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Technical Efficiency of Soybean Farms and Its Determinants in Saboba and Chereponi Districts of Northern Ghana: A Stochastic Frontier Approach

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Abstract

This study analyzes the level and determinants of technical efficiency of soybean farms in the Saboba and Chereponi districts of northern Ghana. A multi-stage sampling technique was used to select 200 soybean farmers from which cross-sectional data was collected using a structured questionnaire. Data collected includes farmers' socio-economic characteristics such as age and education as well as input and output quantities and prices. Data was analyzed using the stochastic frontier approach. Results showed a mean technical efficiency estimate of 53 percent and the return to scale was 0.75. Location of farm, participation in the Agricultural Value Chain Mentorship Project and age of farmer were found to be important in explaining technical inefficiency among soybean farmers. This implies that farmers in the short run can increase their production by 47 percent by adopting practices of the best soybean farms in Saboba and Chereponi districts of northern Ghana.

Keywords: determinants, northern Ghana, soybean, stochastic frontier, technical efficiency

1. Introduction

Soybean (*Glycine max* L.) is an important legume in Ghana. The crop is a good source of plant protein and is used in the preparation of food and feed. The crop is also a good source of edible oil (Ministry of Food and Agriculture, MoFA, 2006). Soybeans have good nutritional and medicinal properties. According to Sanful and Darko (2010), the crop virtually does not contain sodium, a mineral that causes fluid retention in tissues; consequently, soybeans are effective in preventing cardiovascular diseases. Soybeans also contain trace elements such as copper, zinc and manganese. It is the only source that contains all amino acids (Sanful & Darko, 2010).

According to the Statistics, Research and Information Directorate, SRID, of MoFA (2012), majority (77%) of soybean production in Ghana emanates from the Northern Region. The region is therefore a target for most soybean related interventions including the Agricultural Value Chain Mentorship Project, AVCMP, funded by the Danish International Development Agency, DANIDA, through the Alliance for a Green Revolution in Africa, AGRA.

Ghana's Council for Scientific and Industrial Research, CSIR, through the AVCMP and other development projects have been extending soybean technologies to farmers in northern Ghana including those in the Saboba and Chereponi districts. These technologies include good land preparation practices, use of certified seed, dibbling, Integrated Soil Fertility Management (ISFM), Integrated Pest Management (IPM), timely execution of farm operations, soybean-rice rotation among others. In spite of these interventions, MoFA (2011) reported that farmer's average soybean yields (1.5 Mt/Ha) were well below achievable yields (2.3 Mt/Ha). Closing the yield gap presents an opportunity for sustainable growth in production which can be achieved through technical efficiency improvements. Technical efficiency improvement in soybean production means farmers can produce more without necessarily increasing the usage of resources. The resultant saving of these scarce resources allows them to be redistributed to other productive sectors of the economy and consequently alleviate poverty among farmers.

The average technical efficiency of farmers reported in many studies range from 0.46 to 0.82. Singh, Dey, Rabbani, Sudhakaran and Thapa (2009) reported a mean technical efficiency of 0.66 for fish farms in India; In Nigeria, Udoh and Akpan (2007) reported an average technical efficiency of 0.65 for maize farms, Idiong (2007) reported 0.77 for rice farms and Amos (2007) reported 0.72 for cocoa farms. Kebede and Adenew (2011) reported a mean technical efficiency of 0.82 for wheat farms in Ethiopia. The average technical efficiency of maize farms in Malawi was estimated as 0.46 (Chirwa, 2007).

