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# Technical Efficiency of Brinjal Farmers in Sri Lanka: Translog Production Frontier Approach

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## Article Information



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## Abstract

This study estimates the technical efficiency and identifies the determinants of brinjal farming in Vavuniya district, Sri Lanka. The multi-stage sampling method was employed with cross sectional data in selection of 50 brinjal farmers from five villages during the year of 2017/2018. The Translog Production Frontier Model was used to analyse the data. Results revealed that the variance parameter is statistically significant; implying that variation in brinjal output is due to the inefficiency effects rather than random variability. The results of the analysis also revealed that the mean technical efficiency of brinjal was 79.98 %, ranging from 35.54% to 99.86% implies that brinjal producers can reduce current level of input application by 20% given existing technology at the farm level. The estimated Translog Frontier Model shows that costs of labour, capital, and raw materials are the significant determinants of brinjal production in the study area. All possible interactions between the inputs have significantly affected on yield of brinjal and it has been observed the negative and positive signs, reflecting that there is substitution and complementary effects exist among the pair of inputs. Results of Translog function together with the parameters for technical inefficiency effects show that education, extension services and ownership of land found to be significantly affected the technical efficiency of brinjal cultivation in Vavuniya district in Sri Lanka. Findings of the study recommended that emphasis should be given for less efficient farmers to improve the efficiency by adopting the new practices and effective extension services which help them to operate at the frontier in future.

## Introduction

Traditionally, agricultural sector is one of the main sectors in Sri Lanka. Agricultural sector contributes about 7 percent to the national GDP out of which the fisheries sector contributes around 1.2 percent and the livestock sector accounts for 0.6 percent (Expert, 2019). In the domestic agricultural sector, paddy is the main sub-sector that provides the food security in the country and followed by vegetables and fruits are the second major sectors in Sri Lanka. In 2017, 1.5 million Metric ton of vegetable production produced and nearly 26.1% of the people employed in the agricultural sector as well as, it contribute to generate new employment opportunities, earning farm income and export revenue in Sri Lanka (Central Bank Report, 2017).

Sri Lanka has a wide variation in soil and climate with different agro-ecological regions facilitate to cultivate different kinds of vegetable crops. The upcountry vegetables constitute crops such as cabbage, carrot, beetroot, cauliflower, bean, tomato, etc, and the low-country vegetables, which include brinjal, bitter gourd, pumpkin, luffa, cucumber and snake gourd, cultivating less intensively under low input systems..

Vavuniya is predominantly an agricultural district, majoring paddy cultivation and in addition, field crops, livestock, forestry and inland fisheries sectors available in the district. There are 30,912 farm families engaged in agriculture and agricultural related activities. The water resources mainly depend on rainfall and out of 674 minor irrigation schemes. The district also has one major tank, 21 medium tanks, and 674 minor irrigation tanks including 26 anicuts. Recent surveys indicated that 38% of the total land is engaged in agriculture and 47% of the land is under forest. The cultivated field crops include cereals, pulses, oil seeds, root and tuber crops, low country vegetables, up country vegetables and minor export crops etc. (District development plan, Vavuniya-2018-2022). Due to the 30 years of civil war, the district severely affected. Nowadays, it is an emerging district and most of the rural farmers are engaged in cultivating a variety of vegetable crops especially brinjal, long beans, tomato and other field crops and fruits by using traditional agricultural knowledge and techniques. Among the vegetable crops, brinjal is one of the most preferable crops for farmers, which is cultivating mainly for local consumption purpose in most parts of the Northern Province in Sri Lanka.

There are two cultivation seasons namely; Maha and Yala which are synonymous with two monsoons Statistics (2019). Maha Season falls during "North-east monsoon" from September to March in the following year. Yala season is effective during the period from May to end of August. This study focus the cultivation and production of brinjal in Maha season, which is 200(Ha) and 3436Mt in 2016/2017 respectively (Five Year Development Plan, Vavuniya District, 2018-2022).

