An Empirical Study of the Efficiency of Groundnut Production In Central of Myanmar: A Stochastic Frontier Analysis

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Abstract

This paper investigates factors influence technical efficiency in groundnut production systems among farmers in Mandalay division and Magway division, Myanmar. Mandalay and Magway divisions are regions where the groundnut productions have grown the largest areas annually in Myanmar. Primary data were used in the analysis of data. The analytical tools include descriptive statistic and stochastic frontier production function by using the maximum likelihood estimation (MLE). MLE is applied on a cross-sectional of 282 sampled farmers during 2006-07 cropping season. The efficiency measure is regressed on set explanatory variables which include seed (kg ha^{1}), area (ha), amount of chemical fertilizers (kyat/ha), amount of farmyard manure (kg ha^{1}), cost of insecticides and pesticides (kyat/ha), labor (man-day), access to institutions, and access to government services. The result shows that the mean efficiency in groundnut production is about 0.59. It means that it can be rise the groundnut production of Myanmar in this areas about 0.41 (41%) to produce at efficiency level.

Keywords: *Technical efficiency, Groundnut, Stochastic Frontiers, Myanmar*

Introduction

Myanmar's agriculture mainly dominated by rice production and followed by oilseed production. Oilseed crops play a vital role according to Myanmar's high consumption for cooking oil. Even though the oilseed production in Myanmar has been increasing, it is still insufficient for domestic consumption as the demand for edible oil has been increasing over time due to the increasing population. Myanmar's annual average production of vegetable oils, mainly groundnut and sesame oils is estimated at about 500,000 tones. The country also imports an average of 160,000 tones per year of palm oil.

Among of oilseed crops, groundnut is as one of the most important oilseed crops which has been grown both in rainfed and irrigation areas. The productivity of groundnut in Myanmar is still low compared to the world average. The national average yield per harvested hectare has been about 560.20 kg per hectare (CSO, 2006). The expansion in crop area, which was a major source of production growth till the 1995, has been exhausted in Myanmar. Therefore, the principle solution to increasing edible oil production lies in raising the productivity of yield gaps with higher yield potential. Research and development programs for

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continuous improvement in technology generation and its adoption are obviously important to be balance in demand-supply equation.

The largest oilseed crop production area was Mandalay and Magway Divisions, with 149,639 ha and 120,477 ha in rainy seasons. Groundnut in this region is predominantly grown under rain fed condition with different levels of production across division. In 2004-05, the average yield in Magway division (552.26 kg ha^{1}) was about 36 percent higher than the average yield in Mandalay (404.84 kg ha^{1}) (CSO, 2006).

Groundnut production in Myanmar is facing with raising costs of production coupled with declining productivity. At the current level of production, production cost of groundnut gradually increase due to the high seed cost. The profitability and quality of groundnut seeds are important consideration for farmers in growing groundnut. Consequently, production technologies and operational constraints are important elements to increase productivity of groundnut which will finally raise the farm income for growers and reduce the edible oil shortage in Myanmar. Myanmar farmers not only need to be efficient in their production activities, but also to be responsive to technical efficiency, so that the scarce resources are utilized efficiently to increase productivity as well as profitability and ensure supply to the edible oil shortage. Furthermore, efficiency gains will have a positive impact on raising farm income of scarce largely resource poor farmers.

The present study, set out to identify farm-specific characteristics and to analyze technical efficiency of groundnut growers that explain variation in efficiency of individual farmers. The relationship between technical efficiency and household characteristics has not been well studied in Myanmar. An understanding of these relationships could provide the policymakers with information to set programs that contribute to expand the technical efficiency of groundnut production potential of the nation. To increase oilseed production and improve oil processing technologies is expected to enhance rural incomes and food security in the country, where some 75 per cent of the population lives in rural areas and depends primarily on agriculture for its livelihood.

