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Analysis of Technical Efficiency of Small Scale Rice Farmers in the West Region of Cameroon: A Stochastic Frontier Approach

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Abstract
This study was undertaken to analyze technical efficiency of small scale rice farmers in the West Region of Cameroon. The specific objectives were to determine input-output relationships in small scale rice production; identify determinants of technical inefficiency of small scale rice farmers and estimate technical efficiency of small scale rice farmers. A multistage stratified random sampling technique was used in selecting the respondents. A total of 192 small scale rice farmers were purposively selected from four (4) out of eight divisions. Data were collected using structured questionnaires and interview schedule, administered on the respondents were analyzed using descriptive statistics and stochastic frontier production functions. The estimated production function for farm size and labour positively influenced small scale rice output at 5 percent level of probability implying that increases in farm size and labour by one unit lead to increase of rice output by the value of their estimated coefficient. In contrast, fertilizer use negatively influenced small scale rice output at 5 percent level of probability implying that increases in fertilizer use by one unit lead to decreases in rice output by the value of the estimated coefficient. Extension contacts was found to be positively and significantly related to technical efficiency at 5 percent level of probability implying that technical efficiency in small scale rice production could be increased through better extension contact. In contrast, access to credit was found to be negatively related to technical efficiency at 5 percent level of probability implying that accessibility to credit decreases technical efficiency in small scale rice production in the study area. The average technical efficiency in small scale rice production was 82 percent implying that small scale farmers' technical efficiency could be increased by 18 percent if the available resources are efficiently utilized. The study recommends that to increase farmers' technical efficiency level, training aimed at fertilizer application and credit use by small scale rice farmers should be frequently organized in the study area.
Keywords: Technical Efficiency, Small Scale producers, Cameroon

INTRODUCTION

Agriculture is the main-stay of Cameroon's economy and it satisfies the bulk of the population for food, raw materials for agro-industries and the export market. As a primary industry that provides employment for almost 72% of the Cameroonian population, agriculture is likely to remain the back-bone of Cameroon's economy for many generations to come (Winrock International, 2002; Bime ***et al.*** 2014). Until 1980s rice was still regarded as a foreign crop and was only consumed during special events of the year. Rice has gradually become a staple food for rural and urban population in Cameroon. The consumption of rice has increased faster than other food crops and according to projections at the national and international level, this is likely to continue for some time (MINAGRI, 2002; ACDIC, 2006; Piebeb, 2008; Djomo, 2014). Today, rice is one of the most important crop in the world after wheat, yet consumption is growing at an annual rate of 4% and was estimated at 25.9kg per inhabitant in 2008 (MINADER, 2008; Djomo, 2014). In order to boost rice production in Cameroon, three development companies were created by the Cameroonian government namely: *the Societe d'Expansion et de Modernisation de Riziculture de Yagoua (SEMRY)* in 1954; the Upper Noun Valley Development Authority (UNVDA) in 1974 and *the Societe de Development de la Riziculture dans la plaine de Mbo (SODERIM)* in 1978. Despite these magnitudes of investment, Cameroon produces an estimated 80,000 metric tonnes of rice annually of which the West Region accounts for about 20 percent. This is far short of the over 500, 000 metric tonnes required to meet national demand (MINAGRI, 2002; Piebeb, 2008; Djomo, 2014). Moreover, rice demand today exceeds production and large quantities of rice are imported to meet the country's requirement at huge expenses in terms of foreign exchange. Nevertheless, world production indicated that Cameroon had one of the greatest increases in production between 1961 and 2005 with an expansion of over 1500 percent (FAO, 2006; Piebeb, 2008; Djomo, 2014). Although this figure can look significant, the record, however, is one of stability rather than growth. The Cameroonian population has grown faster than total production (World Bank, 2007; Piebeb, 2008; Djomo, 2014). There has been a remarkable importation of rice in recent years. Therefore, a strategy of accelerating production should explore the potentials of this cash crop by analyzing technical efficiency of small-scale rice farmers.