Literature on technical efficiency in the production of many crops abound. There are numerous studies in Nigeria alone (for example, Adinya, Offem, & Ikpi, 2011; Ebong, Okoro, & Effiong, 2011; Nurudeen & Rasaki, 2011; Simonyan, Umoren, & Okoye, 2011; Usman & Suleiman, 2011; Akpan, Nkanta, & Essien, 2012; Balogun, Adeoye, Yusuf, Akinlade, & Carim-Sanni, 2012; Ezeh, Anyiro, & Chukwu, 2012; Ojo, 2012; Bamiro & Aloro, 2013). There are however only a few studies in Ghana (for example, Al-hassan, 2008; Onumah, Br¨ummer, & H¨orstgen-Schwark, 2010; Dadzie & Dasmani, 2010; Essilfie, Asiamah, & Nimoh, 2011; Malik & Mohammed, 2012) and very few studies in northern Ghana (for example, Al-hassan, 2008; Malik & Mohammed, 2012). There is however no known study on technical efficiency of soybean farms in Saboba and Chereponi districts up to date. This study therefore estimates the level and determinants of technical efficiency of soybean farms in the Saboba and Chereponi districts of northern Ghana.

2. Theoretical Framework

Farrell (1957) categorizes the measure of efficiency of a production unit into technical and allocative components and the multiplicative interaction of these two to provide a measure of economic efficiency. Technical efficiency is the ability of a firm to obtain maximum output from a given set of inputs and allocative efficiency is the ability of a firm to use inputs in optimal proportions, given their respective prices.

Technical efficiency is estimated by either parametric or non-parametric approach. The advantages of the parametric approach vis-à-vis the non-parametric approach is its ability to represent a technology frontier in a simple mathematical form and also assume non-constant returns to scale. The non-parametric approach uses methods such as Data Envelopment Analysis (DEA) while the parametric approach uses econometric methods consisting of either deterministic or stochastic modeling. According to Onumah et al. (2010), a weakness of the deterministic model is that it regards all deviations in output as technical inefficiency effects regardless of the fact that, deviations in output could be beyond the control of the producer. Deviations in output may actually arise as a result of random errors such as weather effects or errors of measurement. This study therefore adopts the stochastic model in estimating technical efficiency of soybean farms in the Saboba and Chereponi districts of the Northern Region of Ghana.

2.1 Stochastic Frontiers

The stochastic frontier approach was independently proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and Van Den Broeck (1977). The stochastic frontier for a cross-sectional data is specified as;

$$Y_i = f\left(X_i;\beta\right)\exp\left(\varepsilon_i\right) = f\left(X_i;\beta\right)\exp\left(V_i - U_i\right), i = 1,2....N \tag{1}$$

Where Y_i is the level of output for the ith farm. X_i is a vector of inputs and other explanatory variables associated with the ith farm and β is a vector of unknown parameters to be estimated. ε_i is the error term that is composed of two independent elements V_i and U_i such that $\varepsilon_i = \left(V_i - U_i\right)$. V_i is the noise error term, whilst U_i is a non-negative inefficiency error term. The condition that U_i is non-negative ($U_i \geq 0$) in equation (1), ensures that all observations lie on or below the stochastic production frontier (Aigner, Lovell and Schmidt, 1977; Coelli et al., 2005; Onumah et al., 2010). Following from Onumah et al. (2010), this study assumes that V_i is independently, identically and normally distributed with zero mean and constant variance, $\sigma_v^2\left[V_i \sim N\left(0,\sigma_v^2\right)\right]$. Following from Battese and Coelli (1995), the technical inefficiency effect is defined as:

$$U_i = Z_i\delta + W_i \tag{2}$$

where Z_i is a vector of explanatory variables associated with the technical inefficiency effect which could include socioeconomic and farm management characteristics. δ is a vector of unknown parameters to be estimated and W$_{i's}$ are random variables such that $W_i \geq Z_i\delta$. Following from Kumbhaker, Ghosh and McGuckin (1991), this study estimates the parameters of Equation (1) and (2) by employing maximum likelihood single-stage estimation procedure using the software, Frontier 4.1.