Developing countries like Sri Lanka, the agricultural research efforts are more important to direct towards development of agriculture technologies and to maximum utilization of local inputs in crop production, which is directly impact on increasing production, and reducing costs. In order to improve brinjal production and its productivity, an efficient use of production inputs has necessary for smallholder farmers in the district as well as in the country. Thus, an understanding of the relationships between productivity, efficiency and the farm production techniques would provide policy makers with information to

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design programs that can contribute to increase the food production among smallholder farmers in the study area.

In this above background, this study intends to answer the following questions.

1. Does the brinjal cultivation attains the efficiency or not in the study area?
2. How does the demographic and farming characters effect on technical efficiency in brinjal cultivation?

Objectives of the study have been derived from the research questions to estimate the technical efficiency and identify in what extent the demographic and farming characters determine the efficiency among the brinjal cultivators in Vavuniya District.

## Literature Review

Traditionally, technical efficiency measured as a ratio of output to input and the optimization of technical efficiency can occur by maximizing the outputs for a given input or by minimizing the inputs for a given output. It is not possible to maximize output and minimize inputs at the same time. Technical efficiency is used to estimate the capacity of an industry or firm or farmer to achieve the maximum output with given and obtainable technology. The concept of the technical efficiency has been fundamental for the development and application of econometric models of frontier functions, which enhance the productivity of the output and as well as stability of production in the country as well. Estimates on the extent of inefficiencies could help to make the decision whether to improve efficiency or to develop new technology is necessary to raise the productivity of the output.

Previously, there are many studies have been carried out to analysis for the measurement of efficiency of any agricultural production in worldwide. However, a few empirical studies done by the researchers to estimate the technical efficiency of brinjal production among smallholder farmers particularly in Vavuniya district using stochastic frontier model. In this background, there is a need to do a study related to brinjal production in the district which may contributes to identify the factors influencing the efficiency of the output in the area.

Determinants of technical efficiency differentials among maize farmers in Nigeria were analysed by Olarinde (2011). For this purpose, he was select a sampled of 300 maize farmers from Oyo and Kebbi States and it was analysed using translog frontier production function. Their results indicated that, extension services and farm distance was found as the major determinants of technical efficiency in both states Oyo and Kebbi. Besides that, farming experience in Oyo State and credit accessibility, number of other crops grown and rainfall in Kebbi State determined the technical efficiency in maize production, but age of farmers was insignificant factor in both states.

Basnayake and Gunaratne (2012) studied on estimation of technical efficiency and its determinants in the tea small holding sector in the mid country Wet Zone of Sri Lanka during the period of September - January 2001and sixty smallholder tea producers in the Mid-country Wet Zone is used in the study. They analysed the data using maximum likelihood estimates of the stochastic frontier model for green leaf yield as a function of land extent, family labour, hired labour, fertilizer, chemicals, and dolomite, using Cobb Douglas and translog models. Results of the Cobb-Douglas suggested that, extent of land, family labour, hired labour, fertilizer and dolomite significant effects on yield while the estimation with the translog model showed that, age of farmer, education, occupation, type of crop and type of clone have significant effects on efficiency.

Estimation of technical efficiency in the translog stochastic frontier production model with an application to the oil palm produce mills industry in Nigeria were analysed by Amaechi et al. (2014). They used a multistage 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 37.48% to 93.46%. This wide variation in oil farm output of millers from the frontier model found that those differences were arisen from differences management practices of millers than random variability. In addition, their study implies that education, processing experience, membership of cooperative society, credit, capital, fruits petroleum energy and water are the major determinants of technical efficiency. Their results further highlighted that age, household size and interest on loans negatively affected to technical efficiency among oil palm produce mills industry in Nigeria.

Shrestha et al. (2016) have examined the determinants of inefficiency in vegetable farms and its implications for improving rural household income in Nepal. They employed stochastic translog production function and their results suggested that labour, traction power, seed and organic matter accounted for the efficiency of vegetable production and the efficiency level in vegetable production can be increased by greater accessibility to agricultural materials, higher levels of farmer's education and increased the number of trainings to farmers in the country.