OBJECTIVE: the main objective of this study is to analyze technical efficiency of small scale rice farmers using stochastic frontier model approach. The specific objectives are to determine input-output relationship of small scale rice farmers in the study area; identify and estimate determinants of technical efficiency of small scale rice farmers in the study area.

STATEMENT OF HYPOTHESES:

Based on the specific objectives the following hypotheses were tested:

$H0_1$: There is no significant relationship between input use and output obtained in small scale rice production in the study area.

$H0_2$: Socio-Economic factors have no significant influence on technical inefficiency of small scale rice farmers in the study area.

THEORETICAL FRAMEWORK

Cobb-Douglas Production Function

The theoretical basis of this study focused on Cobb-Douglas (CD) production function which shows a functional relationship between inputs and output. The Cobb-Douglas (CD) function further assumes constant returns to scale and unitary elasticity of substitution.

For two variable inputs, the function can be expressed as $Y = AL^{b1}K^{b2}e$

Where Y = level of output, L and K = variable inputs, A = multiplicative constant, b^1 and b^2 are the coefficient of L and K and they represent the direct measure of elasticity of the respective factors of production, and e = error term. The sum of b^1 and b^2 indicates the nature of returns to scale. Upton (1979); Terfa and Terwase (2011) observed that, the Cobb-Douglas production function cannot show both increasing and diminishing marginal productivity in a single response curve and as a result it does not give a technical optimum and may lead to the over estimation of the economic optimum. Despite these disadvantages researchers still find the Cobb-Douglas production function useful in analysis of survey where many variable inputs are involved and it is necessary to measure returns to scale, intensity of factors of production and overall efficiency of production. It can also provide a means of obtaining coefficients for testing hypotheses (Cobb and Douglas 1928; Erhabor, 1982; Terfa and Terwase, 2011). While commenting on the superiority of Cobb-Douglas production function over other forms of production functions, Terfa and Terwase (2011) stated that, Cobb-Douglas production function is used more than the other two because it satisfies the economic, statistical and econometric criteria of many studies than others**.**

EMPIRICAL REVIEW

Amadou (2007) reported that educational level and access to credit are the main socioeconomic variables that significantly affect the technical inefficiency of Arabica coffee farmers in Cameroon. Dontsop ***et al.*** (2009) determined factors that influence technical efficiency of cocoa farmers in the Centre Province and found that access to credit; educational level; experience of producers; extension contact and membership in mutual aid group are the main source of technical inefficiency of cocoa farmers in Cameroon. Amaza and Maurice (2005) carried out a study which had as objective the identification of factors that influence technical efficiency in rice-based production systems in Nigeria. They found that there were wide efficiency differentials among farmers in the study area and that rice-based crop production could be increased by 20% through better use of resources. Farmer-specific factors such as education and farming experience were found to contribute positively and significantly to farmers' efficiency levels in the rice–based production. Onyenweaku and Ohajianya (2005) found a positive relationship between education and technical efficiency in rice production in their study of swamp and upland rice farms in south-eastern Nigeria. Aye and Mungatana (2012) reported that improved maize seed, inorganic fertilizers, conservation practices, size of farm holdings, education, and access to extension services, credit and market were found to have significant impact on efficiency of maize farmers in Nigeria. Obwona (2006) reported that education, credit accessibility and extension services contribute positively towards the improvement of efficiency of small and medium scale tobacco farmers in Uganda.

METHODOLOGY

The Study Area: The study was conducted in the West Region of Cameroon which has eight divisions namely: Bamboutos, Haut-Nkam, Mifi, Menoua, Khoung-khi, Nde and Hauts-Plateaux. The West Region covers a total land area of 14000 sq km and is located in the West-Central part of Cameroon within latitudes 5° 20' and 7° North and longitude 9° 40' and 11° 10' East of the equator (Yerima and Van, 2005).

