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Technical Efficiency of Cassava Production in the Savannah Zone of Northern Ghana: Stochastic Frontier Analysis

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Abstract
The study adopts a Stochastic Frontier Analysis (SFA) approach to estimate the technical efficiency of cassava production in the Savannah Zone of Northern Ghana. A cross-sectional data from 150 producers generated from a simple random sampling method was used in the analysis. A transcendental logarithmic production functional form fitted into a half-normal distribution model was estimated. The mean technical efficiency of the producers was found to be 51% indicating that about 49% of output level is lost to technical inefficiency. This means that farmers could increase their output level by 49% without additional employment of resources and technology. Technical inefficiency was modelled as a function of farmer specific socioeconomic factors. The hypothesis tested showed that the translog production function best represents the production process. The elasticities of land and planting materials are 0.92 and 0.83 respectively. They are positive but less than one implying they have inelastic effect on the output quantities of cassava obtained. The implication is that 1% increase in the quantities of the inputs will result in less than the corresponding increase in the output level. Other elasticities reported negative values, this means marginal addition of those inputs lead to marginal decrease in outputs. The Scale elasticity is 1.74 implying that the farmers are producing at increasing returns-to-scale.
Keywords: Technical Efficiency, Stochastic Frontier Model, Savannah Zone, Cassava

1. Introduction

Cassava (*Manihot esculenta* Crantz) is a root crop that is indigenous to the South American continent. It soon became a staple crop in many of these places because of its tolerance to drought, poor soil conditions and generally difficult crop environments (Plucknett, Truman and Robert, 2000). Cassava offers a very important solution to the food insecurity issues in areas that have unreliable weather during hunger periods and conflicts. The relevance of the crop to Africa's age old problem of food insecurity is not in doubt. The contribution of cassava production to the agricultural sector GDP is encouraging. Cassava constitutes 22% of Ghana's agricultural GDP (Gross Domestic Product) (FAO, 2013). Over the years, root and tubers have become the most important products in terms of bulk production in Ghana. According to MOFA (Ministry of Food and Agriculture [MOFA], 2013), cassava has led all crops in Ghana in terms of quantity produced since 2002).

In Sub-Saharan Africa, many countries including Ghana depend very much on agricultural production for the growth of their economies as agriculture plays an important role in their agrarian economies. For this reason agricultural productivity growth is arguably a precondition for economic development. The climatic conditions of Sub-Saharan Africa is said to favour the production of the crop resulting in Sub-Saharan Africa emerging as the highest producing geographical block worldwide. Nigeria is the largest producer of cassava in the world with SSA accounting for 62% of world production (FAO, 2013). Maintaining the strength in agricultural productivity is necessary to meet expected demands in the coming decades as basic staple food needs will increase by 60% (FAO, 2010). Africa is forecast to increase production by an average of 7.6% annually (FAO, 2012). Increasing agricultural output levels in Africa in general achieved by expanding land areas under cultivation. This system is deemed unsustainable giving the current pressure on the natural resource. This is due in parts to the seeming pressure as a result of population increase and urbanisation.

The Savannahs are found in parts of the tropics where there is not enough rainfall to create rainforest. They are characterised by two seasons: rainy and dry. The climatic conditions at the various places define their characteristics as such are classified into ecological zones. Agro-Ecological Zones (AEZs) are geographical environment, showing common climatic conditions that influence their ability to support rain-fed agriculture (Sebastian, 2013). According to MOFA (2013), five main agro-ecological zones have been identified on the basis of their prevailing natural vegetation and climate and how soil properties are affected by them in Ghana. There consist of the Rain Forest, Deciduous Forest, Transitional Zone, Coastal Savannah and Northern Savannah (Guinea and Sudan Savannah). The Guinea and Sudan Savannah Zones together form half of the Northern Ghana belt with a unimodal rainfall allowing for one major planting season (Wood, 2013). These zones define the production environment that provides comparative advantage in the production of varied crops (FASDEP II, 2007).

