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***ORIGINAL ARTICLE***

# Does Microcredit Play a Role in Improving the Technical Efficiency of Paddy Farmers? A Case Study in the Anuradhapura District of Sri Lanka

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**Abstract**

This study examines the effect of microcredit on the technical efficiency of paddy production in the *Anuradhapura* district of Sri Lanka using the Cobb-Douglas stochastic frontier analysis. The study employed non-probability sampling techniques to select a sample of 60 farmers consisting of both microcredit borrowers and non-borrowers. The results revealed that the average technical efficiency of the considered paddy farmers was 89%, implying that farmers have the potential to increase their paddy productivity by 11%. Farm inputs such as land extent ($p<0.05$), seed paddy quantity ($p<0.05$), and agrochemical costs($p<0.1$) showed a significant effect on paddy productivity. Agricultural experience ($p<0.05$), education level, extension services, and use of microcredit ($p<0.1$) showed a positive impact on paddy farmers' technical efficiency. The majority of selected farmers (85%) obtained small loans of up to LKR 100,000 for their production, with 57% using only formal credit and 40% using only informal credit. However, there was no significant difference ($p>0.05$) in terms of production efficiency between formal and informal credit access. The results also showed evidence of constant returns to scale. Effective and well-functioning extension services, training to improve the managerial capacity of farmers, and the provision of micro-credit improve the efficiency of paddy production. The findings of this study emphasize the importance of providing agricultural credit facilities to farmers.

***Keywords***: *Cobb Douglas production function, Microcredit, Paddy production, Stochastic frontier analysis*

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## 1. Introduction

Rice is the staple food of almost half of the world's population and about 90 % of the world's rice is produced in Asia (Muthayya et al. 2014). Paddy cultivation is part of Sri Lankan culture and is important for ensuring food security, both at the national and household level. Approximately 1.8 million farm families are engaged in paddy cultivation across the island. Paddy cultivates, on average, 560,000 and 310,000 hectares(ha) in Sri Lanka in two major seasons, namely *Maha* (September to March] and *Yala* (May to August] (Department of Census and Statistics 2019). Approximately 2.7 million tons of rice produced annually, which meets about 95% of the domestic requirement (Rice Research & Development Institution 2020). However, it appears that not all farmers produce at their optimum levels, implying that there is room for improvement in order to reach potential levels. An increase in paddy productivity, will contribute to rural households' income and continue to increase Sri Lanka's comparative advantage in paddy production.

Credit access would be an important factor in improving farming systems because of its capability to access other production factors (Oladeebo and Oladeebo 2008). Credit is regarded as the most important factor in all aspects of production, including agricultural production (Anang et al. 2016). For many years, policymakers and researchers have focused on increasing the efficiency of paddy production systems and improving the comparative advantage of Sri Lanka's paddy industry. Access to credit has also been identified as a critical factor in improving paddy production in developing countries (Duy 2015). This fact is validated in this study by taking into account the microcredit and technical efficiency levels of paddy production in the *Anuradhapura* district of Sri Lanka.

The efficiency of production can be defined as the ability to produce a given level of output using a minimum quantity of input sets or to produce maximum output from a given set of inputs under a certain production technology (Rahman et al. 2012). Measurement of efficiency draws on the seminal work of Farell (1957) in which Farrell suggested that the efficiency of a firm consists of two components: technical and allocative efficiency. Technical efficiency is used to measures the variation that exists among the farmer's production. There is a measuring gap between what farmers produce and what they can produce from the given resources and technology. Hence this study attempted to measure the technical efficiency of paddy production in the Anuradhapura district. Most studies have considered the technical efficiency of paddy production worldwide (Nguyen et al. 2020; Afrin et al. 2017; Anang et al. 2016; and Xiao and Li 2011). Nguyen et al. (2020) studied the weather shocks, credit, and production efficiency of rice farmers in Vietnam and found that access to credit plays a significant role in alleviating the negative impact of weather shocks on rice production. Anang et al. (2016) examined the microcredit and technical efficiency of smallholder rice farmers in Northern Ghana. Findings show that credit-participating households are technically more efficient (63%) than non-participants (61.7%).