The goal of this study is to increase the productivity their derivatives, while ensuring low cost edible oil supplies for consumers and to develop a sustainable agriculture. Thus, understanding reasons for technical efficiency is essential if the target of profitable, sustainable agriculture is to be reached and then technical efficiency becomes major issue in groundnut cultivation in Myanmar.

Analytical framework

Measuring Efficiency using frontier production function

In a production function context, a farm is said to be technically inefficient, for given set of inputs, if its output level lies below the frontier output (the maximum flexible output) (Rahman, 2003). The popular approach to measure the efficiency is the use of frontier production function (Tzouvelekas *et al*., 2001; Wadud and White, 2002; Sharif and Dar, 1996; Russell and Young, 1983). This measurement of firm level efficiency has become commonplace with the development of frontier are attributed to inefficiency, or stochastic, which is a considerable improvement, since it is possible to discriminate between random errors and differences in inefficiency.

Technical efficiency of an individual firm is defined in term of the ratio of the observed output to the corresponding frontier output, given of the levels of input efficiency used by that producer (Coelli, 1998). In a number of studies on efficiency measurement (Sharif and Dar, 1996; Wang *et al*., 1996), the predicted efficiency indices were regressed against a number of household characteristics, in an attempt to explain the observed difference in efficiency among farms, using a two-stage procedure. In this commonly used two-stage approach, the first involves the specification and estimation of the stochastic frontier function and the prediction of inefficiency effects, under the assumption that these inefficiency effects are identically distributed with one-sided error terms. The second stage involves the specification of a regression model for predicted inefficiency effects, which contradicts the assumption of an identically distributed one-sided error term in the stochastic frontier (Coelli and Battese, 1998 and Kumbhakar *et al*., 2000). This study assumed to behave in a manner consistent with the stochastic frontier concept by expressing production function. According to Aigner *et al.* (1977) and Meeusen and van den Broeck (1977), the stochastic frontier production is given by;

$$Y_i = f\,(X_i; \beta) + exp(v_i - \mu)\ , \qquad (1)$$

where Y_i measures the output quantity of the i_{th} firms, X_i represents input quantity, β is a vector of parameters and the production function is represented by $f\,(x_i; \beta)$. Both v_i and μ_i cause actual production to come from this frontier. The random variability in production can not be managed by representing by v_i (e.g. environmental factors such as drought and heavy raining). It is identically and independently disturbed as N $(0, \sigma^2_v)$ which considered as normal error terms. In addition, the independence of the error term $\propto_\iota$ was assumed to be non-negative truncations of the N $(0, \sigma^2_u)$ distribution (or half normal distribution, or have exponential distribution) associated with technical inefficiency in production, independently and identically disturbed as half-normal, $\mu \sim \left| N\,(o, \sigma^2 \mu) \right|$. The maximum likelihood estimation of Eq.(1) yields estimators for β and γ, where $\gamma = \sigma^2_\mu/\sigma^2$, $\sigma^2 = \sigma^2_\mu + \sigma^2_v$, and γ explains the total variation of output from the frontier which can be disturbed to technical inefficiency and lies between zero and one. If γ = 0, it implies that the traditional average response function is an appropriate representation of the data, which can be consistently estimated by ordinary least squares (Battese and Coelli, 1998).

In this study, the technical efficiency effects in the stochastic frontier production function specified by using the flexible trans-log specification. The specified model is assumed to be the appropriate model for analysis of the data.