Population, Sampling procedure and Data Collection: A sample of the population was taken by adopting a stratified random sampling procedure. First, four divisions were purposively selected (Bamboutos, Nde, Noun, and Menoua) based on the high concentration of rice production in those divisions. The second stage involved selection of one subdivision from each of the selected divisions namely: Tonga in Nde division, Foumbot in Noun division, Santchou in Menoua division, and Galim in Bamboutos division. In stage three one community in each of the selected subdivision was selected namely: Keneghang; Babitchoua; Baigom and Sekou. Having drawn the sampling frame of 2400 rice farmers in these communities collected from the West Regional Delegation of the Cameroon's Ministry of Agriculture and Rural Development, 8 percent of the sample frame was randomly selected in each community. Thus a total of 192 small scale rice farmers were selected for the

study.

Variable Specification/Model Specification

Technical Efficiency Model

The production form of Cobb-Douglas stochastic production frontier is given as:

$LnY = \beta_0+\beta_1LnX_1+\beta_2LnX_2+\beta_3LnX_3+\beta_4LnX_4+\beta_5LnX_5+ \beta_6LnX_6+ V_1 – U_1$……..... (1)

Where:

Ln = Natural logarithm to base 10

Y = Total rice output of the farmer in kilogram per hectare (kg/ha).

βs = The parameters to be estimated.

X_1= Farm size (hectares)

X_2= Labour used per hectare (mandays)

X_3= Quantity of seeds planted in kilogram per hectare (kg/ha)

X_4= Quantity of fertilizers applied per hectare (kg/ha)

X_5= Quantity of pesticides used in litres per hectare (litres/ha)

X_6= Quantity of herbicides used in litres per hectare (litres/ha)

V_1= Random errors which are assumed to be independently and identically distributed.

U_1= Non negative random variable associated with technical inefficiency of production.

The inefficiency of production was modelled in terms of the factors that are assumed to affect the efficiency of production of the farmers. Such factors are assumed to be independently distributed such that U_1 is obtained by truncation (at zero) of the normal distribution with variance δ^2 and mean u where the mean is defined by

$U_1= \sigma_0+\sigma_1Z_1+\sigma_2Z_2+\sigma_3Z_3+\sigma_4Z_4+\sigma_5Z_5+\sigma_6Z_6+\sigma_7Z_7$…..…….. (2)

Where;

σ = a vector of unknown parameters to be estimated.

Z_1= age of farmers in years

Z_2= Level of Education (number of years spent in school)

Z_3= number of years of farming experience in rice production

Z_4= household size (number of member living together in a house)

Z_5= rice variety (improved variety=1, local variety= 0)

Z_6= Extension contact (number of extension contact in a year)

Z_7= Access to credit (amount in fcfa).

Wald Test

$$\chi^2_{cal} = \sum \frac{(\beta_i)^2}{\text{var}(\beta_i)}$$

Where:

β_i = estimated coefficients

var (β_i) = variance of the estimated β_i coefficients

Generalized Log Likelihood Ratio

Following Ogundari and Ojo, (2006), the Generalized Log Likelihood Ratio is expressed as:

$LR = -2 \ln \{L (H_0)/L (H_a)\}$

RESULTS AND DISCUSSION

1-Relationship between Input and Output in Small Scale Rice Farming in the West Region of Cameroon

Table 1 summarized the estimate from the stochastic production function of small scale rice farmers. The result indicates that farm size, labour use and fertilizer were the inputs that significantly affect the rice output. Specifically, farm size and labour use were found positive and significantly influence rice output of farmers at 5 percent level of probability, implying that increases in farm size and labour use by one unit will also increase rice output by the value of their coefficients, respectively. This is close to the research finding by Umeh and Atarborh (2011b) who found that farm size and labour use by Nigerian rice farmers were significant at 5 percent. In contrast, the coefficient of fertilizer was negative and significant at 5 percent level of probability. The negative coefficient of fertilizer implies that increases in quantity of fertilizer use will reduce the output of rice by the value of its coefficient. The result suggests that small scale rice farmers in the West Region of Cameroon misused fertilizer. This result agrees with the findings of Ahmadu and Erhabor (2012) who found that the estimated coefficient of quantity of fertilizer use by rice farmers in Taraba State, Nigeria was negative. However, the estimated coefficients for seeds, pesticides and herbicides used were not significant. This implies that these variables have no influence on the level of rice output.