2.2 Empirical Model Specification

The transcendental logarithm (translog) production function is assumed for this study and is specified as:

$$InY = \beta_0 + \sum_{j=1}^{5} \beta_j InX_j + 0.5 \sum_{j=1}^{5} \sum_{i=1}^{5} \beta_{ji} InX_j InX_i + (V - U) \tag{3}$$

Where Y_i is the output of soybean produced in 2012 season by the i[th] farmer and measured in Kg/Ha. X_1 represents the cost of hired labour measured in GHs/Ha. X_2 is the cost of family labour also measured in GHs/Ha. X_3 is the combined cost of other inputs such as chemicals and depreciated cost of intermediate inputs such as hoe and cutlass. Size of the soybean farm in hectares is captured as X_4 and finally, X_5 is the cost of seed measured in GHs/Ha. Descriptive statistics of the output and input variables are summarized in Table 1.

From Equation (3), when, β_{ji} = 0, then the translog production function reduces to the Cobb-Douglas production function given as:

$$InY = \beta_0 + \sum_{j=1}^{5} \beta_j InX_j + (V - U) \tag{4}$$

Estimated coefficients of the Cobb-Douglas production function are interpreted as elasticity. According to Onumah et al. (2010), the first-order coefficients of the translog production function are interpreted as elasticity, if and only if, the output and input variables are normalized by their respective sample means before they are log-transformed. A sum total of the output elasticity from the input variables is the scale elasticity (ε) which is defined as the percentage change in output as a result of a 1 percent change in all input factors.

When (ε) > 1, it is interpreted as increasing returns to scale, (ε) < 1 is interpreted as decreasing returns to scale and (ε) = 1 is interpreted as constant returns to scale.

The technical inefficiency effects are assumed to be a linear function of the exogenous variables and are given by;

$$U_i = \delta_0 + \sum_{i=1}^{11} \delta_i Z_i + W_i \tag{5}$$

Where Z_1 = District in which the soybean farm is located and a farmer is assigned the value of 1, if the soybean farm is located in the Chereponi District and 0 if the farm is located in Saboba District. Z_2 = Participation in Agricultural Value Chain Mentorship Project (AVCMP). A soybean farmer who has benefitted from the project is assigned a value of 1 and 0 otherwise. Z_3= Sex of soybean farmer, a female is designated as 1 and 0 otherwise. Z_4 = Age of Soybean farmer measured in years. Z_5 = Experience in soybean farming captured as number of years in soybean production. Z_6 = Marital status, with 1 assigned to a farmer who is married and 0 otherwise. Z_7 = Number of years of education. Z_8 = Residence status, a native from the community is assigned a value of 1 and 0 otherwise. Z_9 = Electricity is captured as a dummy variable hence a farmer who has access to electricity is assigned a value of 1and 0 otherwise. Z_{10} = Credit, a farmer who received credit in 2012 production season is assigned a value of 1 and 0 otherwise. Z_{11} = Agricultural extension service, a farmer who received agricultural extension service in 2012 production season is assigned a value of 1 and 0 otherwise. Descriptive statistics of the exogenous variables used for the inefficiency model are also presented in Table 1.

2.3 Statement of Hypothesis

The following hypotheses were formulated to ascertain the adequate representation of the functional form adopted for the data and to determine whether the exogenous variables and the conventional input variables in the technical inefficiency model play a role in explaining technical inefficiency. The hypotheses tested are; (1) H_0: $\beta_{ij} = 0$, the null hypothesis that the Cobb-Douglas production function is best fit for the data; (2) H_0: $\gamma = \delta_0 = \delta_1 = ... = \delta_6 = 0$, the null hypothesis that inefficiency effects are absent from the model at every level; (3) H_0: $\gamma = 0$, the null hypothesis that inefficiency effects are non-stochastic. (4) H_0: $\delta_0 = \delta_1 = ... = \delta_6 = 0$, the null hypothesis that simpler half normal distribution is an adequate representation of the data given the specifications of the generalized truncated-normal model; (5) H_0: $\delta_1 = ... = \delta_6 = 0$, the null hypothesis that farm specific factors do not influence inefficiency. These hypotheses are tested using the generalized likelihood-ratio statistic, LR, which is specified as:

$$LR = -2\left[In\left\{ L(H_0) \right\} - In\left\{ L(H_1) \right\} \right] \tag{6}$$

Where $L(H_0)$ and $L(H_1)$ are values of likelihood function under the null (H_0) and alternative (H_1) hypotheses respectively. LR has approximately a Chi-square distribution (Onumah et al., 2010).