Gunaratne and Thiruchelvam (2002) and Shantha (2013) investigated the technical efficiency of paddy production under major and minor irrigation schemes in Sri Lanka. The results of these studies suggest that increasing technical efficiency is the most appropriate means of enhancing paddy production in irrigation systems. Illukpitiya and Yanagida (2016) investigated the determinants of improving agricultural production through technical efficiency, as a case study of smallholder paddy farming in Sri Lanka. The study found that age, education, experience, and extension assistance for farmers are the major factors affecting technical inefficiency. Thiruchelvam (2005) investigated the efficiency of rice production and issues related to the cost of production in the *Anuradhapura* and *Polonnaruwa* districts. It finds that small landholdings, high post-harvest losses, low output quality, high production costs, and poor participation in farmer organization activities have a significant impact on the efficiency of low-performing farmers in both districts. An investigation into the technical efficiency of paddy farmers in the *Batticaloa* district finds that training for farmers, fertilizer subsidies, irrigation systems, farmer experience, and family size are key factors contributing to efficient production (Bhavan and Maheswaranathan 2014).

The lack of financial capacity is one of the major constraints faced by paddy farmers in Sri Lanka (Adhikarinayake 2005; Kajenthini and Thayaparan 2017). Microcredit is an option to reduce financial limitations and contributes to increasing the efficiency of paddy production by enabling them to purchase the necessary inputs on time (Rahman et al. 2012). In addition, access to credit also enables farmers to adopt more capital-intensive production methods (Hazarika and Aiwang 2003). However, it is indicated that the capacity of farmers to adopt improved production technologies is limited for resource-poor farmers. In view of the importance of this, the government, as well as many financial institutions, are involved in financing the agricultural sector. Farmers have access to credit from both formal financial institutions and informal channels. Regulated banks and leasing companies, finance companies, cooperatives, NGO-MFIs, and CBOs serve as sources of formal finance (Kelegama and Tilakaratane 2014). Alternatively, money lenders, pawnbrokers, traders and merchants, landlords, friends, and relatives act as informal sources of credit. However, the impact of microcredit on the technical efficiency of paddy production is not adequately investigated. For instance, the type of microcredit, whether formal or informal, may have a different impact on technical efficiency which has yet to be explored. More specifically, the study addresses the following research questions.

(1) What is the level of technical efficiency of paddy production in the *Anuradhapura* district?

(2) What are the determinants of the technical efficiency of paddy farmers?

(3) How does microcredit (formal and informal) affect the technical efficiency of paddy production in the *Anuradhapura* district?

The rest of the article is organized as follows. Section 2 sets out the methodology used for the present research work. The empirical results and discussion of the findings are provided in Section 3. Finally, Sections 4 and 5 offer conclusions and recommendations.

## 2. Methodology

***Study area, sampling and data collection***

All paddy farmers in the *Anuradhapura* district were considered as the target population of the study. Out of 43 Agrarian Service Centers (ASCs) in the district, four of them namely, *Talawa*, *Eppawala*,*Pemaduwa*, and *Thanthirimale* were purposively selected based on the land extensiveness of paddy cultivation. The study employed a combination of non-probability sampling techniques (i.e. quota and snowball sampling) to select 60 farmers consisting of both microcredit borrowers (35 farmers) and non-borrowers (25 farmers) from the selected ASCs. Given the purpose of the study, the sample required the inclusion of microcredit borrowers both from formal and informal sources together with non-borrowers. The lack of information on credit borrowers made it difficult in accessing them for the survey and hence employed a snowball sampling technique for the selection. Also, a quota sampling technique was employed, specifically to select non-borrowers where the selection is based on some predetermined characteristics to equalize two categories so that the total sample is assumed to have the same distribution of characteristics as the wider population. Primary data were collected through a field survey using a structured and pre-tested questionnaire that consists of information relevant to paddy production (quantity and price details of the inputs and outputs), socio-demographics of the respondents, access to microcredit, and key management practices of paddy cultivation. The field survey was conducted in the selected ASCs during the *Maha* season 2019/2020. A comparison was done using sample parameters with published statistics (DoA,2020) for the *Anuradhapura* district. There is no significant difference between sample parameters and published statistics (paddy output, $p=0.51$; the amount of seed paddy, $p=0.77$; cost of machinery, $p=0.33$, and cost of agrochemicals, $p=0.49$) confirming that the used sample adequately represents the target population.