Several socio-economic factors affect technical efficiency of any production process. In cassava production the variables that mostly affect the production process include; farm size, farmer educational level, farm experience, income levels, and land ownership. The emergence of technical efficiency concept has presented an interesting view to the contribution of age in the production process. Depending on the effects of other socio-economic factors on the age of a farmer, it can either enhance or reduce technical efficiency. According to empirical literature older farmers are more technically efficient than younger farmers (Siddighi-Balde *et al*., 2014; Erhabor and Emokaro, 2007; Binici *et al.,* 2006; Alemdar and Ören, 2006). Older farmers are thought to be more reasonable and adhere to extension information and other agronomic practices that increase their efficiency. Other studies also support young farmers as being more technically efficient than older farmers (Samual Twumasi Amoah *et al*., 2014; Latruffe, 2010; Sibiko *et al.,* 2013). They hold the conclusion that older farmers may be reluctant to change and sometimes their unwillingness or inability to adopt technological innovations reduces their technical efficiency.

Sex of the producers has also got significant impact on technical efficiency in production. Many studies have concluded that male farmers are more technical efficient than their female counterparts (Abdulai *et al.,* 2013; Asante *et al.,* 2013; Onumah *et al.,* 2013). They contend that in some geographical localities, the culture of the people will likely exclude women in extension information dissemination because they are not considered as farmers like their male counterparts. Also due to gender alignment issues, extension information content may not address the needs and conditions of women producers. Few works however assert that the women off-farm time could be used to gain more knowledge and information thereby increasing their technical efficiency (Latruffe, 2010; Ebo-Onumah, 2010).

Considering that technical efficiency of any production process is an amalgam of factors both within and outside the control of the producer, technical inefficiency can result unintended. Geographical locations of production sites have varied climatic conditions and altitudes with varied effects on production (Sabasi and Shumway, 2014). The vulnerability of some localities to shocks and negative weather effects and also proximity of producers to information all affect the level of output obtained in production. For instance in measurement of aggregate and industry-level productivity growth, Latruffe (2010) concluded that, competitiveness differences among farms may arise from locational and environmental characteristics.

Conventionally, farmers with high education ought to be more technical efficient than those with lesser education. Empirical literature from several studies has supported this view (Rahman *et al.,* 2012; Mailena *et al.,* 2014; Siddighi- Balde *et al.*, 2014; Basnayake and Gunaratne, 2002). The level of knowledge of a particular production process is positively correlated with experience and education. The argument for the enhanced efficiency is the results of their ability to read and understand instructions on improved agronomic practices and also be able to understand concepts and innovations for adoption. However (Ören and Alemdar, 2006) stated that highly educated farmers are not often committed farmers since they would likely have off-farm professional work which engages them. This in their view may render them technically inefficient at the farms.

Farming is a business venture undertaken in risky and uncertain environment. Producers who have been working on the farms become perfect by doing (Abdulai *et al*., 2013; Ogunbameru and Okeowo, 2013; Mailena *et al*., 2014; Basnayake and Gunaratne, 2002). Their continual work on the same environment makes them masters of their activities through experiential learning. Experienced farmers therefore become more technically efficient than their inexperienced counterparts. Byma and Tauer (2010) in exploring the role of managerial ability in influencing dairy farm efficiency indicated that experience does not equal the length of time a producer has been on a job. They concluded that younger farmer with better appreciation of new production systems; technologies and methods would definitely be more efficient than the dull and dogmatic experienced farmer.

Farm size is one of the few factors that put investigators in debate to date. Sections of researchers hold the view that large farms are more technically efficient (Abdulai *et al*., 2013 and Binici *et al*., 2006). They assert that large farms enjoy economies of scale in input acquisition and also enjoy preferential treatments in markets both at the point of sale of their products and the point of purchase of inputs. Others explained that the large nature of the firm makes labour management ineffective and sometimes problematic which results in technical inefficiency (Rahman *et al.,* 2012, Badunenko *et al*., 2006; Sabasi and Shumway, 2014). The average production of the crop over the past 50 years has been between 2 and 4 percent yearly (FAO, 2013). MOFA reports that farm holding of less than two hectares in size constitute about 90% of farming population.

According to literature, extension contacts enjoyed by farmers enhance their technical efficiency (Al-hassan, 2008 and Onumah *et al*., 2013. They observed that farmers learn new and improved methods of production from them. However, Onubuogu *et al.,* (2014) in studying resource use efficiency of small holder cassava farmers in Oweri Agricultural Zone in Imo State, Nigeria concluded that the integrity of the Extension Officer is as important as the message they deliver. Because many farmers trivialise extension information on personal grounds which may render them technically inefficient despite the availability of extension officers. Household of farmers has been an important source of family labour particular in Ghana's agriculture. Many studies have reported positive relationship between household size and technical efficiency (Al-hassan, 2008; Orewa *et al*., 2012). Also, Mailena *et al*., (2014) working on rice farms efficiency and factors affecting the efficiency in MADA Malasia, reported large households as being more technically efficient. They concluded that the households are a source of highly motivated family labour who do not have to be supervised to work hard.

