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PROFIT EFFICIENCY OF SMALL SCALE YAM PRODUCTION IN NORTHERN GHANA

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ABSTRACT: *Contribution made by small scale yam producers in Northern Ghana cannot be over emphasis, however very little attention is given to their profit efficiency and its determinants. This research used the stochastic efficiency frontier model to identify the level of yam farmers profit efficiency. Multistage random sampling method was adopted to obtain 225 small scale yam farmers across northern Ghana. On average, the profit efficiency of yam farmers was 56.75% in the study area with a minimum and maximum efficiency of 20% and 100% respectively. This implies there is an opportunity to increase profit by 43.25%. The inefficiency model showed that sex, household size, educational level, extension access and land ownership have negative coefficients, meaning that as these variables increases the profit efficiency of the farmer increases. The variable sex inverse relation suggests that; male farmers are more efficient than their female counterparts which needs to close.*

KEYWORDS: Yam Production, Stochastic Profit frontier, Profit efficiency, Northern Ghana

INTRODUCTION

The flowering plants of Yams (*Dioscorea*) genus are Angiosperms are monocotyledons (Norman *et al.*, 1984). Yam has about 600 species which have an annual life cycle characterized by five stages. The first stage is sprouting of the dormant tuber. Tubers function is to store food reserves mainly carbohydrates to ensure continuity in the life cycle of the plant. Rhizome is the outcome of the growth of the new plant or tuber from which stems and roots emerge. Development of the new tuber is accumulation of starch reserves. The stem climbs by twining, carry petiolate leaves and dioeceois flowers. The growth of flowers leads to fruit which form trilocular capsules. The tuber maturity is characterized by the death of the plant shortly after which the tuber goes into a dormant life.

In the whole of West Africa, yam is one of the most popular staple food. Both small and large scale cultivars of the *Dioscorea Cayenensis - Dioscorea rotuncla complere* are among the comparatively few truly West African domesticated plants. Yams serve as source of food in Asia, Oceania, and other parts of Africa, America and beyond these continent. The most nourishing plant in the diet of many inhabitants of inter-tropical regions is yam. Over 18 million are provided with tons of food a year to the people of West Africa.

Yams constitute a critical source of food and income and play a major role in the socio-cultural life of a varied range of smallholder households. As a result of its importance in the West African sub-region, it is within the capacity of yam to alleviate poverty and ensure food security among rural producers, traders, processors and consumers (Chukwu and Ikwelle, 2000; FAO, 1996). Agriculture is the growth foundation of the Ghanaian economy, and has been the main driver of growth for the last twenty years (World Bank, 2008). Roughly, agriculture contributes 34% to Ghana's GDP. About one-half of agricultural GDP comes from Ghana's roots and tubers (MoFA, 2010).

A fifty-five (55%) rise of farmers in Ghana, root and tuber crop improvement is a major poverty reduction strategy for the country (RTIMP, 2004). It is critical if 90% of marketers and processors of root and tubers are women (IFAD, 2009; RTIMP, 2006). Root and tuber crops especially yam them are considered to be food security crops in Ghana and the range of root and tuber consumption forms between 16% and 31% of per capita daily calorie consumption in the country (GLSS 5; GSS, 2005). Scott et al., (2000) observed that, there is greatest potential in agricultural crops such as yam and cassava1. Yams are crops that are adaptable to unfavourable environments, drought resistant and grow well in poor soils. In addition, yams contribute to the reduction of food insecurity of household, since they are cultivated by the poorest sector of the population in Ghana (RTIMP, 2004). In mixed cropping systems, yams are also flexible which benefit the input and improvement of soil nutrients. Also, yam is an annual grown crop in Ghana. The uses and advantages of roots and tubers make them an important focus for targeting and improving the welfare of the poor and smallholder farmers have access to markets, and ensuring inclusion of smallholder farmers in global value addition chains.

Developing economy such as Ghana, the features of weak institutional and infrastructural framework, the absent of organization and coordination, usual put small-scale producers (and others) in extremely disadvantage status. The small-scale producers often lack finance to invest, rely on family and relatives for man-power and employed olden or traditional techniques to process, and are at risk of being excluded from world markets (Trienekens, 2011: De Janvry and Sadoulet 2005; Daviron and Gibbon 2002; Reardon and Barret 2000). Small-scale producers have limited access to work in a secure environment means that they have to rely on other parameters in order to reduce risk and transaction costs in generating income and marketing.