***Theoretical model***

A producer or a company is technically efficient in production if it is possible to achieve maximum output from a given set of inputs and production technology. This implies that, given the fixed input levels, the producer necessarily produces at or very close to the production frontier. Since the producers are different in their capacity to produce, relative efficiency is considered to be technical efficiency (Akram et al. 2013). Two broad approaches, parametric and non-parametric methods, are used to estimate technical efficiency (Chakraborty et al. 1999). The parametric approach often involves Stochastic Frontier Analysis (SFA), while the latter uses Data Envelopment Analysis (DEA) (Anang et al. 2016). The parametric approach is based on a regression model consisting of a deterministic component and an error term. The non-deterministic part is caused by stochastic error and inefficiency.

The general form of the Stochastic Frontier Production Function (SFPF) is specified as follows:

$$Y_i = f(\beta X_i) + \exp(V_i - U_i) \qquad \text{(Eq. 1)}$$

where, respondents and inputs (variables) are represented by subscripts *i*;

$Y_i$ = Total production of $i^{th}$ farmer output of paddy

$X_i$ = vector of inputs $i^{th}$ farmer

$\beta$ = vector of parameters to be estimated

$V_i$ = random error term (which is not under the control of the farmers (such as rainfall, natural hazards), having N (0, $\sigma_v^2$ ) distribution)

$U_i$ = non-negative random error term (which is associate with factors responsible for the farmer's inefficiency and assumed that the inefficiency effects are independently distributed with a half-normal distribution (U~ $N(0, \sigma_u^2)$ )

Technical efficiency (TE) is determined as the ratio of the observed output $Y_i$ to the corresponding frontier output $Y_i^*$ that represents by the following equation.

$$TE_i = \frac{Y_i}{Y_i^*} = \frac{\exp(Xi\,\beta + Vi - Ui)}{\exp(Xi\,\beta + Vi)} = \exp(-Ui) \quad \text{(Eq. 2)}$$

where, $0 \le TE \le 1$.

In the second stage, technical inefficiency is estimated. The technical inefficiency effect is;

$$U_i = \delta_0 + \delta_i Z_i \quad \text{(Eq. 3)}$$

where, $Z_i$ represents a vector of socio-economic factors and other determinants of technical efficiency and δ is a vector of unknown coefficients of the farm-specific inefficiency effects.

***Empirical model***

Both the Cobb-Douglas and the Transcendental Logarithmic (translog) functions developed by Christensen et al. (1973) are widely used for econometric estimation (Asante et al. 2013). However, the Cobb-Douglas function is the preferred production function for this study, given the simplicity of the model and the efficient handling of multicollinearity, heteroscedasticity, and autocorrelation problems. The specification of the model used in this study is expressed below:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + (Vi - Ui) \quad \text{(Eq. 4)}$$

where, *ln* denotes the natural logarithm,

$Y$ = total paddy yield (kg)
$X_1$= total land area of paddy cultivated (ha)
$X_2$= total labor (man-days)
$X_3$= quantity of seed planted (kg)
$X_4$= cost of the machinery (LKR)
$X_5$= cost of fertilizer applied (LKR)
$X_6$= cost of agrochemicals (LKR)

The technical inefficiency effect $U_i$ is defined as follows.

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 \ldots\ldots\ldots\ldots\ldots.\ldots\ldots + \delta_{11} Z_{11} + e_i \quad \text{(Eq. 5)}$$

where, $\delta_i$ is the coefficient of the explanatory variables. $Z_i$ represents socio-economic factors accounting for inefficiency in paddy production. $e_i$ is the random error term in the model. The $Z_i$ variables included in the inefficiency model are shown in Table 1.

**Table 1.** Variable description of the technical inefficiency model

| Variable description | Unit of measurements |
|---|---|
| Gender of the farmer ($Z_1$) | Male=1 and Female=0 |
| Age of the farmer ($Z_2$) | No. of years |
| Farming experience ($Z_3$) | No. of years |
| Educational level ($Z_4$) | None=1, Primary=2, Middle 6-10=3, O/L=4 and A/L=5 |
| Size of the household ($Z_5$) | Number of people living in one household |
| Membership in farmer organization ($Z_6$) | Member=1, Non-member=0 |
| Contact with extension agents ($Z_7$) | No. of effective contacts |
| Off-farm income source ($Z_8$) | Exist=1, Non-exist =0 |
| Microcredit usage ($Z_9$) | Yes=1, No=0 |
| Mortgage practice ($Z_{10}$) | Yes=1, No=0 |
| Loan source ($Z_{11}$) | Formal=1, Informal=0 and Both=2 |

Estimates of the parameters for the SFA were obtained using the computer program, FRONTIER version 4.1.