An action taken to raise productivity performance of farmers requires accurate information to observe performance of its components (Fried *et al.,* 2008). If policy planning is to concern itself with cassava production in Ghana, it is useful to know how much the production output level can be increased by simply improving farmers' technical taking on board additional resources. This knowledge is dear to the producer and policy maker alike. Technical inefficiency can result from inaccurate information, for which reason clear understanding of factors behind technical inefficiency by policy makers are necessary (Sharpe, 1995). In this study we intend to estimate the technical efficiency and its determinants on production of cassava in the Savannah zone of Northern Ghana. The findings would provide information for policy formulation and also serve as information for other researchers. We would adopt the stochastic frontier approach in the investigation.

2. Materials and Methods

2.1 Data and Study Area

The research was conducted in the Savannah Zone of Northern Ghana. Six districts were selected in the three regions. Northern, Northern, Brong Ahafo and Northern Volta regions all have the characteristics of Guinea Savannah dominated by grasses and few trees. Some portions of Northern Volta and Northern Brong Ahafo regions also fall right under the Northern Savannah zone. The criterion for the selection took into consideration two factors; cassava production level and location of the district. The districts were purposively selected based on available information about the location in relation to the Savannah geographical area and the production levels of cassava. With this approach, the likelihood of selecting from the same agro-ecological zone was high.

A simple random sampling was conducted to obtain producers from the study area. The study area was divided into six districts representing various parts of the Savannah zone. It formed three clusters; the Northern, Northern Volta and Northern Brong Ahafo regions. Some 150 producers in the research catchment area were interviewed with questionnaires. Focus Group Discussions were used to ascertain the nature and kind of answers that were to be expected from interviews. The research was both qualitative and quantitative with open-ended and closed structured questions. The questionnaire developed for this study was pre-tested to ensure its applicability in the field. Both socio-economic and farm specific related information were taken from the farmers for the purposes of this analysis.

2.2 Conceptual Framework

The foundation of production function models is the economic theory which emphasizes on building consistent models as its core goal (Wan and Battese, 1992). Agricultural production system involves the process by which natural resources are transformed into products for human benefits. The process involves managerial skills, technology, knowledge and productive inputs. The study postulates that output from the production process is obtained by the interactions of some factors; technical input factors, technical inefficiency factors and stochastic factors. This concept of production function is consistent with that outlined by Aigner *et al.* (1977). The framework depicts the real production environment in the study area. Three separate groups of factors determine the output level of the production process; the technical input factors, the stochastic factors and the technical inefficiency factors

2.3 Stochastic Frontier Model

Following the inadequacies in the explanatory ability of the deterministic model in the production process, Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977) independently propose the stochastic frontier approach as the solution. The concept of the Stochastic Frontier Approach depicts a normal production setting that is bedevilled with varied number of factors some of which not under the influence of the producer. The production process may have some stochastic components that are not associated with inefficiency such as luck, weather, measurement errors in the dependent and independent variables. These resulted in the introduction of the stochastic error term which represents different set of errors which were hitherto added to the inefficiency of the producer. The generalised deterministic frontier production function is expressed below:

$$Y_i = \exp(X_i \beta) + (\varepsilon_i) \qquad i = \ldots, N \tag{1}$$

Where;

Y_i represents the logarithm of production of output of the *i*-th firm;

X_i is K x 1 vector containing the logarithm of inputs quantities of the *i*-th firm;

β is a vector of unknown parameters;

ε_i Error term

Adopting from Aigner *et al*. (1977) the stochastic frontier production function for the production process is represented below.

$$Y_i = \exp(X_i \beta) + (V_i - U_i) \quad i = 1, \ldots, N \tag{2}$$

The error term in generalised production function is considered a compost error term by Aigner *et al.,* 1977 and Meeusen and Van den Broeck (1977) which embodied both the inefficiency and statistical noise.

$$\varepsilon_i = v_i + u_i \quad i \quad = 1, \dots, N \tag{3}$$

ε_i is the compost error term

$V_i$are random variables which are assumed to be iid$N(0, \sigma_v^2)$ and independent of the

$U_i s$ are non-negative random variable and assume to account for technical inefficiency in production and are often assumed to be iid$N^+(0, \sigma_u^2)$.