Geta, et al. (2016) conducted a study in order to ascertain the productivity and efficiency analysis of smallholder maize producers in Sothern Ethiopia. Results of the normalized translog production function revealed that use of human labour, application of chemical fertilizer, planting methods, use of hybrid maize seed and application of integrated soil fertility management practices are the important factors, which positively influenced on productivity of maize. Further, results of the data envelopment analysis indicated that 0.4 average technical efficiency among smallholder maize producers' in the country.

Another study done by Tiruneh and Geta (2016) on technical efficiency of smallholder wheat farmers in the case of Welmera district, Central Oromia, Ethiopia for their study, they collect primary data pertaining to farm production, input usage, and socioeconomic and institutional factors during 2012/13 cropping year through a structured questionnaire from randomly selected 180 wheat farmers. The stochastic frontier and Translog functional form with a one-step approach employed to assess efficiency and factors affecting efficiency in wheat production and according to that, technical efficiency was found that 57%. Factors such as sex, age and education level of the household head, livestock holding, group membership, farm size, fragmentation, tenure status and investment in inorganic fertilizers positively effect on efficiency in the district.

Umar, et al. (2017) compared Cobb-Douglas and Translog frontier models in the analysis of technical efficiency in dry season tomato production in Jos-South area of Plateau State. Based on the 60 dry-season tomato farmers the analysis of Cobb Douglas frontier function, it revealed that 89% mean technical efficiency while 54% mean efficiency identified under Translog frontier function. The findings of the study concluded that estimated elasticities, efficiency scores and inefficiency effects are significantly different between Cobb Douglas and Translog frontier model.

Dominic, Franklin, and Hamdiyah (2019) examined the technical and resource use efficiency among smallholder rice farmers in Northern Ghana (2019). Multistage sampling method used to collect data from 126 smallholder farmers in the study area and the collected data analysed using translog production frontier. They found that technical efficiency score varied with the range 11% to 98% and technical inefficiency of farmers was determined by age, extension, household size, education and credit availability.

Another study related to efficiency done by Tadie, Abebe, and Taye (2019) titled on Technical efficiency of smallholder farmers in red pepper production in North Gondar zone Amhara regional state, Ethiopia. They applied multistage sampling with cross-sectional data and those data were collected from 385 systematically selected households. Stochastic frontier Cobb–Douglas production was estimated in the study and its results reveal that, age, education status, land size, land fragmentation, extension service, credit access and market information were found to statistically and significantly affect the level of technical efficiency of red pepper farmers in Ethiopia.

## Methodology

This sub section describes the method of data collection and the sampling method, which used in the study and the collected data was analysed using production function approach explained under the methods of data analysis.

**Sample and sampling method**

According to the district development plan (2018-2022), Vavuniya is one of the most brinjal producing districts in Sri Lanka. Compared to other vegetable crops, brinjal production contributes more in terms of income, market price, high demand and food security in the region. As a result, this study focused on the farmers who cultivate the brinjal as their major crop. Sample farmers from the study area were selected using multistage sampling technique and in the first stage, Vavuniya district purposely selected among the Northern Province in the country based on the extent of brinjal cultivation. Vavuniya district has four Divisional Secretariats (DS) and in the second stage, only Vavuniya North was selected from the four divisions. Finally, five villages have been chosen based on the survey and information collected by the previous researchers and from each village, ten farmers randomly selected with the total of fifty farmers as a sample during the year of 2017/2018.

**Methods of data analysis**

To measure the efficiency scores of individual farmers, Cobb- Douglas production function that used in the study where the brinjal production, taken as an output and four inputs such as land size, cost of labour, cost of capital and material cost defined as production inputs. The production function shows the maximum amount of the brinjal output that could be produced using alternative combinations of the above four inputs. The empirical model of the Cobb-Douglas functional form is given by:

$$LnY_i = \beta_0 + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \epsilon_i \ldots\ldots\ldots (1)$$

Where,

$Y_i$ = Production of brinjal (Kg)

$X_{1i}$ = Size of land (Ha)

$X_{2i}$= Cost of labour (Rs)

$X_{3i}$ = Cost of capital (Rs)

$X_{4i}$ =Cost of raw materials (Rs)

$\beta_0$= Constant term

$\epsilon_i$= Error term

$\beta_1$, $\beta_2$, $\beta_3$ and $\beta_4$are the respective unknown parameters of each explanatory variable those to be estimated from the model.