However, studies on yam has concentrated more on pre-production issues to the neglect of post-harvest issues like marketing, consumer demand and storage. The connection between the producer and the consumer is marketing. But the challenges associated with transportation, wholesaling and retailing activities, popularly called distribution activities in the yam sector, have less attention paid by researchers, particularly in Ghana (Bancroft**,** 2000).

Small scale farming faces several constraints including an effective lack of access to production inputs and efficient produce markets. Advance technologies such as improved seed varieties and agro-chemicals have been found to be considered unaffordable by the average small scale farmer who usually has very limited access to credit from the formal sector. This means that adoption of technologies is limited among small scale. Therefore, resulting in low annual yields and incomes. Yam farmers who engaged in small scale production continue to use traditionally unproductive methods that leads to low productivity and high post-harvest losses (Bidzakin, 2014). The persistent use of the same plots of land season after season, without applying fertilizer leads the soil to becomes less fertile which consequently contributes to low yields. On the contrary, some farmers are able to make their best out of their limited resources and skills to raise themselves out of this situation. Such successful farmers have shown that they can be assisted to help other framers out of poverty through better agro-business management so that they can become more efficient and competitive.

According to Bravo-Ureta and Pinhiero, (1993), most less developed economy studies that examine efficiency concentrate on technical efficiency. With or without understating the importance of technical efficiency, understanding and improvement in economic efficiency will lead to greater production efficiency. Xu and Jeffrey, (1998) and Pierani and Rizz, (2003) observed that, few studies have assessed the effects of technical change of efficiency. With the availability of variety of empirical tools, selection of the most appropriate method is ambiguous (Xu and Jeffrey, 1998). Though, there has been many schemes and research work done in Ghana (such as Aidoo et al, 2012, and in 2009/2010 by the International Institute of Tropical Agriculture (IITA)), a wide gap of doubt and limited knowledge on the profit efficiency of small scale yam producers in Northern Ghana still exist and it needs redress. This research aims at finding solution to the margin of profit efficiency and the determining factors that affects the profit efficiency of yam farmers in Northern Ghana who engaged in small unit production.

LITERATURES REVIEW

A firm performance is determining through the concept of economic efficiency, which is made up of two components - technical efficiency and allocative efficiency (Kalarijan and Shand, 1999). Vensher (2001) assert that every profit oriented organisation is said to be technically efficient when it produces greater output with a given amount of inputs or produces a specified output with little amount of a given resources. Relatively, Ellis (1988) sees technical efficiency as the optimum possible level of outputs gained from a given set of inputs through the employment of a range of alternative technologies available. Comparatively, technical efficiency is old like neoclassical economics in terms of its measurement. Probably this is explained by the fact that neoclassical economics assumes full technical efficiency. Kalarijan and Shad, (1999) assert that two main reasons justify the measurement of technical efficiency; Firstly, the gap that exists between realized efficiency and theoretical assumption of full technical efficiency which has been observed by Bauer (1990) and Kalarijan and Shad (1999) that, where technical inefficiency function, it will call for an inverse influence on allocative efficiency with a direct impact on economic efficiency. The thematic area of technological efficiency has also caught the attention of researchers. Changes in technology occurs stage by stage, firstly, it can yield more output for the same or less units of input than older processes. Some researchers argue that, introducing such a new technology to production process can render all previous processes technically inefficient (Ellis, 1988). According to Meier (1995), in the context of efficient research, technology entails the series of all known techniques for producing a particular output. Though, is critical to mention that, the invention of a new technology does not guarantee its availability to all producers, especially, small scale farmers. Two types of inefficiency can be realized, that is, inefficiency that occurs due to operating off the isoquant for a given technology and also inefficiency due to failure to move to a different isoquant when there is an introduction of new technology (Ellis, 1988). The former can be exemplified by a situation in which the same output of a particular crop say yam can be obtained by using a small units of a given means. An illustration of the latter will be a situation in which a new technology is introduced and a farmer is not able to use it for various reasons.

Ellis (1988) notes two forms of technological change or progress; the first is process innovation, which deals with improvement of the production of existing products; the second is product innovation, which deals with development of sustainable improved outputs. Technological change denotes innovation, improving technical efficiency under a given technology. it is essentially about catching up with what is technologically possible (Fare *et al*., 1997). Primarily, the concept underlying the computation of technical efficiency based on the description of a production technology. Production technologies are usually by illustrated by isoquants, production functions, costs functions or profit functions. Many studies have attempted to estimate the efficiency of agricultural production (Xu and Jeffrey, 1998; Khem *et al*., 1999; Gavian and Ehui, 1999).