The return to scale is 0.51 with respect to farm size, labour and quantity of fertilizer used, which is

positive. Technically small scale rice farmers are in stage II of their production cycle as the output is increasing at decreasing rate relative to quantity of input use. This also implies that 1 percent increase in all inputs lead to 0.51 percent increase of output.

Table 1: Maximum Likelihood Estimate of Production Function of Small Scale Rice Farmers in the West Region of Cameroon

Variables	**Parameters**	**Coefficient**
Constant	β_0	6.558 (11.11*)
Farm Size	β_1	0.277 (4.44*)
Labour	β_2	0.426 (4.91*)
Quantity of Seeds	β_3	0.127 (1.35)
Quantity of Fertilizer	β_4	-0.193 (-2.33*)
Quantity of Pesticides	β_5	0.161 (1.09)
Quantity of Herbicides	β_6	-0.556 (-0.48)

Source: Field Survey, 2014 * significant at 5% figures in bracket are t values

2-Determinants of Technical Inefficiency of Small Scale Rice Farmers in the West Region of Cameroon

The result of estimated parameters of the inefficiency effects models of small scale rice producers in the West Region of Cameroon is shown in table 2. As indicated in the table, the estimated sigma square ($\sigma 2$) is significant at 5 percent level of probability for small scale rice farmers indicating goodness of fit and correctness of the specified distribution assumption of the composite error terms. The estimated gamma (Γ) is significant at 5 percent implying that 3.3 percent of the variability in small scale rice output is due to technical inefficiency.

The estimated coefficients of technical inefficiency effects model in Table 5 indicates that extension contact and access to credit significantly influence technical inefficiency of small scale rice farmer's in the West Region of Cameroon. However, age, education, experience, household size and rice variety have no influence on technical inefficiency of smallholder rice farmers in the study area. The Coefficients of extension contact and access to credit were respectively negative and positive and significant at 5 percent level of probability. The implication is that technical inefficiency effects in small scale rice production in the West Region of Cameroon declined with increase in extension contacts. In order words, farmer's contact with extension agents in the West Region of Cameroon has positive effects on technical efficiency in small scale rice production. It is therefore important for achieving effective utilization of inputs in small scale rice production in the West Region of Cameroon. In addition, this is an indication that knowledge and orientation on agricultural technologies from extension contacts have strong influence on technical efficiency, following Dimelu ***et al.*** (2009); Simonyan ***et al.*** (2011). As for access to credit, the implication of the result is that technical inefficiency effects in small scale rice production increases with access to credit. The result suggests that small scale rice farmers' misused credit obtained from financial institutions. It is therefore not important for achieving efficient use of inputs in small scale rice production. In other words access to credit by smallholder rice farmers contribute to achieve lower level of technical efficiency. This is contrary to the findings of Dontsop ***et al***. (2009) and Amadou (2007) who found that access to credit decreases technical inefficiency of cocoa and Arabica coffee farmers respectively in Cameroon.

Table 2: Estimated Parameters of the Inefficiency Effects Models of Small Scale Rice Farmers in the West Region of Cameroon

Variables	**Parameters**	**Coefficient**
Constant	Z_0	0.057 (0.13)
Age	Z_1	0.070 (0.66)
Education	Z_2	8.143 (0.43)
Experience	Z_3	-0.020 (-0.84)
Household Size	Z_4	-0.021 (-0.33)
Rice Variety	Z_5	-0.070 (-1.56)
Extension Contact	Z_6	-0.078 (-5.11*)
Access to Credit	Z_7	9.023 (2.32*)
Sigma Square	σ^2	0.063 (9.54*)
Gamma	Γ	0.033 (2.57*)
Log likelihood Function		-8.13
LR test	LR	28.64*