Table 1. Descriptive statistics of all variables in the frontier and inefficiency models

Variable	Unit	Minimum	Maximum	Mean	Standard Deviation
Output	Kilogram	100.00	3800.00	757.00	644.87
Hired labour	Ghana cedi	0.00	383.00	42.95	57.71
Family labour	Ghana cedi	0.00	405.00	50.82	54.24
Other input	Ghana cedi	0.00	449.00	75.68	77.34
Land	Hectares	0.40	2.80	0.80	0.51
Seed	Ghana cedi	1.00	12.00	2.60	1.71
District	Dummy	0	1	0.52	0.50
AVCMP	Dummy	0	1	0.25	0.44
Sex	Dummy	0	1	0.36	0.48
Age	Years	17	80	40.10	11.87
Experience	Years	1	10	5.17	2.40
Marital status	Dummy	0	1	0.90	0.30
Education	Years	0	20	1.82	3.89
Native	Dummy	0	1	0.97	0.18
Electricity	Dummy	0	1	0.22	0.41
Credit	Dummy	0	1	0.27	0.45
Extension	Dummy	0	1	0.45	0.50

3. Sampling and Data Collection Method

A multi-stage sampling procedure was employed. Northern Region, and Saboba and Chereponi districts were purposively selected for the study. The districts and region represents a major soybean producing area in Ghana. Within each district, 10 major soybean producing communities were randomly sampled. Within each community, 10 soybean farmers were then selected based on simple random sampling technique.

Cross sectional data were collected from 200 soybean farmers on output, input variables and other relevant socioeconomic variables with the aid of a structured questionnaire. The survey was conducted between February and March 2013.

4. Empirical Results

Results of the hypothesis tests as presented in Table 2 indicate that all the five null hypotheses are statistically insignificant at 1 percent level. According to Singh et al. (2009), the choice of a functional form has an effect on the estimated technical efficiency hence testing the Cobb-Douglas against the translog functional form is justified. The first hypothesis that the Cobb-Douglas production function is better fit for data is rejected. This result contradicts the findings of Kebede and Adenew (2011), Singh et al. (2009) and Amos (2007) who did not reject the Cobb-Douglas production function. The result is however consistent with Onumah et al. (2010). The translog production function is therefore best suited for the data. The second and third hypotheses are also rejected hence inefficiency effects are present in the model and are not non-stochastic which implies that the use of the traditional ordinary least square (OLS) regression technique cannot be supported by the data. This finding is supported by several authors (Amos, 2007; Singh et al., 2009; Onumah et al., 2010, Kebede and Adenew, 2011). The fourth hypothesis is also rejected hence the simpler half normal distribution is not an adequate representation of the data. This implies that the intercept and coefficients of the inefficiency model are statistically different from zero. This result is consistent with Onumah et al. (2010) and Kebede and Adenew (2011). Finally, the fifth hypothesis that farm specific factors do not affect inefficiency is also rejected hence farm and farmer characteristics are important in explaining inefficiency. The result of this hypothesis is almost unanimous in the literature (see for example, Amos, 2007; Singh et al., 2009; Onumah et al., 2010, Kebede & Adenew, 2011).