Considering technical efficiency as the ratio of observed output and frontier output gives:

The quantity of U_i can be found by breaking down the composite error term, ε. The disturbance is given by $\varepsilon_i = v_i - u_i$. Specific firm efficiency estimates, u_i can be obtained according to Jondrow *et al.*, (1982) from this relationship;

$$E(u_i|\varepsilon_i) = \sigma_* \left[\frac{f(\varepsilon\lambda/\sigma)}{1 - F(\varepsilon\lambda/\sigma)} - \left(\frac{\varepsilon\lambda}{\sigma}\right)\right] \tag{4}$$

Where; f and F represent the standard normal density and cdf, respectively.

Also $-\mu_*/\sigma_* = \varepsilon\lambda/\sigma$, where $\lambda = \sigma_u/\sigma_v\lambda$.

The parameterizations proposed by Battese and Corra (1977) were used. The specification is stated below;

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \tag{5}$$

$$\lambda = \frac{\sigma_u}{\sigma_v} \tag{6}$$

The σ_u^2 represents the variance of the u_i and σ_v^2 for the variance of v_i. σ^2 constitutes the sum total error variance of the u_i and v_i. The λ is a positive real number and measures the total variation between the observed output and the frontier and this is regarded as technical (in) efficiency. If the value of λ = 0, it indicates that inefficiency is not present in the production as such deviations of observed outputs from the frontier are purely due to noise. However, if λ = 1, It shows that deviations are caused by inefficiency in the production (Battese and Coelli, 1995).

$$\frac{\exp(X_i\beta + V_i - U_i)}{\exp(X_i\beta + V_i)} = \exp(-U_i) \tag{7}$$

2.4 Empirical Model

Primarily, the producers of cassava in the Savannah Zone of northern Ghana depend on nature as such their production process is not under their complete control. This farmer farming condition is best suited for SFA which allows for a stochastic relationship between the inputs used and the outputs produced. Many researchers have employed the translog production function in efficiency studies. Some of the works that used translog include; (Ramat *et al*., 2013; Chukwuji, 2007; Thanaporn Athipanyakul *et al*., 2014; Issahaku *et al.,* 2011; Etwire *et al.,* 2013; Al-hassan, 2008). According to Debertin and Pagoulatos (1985), the reason to represent a production process by a Cobb-Douglas type production function within agriculture production is mainly one of mathematical convenience. However the Cobb-Douglas production function is often criticised for its restrictive property of constant elasticity of production and elasticity of substitutions between inputs used. The transcendental logarithmic functions are flexible and do not impose assumptions about constant elasticity of production function nor elasticity of substitutions between inputs (Dawson *et al.,* 1991). The production function is linear in parameters, simple and makes parameter estimation easier (Coelli, 1995). Because of the comparable superiority of the flexible functional forms, the continued usage of Cobb-Douglas production for stochastic efficiency estimation is not advised (Sauer *et al*., 2006).

The model of the stochastic frontier production for the estimation of the technical efficiency is stated below;

$$\text{In}Y_i = \beta_0 + \sum_{j=1}^{5} \beta_j \text{In}X_j + \frac{1}{2}\sum_{j=1}^{5}\sum_{i=1}^{5} \beta_{ji}\, \text{In}X_j \text{In}X_i + (V_i - U_i) \tag{8}$$

Where;

Y_i = The output of cassava harvested by the *i*-th producer (Kg);

X_1 = Size of cultivated land planted to cassava (acres);

X_2 = Total amount of labour utilised in the farming activity (man days);

X_3 = Value of cassava planting materials (GHc);

X_4 = Total cost of agro-chemicals used on the farm (GHc);
X_5 = Represents other costs incurred on the farm (GHc);
β_i = (i = 0, 1, 2, 3, 4, 5): represent the regression coefficients to be estimated.
$V_i s$ = Random errors that are assumed to be independent and identically distributed as $N(0,\sigma_v^2)$ random variables.
$U_i s$ = Non-negative technical inefficiency effects that are assumed to be independently distributed with half-normal distribution among themselves and between the $V_i s$ such that U_i is defined by of $N^+(0,\sigma^2)$ distribution.