## 3. Results and Discussion

***Descriptive statistics***

The sample included 58% microcredit borrowers and 42% non-borrowers. Table 2 provides descriptive statistics for the key variables used in the stochastic frontier production (SFP) models. The study focused on farmers who relied heavily on paddy cultivation as their primary source of income. The production includes harvest that is sold, kept for seed, and reserved for home consumption. The results show that an average paddy yield of 5,744.12 kgha which is comparable to the district's average paddy yield (5,785 kgha$^{-1}$) in the 2018/2019 *Maha* season (Department of Census and Statistics 2019). Paddy yield varies greatly, ranging from 2,576.54 kgha$^{-1}$ to a maximum of 8,588.47 kgha$^{-1}$. The average farm size for paddy production in the area is 0.93ha, with sizes ranging from 0.3 to 4 ha. The average labor use per hectare is approximately 27 man-days. The average amount of seed paddy used per ha is 113.15 kg. The average cost of machinery, fertilizer, and agrochemicals per ha is LKR 44,629.63, LKR 6,357.10, and LKR 12,573.11, respectively.

**Table 2.** Descriptive statistics of the variables used in the SFP model

| Variable | Minimum | Maximum | Mean | Std. deviation |
|---|---|---|---|---|
| Paddy yield (kgha$^{-1}$) | 2,576.54 | 8,588.47 | 5,744.12 | 965.99 |
| Land (ha) | 0.30 | 4.05 | 0.93 | 0.08 |
| Labor (man-daysha$^{-1}$) | 4.93 | 39.50 | 27.09 | 0.83 |
| Seed paddy (kgha$^{-1}$) | 46.37 | 154.59 | 113.15 | 2.50 |
| Machinery cost (LKRha$^{-1}$) | 24,691.35 | 55,555.55 | 44,629.62 | 1,314.89 |
| Fertilizer cost (LKRha$^{-1}$) | 3,209.87 | 2,2716.04 | 6,357.10 | 439.65 |
| Agrochemical cost (LKRha$^{-1}$) | 2,345.67 | 35,308.64 | 12,573.11 | 797.19 |

### *Technical efficiency*

The maximum likelihood estimates of the parameters of the Cobb-Douglas SFPF and inefficiency model given by the two equations (Eq 4 and 5) were simultaneously obtained by using Frontier 4.1 software and are presented in Tables 3 and 4. As shown in Table 3, the estimated coefficients are the direct input elasticities of the SFPF. It indicates that the magnitude of the output elasticity concerning the cultivated extent is 0.87 and is positive and statistically significant at a 99% confidence interval. This implies that a one percent increase in paddy cultivated extent will increase paddy output/unit area by 0.87%.

It reflects the fact that the land is an important factor of paddy production in the study area. This finding is consistent with the findings of Kajenthin and Thayaparan (2017); Bhavan and Maheswaranathan (2014); and Gunaratne and Thiruchelvam (2002).

The output elasticity of the seed paddy is 0.24, which is statistically significant at a five percent confidence level. This implies that a one percent increase in seed paddy will increase the output/unit area of paddy by 0.24%. This finding is consistent with the work of Abdallah (2016) and Zalkuw et al. (2014) who found that seed was a significant factor in production. The output elasticity of the cost of agrochemicals is 0.07 and is statistically significant at 10%, which implies that a one percent increase in the cost of agrochemicals will increase the output/unit area of paddy production by 0.07%. However, the estimated output elasticities of labor, cost of machinery, and fertilizer are found to be negative and insignificant. The result is inconsistent with the work of Duy (2015), who found that the cost of agrochemicals is a significant factor in paddy cultivation.

**Table 3.** Maximum-likelihood estimates of the parameters of the SFP model

| Variables | Co-efficient | |
|---|---|---|
| Intercept ($\beta_0$) | 8.01*** | (0.97) |
| Land ($\beta_1$) | 0.87*** | (0.14) |
| Labor ($\beta_2$) | -0.10 | (0.12) |
| Seed paddy ($\beta_3$) | 0.24** | (0.13) |
| Machinery cost ($\beta_4$) | -0.07 | (0.06) |
| Fertilizer cost ($\beta_5$) | -0.01 | (0.07) |
| Agrochemical cost ($\beta_6$) | 0.07* | (0.03) |
| Return to scale | 1.01 | |