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

$$ln\Upsilon = \alpha + \sum_{\kappa=1}^{\kappa} \beta_\kappa \, ln\text{X}_\kappa + \frac{1}{2}\sum_{\kappa=1}^{\kappa}\sum_{m=1}^{\kappa} \Upsilon_{km} \, ln\text{X}_\kappa ln\text{X}_m \ldots\ldots\ldots\ldots\ldots..(2)$$

Where, α is constant and $\beta$ is the production function parameter which to be estimated for each input, Xs are the explanatory variables as mentioned in function (1) while $ln\Upsilon$ is the quantity of brinjal output produced in logarthim.

After estimating the technical efficiency scores using Translog production, the inefficiency effect model also employed to identify the impact of farmer's demographic and farming characteristics on technical efficiency. For this purpose, variables related to demographic and farm characteristics among the smallholder agricultural farmers collected from the respondents in the study area. For the investigation of these characteristics affecting technical efficiency, the following inefficiency model was estimated in the study.

$\mu_i = \delta_0 + \delta_1$age + $\delta_2$ education + $\delta_3$ household size + $\delta_4$ farming experience + $\delta_5$ extension services + $\delta_6$ ownership of land + $\delta_7$ credit access + $\delta_8$ irrigated land

Where,

$\mu_i$ is technical inefficiency and δ is regression coefficient. The first three variables represent the demographic related characters while rest of the other variables related to the farming characters that were included into the inefficiency model, assuming that both characters directly affect on technical efficiency.

**Table 1:** Variables and their measurements

| Variables | Measurements |
|---|---|
| Age | Age of the respondent in years |
| Education | Formal education of the respondent in years |
| Household size | Number of household size |
| Farming experience | Farming experience in years |
| Available of extension services | Dummy variable measured by 1 for yes, otherwise 0. |
| Ownership of land | Dummy variable measured by 1 for own land, otherwise 0. |
| Possibility of credit access | Dummy variable measured by 1 for yes, otherwise 0. |
| Extend of irrigated land | In Ha |

## Results and Discussions

This study focused to measure the technical efficiency scores and identify the determinants of technical efficiency of brinjal farmers in Vavuniya district, Sri Lanka. There are many measures can be used to estimate the efficiency even though, this study used Translog production function with the major four inputs such as, cultivated land, expenditures on labour, capital expenses and cost of raw materials on brinjal cultivation. The results of maximum likelihood estimates of the Translog stochastic production parameters shown in the table 1 and according to that, the coefficients of variance parameters that are the sigma squared ($\sigma^2$) and the value of gamma (γ) for the model has 0.025 and 0.99 respectively. The sigma squared is 0.071 and it is statistically significant at 5% level indicated a good fit of the model as well as it confirmed that the specified distribution assumption of the composite error term is correct. At the same time, the value of gamma in the model is 0.99 and it is statistically different from zero at 1% level showed that, 99% of the deviation in brinjal output attributed due to the presence of technical inefficiency in the four inputs used during the production period. The estimated parameter gamma (γ) was closed to 1.0 in the Translog stochastic frontier and statistically significant at 1 per cent level suggesting that inefficiency effects are highly significant in the analysis of production of brinjal by the farmers.