The model to be estimated is defined by

$$\ln Y_i = \beta_0 + \sum \beta_k \ln X_{ji} + 1/2 \sum_j \sum_k \beta_{kj} \ln X_{ji} \ \ln X_{ki} + v_i - u_i \qquad (2)$$

The error term is defined as

$\varepsilon_i = v_i - \mu_i$

i = 1,2,…,n farms,

v_i= an error term, independent and identically distributed (iid) with N (0, σ_v^2);

μ_i= a non-negative random term, accounting for inefficiency, iid, with N (0, σ_u^2), truncated half normal.

$$\mu_i = \delta_0 + \sum \delta_m Z_i \qquad (3)$$

Where, δ = the corresponding vector of parameters to be estimated

Z_i = the variables representing socio-economic characteristics of the farm to explain inefficiency

Technical efficiency will be obtained from equation (2) and (3) using method of maximum likelihood estimation to estimate to the production frontier. The method of maximum likelihood is used to estimate the unknown parameters β and the μ_i by expressing two-step procedure, in which involves the use of OLS and the MLE to estimate the intercept and the variances of two error components. Thus the technical efficiency of each producer is estimated by using the distributional assumptions simultaneously in the computer program FRONTIER Version 4.1.The likelihood function is expressed in terms of the variance parameters, $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2/\sigma^2$ (Coelli, 1998). The cause of technical inefficiency can be investigated by regressing inefficiency on explanatory variables. Since u_i are non-negative random variables, which are assumed independently distributed such as u_{ji} is defined by the truncation (at zero) of normal distributions with mean u_i and variance σ_u^2 respectively.

Data and the Empirical model

The data sources and description of variables

The data used for this study is cross-section primary data from a farm-survey of groundnut producers in two largest groundnut growing areas, Magway and Mandalay divisions, of Myanmar during April-May 2007. Data of 282 farm households from eight villages within the two divisions, 158 samples from Magway and 124 from Mandalay were collected using stratified random sampling procedure. The collected data covered information on input used and output of groundnut production and related socio-economic data of farm households.

Table 1 describes selected farm and socio-economic characteristics of the sample farm households. The average groundnut production areas were small in both divisions, with average size of 1.37 ha. The average yield production is 813 kg ha^{1} for all firms. The average production of Mandalay firms is 782 kg ha^{1} and that for Magway firms is 1036 kg ha^{1}. Total labor use in groundnut production is 78 man-day ha^{1} for Magway farmers and Mandalay farmers used the total labor in groundnut production are 119 man-day ha^{1}. The amount of chemical fertilizer is applied for groundnut production is 33.17 kg ha^{1} in Mandalay area and that for Magway area is applied for 44.04 kg ha^{1} the amount of chemical fertilizer. This study indicates that Magway firms are more used to manure fertilizer than Mandalay firms with the amount of 63.1 tons ha^{1} and 48.1 tons ha^{1}, respectively. Crops grown on their land were same crops such as groundnut, beans, sesames, and other crops. The average age of household heads was 49 years in both the study area and the average level of education of the farmer is 6 years in both that implies it is completely finished the primary school.

Empirical Model

A stochastic frontier analysis was conducted to estimate farm technical efficiency. The results is linked the efficiency to the management systems and in characterizing the factors into change in production. These are among the estimation of technical efficiency for both Mandalay area and Magway area. For the analysis, the parametric stochastic frontier approach was used. The general form of technical efficiency model for the cross-sectional data with Cobb-Douglas function by using Ordinary Least Squares (OLS) method is

$$\ln y_i = \beta_0 + \Sigma_n \beta_n \ln x_{ni} + v_i - \mu_i$$

However, the parameter of stochastic frontier production function using the maximum-likelihood (ML) method proposed by Richmond (1974) is better more efficient than the OLS estimators while the contribution of the technical inefficiency effects to the total variance term is large (Coelli, 1998). Therefore, the translog stochastic frontier production function is appropriate model for the analysis of the data available on 282 groundnut farmers. The model to be estimated is applied to a largest sample of groundnut producers in two divisions of Myanmar. Thus, the translog functional form is defined as;

$$\ln Y_i = \beta_0 + \beta_0^{*} D_{1i} + \beta_0^{**} D_{2i} + \sum_{j}^{6} \beta_j \ln X_{ji} + \frac{1}{2} \sum_{j}^{6} \sum_{k}^{6} \beta_{jk} \ln X_{ji} \ln X_{ki} + \nu_i - \mu_i, \quad (4)$$