***, ** and * denote significant at 1%, 5% and 10% respectively. Standard errors are in parenthesis.

The sum of elasticity of production reveals information about the returns to scale, that is, the response of output to a proportionate change in input. If the sum of elasticity is one, then the returns to scale is constant. It means that doubling the inputs will result in a doubled output, tripling the inputs will result in a tripled output, and so on. If the sum of elasticity is less than one, the returns to scale is decreasing. It can be stated that doubling the input results in less than doubling the output. Accordingly, if the total elasticity is greater than one, there is increasing returns to scale; doubling the inputs results in more than doubling the output (Gujarati, 2007). The estimated returns to scale at mean input values in this study was 1.01. (Table 3), which is closer to one indicating constant returns to scale. Furthermore, hypothesis testing was done using a t-test and the computed $p$-value is 0.91. Hence the null hypothesis of constant returns to scale cannot be rejected, confirming that the specified Cobb Douglas production function in this study exhibits constant returns to scale.

***Technical efficiency indices***

Figure 1 shows the distribution of the estimated technical efficiency of the respondents. The average technical efficiency is 0.89 with a maximum of 0.98 and a minimum of 0.44. This means that, on average, paddy farmers produce about 89% of the potential of (stochastic) frontier production levels, given the technology currently in use. Therefore, there is a capacity to increase paddy production by 11% through the adoption and use of the best techniques and practices used by paddy farms in the study area. In the present study, the majority of paddy farmers (70%) have a technical efficiency between 0.91 and 1.00. Twenty-seven percent of paddy farmers have a technical efficiency in the range of 0.81-0.90. The remaining proportion of farmers shows that the technical efficiency ranges from 0.41 to 0.70. This implies that most of the sampled paddy farmers are technically efficient on average in the allocation and use of inputs and technology in their production. Similar results have been reported by Illukpitiya and Yanagida (2016); Hasnain et al. (2015); and Gedara et al. (2012) which show that the average technical efficiency of paddy farms is 74, 89.5, and 72 percent respectively.

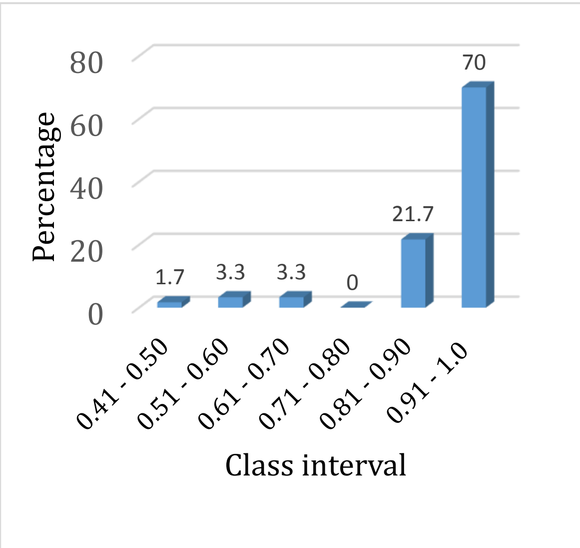


**Figure 1.** Frequency distribution of technical efficiency scores

### *Factors affecting technical inefficiency*

Table 4 presents the coefficients of the inefficiency model, which explains the level of technical inefficiency among the paddy farmers considered. It should be noted that the signs of the coefficient in the inefficiency model are interpreted in the opposite direction and therefore, a negative sign indicates that the variable increases efficiency and the positive sign indicates that the efficiency decreases (Adebayo 2007). The farming experience coefficient (0.03) is negative and statistically significant at the five percent confidence level. This implies that more experienced farmers are more efficient than those with less experience and it suggests that farming experience is a critical factor.

The estimated educational level coefficient (-0.13) is negative and statistically significant at a 10% confidence level. This means that the knowledge acquired by farmers is linked to the higher technical efficiency of paddy production. Besides, education improves the ability of farmers to read and understand agricultural information and basic instructions on the rates of application of agrochemicals, fertilizers, seeds, and other inputs. Also, the level of education has a positive relationship with entrepreneurship and hence the efficiency of production. This implies that at least some level of formal education for farmers is better suited to become efficient producers. In addition, the estimated extension service coefficient (-0.17) also shows a negative and statistically significant sign at a 10% confidence level. This indicates that increased access to extension services is likely to improve technical efficiency. Illukpitiya and Yanagida (2016) found similar effects of experience, education, and extension services on the efficiency of paddy production.