2.5 Technical Inefficiency Model

The amount by which a firm lies below its production frontier and the amount by which it lies above its cost frontier can be regarded as measures of inefficiency (Kang, 1997). Irrespective of the rationality and determination of a producer in the production cycle, inefficiencies outside of his control will likely show up in the output.
The technical inefficiency model is specified below;

$$u_i = \delta_0 + \sum_{j=1}^{5} \delta_{0j} D_{0ji} + \sum_{j=1}^{6} \delta_j Z_{ji} + W_i \tag{9}$$

Where;
Z_1^* = Farmers regional located (Dummy variable: BA and Volta =1 and Northern = 0)
Z_2^* = Gender of farmer (Dummy variable: Male = 1 and Female = 0)
Z_3 = Educational level of farmer
Z_4 = Age of farmer
Z_5 = Experience of farmer
Z_6 = Household size
Z_7^* = Land ownership (Dummy variable: Own land = l and Rented land = 0)
Z_8^* = Extension availability (Dummy variable: Visits = l and No visits = 0)
Z_9^* = Improved planting materials (Dummy variable: Improved = l and Local = 0)
Z_{10}= Farm size
δ_i = (i = 0, 1, 2, ...,10) Vector parameters to be estimated.
Elasticities of the production factors that is the contributions by factors of production to overall production quantity is determined by their respective elasticities. The relationship stated below was used to estimate the values of each of the factors.

$$\varepsilon = \frac{\partial \text{InY}}{\partial \text{InX}i} = \beta_i + 2\beta_{ii}\ln X_i + \sum_{i \neq j} \beta_{ij} \ln X_j \tag{10}$$

The returns-to-scale parameter is given by the relation. The return to scale does not only depend on the production function but on actual values of the data

$$\gamma^y = \sum_{i=1}^{5} \frac{\partial \ln Y}{\partial \ln X_i} \tag{11}$$

2.6 *Definition of Variables*

- Output: Cassava output refers to the physical quantity of cassava obtained in the production process. The quantity will be measured in kilograms (Kg) for purposes of this study.
- Land: refers to the quantity of land under cassava cultivation for the farming season under consideration. The quantity of land shall be measured by acres.
- Labour: The combination of both family and hired labour that worked on the cassava farm during the production year. The unit for this measure is man days. A conversion system shall be used to calculate the man days per each labour. The system to be used is; one adult male, adult female and a child are 1, 0.75 and 0.5 respectively.
- Planting Materials: The cassava stems is used in planting. For the purpose of this research, the monetary value of a bundle of hundred stems (cuttings) shall be considered. As such the unit for this measure will be money (Gh¢).
- Other Cost: This refers to the aggregate cost incurred in hiring services during the production season. That is cost in clearing land for planting, payment of hired labour, and payment for rented land. The unit is Gh¢.

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2.7Hypotheses
The hypotheses were tested using maximum likelihood technique as stated below;

$$\lambda = -2\ln\left[L(H_0)/L(H_1)\right] \quad (12)$$

3. Results and Discussions

Table 2. Hypothesis Testing

Null Hypothesis	Test Statistic	Critical Value	Decision
Ho: $\beta_{ij} = 0$	96.61	25.00	Reject
Ho: $\gamma = 0$	7.59	5.14	Reject
Ho $\gamma = \delta_0 = \delta_1 = \ldots = \delta_{10} = 0$	13.47	19.05	Accepted
Ho: $\delta_1 = 0$	37.62	3.84	Reject

*The critical value for the generalised likelihood-ratio test of null hypothesis, with $\gamma = 0$, is obtained from table 1 of Kodde and Palm (1986). The degree of freedom for this test is calculated as q+1, where q is the number of parameters, other than γ, specified to be zero in H_o. Thus in this case, q = 11.

The results of various hypothesis tested in the analysis are presented below. The null hypotheses that Cobb-Douglas production function is adequate representation of the data is rejected. This therefore makes room for the estimation of the alternative translog function. The null of the second hypothesis was rejected this specifies the availability of technical inefficiency in the production process. Hence the traditional average response function is not an adequate representation for the data, given the specification of the translog stochastic frontier production function. This means that there are technical inefficiency effects in the translog production model. The third null hypothesis that the technical inefficiency effects are non-stochastic is accepted indicating that the inefficiency effects present in the model are not random. The fourth null hypothesis of regional effects not available in the model is rejected meaning the regions/location have effect on the technical efficiency of producers.

3.1 Maximum likelihood estimates of stochastic frontier
The mean average technical efficiency of cassava farmer is 51%. It ranged between 0.26 to 99.9%. The estimated coefficients of the various parameters are stated below.