To identify how the demographic and farming characters effect on technical efficiency, the gamma is estimated at 0.99, indicating that about 99% discrepancies between the observed output and the frontier output are due to the technical inefficiency. Moreover, the shortfall of observed output from the frontier output is primarily due to the differences in farmer's practices which are within the control of them than random variability. Further, it illustrated that, these factors are under the control of the farmer and influence of which can be altered to enhance technical efficiency of brinjal cultivation in the district. The above results confirmed that the effect of technical inefficiency is significant and a classical regression model of the production function based on an ordinary least squared estimation would be inadequate representation of the data. Therefore, stochastic parametric production function and maximum likelihood estimation are more relevant and appropriate in the study. The estimated results from Translog production function and the influence of each input used in the brinjal production and their interactions are presented in the table 2.

**Table 2:** Results of maximum likelihood estimate of Translog production frontier

| Variable | Coefficient | Standard error | t - ratio |
|---|---|---|---|
| Intercept | 29.32 | 0.96 | 30.35 |
| ln land | 1.26 | 1.01 | 1.24 |
| ln labour | -10.30 | 0.67 | -15.17*** |
| ln capital | -4.38 | 0.88 | -4.95*** |
| ln raw materials | 2.67 | 0.64 | 4.125*** |
| ln land$^2$ | -0.511 | 0.29 | -1.72* |
| ln labour$^2$ | -0.147 | 0.23 | -0.63 |
| ln capital$^2$ | 0.518 | 0.22 | 0.71 |
| ln raw materials$^2$ | -0.040 | 0.086 | -0.47 |
| ln land* ln labour | -1.97 | 0.56 | -3.50*** |
| ln land* ln capital | 1.08 | 0.39 | 2.73*** |
| ln land* ln raw materials | 0.90 | 0.32 | 2.80*** |
| ln labour* ln capital | 2.08 | 0.34 | 6.13*** |
| ln labour* ln raw materials | 0.67 | 0.41 | -3.30*** |
| ln capital* ln raw materials | -1.30 | 0.39 | 4.38*** |
| log – likelihood function | 39.16 | 0.20 | ........ |
| sigma square ($\sigma^2$) | 0.025 | 0.01 | 2.35** |
| gamma (γ) | 0.99 | 0.03 | 25.34*** |
| Sample size (n) | 50 | | ......... |

Note: ***and ** and * represents the 1%, 5% and 10% significant levels respectively.

Source: Calculated by authors` from survey data, 2017.

In the above results showed that out of four inputs, three of them such as labour cost, capital expenditures and cost of raw materials have statistically significant impact on brinjal production while cultivated land area has insignificant in the study. In the frontier model, the coefficients of raw materials cost were positive and significant implying that an increase to some optimum level in the raw materials would increase brinjal output while coefficients for costs of labour and capital were negative indicating that an increase in these input costs would reduce the average production of brinjal in the district.

The coefficient value of labour cost was 10.30 with negative sign and significant refers that an increase in labour cost by 1 % would likely to reduce the average production of brinjal by 10.30% assumed that all other inputs held constant. In other words, increasing labour cost in brinjal production in operations such as land preparation, planting, application of fertilizer, and weeding would significantly reduce the brinjal production. This result was consistence with the findings of study done by Geta et al. (2016) in Sothern Ethiopia.

In case of capital expenses, as the farmers increase their expenditures on capital by 1% will reduce the average production of brinjal by 4.38% assumed that other three inputs held constant. This result depicts that farmers who spend more money on capital such as machinery and water pump receive less yield in brinjal cultivation. Therefore, to make efficiency in brinjal production, the farmers should take necessary actions to reduce these types of labour costs and capital expenses in their farming. Further, the cost of capital which includes the interest on operating capital, and hence due to the increasing trend of interest rate, cost of capital increases which cause to the production reduction. These findings were inconsistent with the study done by Amaechi et al. (2014).