The current study focuses on the role of microcredit in technical efficiency, which is captured by the variable "microcredit usage" in the inefficiency model. Given a negative significant coefficient for microcredit usage in the inefficiency model, there is a positive relationship between microcredit usage and paddy production efficiency when compared to non-users. The coefficient value for this variable is -1.31, indicating that farmers who use microcredit are 1.31 times more efficient in paddy production than non-users. Credit availability shifts the cash constraint outward and enables farmers to purchase production inputs at the most appropriate times and to have a better choice of technology when funding is available from loans. Availability of credit also facilitates investing in expanding the production through new technologies. Furthermore, it contributes significantly to the reduction of risk and to access all the resources on which farmers depend in the production process. The results of this study are consistent with Idiong (2007); Akram et al. (2013); and Udayangani et al. (2006).

**Table 4.** Maximum likelihood estimates for the parameters of the inefficiency effects model

| **Variables** | **Co-efficient** | |
|---|---|---|
| Intercept ($\delta_0$) | -0.12 | (0.98) |
| Gender ($\delta_1$) | 0.26 | (0.34) |
| Age ($\delta_2$) | 0.02 | (0.01) |
| Farming experience ($\delta_3$) | -0.03** | (0.01) |
| Educational level ($\delta_4$) | -0.13* | (0.11) |
| Household size ($\delta_5$) | -0.33 | (0.21) |
| Membership in FO ($\delta_6$) | -0.12 | (0.98) |
| Extension service ($\delta_7$) | -0.17* | (0.15) |
| Off farm income ($\delta_8$) | 0.31 | (0.28) |
| Microcredit usage ($\delta_9$) | -1.31* | (0.78) |
| Mortgage practice ($\delta_{10}$) | 0.34 | (0.22) |
| Loan source ($\delta_{11}$) | -0.70 | (0.52) |
| **Variance of parameters** | | |
| Sigma square ($\sigma^{2)}$) | 0.07** | (0.03) |
| Gamma ($\gamma$) | 0.88*** | (0.05) |

***, ** and * denote significant at 1%, 5% and 10% respectively. Standard errors are in parenthesis.

Coefficients of the household size (-0.32), the membership in the farmer organization (-0.12), and the source of the loan (-0.70) also show negative signs. These factors, however, are statistically insignificant in the current study. Coefficients of gender (0.29), age (0.02), non-farm income (0.31), and mortgage practices (0.34) show positive and statistically insignificant effects in the present study.

The estimated sigma squared ($\sigma^2$) is 0.07 and is significantly different from zero (Table 4). This indicates that there is a good fit and correctness of the specified distributional assumption for the composite error term. The variance ratio of gamma ($\gamma$) associated with the variance of the technical inefficiency effect at the stochastic frontier is 0.88 in the production system. This indicates that the variation in paddy output/unit area is due to a higher percentage (88%) of technical inefficiency, implying that a small percentage (12%) is due to random shocks outside the control of farmers.

***Formal and informal credit sources***

When considering the source of the loan, there is no significant difference in the efficiency of production between formal and informal access of credit. That is, both formal and informal credit appear to improve the technical efficiency of paddy production in the same way. This finding is consistent with Duy's work (2015). Further, 57% of farmers use formal sources of credit as their financial source, while 40% of farmers use informal sources of credit (Figure 2). Figure 3 shows the distribution of the loan amount borrowed by the respondents. The mean value of the loan amount taken is LKR 49,857, ranging from a minimum of LKR 10,000 to a maximum of LKR 150,000. A large number of farmers (85%) take up small loans not exceeding LKR 100,000. In addition, most farmers (45%) have a loan intake of LKR 50,000 to 99,999.