where the subscript i, indicates the ith farmers in the sample, ln represent the natural logarithm, Y the total output of groundnut production in kilogram on a given farm, D_1 and D_2 the soil quality dummy variables, which D_1 represent the good quality of soil and D_2 represent the fair quality of soil, β_{jk} (j,k =1,2,..,6 with j ≤ k) the unknown parameters, associated with the explanatory variables in the production function, and X_i represent the total groundnut production area in hectare, seed used for groundnut production in kilogram per hectare, amount of chemical fertilizer used for groundnut production in kilogram per hectare, amount of manure used for groundnut production in ton per hectare, cost of insecticides and pesticides for groundnut production in US$ per hectare, labor used for groundnut production in man-day per hectare. The v_i is assumed to be independent and identically distributed (iid) random error with N (0, σ_v^2) distribution. The μ_i is non-negative random term, accounting for inefficiency, iid, with N (0, σ_u^2), truncated half normal.

Table 1 Selected farm and socio-economic characteristics of the sample farm households in Myanmar, 2007.

Variables	Mandalay(N=124)		Magway (N=158)	
	Mean	Std	Mean	Std
groundnut area (ha)	0.98	0.84	1.69	1.70
Yield (kg ha^{1})	782	296	1036	542
Seed (dried) (kg ha^{1})	53.5	6.1	54.5	9.9
labor used (man-day ha^{1})	78	42	119	31
Chemical fertilizer (kg ha^{1})	33.17	37	44.04	34
Manure(tons/ha)	48.1	32.9	63.1	101.1
Cost of pesticides and Insecticides (US$ ha^{1})	3.2	1.6	3.9	4.1
Labor availability (ME-equvalent unit))	4.1	1.37	4.41	1.65
Credit access (%)	96.77	17.74	36.08	48.18
Extension services (%)	11.29	31.76	32.28	46.90
Age of head (years)	49	13	48	12
Education (years)	5	2	7	3
Experiences (years)	26.20	13.19	27.41	11.28
Total agricultural areas (ha)	2.13	1.42	5.86	4.47
Soil quality (%)				
1.sandy-loam	25	-	55	-
2.sand	60	-	43	-
3.loam	16	-	4	-

Source: Field survey, 2007.

Note: 1 US $= 1050 kyats.

In this study, the inefficiency equation is defined as follows;

$$\mu_i = \delta_{11} + \delta_{12}\, Education_i + \delta_{13}\, Age_i + \delta_{14}\, labor\ force_i + \delta_{15}\, D_{credit} + \delta_{16} D_{extent} \qquad (5)$$

where δ_s are parameters to be estimated. The variable *Education* represents the number of years of schooling achieved by the household head, *Age* the age of the household head as the farm manageer, *Labor* the availability of labor force in the household (in the Man-equivalent unit), D_{Credit} the dummy variable for source of credit which has a value one if farmer having access to credit and zero otherwise, $D_{extension}$ the dummy variable for having access to extension officers which has a value one if farmer having access to extension officers, zero otherwise.

Therefore, the null hypothesis to test the suitability of the translog versus the Cobb-Douglas production function is captured by.

H_0: $\Sigma i\ \beta_{jk} = 0$ for all j,k and over all plots

Results and discussion

The results of the maximum likelihood estimates of the stochastic production frontier with‘t’ statistics for the groundnut crop are presented in Table 2 and inefficiency model is presented in Table3. It was started with the full translog specification and tested whether some parameters could be eliminated. The full translog functions were examined to be the most appropriate specification. Considering that the Cobb-Douglas from is nested within the translog functional form.