On the other hand, positive sign of raw materials 2.67 showed that, increase in raw material costs by 1% enhances the average production of brinjal by 2.67% without changing other inputs in the district. This finding revealed that, applications of raw materials have significant and positive influence on brinjal production and it is statistically significant at 1% level and an increasing the current expenditures on capital instruments would help to raise the average production of brinjal. In the square terms of coefficients for land, labour and raw materials showed negative while capital has positive sign. In case of square variables, they showed that the coefficients of land square, labour square and raw materials square are negative while capital square has positive sign. The negative coefficients of these square terms imply that the increase of these variables may increase the production of brinjal at a decreasing rate while positive sign of the capital square indicates that an increase in capital input may increase the yield of brinjal at an increasing rate. Out of four square inputs, only land square has statistically significant at 10% level and other three are insignificant effect on the production of brinjal. The coefficient of square term of land has -0.511, reveals that, as the size of cultivated land increases, the average production of brinjal increases at a decreasing rate of 1.022% assuming other factors are constant.

In the interaction term, all possible interactions between the inputs have significant impact on the yield of brinjal. The interaction coefficients between the inputs revealed the substitution and complementary effects and elasticity of the inputs used in brinjal production and all possible interactions are significant at 1% level in the study. In table 2, interaction between cultivated land and labour cost and the interaction between costs of capital and raw materials have negative sign with statistically significant implying that there is a competitive relationship exist among these pair inputs in the model. The negative substitution elasticity for pair inputs of land and labour cost has1.97 and for costs of capital and raw materials has 1.30 indicate that there is a substitution effects existing among these pair inputs. This implies that, an increase in usage of one input could be compensating by the reduction of other input and when the pairs of these inputs are jointly increased, the output of brinjal will reduce in the study area.

Conversely, the positive elasticity for other pair of inputs with positive interaction between them indicate their complementary relationship and these pair inputs should be increased together to obtain the higher production in brinjal cultivation. In the table 2, positive sign of the estimated elasticity for cultivated land and capital cost (1.08), land and cost of raw materials (0.90), costs of labour and capital (2.08) and costs of labour and raw materials (0.67) implying the complementary relationship and thus, these inputs need to be increased together to increase the production.

The dispersion of the scores for all 50 brinjal farmers depicted in a stem and leaf diagram as below:

**3** 5

**4** ......

**5** 5 6 7 7 9 9

**6** 3 4 4 4 5 6

**7** 0 2 4 4 6 7 7 8 8 9

**8** 0 0 1 2 3 4 4 6 7

**9** 0 1 2 3 3 4 4 4 4 5 5 6 6 6 8 8 9 9

**Figure 1**: Stem and leaf of technical efficiency scores

Source: Calculated by authors using Frontier 4.1

The following table presents the frequency distribution of efficiency scores obtained from Translog stochastic frontier models and according to that, their scores vary with the minimum value of 35.54 and the maximum value of 99.86. Further, in the table revealed that, the mean technical efficiency was nearly 80% implies that on the average, brinjal farmers have an opportunity to increase the output by 20% with a given production technology and input combinations.

**Table 3:** Frequency distribution of technical efficiency in brinjal cultivation

| **Range of technical efficiency (%)** | **Frequency** | **Percentage** |
|---|---|---|
| Less than50 | 01 | 02 |
| 50- 59 | 06 | 12 |
| 60- 69 | 06 | 12 |
| 70-79 | 10 | 20 |
| 80-89 | 09 | 18 |
| 90 and above | 18 | 36 |
| Total | 50 | 100 |

Mean technical efficiency 79.98

Minimum technical efficiency 35.54

Maximum technical efficiency 99.86

Source: Calculated by authors` from survey data, 2017.

Out of 50 sampled farmers, 36% of them were achieved the technical efficiency at 90% indicates that those farmers were the best practice farm and they used their inputs optimally. Thus, they could decrease the inefficient effect on the brinjal production. On the other hand, only 2% of the farmers attained the efficiency at less than 50% showed that need to be improved and thereby they could not attain the maximum output as achieved by the best practice farmers in the study area.