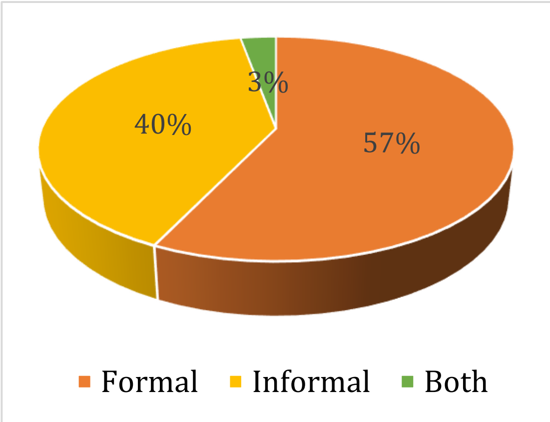


**Figure 2.** Distribution of loan source

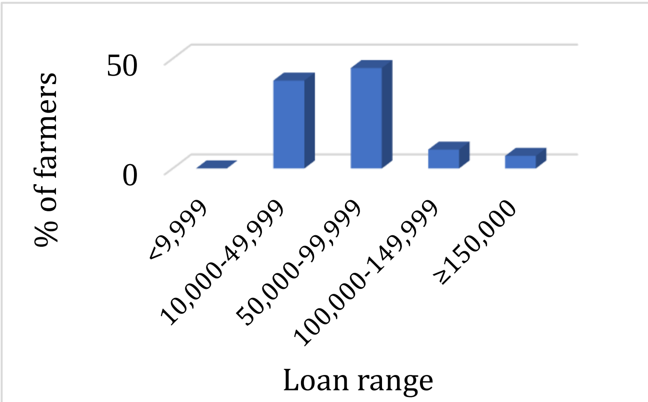


**Figure 3.** Distribution of loan amount

## 4. Conclusions

This paper investigated whether microcredit plays a role in improving the technical efficiency of paddy production in Sri Lanka, as a case study in the Anuradhapura district. The stochastic frontier approach and the Cobb Douglas production function were used in the study to determine the levels of technical efficiency, the magnitudes of the impact of technical inputs, and the socioeconomic factors influencing technical inefficiency. The results revealed that the average technical efficiency of paddy production was 89% in the area implying that the resource allocation of farmers is efficient. However, still, there is a scope to increase production by increasing its efficiency. Among the technical inputs, land, seed paddy and agrochemicals showed positive significant effects on paddy production. The role of microcredit on technical efficiency, as expressed by farmer microcredit usage, has a positive and significant impact on technical efficiency. The use of microcredit improves farmers' ability to overcome cash constraints in input purchases and use new technology. Furthermore, the results revealed that the agricultural experience of the farmer, the level of farmers' education, and the access to extension services significantly improved the technical efficiency of paddy production in the area. Although credit usage has a significant positive impact on paddy production efficiency, the source of credit, whether formal or informal, does not provide sufficient evidence to show a significant impact on technical efficiency in this study.

**Conflicts of interest:** The authors have no conflicts of interest regarding this publication.

## 5. References

Abdallah A (2016) Agricultural credit and technical efficiency in Ghana : is there a nexus. 76(2) pp. 309–324. doi: 10.1108/AFR-01-2016-0002.

Adebayo E F (2007). Analyzing the technical efficiency of rubber tapping in Nigeria. Journal of Agriculture and Social Sciences (Pakistan).

Adhikarinayake T B (2005) Methodical design process to improve income of Paddy farmers in Sri Lanka.

Afrin S, Haider M Z, Islam M S (2017) Impact of financial inclusion on technical efficiency of paddy farmers in Bangladesh: Agricultural Finance Review. 77(4), pp. 484–505. doi: 10.1108/AFR-06-2016-0058.

Akram W, Hussain Z, Ahamad N, Hussain I (2013) Does agriculture credit affect production efficiency ? Frontier production function approach. 51(2), pp. 179–190.

Anang B T, Backman S, Sipilainen T (2016) Agricultural microcredit and technical efficiency: The case of smallholder rice farmers in Northern Ghana. Journal of Agriculture and Rural Development in the Tropics and Subtropics, 117(2), pp. 189–202.

Asante B O, Osei M K, Dankyi A A, Berchie J N, Mochiah M B, Lamptey J N L, Haleegoah J, Bolfrey-Arku G (2013) Producer characteristics and determinants of technical efficiency of tomato based production systems in Ghana. 5(March), pp. 92–103. doi: 10.5897/JDAE12.054.

Bhavan T, Maheswaranathan S (2014) Technical efficiency of paddy farmers in Batticaloa district of Sri Lanka (December 2012).

Chakraborty K (1999) Technical efficiency in stochastic production frontier : a simultaneous equation approach. Economic research institute study papers, Paper 160.

Christensen L R, Jorgenson D W, Lau L J (1973) Transcendental logarithmic production frontiers. The review of economics and statistics, 28-45.

Department of Agriculture: Cost of Cultivation of Agricultural Crops 2018/2019 Maha (2020), Peradeniya, Sri Lanka.

Department of Census and Statistics: Paddy statistics 2018/2019 Maha Report (2019), Colombo, Sri Lanka, pp. 2.