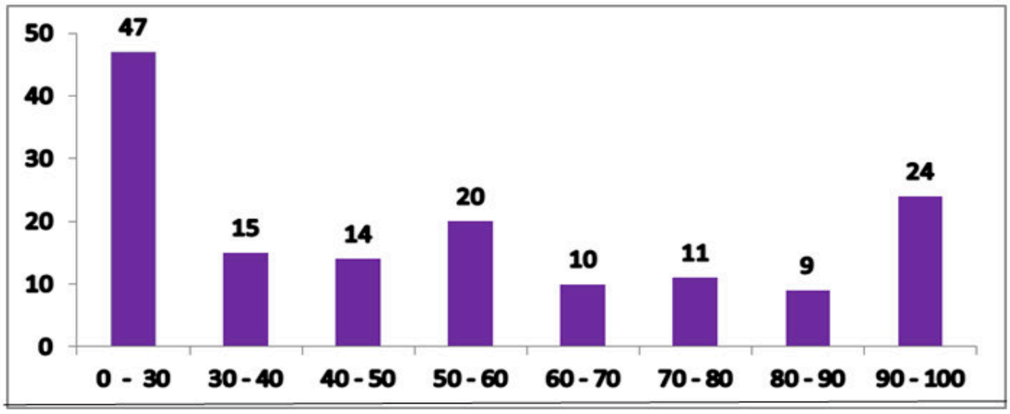
Table 3. Maximum Likelihood Estimates of Stochastic Frontier

Variable	Parameter	Coefficient	Standard error	T-ratio
Constant	β_0	-1.2115	1.0938	-1.1076
Land	β_1	2.1406	0.3593	5.9580
Lab	β_2	1.1213	0.4908	2.2847
PM	β_3	3.9703	0.8297	4.7853
Agro-chemicals	β_4	1.3873	0.6223	2.2294
OC	β_5	-1.8113	0.3601	-5.0296
$(\text{land})^2$	β_{11}	0.0577	0.0461	1.2536
$(\text{Lab})^2$	β_{22}	0.0239	0.0187	1.2779
$(\text{P M})^2$	β_{33}	-0.7191	0.1328	-5.4131
$(\text{Agro-chemicals})^2$	β_{44}	-0.8916	0.0762	-11.7036
$(\text{OC})^2$	β_{55}	0.0007	0.0515	0.0133
Land x Lab	β_{12}	0.4019	0.0394	10.2065
Land x P M	β_{13}	0.2165	0.0484	4.4722
Land x Agrochm	β_{14}	0.2423	0.1024	2.3666
Land x OC	β_{15}	-1.0145	0.0429	-23.6408
Lab x P M	β_{23}	-0.1238	0.0839	-1.4756
Lab x Agrochm	β_{24}	0.1242	0.0337	3.6836
Lab x OC	β_{25}	-0.2220	0.0270	-8.2078
P M x Agrochm	β_{34}	-0.3180	0.0988	-3.2175
P M x OC	β_{35}	0.7659	0.0996	7.6933
Agrochm x OC	β_{45}	0.2816	0.0652	4.3194
Variable Parameters				
Sigma-squared	σ^2	1.1414	0.1041	10.9685
Gamma	γ	0.9999	0.0002	6065.164
Log likelihood function			-124.4239	

Note: *, **, *** corresponds to 0.1, 0.05 and 0.01significance levels respectively.
Source: Field Survey, 2015

3.2 Technical Efficiency Distribution of Cassava Farmers

The technical efficiency ranges from 9.1percent to 99.6percent. About 24% (24 percent) of the farmers are operating in the technical efficiency range of 90 to 99.6percent. As can be seen in figure 1 below, majority of the famers operate under 30% technical efficiency. The least technical efficient farmers range from 9.1percent to 40percent. The mean technical efficiency is 51% implying that farmers lost about 49% of output technical inefficiency. This means output levels could be increased by 49% without the employment of additional resources.



Source: Field Survey 2015

Figure 1. Technical Efficiency Distribution of Cassava Farmers
Mean Technical efficiencies

3.3 Technical Efficiency Determinants

The positive signs on the coefficients of the factors in table 2 indicate that they contribute positively to the output level of cassava. The negative signs are the vice versa. The coefficient of land is positive but not significant. However the positive sign implies that as more land is put under cultivation of cassava, output level increases. Land interaction with other factors of production however produced significant estimates. The relevance of land productivity to the production process is held in high esteem. Sebastian (2013) contends that, land productivity functions as a compact measure of general status of agriculture and rural development. The large part of Sub-Saharan cropped area is worked by family farms. Cultivation of larger parcel of land increases technical efficiency. For this study, it is realised that large area farms are more technically efficient. However, land fragmentation is still an issue in Ghana's agriculture. Small parcels of land are owned by several land custodians making ownership of larger portion of land a difficulty.