According to Xu and Jeffrey (1998), research that are empirical in nature in the estimation of production efficiency have employed a variety of modelling methods including parametric versus nonparametric; programming methods versus statistical methods and deterministic versus stochastic. Broadly speaking, the production efficiency estimation techniques can be grouped into stochastic frontier production approaches and nonparametric mathematical programming approaches (Khem *et al*., 1999). Critical analysis of the strengths and weakness of these approaches has been done by Ceolli (1995). Analytically, stochastic frontier approaches have key strengths of dealing with factors beyond the researcher's control and measurement errors (stochastic noise). It also allows for statistical test of hypotheses that pertain to production structure and the degree of inefficiency. The weaknesses of stochastic frontier approaches do not exclude the need to impose an explicit parametric form for the technology in question and an explicit distributional assumption for the inefficiency variable. According to Mawuli Yevu (2013)**,** the key strengths of the nonparametric approaches which is usual called Data Envelopment analysis (DEA) are that: parametric specification of technology is avoided and there is distributional assumption of the inefficiency variable. The weaknesses of the DEA approach are that; it is deterministic and attributes all deviations and abnormalities from the frontier to inefficiencies which render the model liable to measurement errors or other errors in the data set. In the stochastic frontier approach, the technical linkages between inputs and outputs of a production process is explained by a production function which establishes the maximum level of output attainable from a given vector of input variable. This is usual known as the production frontier. Production frontier efficiency can be traced back to the seminal work of Farrell (1957). Stochastic Production Frontier (SPF) was however soley developed by Aiger et al., (1977) and Meeusen and van den Broeck (1977). Review of specific methodologies used by earlier researchers is significant. The work done by Khem *et al*. in 1999 and Xu and Jeffrey in 1998 adopts dual stochastic frontier efficiency decomposition model though the Khem *et al*. (1999) move ahead by comparing the stochastic approach to a nonparametric method using the same data set. The most popular stochastic frontier function employed by both studies indicates that; Y is output, X is input vector and β the vector of production function parameters, V is a random error term with zero mean, and U, a nonnegative one-sided error term which gives a measure of inefficiency. The two group of researchers used the

Cobb-Douglas functional form, which characterised by less flexibility compared to the translog functional form which is self-dual and has been used in many empirical studies. Appropriate estimation methods exist for the estimation of efficiency and inefficiency equations. The methods include: the maximum likelihood procedure, the corrected Ordinary Least Square method (COLS) (Jaforullah and Premachendra, 2003) and Zellner's Seemingly Unrelated Regressions (SURE) approach. In stochastic efficiency estimation the use of OLS leads to parameter estimates which are under cast in terms of their efficiency, particularly the intercept compared to maximum likelihood estimates (Greene, 1980). The stochastic frontier model is nonlinear, as a result of that, its estimation procedure produces consistent and efficient estimates (Greene, 1995). According to Greene (1995), by merit, OLS provides best linear unbiased estimates and computed standard errors at the slope, however, it provides estimated intercept which is downwardly biased. Consequently, Green suggests that, the intercept that is computed using OLS should be adjusted by the largest positive OLS error. The two-step procedure suggested by Green is what is called the Corrected Ordinary Least Squares (COLS) method. Estimation of the factors that induce inefficiency has generated considerable debate in the studies of frontier.

According to Khem *et al*. (1998) estimation of efficiency scores first is the most popular procedure, after which, regress the efficiency scores against a set of identified factors. Alternatively, nonparametric or analysis of variance (ANOVA) can be use. Kalirajan (1991) and Ray (1988) stood for the two-step procedure, Kumbhakar *et al*. (1991), Battese and Coelli (1995) criticised the approach by arguing that, the identified factors should be incorporate directly in the estimation of the production frontier because such factors have a direct effect on efficiency. Notwithstanding this criticism, Green error correction two-step procedure is still quite popular in examining the relationship between efficiency and identified variables (Khem *et al*., 1998). Studies that aim at integrating specific effects directly into the frontier model are limited or restricted to the parametric approach (Kumbhakar *et al*., 1991; Battese and Coelli, 1995). On the same pace, the expression of the inefficiency effects as an explicit function of a variable vector and a random disturbance, as well as the estimation of all the parameter estimates in a single-stage maximum-likelihood procedure is limited Reifschneider and Stevenson (1991). Bonilla *et al*. (2001) suggest a model for a stochastic production function. In Bonilla et al., model, technical inefficiency effects are expressed as a function to some specific factors in addition to input variables of a production frontier that interacts with the identified factors.

