.022
Ln (Chemical cost* machinery cost)			

Ln (Seed cost* machinery cost)	

Note: * ** and ** represent the statistically significant levels at 1% and 5% respectively

Source: Estimated by author using Frontier 4.1

Among the coefficients of inputs in squared terms, only labour squared has negative value $(-0.140)^2$ with significant effect while rest of other inputs were insignificant effect on paddy production in the model. The negative coefficient of the square terms implies that the increase of labour cost may increase the production of paddy at a decreasing rate. According to that, negative sign of cost on labour power implied that further increase in labour cost increases the output of paddy at a decreasing rate of 0.28 Kg in the long run. Among the interaction variables, the coefficients of interaction between (land and chemicals), (labour and seed) and (fertilizer and seed) were significantly positive with implying that an increase in these inputs would increase the yield of paddy production. The interaction between the above variables were positive and significant at 1% and 5% levels implying that increases in the joint use of theses inputs leads to increase in paddy yield and these inputs have complementary effects between them. Hence, these pair input should be increased together to obtain a higher production of paddy. On the other hand, the interaction between **(**land and seed), and (fertilizer and chemicals) were negative and significant at 1% and 5% levels implying that, when the pairs of these factors are jointly increased, the output level of paddy will reduce in the study area. This indicates that statistically these inputs have substitution effects which mean the competitive relationship among these pair of inputs exist in the model. Moreover, coefficients of other interactive variables are statistically insignificant indicating that, they are not influencing the production of paddy and thus not meaning to explain them in the study.

5.4 Distribution of technical efficiencies

The frequency distribution of technical efficiency levels among paddy farmers in the study area is presented by a pie chart in Figure 1.

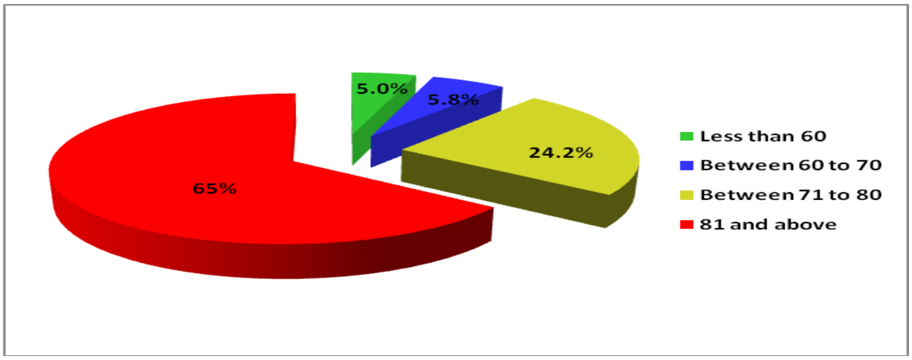

Figure 1. Frequency distribution of technical efficiency

Out of 120 paddy farmers, 65% of them were being operated at more than 81% of technical efficiency which implies that a large number of farmers in the sample attained efficiency in paddy production. About 24% of them were being operated at the efficiency level between the percentages of 71 and 80 and less than 60% of efficiency was attained by 5% of the farmers in the study.

Figure 2 shows the technical efficiency across gender and according to that, 54 male farmers attained the efficiency level at 81 % and above while only 24 female farmers attained the same efficiency level. Less than 60% of the efficiency attained by 4 male and 2 female farmers which represents that, distribution of the efficiency scores attained by male and female farmers significantly differ in the sample.

Figure 2. Efficiency range across gender

Similarly, can be seen in figure 3, farmers who receive off-farm income have a greater margin and reached higher range of efficiency compared to those who do not have it in the study. Out of 120 farmers, 21 of them who have non- farm income belongs to the efficiency range between 71% to 80% and 47 of them belongs to the efficiency level 81% and above in the study area. On the other hand, out of 120 farmers only 8 of them who don't have non – farm income achieved the efficiency range between 71% - 80% whereas, 31of them attained the efficiency level 81% and above. The same results were obtained from the inefficiency effects model which implied that the farmers who have off – farm income, they improved the efficiency of paddy production by spending more money on their farming than others.

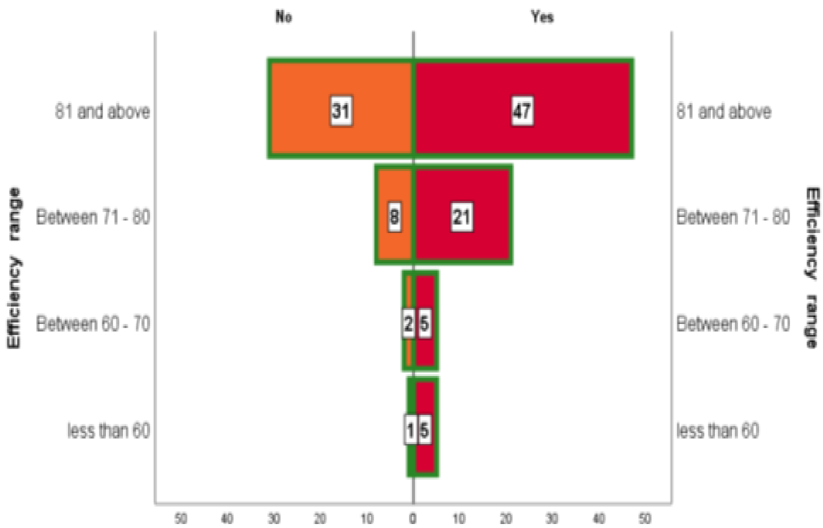

Figure 3. Efficiency range across availability of non- farm income

5.5 Determinants of technical efficiency

In order to identify the sources of technical efficiency differentials among the farmers, technical inefficiency effects model also estimated in the study.