3.4 Technical efficiency across Gender

The technical efficiency across the gender just like managerial abilities and resource availability vary. The various factors that affect technical efficiency are different across sex backgrounds. It therefore follows the technical efficiency ceteris paribus too will differ as a matter of natural sequence. A total of 110 males and 40 females were interviewed in the study. Majority of the female efficiencies centred around 40 to 59 whiles that of the males centred around 70 to 99. The range for males is 46.4 to 99.9 whilst that of the females is 26.6 to 71.8. The breakdown is presented below.

Table 4. Technical Efficiency Across Gender

Efficiency Range	Frequency	Male	Female
0 - 30	47	36	11
30 - 40	15	10	5
40 - 50	14	9	5
50 - 60	20	13	7
60 - 70	10	8	2
70 - 80	11	8	3
80 - 90	9	7	2
Mean		51.76	48.96
Minimum		9.95	9.13
Maximum		99.31	99.60
Standard Deviation		28.88	27.10

Source: Survey, 2015

The coefficient of sex is negative and significant at 1%. This implies a higher level of influence on technical efficiency and that males famers are more technically efficient than female producers. The results concurred with that of Abdulai *et al.* (2013) in their study of the technical efficiency of maize production in Northern Ghana. Also Asante *et al.* (2013) found negative coefficient for gender. Inspite of their great contribution to the economy, they are confronted with resource issues needed to improve their productivity and incomes. Women have limited access to land for agricultural production.

3.5 Technical Inefficiency

The parameters of the various technical inefficiency determinants were estimated by maximum likelihood method. The coefficients of the parameters determine the rate at which they affect technical inefficiency.

Table 4. Technical Inefficiency Estimation

Variable	Parameter	Coefficient	Std error	t-ratio
Inefficiency Model				
Constant	δ_0	0.1692	0.1777	0.9520
Region	δ_1	-0.0979**	0.0427	-2.2949
Sex	δ_2	-0.7447***	0.1033	-7.2091
Education	δ_3	0.2130***	0.0663	3.2130
Age	δ_4	0.0152***	0.0043	3.5287
Experience	δ_5	-0.0259***	0.0057	4.5674
Household size	δ_6	0.0014	0.0033	0.4313
Land ownership	δ_7	0.1450***	0.0372	3.8953
Extension	δ_8	0.0836**	0.0334	2.5018
Planting materials	δ_9	0.3019*	0.1759	1.7160
Farm Size	δ_{10}	0.0481***	0.0147	3.2813

Note:, *, **, *** corresponds to 0.1, 0.05 and 0.01significanct levels respectively.
Source: Field Survey, 2015

3.6 Determinants of Technical Inefficiency

Negative signs imply reduction in technical inefficiency and thereby increase technical efficiency. According Sebastian (2013), differences in geographic and climatic conditions results in different levels of technical efficiency in the research area. The coefficient of region is negative and significantly different from zero. This indicates that cassava producers in Northern Brong Ahafo and Volta regions have the tendency to be more technically efficient than Northern region producer.

The coefficient of education is surprisingly positively related to technical inefficiency implying educated farmers are less technically efficient than the uneducated ones. Chukwuji (2007) reported negative for education in the determinants of technical efficiency in Gari processing in delta state in Nigeria. This could be attributable to the fact that farmers don't have content related education. That is the lack of cassava production technicalities.

Farm size is negative for inefficiency indicating that small size farms are more technically efficient that large scale farmers. This is consistent with the result reported by Badunenko *et al.* (2006) on what determines the technical efficiency of a firm and Abdulai *et al.* (2013). Sabasi and Shumway (2014) argue that it could be attributed to managerial ineffectiveness as farms get larger. Also these farmers could form part of the poor group of farmers who lives depend on their farms. For which reason they give the farming every attention needed for higher yields hence more efficient despite the size. Experience as a factor that influences technical inefficiency has a negative sign implying experienced farmers are more technical efficient. Onumah et al., 2013 presented the same coefficient sign in their investigation of productivity and technical efficiency of cocoa productivity in Eastern Ghana. The result is consistent with the *a prior* expectation of the study and findings of similar research work of Backman (2009). Backman concluded that the farmers became efficient through learning-by-doing in an uncertain production environment.