METHODOLOGY

Study Area and Sampling Techniques

The small scale yam farmer living within northern Ghana was the unit of study. Small scale farmers were sampled through a multistage sampling approach. The area was classified in to three main regions representing the three ecological zones in the northern sector. These included northern, upper east and upper west regions. From each region three major yam producing districts were purposively chosen, after which five community each from the districts was randomly selected giving us a total of nin communities. Five small scale yam farmers were randomly selected from each community giving us a total sample size of 225. The main data for the study was primary data, which was collected from the farmers using structured questionnaires. Data was analysed using descriptive statistic and the stochastic profit frontier function model.

The Stochastic Profit Frontier (SPF)

The SPF method of analysing efficiency is chosen for this study. The justification is that, unlike other methods such as the Data Envelopment Analysis (DEA), the SPF usual give way for the sensitivity of data to random shocks by including a conventional random disturbance term in the estimation of the profit frontier such that only deviations that is influenced by controllable decisions are attributed to inefficiency (Joforullah and Premachandra, 2003). Inefficiency is assumed to be part of the error term consisting of two parts-a random error term which is normally distribution N (0, σ^2) and represents random shocks and statistical errors, and the inefficiency term which is one sided (non-negative). The inefficiency error term is assumed to have a half normal distribution. The SPF is expressed mathematically as:

$$\pi_i = f(X_i, \beta)e^{V-U} \text{ ………………… (1)}$$

Expressing SPF to logarithm terms leads to

$$\ln \pi_i = \ln f(X_i, \beta) + V_i - U_i \text{ ………………… (2)}$$

Where π_i is the output vector, X_i is the input vector, β is parameter vector which is not known, Vi is the random error term assumed to be identically and independently distributed (N (0, σ^2)), U_i is the inefficiency term independently distributed from V_i. In this study the half normal distribution of the error term used by Jaforullah and Premachandra (2003) in a cross sectional data similar to this study is adopted.

Model specification

Profit efficiency in this study is defined as profit gain from operating on the profit frontier, taking into accounts farm-specific prices and identified factors. Considering a farm that maximizes profit subject to perfectly competitive input and output markets. The explicit Cobb-Douglas functional form for the small scale yam farmers in the study area is therefore specified as follows:

$$\ln \pi_i = \ln \beta_o + \ln \beta_1 FS + \ln \beta_2 LC + \ln \beta_3 PF + \ln \beta_4 PYS + \ln \beta_5 PFT + \ln \beta_6 Z + (V_i - U_i) \text{....................(3)}$$

Where: π_i represents normalized profit computed as total revenue less variable cost divided by farm specific yam price; FS represents Farm size; LC represents average cost per man day of labour; PF represents average price per tuber of fertilizer; PYS represents average price per tuber of yam seed; PFT represents average price of farm tools and Z represents other operating cost. The inefficiency model (Ui) is defined by:

$$U = \alpha_o + \alpha_1 Age + \alpha_2 Sex + \alpha_3 HHSize + \alpha_4 Edu + \alpha_5 Exp + \alpha_6 Ext + \alpha_7 Cre + \alpha_8 Lown \text{.........(4)}$$

Where: Age, Sex, HHSize, Edu, Exp, Ext, Cre and Lown represent age of respondents, respondent gender, household size, educational level, farming experience, Extension service, Credit Access, and Land ownership of respondents respectively. Sex of respondents is a dummy variable representing 0 = female and 1 = male, Extension service and credit access are also dummy variables, where 1 = having access and 0 is otherwise. The inefficiency model differs slightly from that of Ogundari Kolawole (2006) by the introduction of the sex variable. These socio-economic variables are included in the model to indicate their possible influence on the profit efficiencies of the yam farmers (determinant of profit efficiency). The variance of the random errors, $\sigma^2 v$ and that of the profit inefficiency effect $\sigma^2 u$ and overall variance of the model σ^2 are related thus:

$$\sigma^2 = \sigma^2 U + \sigma^2 V \text{.....................}(5)$$

This measures the total variation of profit from the frontier which can be attributed to profit inefficiency (Battese and Corra, 1977). The log likelihood function estimates the gamma (λ) as:

$$\lambda = {\sigma^2 U}\big/{\sigma^2 V} + \sigma^2 U \text{.....................}(6)$$