Duy V Q (2015) Access to credit and rice production efficiency of rural households in the Mekong Delta: Sociology and Anthropology, 3(9), pp. 425–433. doi: 10.13189/sa. 2015.03 0901.

Farell M J (1957) The measurement of productive efficiency, J. Royal Statistics Assoc. Series A (general) 21:253-281.

Gedara K M, Wilson C, Pascoe S, Robinson T (2012) Factors Affecting Technical Efficiency of Rice Farmers in Village Reservoir Irrigation Systems of Sri Lanka. pp. 1–12. doi: 10.1111/j.1477-9552.2012.00343.x.

Gujarati D N (2007) Basic Econometrics, 4$^{th}$ ed. Newdelhi: Tata McGraw-Hill

Publish Company Limited.

Gunaratne R U M S, Thiruchelvam S (2002) Comparative Study on Technical Efficiency of Paddy Production Under Major and Minor Irrigation Schemes in *Anuradhapura* District. 14, pp. 341–350.

Hasnain N, Hossain E, Islam K, (2015) Technical Efficiency of Boro Rice Production in Meherpur District of Bangladesh : A Stochastic Frontier Approach 3(2), pp. 31–37. doi: 10.11648/j.ajaf.20150302.14

Hazarika G, Ai J (2003) Access to credit, plot size and cost inefficiency among smallholder tobacco cultivators in Malawi. 5150(03). doi: 10.1016/50169-5150(03)00020-3.

Idiong I C (2007) Estimation of farm level technical efficiency in smallscale swamp rice production in Cross River State of Nigeria : A stochastic frontier approach 3(5), pp. 653–658.

Illukpitiya P, Yanagida J F (2016) Improving agricultural production through technical efficiency : A case study of small-holder paddy farming in Sri Lanka (February).

Kajenthini A, Thayaparan A (2017) Impact of Microfinance Loans on Paddy. 17(4).

Kelegama S, Tilakaratane G (2014) Financial Inclusion, Regulation, and Education in Sri Lanka. SSRN Electronic Journal,(504).doi:10.2139/ssrn.2528926.

Muthayya S, Sugimoto J D, Montgomery S, and Maberly G F (2014) An overview of global rice production, supply, trade, and consumption: Annals of the New York Academy of Sciences, 1324(1), 7-14.

Nguyen T T, Nguyen T T, Grote U (2020) Weather Shocks, Credit and Production Efficiency of Rice Farmers in Vietnam. 03(March).

Oladeebo J O, Oladeebo O E (2008) Determinants of Loan Repayment among Smallholder Farmers in Ogbomoso Agricultural Zone of Oyo State, Nigeria, Journal Social Science17, 59-62.

Rahman K M M, Mia M I A, Bhuiyan M K J (2012) A stochastic frontier approach to model technical efficiency of rice farmers in Bangladesh : An empirical analysis. 10(November), pp. 9–19.

Rice Research & Development Institute, Bathalagoda (2020) [Online] Available at:<https://doa.gov.lk/rrdi/index.php?option=com_sppagebuilder&view=page&id=42&lang=en> [Accessed 11 January 2020].

Shantha A A (2013) Technical Efficiency Of Paddy Farming Under Major Irrigation Conditions In The Dry-Zone Of Sri Lanka: A Parametric Approach. Australian Journal of Basic and Applied Sciences, (April 2013), pp. 104–112.

Thiruchelvam S (2005) Efficiency of rice production and issues relating to cost of production in the districts of *Anuradhapura* and *Polonnaruwa*. Journal of the National Science Foundation of Sri Lanka, 33(4), pp. 247–256. doi: 10.4038/jnsfsr.v33i4.2114.

Udayanganie A D D, Prasada D V P, Kodithuwakku K A S S, Weerahewa J, Little D C (2006) Efficiency of the agrochemical input usage in the paddy farming systems in the dry zone of Sri Lanka. pp. 1–21.

Wijesinghe P (2015) Technical efficiency of paddy farming in low country wet zone.

Xiao J, Li D (2011) An analysis on technical efficiency of paddy production in China. Asian Social Science, 7(6), pp. 170–176. doi: 10.5539/ass.v7n6p170.

Zalkuw J,Singh R, Pardhi R, Gangwar A (2014) nalysis of technical efficiency of tomato production in Adamawa State, Nigeria. International Journal of Agriculture, Environment and Biotechnology, 7(3),645.