**Sources of technical inefficiency**

Determinants of technical inefficiency for brinjal production identified by the estimated coefficients of the inefficiency effect model and its results presented in table 4. A perusal of the factors affecting technical inefficiencies suggests that education of the farmer, available of extension services, and ownership of land whether they cultivate own land or other land had a significant effect on the technical inefficiencies of the farmers. On the other hand, other demographic and farming characterise such as age of the farmer, household size, farming experience, credit accessibility and extend of irrigated land have insignificant impact on technical inefficiency scores in brinjal cultivation. The coefficient of age has insignificant in the model and this result is line with findings of the study done by Olarinde (2011). The coefficient of education is negative and significant at 5% level in brinjal cultivation as a prior expectation implying that, increase in education help to the farmers to adopt new techniques and skills which reduces the technical inefficiency. In addition, education improves the ability of the farmers to make informed decision about production inputs and it help them to access better agricultural information and higher tendency to adopt and utilize improved inputs more optimally and efficiently. This finding suggests that education is one of the factors in determining the technical inefficiency in brinjal production and it is in line with the findings of Basnayake and Gunaratne (2012). The coefficient of household size and farming experience were insignificant in the model as found by Umar et al. (2017).

As expected, negative sign of the extension services revealed that the farmers who are having extension services, they were able to reduce the technical inefficiency of brinjal farming in the study area and it was statistically significant at 1%. This denotes that the brinjal farmers who have extension accessibility, they are able raise the technical efficiency than their counterparts. The estimated coefficient for ownership of land has negative sign with statistically significant at 1%, indicating that the farmers who are cultivating the brinjal using their own land, they could reduce the technical inefficiency than other farmers who are cultivating in tenant or leased land. In other words, as it was in prior expectation own operated brinjal farms are more efficient than tenants operated farms and thus, to increase the efficiency better to cultivate the crops by own land than other tenant or leased land in the district.

**Table 4:** Determinants of Technical inefficiency of Brinjal cultivation

| Variable | Coefficient | Standard error | t - ratio |
|---|---|---|---|
| Constant | 0.90 | 0.200 | 4.38 |
| Age | 0.38e - 02 | 0.005 | 0.72 |
| Education | -0.047 | 0.017 | -2.74*** |
| Household size | 0.30e - 03 | 0.055 | 0.05 |
| Farming experience | -0.0034 | 0.003 | -1.05 |
| Extension services | -0.246 | 0.119 | -2.06** |
| Ownership of land | -0.588 | 0.176 | -3.33*** |
| Credit accessibility | 0.221 | 0.135 | 1.63 |
| Extend of irrigated land | 0.0372 | 0.034 | 1.09 |

Note: ***and ** represents the 1% and 5% significant levels respectively.

Source: Calculated by authors` from survey data, 2017.

Finally, the overall results of the above table concluded that among demographic characters only education of the farmer has significant impact on technical inefficiency while among farming characters, availability of extension services and ownership of land have significantly influencing the technical efficiency in brinjal cultivation in the study area. Compared to previous studies, other variables namely, age, household size, farming experience and credit accessibility were not significant influencing the technical efficiency in the study.

## Conclusion and Recommendations

This study examined the estimation of the technical inefficiency and its determinants of brinjal cultivation in Vavuniya district, Sri Lanka. By applying stochastic frontier production model inefficiency scores was measured and to identify the factors causing inefficiency over the reference period 2017 inefficiency effects also used in the study. Results obtained from the stochastic frontier estimation concluded that, the average technical efficiency score of brinjal production given by the translog model is 0.79 indicates that farmers are only producing on average nearly 80% of their maximum possible output and there is a scope to further increase the output by 20% without increasing the levels of inputs. From the maximum likelihood estimates, value of gamma ($\gamma$) is 0.99 and it is statistically different from zero at 1% level, interpreted that 99% of random variation is the value added among the brinjal production due to inefficiency than random variability. The inefficiency effects model identified the determinants of technical inefficiency and its results showed that among three demographic factors such as age, education and household size of the farmer, only education has significantly contributed to improve the technical efficiency in brinjal production. On the other hand, out of five farming characters namely farming experience, availability of extension services, ownership of cultivated land, credit accessibility and extend of irrigated land, only availability of extension services and ownership of cultivated land are the major variables contributed to improve the technical efficiency in brinjal production in the district. Rest of other demographic and farming characteristics were not significant implying that, these variables are not important factors in determining the technical inefficiency of brinjal production in Vavuniya district, Sri Lanka.