Table 2. Results of the hypotheses tests

Null hypothesis	Log-likelihood value	Test statistics (λ)	Critical value ($\lambda^2_{0.01}$)	Decision
H_0: $\beta_{ij} = 0$	148.25	36.64	30.58	Reject H_0
H_0: $\gamma = \delta_0 = \delta_1 = \dots = \delta_{11} = 0$		142.90	27.03	Reject H_0
H_0: $\gamma = 0$	166.95	68.85	5.14	Reject H_0
H_0: $\delta_0 = \delta_1 = \delta_2 = \dots = \delta_{11} = 0$	166.30	72.76	26.22	Reject H_0
H_0: $\delta_1 = \delta_2 = \dots = \delta_{11} = 0$	160.08	60.32	24.73	Reject H_0

Table 3. Estimates of the stochastic frontier model

Variables	Coefficient	Standard Error	T-Ratio
Constant	0.779***	0.065	11.983
LnHiredLabour	-0.019	0.071	-0.262
LnFamilyLabour	0.003	0.154	0.019
LnOtherInput	-0.069***	0.012	-5.789
LnLand	0.849***	0.021	41.055
LnSeed	-0.016	0.026	-0.603
0.5(LnHiredLabour)^2	-0.045	0.027	-1.633
0.5(LnFamilyLabour)^2	-0.074	0.142	-0.518
0.5(LnOtherInput)^2	-0.085	0.066	-1.296
0.5(LnLand)^2	0.138	0.326	0.423
0.5(LnSeed)^2	-0.128	0.146	-0.881
LnHiredLabour * LnFamilyLabour	-0.086***	0.019	-4.599
LnHiredLabour * LnOtherInput	-0.027	0.079	-0.346
LnHiredLabour * LnLand	0.055	0.072	0.767
LnHiredLabour * LnSeed	0.139***	0.039	3.566
LnFamilyLabour * LnOtherInput	-0.018	0.157	-0.112
LnFamilyLabour * LnLand	0.064	0.043	1.495
LnFamilyLabour * LnSeed	0.084**	0.043	1.947
LnOtherInput * LnLand	0.014	0.083	0.169
LnOtherInput * LnSeed	-0.072***	0.027	-2.711
LnLand * LnSeed	0.268**	0.134	1.997
Sigma-squared ($\sigma^2 u/\sigma^2$)	0.947***	0.299	3.169
Log likelihood	129.93		

** and *** imply statistical significance at 5% and 1% respectively.

Table 4. Elasticities of mean output

Elasticities with respect to				
Hired Labour	Family Labour	Other Input	Land	Seed
-0.019	0.003	-0.069***	0.849***	-0.016

*** imply statistical significance at 1%.

4.1 Estimates of the Frontier Model

Frontier estimates of parameters, standard errors and critical t-values of the translog model are presented in Table 3. Following from Onumah et al. (2010), the discussion of the parameters is based on the output elasticities with respect to each individual input evaluated at their mean values as shown in Table 4. Output elasticities with respect to family labour and land are positive hence there is a positive correlation between output levels on one hand, and family labour and land kept under soybean cultivation on the other hand. Ogundele and Okoruwa (2006) found the effect of family labour on rice production in Nigeria to be negative when farmers produced under traditional technologies and positive when they adopted improved technologies. Increasing family labour and farm size up to a certain threshold, ceteris paribus, will result in an increase in soybean production in the Saboba and Chereponi districts. Chirwa (2007) and Idiong (2007) both reported a positive relationship between farm size and production of maize in southern Malawi, and Rice in Cross River State in Nigeria, respectively. Al-hassan (2008) also reported a positive relationship between farm size and rice production in northern Ghana. The finding of the study however contradicts that of Kebede and Adenew (2011) who reported a negative relationship between farm size and commercial wheat production in Ethiopia.