A nested hypothesis is performed to determine whether the Cobb-Douglas specifications an adequate representation of the frontier production function. A test of significant of γ in this study is that there is no technical inefficiency of the null hypothesis. The estimation of the γ-parameter which is associated with the variance of the technical inefficiency effects in the stochastic frontiers are 0.98 in the selected survey area and it is the fact that a high level of inefficiency exists in the groundnut production. Thus, a significant part of the variability in the production among farms is explained by the existing difference in the level of technicalinefficiencies. These result suggested that technical inefficiency effects is a significant component of the total variability of groundnut output for the sample firms (Coelli, 1998). It implies that the yields are related to the area in which increasing land is grown for groundnut production.

The analysis indicates the null hypothesis of the Cobb-Douglas form can be rejected at the 5% level. Therefore, all results refer to the translog. The rejected second null hypothesis shows that there are no inefficiency effects in the production function (Table 4). Thus, the explanatory variables in the technical inefficiency model contribute significantly to the explanation of the technical inefficiency effects for the groundnut farms. The third null hypothesis is also rejected within the selected study area, showing that the joint effects of these variables on technical efficiency are statistically significant.

Table 2 Maximum likelihood estimates of the parameters of the translog stochastic frontier groundnut production function in Myanmar.

Variables	Parameters	Coefficient	t-ratio
Intercept	β_0	7.65**	12.52**
D1(good soil)	β_0^*	0.355	-0.927
D2(fair soil)	β_0^{**}	0.020***	3.133***
ln(area)	β_1	-0.154	-0.14
ln(seed)	β_2	-0.796	-0.47
ln(chemicalfertilizer)	β_3	-0.234	-0.23
ln(manure)	β_4	0.237	0.02
ln(cost of insecticides)	β_5	-0.536	0.54
ln(laborused)	β_6	-0.845	-0.88
ln(Area)2	β_{11}	-0.459**	-2.89**
ln(Area xln(seed)	β_{12}	-0.254	-0.27
ln(Area xln(chemfertilizer)	β_{13}	-0.297	-1.01
ln(Area xln(manure)	β_{14}	-0.229	-0.19
ln(Area x ln(insecticides)	β_{15}	0.251	1.30
ln(Area x ln(laborused)	β_{16}	-0.212	-0.39
ln(Seed) 2	β_{22}	0.113*	1.67*
ln(Seed x ln(chemfertilizer)	β_{23}	-0.106	-0.13
ln(Seed x ln(manure)	β_{24}	-0.412	-1.08
ln(Seed xln(insecticides)	β_{25}	0.233**	1.99**
ln(Seed x ln(laborused)	β_{26}	0.425**	2.57**
ln(Chem.fert) 2	β_{33}	0.408	0.66
ln(Chem.fert xln(manure)	β_{34}	0.377	0.09
ln(Chem.fert) xln(insecticides)	β_{35}	0.104	0.48
ln(Chem.fert) xln(laborused)	β_{36}	-0.955	0.41
ln(Manure)2	β_{44}	0.293	0.50
ln(Manure) xln(insecticides)	β_{45}	0.105	0.34
ln(Manure) xln(laborused)	β_{46}	-0.574	-1.18
ln(Insecticides) x ln(insecticides)	β_{55}	0.210	0.79
ln(Iinsecticides) xln (laborused)	β_{56}	-0.229	-0.16
ln(Laborused) x ln(laborused)	β_{66}	-0.548	-0.56
Variance parameters $\sigma^2 = \sigma_v^2 + \sigma_u^2$ $\gamma = \sigma_u^2/\sigma^2$ log-likelihood function	σ^2 γ -210.06	1.65*** 0.98***	3.368*** 107.75***

Note: * Significant at 0.1 level, **Significant at 0.05 level, *** Significant at 0.01 level.

Source: Analyzed by FRONTIER 4.1

Table 3 Technical inefficiency effects of groundnut production

Variables	Parameters	Coefficient	t-ratio
Intercept	δ_0	7.57***	8.98***
School years	δ_1	-1.96**	-2.18**
Age of head households	δ_2	-2.33***	-5.10***
Labor force availability	δ_3	0.537	0.942
Credit access	δ_4	0.243	0.305
Extension services	δ_5	0.216	0.475

Note: **Significant at 0.05 level. *** Significant at 0.01 level.