Land ownership has a positive coefficient implies it reduces technical efficiency. This is likely that land owners don't struggle on the farms like renters. Land renters struggle to make more output to pay off their debt and still make profit. Land ownership increases technical inefficiency which is significant at 1%. This apparently is due to the fact that, owners are not under any pressure to produce and pay off debt. Extension contacts have a positive sign for inefficiency indicating that availability of extension services increases technical inefficiency**.** This is consistent with what was reported by Onubougu *et al*. (2014). This deviates from the a-prior expectation of the study and could be a reason that farmers take the extension information trivial and for that matter feel reluctant to adopt them.

3.7 Productivity and Income Improvement

Productivity information is contingent on its measurements. According to (OECD, 2012), for agriculture to respond to future challenges, farmers will need to improve their innovative abilities so that they will be efficient in converting inputs to outputs. The income levels and productivity of cassava producers can be improved by the following; increasing their efficiency levels, exploiting economies of scale and adopting new farming technologies (Latruffe, 2010). The present technical efficiency level of farmers indicates that there is an opportunity for producers to increase their productivity and make more income. Without the addition of productive resources about 49% extra output can still be realised from the production process.

The production elasticities of the various inputs are, 0.92, -0.12, 0.83, -0.29 and 0.40 for land, labour, Planting Materials, agro-chemical and other cost respectively. The estimates of land, planting materials and other cost are positive, indicating a one percentage increase in any of them leads to an increase in the level of cassava output. Farmers need to put in more efforts to develop their production process and also avail themselves to new but tested methods of cassava cultivation. Farmers could also mobilize into groups to enable them acquire inputs at cheaper cost and dispose-off farm products at appreciable market values.

The returns-to-scale parameter is given by the relation. The return to scale does not only depend on the production function but on actual values of the data

$$\gamma^{y} = \sum_{i=1}^{5} \frac{\partial \ln Y}{\partial \ln X_i}$$

$$\gamma^{y} = 0.92 + (-0.12) + 0.83 + (-0.29) + 0.40 = 1.74$$

The returns-to-scale parameter makes information available on the level of operation of the firms. The firms could either be operating under its capacity or right on it. The value of 1.74 is case of increasing returns to scale. The values from the above equations will give the maximum likelihood estimates of the β parameters. The elasticities are computed at the sample means of the various inputs, land, Labour, Planting Material, Agro-chemicals and Other Cost.

4. Discussions and Conclusion

Some of the signs according to the a-priori have been obtained but not significant. We were specific about the sign of land variable to be positive. It has been so but insignificant. The other variables were expected to take any sign based on the socio-economic characteristics of the producers. The expected technical efficiency value was not achieved. Djokoto (2012) estimated the technical efficiency of Ghana's agriculture to be 82%. Given the fact that cassava production in Ghana is on the ascendency, it was expected that the technical efficiency will be higher than the figure obtained by Djokoto for Ghana's Agriculture. The sign for sex was expected. Past researches in Ghana have reported positive relationship between technical efficiency and sex in favour men (Asante *et al.,* 2013 and Onumah *et al*., 2013). Again the socio-economic nature of the study area indicates that women have much other off-farm works which may negatively affect their technical efficiency. Education is surprisingly positive for technical inefficiency. This may be so because farmers do not have cassava content related education which might affect their technical efficiency level irrespective of their educational level.

Extension officers should be offered specific relevant education in the respective areas of production rather than the present system of officers overseeing for all sectors of production including what they do not have the requisite technical expertise on. Farmer Field Schools should be introduced to enable younger and inexperienced farmers learn from the experienced ones. Although young farmers could be illiterates, field demonstrations by their senior colleagues could make learning and adoption of new technologies comfortable. Farmers should also form groups to enable them acquire production inputs at lower cost due to economies of scale. A seed production and distribution policy is needed to completely remove the over reliance of cassava farmers on the age-long tradition of using their previous years' cultivars as cuttings for the succeeding years. Is has been observed that farmers continual use of that system contributes to their technical inefficiency. There should be a direct coordination between seed producers and farmer groups. Cassava value-chain system needs to be strengthened. RTIMP should expand its activities to the Northern Savannah and establish more Good Practicing Centres (GPC) to increase the value-chain drive around the geographical areas.

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