Output elasticities with respect to hired labour, seed and 'other' inputs are negative. This implies that an increase in hired labour, seed and 'other' inputs will have a negative effect on soybean production. Hired labourers, as the name suggest, are usually engaged to undertake a specific farm operation after which their services are paid for. Hired labourers are mostly interested in their fees and may not have any attachment for the farm. They are therefore less likely to put in their best efforts as compared to family labour especially in the absence of effective supervision. Also, different people may be hired to undertake different farm operations which may have a negative effect on production unlike the usage of family labour where the same set of people are more likely to undertake different farm operations hence there is continuity, knowledge build up and attachment to the farm which is likely to have a positive effect on production. Ogundele and Okoruwa (2006) found a negative relationship between hired labour and rice production using traditional technologies and a positive correlation between hired labour and rice production under improved technologies in Nigeria.

According to Etwire et al. (2013), majority of farmers in Ghana obtain their seed from informal sources hence they prefer to select their seed from the previous harvest instead of buying certified seed. Continuous use of any seed including improved seed will result in loss of vigour and consequently a reduction in productivity and production. This could probably be the explanation for the inverse relationship between seed and output. Singh et al. (2009) reported that seed quality is an important determinant of technical efficiency. Seed positively and significantly affects the technical efficiency of commercial wheat farms in Ethiopia (Kebede & Adenew, 2011). Analysis of the data indicates that farmers who use 'other' inputs such as herbicides and insecticides do not apply them appropriately, hence increasing the level of usage of 'other' inputs may not only result in low farm productivity, it may even be hazardous to the farmer. The finding of this study contradicts that of Amos (2007) who found a positive relationship between herbicide use and cocoa production in Nigeria. Kebede and Adenew (2011) also estimated a positive and significant relationship between agro chemical use and wheat production.

Farm size and 'other' inputs are however the only significant determinants of soybean production in the Saboba and Chereponi districts of northern Ghana. A 1 percent increase in land kept under soybean production will result in an increase in production of about 0.85 percent ceteris paribus. Similarly, a percentage increase in the use of 'other' inputs will result in a 0.07 percent reduction in soybean production, all other things being equal. The sum of all the output elasticities which is also the return to scale is estimated to be 0.75. This implies that, on the average, soybean farms in Saboba and Chereponi districts are operating under decreasing returns to scale. Hence, a percentage increase in all factors of production will result in 0.75 percent increase in output, all things being equal. The estimated return to scale is similar to the 0.90 estimated by Chiang, Sun and Yu (2004) and Chirwa (2007) but less than the 1.26 and 1.57 estimated by Amos (2007) and Idiong (2007) respectively.

Sigma-squared ($\sigma^2 u/\sigma^2$) is estimated to be 0.947 which implies that the variance in the stochastic error is less than the farm specific error term. According to Onumah et al. (2010), this result shows that measurement errors and other random disturbances are dominated by the one-sided inefficiency random component.

4.2 Inefficiency Model

Estimates of the technical inefficiency model are presented in Table 5. The parameter estimate for district is significant and positive indicating that soybean farmers in the Chereponi District are less technically efficient as compared to their counterparts in Saboba District. Access and perhaps distance to an agro-based institution may be important in determining technical efficiency. There appears to be more agro-based institutions in Saboba District as compared to Chereponi District in terms of both count and number of years of existence. The

Chereponi District until 2008 was part of the Saboba-Chereponi District with its capital being Saboba. Before the creation of the Chereponi District, administrative offices of all Governmental and Non-Governmental Organisations of the then district were based in Saboba. Consequent to the creation of the Chereponi District, some new offices were created in Chereponi to be responsible for the district including offices for the Ministry of Food and Agriculture and District Assembly. Radio Kitawoln which airs agricultural programs in the local dialect is located in Saboba. Soybean farmers in Saboba District are therefore more likely to have access or working relations with an agro-based institution for a relatively longer time as compared to farmers in Chereponi District. Location of a farmer is perhaps important in determining technical efficiency.