From the above analysis, the study found that compared to elder farmers, involvement of young farmers may motivate to use new techniques and farming practices, which cause to increase the efficiency in brinjal cultivation. Further, experience in farming is another character that helps the farmers to adapt new farming production techniques to raise the efficiency of brinjal production. Through training and skills, the farmers may able to learn more experience in farming and thus brinjal production becomes more efficient in future.

**Limitations of the study**

Apart from statistical analysis, the researchers made the interview with the respondents and they identified that, the farmers who are cultivating brinjal they do not have proper records regarding to their farming information. Based on their memory power they gave the information that is may not true perfectly. Further, due to the non – availability of other inputs and time, only limited inputs used in the study and since brinjal is an agricultural product it will affected by the climate changes. However, this study not taken the environmental and climate changes as one the factor in the model.

## References


Amaechi, E. C. C., Ewuziem, J. E., & Agunanna, M. U. (2014). Estimation of technical efficiency in the translog stochastic frontier production function model: An application to the oil palm produce mills industry in Nigeria. *Advances in Applied Science Research*, *5*(3), 230-236.

Basnayake, B. M. J. K., & Gunaratne, L. H. P. (2011). Estimation of technical efficiency and it's determinants in the tea small holding sector in the Mid Country Wet Zone of Sri Lanka. *Sri Lankan Journal of Agricultural Economics*, *4(1)*, 137-150.

Central Bank of Sri Lanka. (2017). *Annual Report*. Retrieved from: https://www.cbsl.gov.lk/en/publications/economic-and-financial-reports/annual-reports

District Secretariat,Jaffna. (2018). *Five year district development plan 2018-2022*. Retrieved from http://www.jaffna.dist.gov.lk/index.php/en/planifive-year-district-development-planng-unit.html. 1-21.

Expert (2019). Sri Lanka - Agricultural Sector. Retrieved 1 November, 2019, Retrieved from https://www.export.gov/article?id=Sri-Lanka-Agricultural-Sector

Dominic, T., Franklin, M. N., & Hamdiyah, A. (2019). Technical and resource use efficiency among smallholder rice farmers in Northern Ghana. *Cogent Food & Agriculture*,*5*,1651473.

Geta, E., Bogale, A., Kassa, B., & Elias, E. (2013). Productivity and efficiency analysis of smallholder maize producers in Southern Ethiopia. *Journal of Human Ecology*, *41*(1), 67-75.

Olarinde, L. O. (2011). Analysis of technical efficiency differentials among maize farmers in Nigeria. *African Economic Research Consortium, Nairobi*, 1-40.

Ranasinghe, R., & Sugandhika, M. G. P. (2018). The Contribution of Tourism Income for the Economic Growth of Sri Lanka. .*Journal of Management and Tourism Research*.

Statistics (2019). Paddy Statistics (2019). Retrieved from: http://www.statistics.gov.lk/agriculture/Paddy%20Statistics/PaddyStats.htm

Shrestha, R. B., Huang, W. C., Gautam, S., & Johnson, T. G. (2016). Efficiency of small-scale vegetable farms: policy implications for the rural poverty reduction in Nepal. *Agricultural Economics/ZemedelskaEkonomika*, *62*(4), 181–195.

Tadie, M. A., Abebe, B. D., & Taye, M. M. (2019). Technical efficiency of smallholder farmers in red pepper production in North Gondar zone Amhara regional state, Ethiopia. *Journal of Economic Structures*, *8*(18), 2-19.

Tiruneh, W. G., & Geta, E. (2016). Technical efficiency of smallholder wheat farmers: The case of Welmera district, Central Oromia, Ethiopia. *Journal of Development and Agricultural Economics*, *8*(2), 39-51.

Umar, H. S., Girei, A. A., & Yakubu, D. (2017). Comparison of Cobb-Douglas and Translog frontier models in the analysis of technical efficiency in dry-season tomato production. *Agro search*, *17*(2), 67-77.