Source: Field Survey, 2014 * significant at 5 % Figures in bracket are t values

3-Efficiency Estimates of Small Scale Rice Farmers in the West Region of Cameroon

The technical efficiency estimates summarized in table 3 indicates that small scale rice farmers in the West Region of Cameroon had technical efficiency varying from 65 to 99 percent with the mean of 82 percent. This implies that technical efficiency in small scale rice production in the West Region of Cameroon could be

increased by 18 percent through efficient use of available resources given the current state of technology and this could be achieved through better extension contacts. This result is however; above the findings of Binam ***et al.*** (2005) who found the average technical efficiency of 77 percent, 78 percent and 80 percent respectively for maize/groundnut intercrop systems, groundnut monocrop and maize monocrop in Cameroon. Specifically, 9.4 percent of small scale rice farmers had technical efficiency of 0.61 to 0.70; 38.5 percent of small scale rice farmers had technical efficiency of 0.71 to 0.80; 31.8 percent had technical efficiency of 0.81 to 0.90 and finally, 20.3 percent had technical efficiency of 0.91 to 1.

Table 3: Distribution of Respondents by Efficiency Estimates of Small Scale Rice Farmers in the West Region of Cameroon

Technical Efficiency	Frequency	Percentage (%)
0.61-0.70	18	9.4
0.71-0.80	74	38.5
0.81-0.90	61	31.8
0.91-1	39	20.3
Total	192	100
Minimum	0.65	
Maximum	0.99	
Mean	0.82	

Source: Field Survey, 2014

RESULTS OF HYPOTHESES TESTED

Wald Test for Join Significance of the Effect of Input use on Output obtained in Small Scale Rice Production

The result in table 4 indicates that calculated Chi-Square is greater than tabulated Chi-Square for hypothesis 1. Therefore, null hypothesis 1 that stipulated that there is no significant relationship between input use and output obtained in small scale rice production in the West Region of Cameroon is rejected.

Table 4: Result of Wald test

Null Hypothesis	χ^2_{cal}	$\chi^2_{tab(6,5\%).}$	Decision
$\beta_i = 0$	77.85	12.59	Reject H_0

Source: field survey, 2014

Generalized Log Likelihood Ratio for Join Significance of the influence of Socio-economic Factors on Technical Inefficiency of Small Scale Rice Farmers

The result in table 5 indicates that Generalized Log Likelihood Ratio (28.64) is greater than tabulated Chi-Square (14.06) for hypothesis 2. Therefore, null hypothesis 2 that stipulated that socio- economic factors have no significant influence on technical inefficiency of small scale rice farmers in the study area is rejected.

Table 5: Result of Generalized Log Likelihood Ratio

Null Hypothesis	LR	$\chi 2$ (7, 5%)	Decision
$\Gamma = 0$	28.64	14.06	Reject H_0

Source: field survey, 2014

CONCLUSION AND RECOMMENDATIONS

This Study was undertaken to analyze technical efficiency of small scale rice farmers in the West Region of Cameroon using stochastic frontier model approach. The results revealed that farm size and labour have significant effects on the output of rice at 5 percent level profitability implying that increases in farm size and labour use lead to increases in rice output. In contrast, fertilizer affects the output of rice negatively at 5 percent level of probability implying that increases in quantity of fertilizer lead to decreases in rice output. The results revealed that extension contacts decreases technical inefficiency. In contrast, access to credit increases technical inefficiency of small scale rice farmers. The mean technical efficiency for small scale rice farmers is 82 percent. This suggests that technical efficiency could be increased by 18 percent given the current level of technology if the available resources are efficiently utilized. It is therefore recommended that:

-Training aimed at fertilizer application and credit use by small scale farmers should be frequently organized in the studied area.

-A study on allocative and economic efficiency of small scale rice farmers should be carried out in order to give more insight to efficiency studies.

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