The coefficient of AVCMP is significantly negative implying that farmers who are receiving mentorship from the project are more technically efficient as compared to other farmers who are not participating in the project. AVCMP has been extending both tangible and intangible benefits to its beneficiary farmers since the 2011 production season. The project has being establishing on-farm demonstrations on improved management of soybean, crop rotation and use of inoculants across 16 districts in the Northern Region of Ghana including Saboba and Chereponi districts. Farmers working with the project either benefit by managing a demonstration or participating in a field day organised on a demonstration. The project, being a value chain facility, has been linking farmers to both input and output markets. Farmers working with the project have also benefitted from entrepreneurial skills development and awareness creation activities including agricultural programs on Radio Kitawoln and Savannah Radio, and on-stage drama performance on Integrated Soil Fertility Management (ISFM) practices. Access to agricultural information and extension service could be critical in explaining variations in technical efficiency between farmers. The result of this study is consistent with Muhammad-Lawal, Omotesho and Falola (2009) who observed that participation in the 'Youth in Agriculture Programme' increased the technical efficiency of cassava farms in Ondo State of Nigeria. Balogun et al. (2012) found out that farmers in Oyo State, Nigeria who participated in the National Fadama II Project had higher efficiency scores as compared to those who did not benefit from the project. Several authors have reported a positive relationship between access to agricultural extension and technical efficiency improvement in production (Usman & Suleiman, 2011; Ebong et al., 2011; Simonyan et al., 2011; Javed, Khurshid, Hassan, & Nadeem, 2012; Ezeh et al., 2012; Balogun et al., 2012).

Table 5. Estimates of the inefficiency model

Variables	Coefficient	Standard Error	T-Ratio
Constant	0.573	1.720	0.333
District	0.779***	0.077	10.122
AVCMP	-1.489***	0.579	-2.569
Sex	0.356	0.984	0.362
Age	-0.037***	0.010	-3.574
Experience	0.269	0.168	1.603
Marital	-1.010	3.856	-0.262
Education	-0.063	0.162	-0.387
Native	-0.090	2.177	-0.041
Electricity	-0.117	0.312	-0.376
Credit	0.753	1.489	0.506
Extension	0.299	0.724	0.413

*** imply statistical significance at 1%.

The coefficient of age is negative and statistically significant indicating that older soybean farmers are more technically efficient as compared to younger soybean farmers in Saboba and Chereponi districts of the Northern Region of Ghana. Older farmers tend to be more resource endowed as compared to younger farmers. Production resources such as family labour, land and cash tend to be less constraining with age. Younger members of a farm household become available for farm work with passage of time. Also, family lands when they become vacant as a result of the inability of the initial users to utilise them are eventually reallocated to members of the family, mostly based on age. Soybean production in Saboba and Chereponi districts is mainly under rain-fed conditions hence the crop is cultivated only once in a year since rainfall is uni-modal. Older farmers who have been producing soybean for a relatively longer time are therefore expected to accumulate more wealth from the crop as compared to younger farmers. Age is perhaps a good proxy for experience hence older farmers are likely to have more experience about good agricultural practices. Good agricultural practices are critical in increasing productivity. Age could therefore be important in explaining technical efficiency. The findings of this study contrast that of Shaheen, Sial, Sarwar and Munir (2011) and Onumah et al. (2010) who both opined that younger farmers are more progressive and willing to implement new technologies and are therefore more technically efficient than older farmers. The findings of the study is however consistent with Ebong et al. (2011) who reported a positive relationship between age and technical efficiency improvement in urban crop production.

4.3 Technical Efficiency

Graphical representation of the technical efficiency estimates of soybean farms in the Saboba and Chereponi districts is presented in Figure 1. The technical efficiency estimates ranged between 0.11 and 0.99. A high proportion of farmers (46.5%) had efficiency scores of less than 0.50. The efficiency score of 24 percent of the sample ranged between 0.50 and 0.69. More than a quarter of the sample (29.5%) had efficiency score of 0.70 and above. The mean technical efficiency of the sample for the 2012 production season was 0.53. This implies that on the average, soybean farms in Saboba and Chereponi districts are producing 53 percent of the potential frontier output, given the present level of technology and input use. Hence, 47 percent of the potential frontier output is not realised. Soybean farmers in the 2 districts can therefore increase their production by 47 percent in the short run by adopting practices of the best soybean farms. Otitoju and Arene (2010) estimated that medium-scale soybean farms in Benue State, Nigeria are 73 percent technically efficient.