Table 5. Inefficiency effect model

Variables	Coefficient	Standard error	t- ratio
Constant	0.609	0.578	1.053
Age	0.0158	0.011	1.333

Gender	-0.153**	0.076	-2.009
Education	0.0810	0.103	0.781
Family size	-0.327***	0.094	-3.455
Farm income	-0.398E-4***	0.938672E-05	-4.243
Availability of off- farm income	-0.3248**	0.1239	-2.620
Experience in farming	-0.001263	0.000913	-0.138
Types of labour	0.1277	0.104	1.221
Accessibility of credit	-0.00591	0.0872	-0.6780

Note: *** and ** represent the significant levels at 1% and 5% respectively
Source: Estimated by author using Frontier 4.1

According to the estimated results represented in Table 3 suggest that, out of nine perusal factors, four variables such as gender, family size, income from farming and non- farm were found to affect significantly on the inefficiency of paddy farmers. The coefficient of farmers' age was not significant indicates that, whether the farmer is younger or older it will not effect on inefficiency of paddy production in the study. This result is contrast with many other studies where the age has either positive or negative impact on technical inefficiency at statistically significant levels (Goyal et al., 2006; Dominic Tasila Konja., et al., 2019). The gender has negative sign with 5% level of significance indicating that male farmers are operating more efficiently and more likely to be efficient compared to their female counterparts. This could be possible due to the male farmers have better access to institutional support and capital resources than females. Further, male farmers may have more time to spend on farming and more possibilities to adopt new farming practices with hard working than females which contribute to reduce the inefficiency of paddy production. In addition to the age of the farmers, other coefficients for three variables namely education, experience in farming and types of labour were not statistically significant and they were not influencing the technical inefficiency of paddy production in the sample.

The coefficient for family size in the inefficiency model is negative and statistically significant at 1% level shows that the farmers who have more members in the family tend to be more efficient than the farmers who have less members. It is may be due to the fact that farms with large family size may be using their members for the farming as family labour and financially also they can help to spend more money on paddy farming to increase the efficiency compared to those having small family size in the study area. Further, the farmers with large family size would manage crop plots on time than their counterparts especially during the time of peak seasons, there is shortage of labour. This is possible since more labour can be deployed during peak season in order to timely undertake the necessary farming activities like ploughing, weeding and harvesting that raise efficiency. This result is in line with the study by Goyal et al., (2006). The income from paddy farming is significant at 1% level reveals that, as the farm income increases, it is possible to reduce the technical inefficiency by spending more expenditure on paddy to buy necessary inputs and improve the production in the next season.

Further, the estimated result from the inefficiency model reveals that off-farm activity has negative and significant effect at 5% level of significance on farmers' efficiency in paddy cultivation. Incomes from off – farm or non-farm activities may be used as an extra cash to buy agricultural inputs and can also improve risk management capacity of paddy farmers in the sample. The finding of this study is same line with the study done by Aruna Shantha at el. (2013) in Sri Lanka. Finally, credit accessibility has negative sign indicates that, the farmers who have credit facilities, tend to improve the levels of the efficiencies in paddy farming than other farmers who don't have it. However, credit availability is not significant in the model.

6. Conclusion and Implications

Empirical findings of the technical efficiencies indicated that, the farmers achieved 84% of technical efficiency in paddy production on average and 65% of them were being operated at more than 81% of technical efficiency. Cobb – Douglas production function was estimated to identify the impact of each input on paddy yield and the results showed that, size of cultivated land, cost of fertilizer, seed cost and machinery cost were the significant factors in the model.

Results of inefficiency model revealed that gender, family size, farm income and non- farm income were negatively influencing the technical inefficiency in the study. Coefficients of gender and family size have negative signs indicated that male farmers tend to be more efficiency than females and also the farmers who have more members in the family also tend to be more efficiency in the study. Similarly, the coefficients of farm income and availability of non – farm income have negative signs revealed that, the farmers who have more income from paddy farming as well as off- farm income, their efficiency is higher than their counterparts. Based on the evidence, the policy implications are clearly revealed that farmers who have farm and non – farm income should be encouraged more to improve their levels of technical efficiency further. Also, greater efforts must be taken by the financial institutions and banks focusing on credit accessibilities for small farmers which is necessary to stimulate technological that would help them to increase their current levels of efficiency and productivity of paddy yield in future. The findings of this research might have some benefits for paddy farmers to increase the technical efficiency and also the cooperatives could offer some more services to the members which help to improve their profit in paddy production. All these aspects may help to the government and policy makers to take necessary measures actions to improve the paddy farming in the region in future.

Recommendation for Further Research

There are different methods are available to measure the technical efficiency and thus further studies can concern on such methods like stochastic frontier approach, Malmquist index and Fare- Primont index which may more use full to compare the findings in future. Further, by considering different set of other agricultural crops, determinants of technical efficiency and its differential can be compared in future.

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