Source: Analyzed by FRONTIER 4.1

Table 4 Likelihood ratio tests of hypothesis involving parameters of the stochastic frontier inefficiency model for Mandalay and Magway firms in Myanmar.

Null hypothesis	Likelihood Ratio (γ)	X^2 Critical Value	Decision
H_0: $\beta_{ij} = 0$ H_0: $\lambda = \delta_0 = \delta_1 = \ldots = \delta_6 = 0$ H_0: $\delta_0 = \delta_1 = \delta_2 = \delta_3 = \ldots = \delta_6 = 0$			
Cobb-Douglas	107.69	11.07	Rejected H_0
Translog	98.97	40.11	Rejected H_0

Note: The critical values correspond to 5%level of significance. γ = -2 [Log likelihood (H_o) – Log likelihood (H_1)]

A negative sign on a parameter that is explaining inefficiencies means that the variable is improving technical efficiency, while for a positive sign the reverse is true. The results as shown in the Table 3 reveal that the school year and age of household head are negatively significant variables affecting the technical inefficiency of groundnut production in the study area. This indicate that a higher level of education of a household head increase the technical efficiency of the farmers. Also, older farmers appear to be more efficient than younger farmers. There are no significant relationship between efficiency and labor availability, access to credit as well as access to extension service.

Technical efficiency

It has been assumed in the analysis that farmers who produced the groundnut crop in Myanmar use identical production technologies. Production function estimates can be used to test the restriction. The estimation involves interacting each of the parameters in the specified stochastic production frontier function and testing the hypothesis that the interaction effects are jointly zero.

A technical efficiency measure of 100 indicates a completely efficient use of the inputs included in the frontier function specification (Abdulai and Eberlin, 2001). The result show that the sample farms technical efficiency varies widely in the empirical work. The technical efficiencies for groundnut farmers in Mandalay was 91% with mean technical efficiency estimated to be 53%. For production in Magway, the technical efficiencies was 96%, with mean efficiency of 59%. The distribution of technical efficiency of groundnut production is shown in Table 5. The average technical efficiency core is 0.59 implying that groundnut farms in these areas produce to grown up about 40% at efficiency level. A comparison of the technical efficiencies of farmers between two divisions show that the farmers in Magway display higher efficiencies in groundnut production than the farmers from Mandalay area.

Table 5 Technical Efficiency estimation of farm household.

Technical Efficiency	Mandalay		Magway		Total	
	Count	%	Count	%	Count	%
0.01-0.19 (very low)	1	0.9	4	2.7	5	1.90
0.20-0.39 (low)	51	4.7	28	18.9	79	30.00
0.40-0.59 (medium)	8	7.0	13	8.8	21	8.00
0.60-0.89 (High)	52	45.6	96	64.9	148	56.70
0.90-1.00 (very high)	2	1.8	7	4.7	9	3.40
Total	114	100.0	148	100.0	263	100.00
Max	0.91		0.96		0.96	
Mean	0.53		0.63		0.59	

Conclusion

This paper has examined technical efficiency among a sample of farmers in two regions of Myanmar with a translog stochastic frontier modelusing detailed survey data obtained from 282 groundnut farmhouse holds in 2007. Factors that cause some farmers to be more efficient than others are determined. The analysis is performed for groundnut crop, edible crop. The average technical efficiency levels were 59%. These results suggest that this sample of farmers could increase their technical efficiency and output through better use of available resources given the state of technology. The findings also show that the level of education and age of households are significant variables for improving technical efficiency.

Overall, this study indicates that extensive productivity gains can be obtained by continuously improving farm household production efficiency. Hence, it is important for agricultural development in Myanmar to have an institutional environment that facilitates farmer's accessibility to education.

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