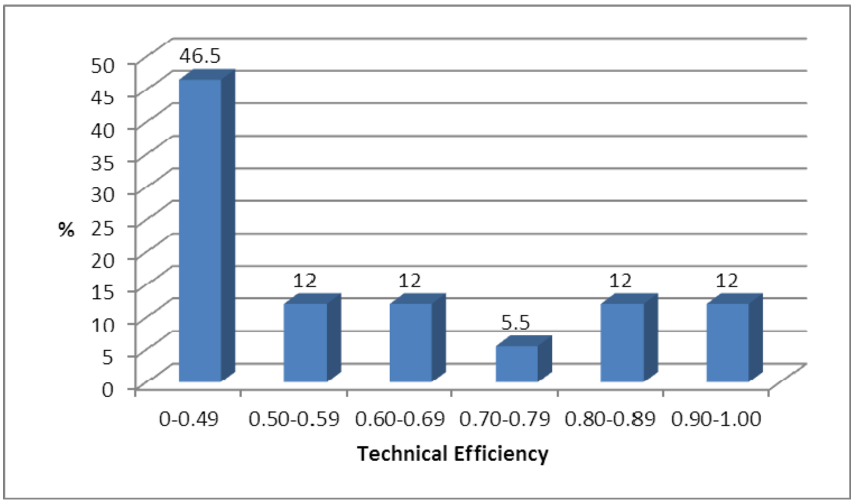

Figure 1. Distribution of technical efficiency

5. Conclusions

The translog production function is best fit for estimating technical efficiency of soybean farms in Saboba and Chereponi districts. Inefficiency effects were found to be important in determining variations in production levels of soybean farms hence the use of the stochastic frontier approach.

Farm size and 'other' input are the significant determinants of soybean production in the Saboba and Chereponi districts of northern Ghana. A 1 percent increase in land kept under soybean production will result in an increase in production of about 0.85 percent, ceteris paribus. Similarly, a percentage increase in the use of 'other' input will result in a 0.07 percent reduction in soybean production, all other things being equal. The sum of all the output elasticities which is also the return to scale is estimated to be 0.75. This implies that, on the average, soybean farms in Saboba and Chereponi districts are operating under decreasing returns to scale. Hence, a percentage increase in all factors of production will result in a 0.75 percent increase in output, all things being equal.

Location of farm, participation in the AVCM Project and age of farmer were found to be important in explaining technical inefficiency among soybean farmers. Farmers in the Chereponi District are less technically efficient as compared to their counterparts in Saboba District. In addition, farmers who are receiving mentorship from the AVCM Project were found to be more technically efficient as compared to other farmers who are not participating in the project. Older soybean farmers were also found to be more technically efficient than younger soybean farmers in the Saboba and Chereponi districts of the Northern Region of Ghana.

The mean technical efficiency of the sample for the 2012 production season was found to be 0.53. This implies that on the average, soybean farms in Saboba and Chereponi districts are producing 53 percent of the potential frontier output, given the present level of technology and input use. In the short run, soybean farmers in the 2 districts can increase their production by 47 percent by adopting practices of the best soybean farms.

The findings of this study have important policy implications. There is the need to improve access to extension services on soybean production, with more emphasis on Chereponi District. Extension services could be improved through scaling up of current agricultural interventions, implementation of new agricultural projects, employment of more agricultural extension agents, improvement in logistical support for agricultural extension agents among others. In addition, there is also the need to create an enabling environment for soybean farmers, which will serve as an incentive for them to continue to remain in production until they are well advanced in age. Government and its development partners can create a conducive environment through improvements in access to inputs, financial services and output markets.

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