The parameter λ represents the portion of inefficiency in the whole residual variance with values ranging between 0 and 1. A value of 1 suggests the existence of a deterministic frontier, where as a value of 0 can be seen as evidence in the favour of OLS estimation. All the parameters estimate of the stochastic frontier profit function and the inefficiency model are simultaneously arrived using the program Limited Dependent variables (LIMDEP). A three-step estimation method is used in obtaining the final maximum likelihood estimation (MLE) and the MLE procedure uses Davidson Fletcher Powel Quassi Newton algorithm. In this research for relativity purpose, two varied models were estimated in the final MLE. Model 1 is the traditional response function OLS in which the efficiency effects are not present ($U_i = 0$). It is a special form of the stochastic frontier production function model in which the aggregate variation of output as a result of technical inefficiency is zero that is $\gamma = 0$. Model 2 is the MLE model where there is no restriction and thus $\gamma \neq 0$. The two models were compared for the presence of profit inefficiency effects using the gamma (γ) test of significance.

Hypothesis and significance test

The following null hypothesis is tested using the gamma test: There is no inefficiency of profit ($\gamma = 0$) which mean each yam farm is operating on the profit frontier.

RESULTS AND DISCUSSION

The summary statistics of variables used in the profit frontier model are presented in Table 1. The results indicate a wide variation in profit earned by the yam producers, ranging from a minimum of GH¢ 0.87 to GH¢ 2.43, and the mean profit earned per tuber is GH¢1.32**,** means that most of the yam producers produce below the maximum profit per tuber. This might be due to inefficient methods of farming at the given technology. The profit gap between the mean and the minimum profit is GH¢ 0.45 per tuber, and that between the mean and the maximum profit is GH¢ 1.11 per tuber. This also suggests that there is potential for increasing the mean profit per tuber of yam production in the study area.

Variables	Unit of Measurement	Minimum	Maximum	Mean	Standard Deviation
Profit	Ghana cedi/tuber	0.87	2.43	1.32	0.93
Age	Number of year	23	74	35.4	14.5
Education level	Number of year	2	8	3.2	4.3
Farming Experience	Number of year	4	52	24.3	16.8
Farm size	Hectares	3	48	5.7	3.9
Wage of labour	Ghana cedi/man day	0.4	1.5	0.6	0.3
Price of fertilizer	Ghana cedi/tuber	15	34	13.5	7.3
Price of yam seed	Ghana cedi/tuber	0.25	0.75	0.4	0.03
Cost of capital input	Ghana cedi/tuber	21	46	25.6	6.7
Other operating cost	Ghana cedi/tuber	16	28	13.3	8.9

Table 1: Summary Statistics of Variables Used in the Profit Frontier Model
Source: Authors` computation of field data, 2015.

Maximum likelihood estimates of the parameters of the stochastic profit frontier

The maximum likelihood estimates (MLE) of the parameter estimates of the stochastic profit frontier model are presented in Table 2. The Table 2 below show that, cost per man day of labour, cost of farm tools and cost of other operations estimated coefficients of the parameters of the normalized profit function which works on the assumption that, competitive markets are positive. The variables - farm size, price of fertilizer and price of yam seed in the normalized profit model which have positive coefficient, indicate that as these variables increase the normalized profit of the farmer increases, whiles the variables that have negative signs show that, when such variables increase, the normalized profit of the farmers' decreases.

	OLSE Model			MLE Model		
Variable	Estimate	Stand. Error	t-ratio	Estimate	Stand. Error	t-ratio
Farm size	0.7433***	0.0034	3.2738	0.6543***	0.0036	2.9273
Wage of labour	-0.7822***	0.0024	-2.2322	-0.7382***	0.0032	-1.9282
Price of fertilizer	0/3892***	0.0201	1.2378	0.0372**	0.0035	1.3783
Price of yam seed	0.0934**	0.0008	1.2983	0.1253*	0.0012	2.0001
Price of farm tools	-0.0678***	0.0077	-0.9876	-0.0542***	0.0069	-1.1923
Other operating cost	-0.0475	0.0017	-0.8976	-0.0566	0.0024	-0.8894
Constant	0.4651***	0.0063	1.2832	0.4755***	0.0048	1.3424
Gamma				0.996***	0.0005	2.47
Sigma	0.34			0.79***	0.0054	12.57
Log likelihood	82.25			78.54		

Table 2: Maximum Likelihood Estimates of the Stochastic Profit Frontier Model
Source: Authors` computation of field data, 2015 *** , ** and * denote 1%, 5% and 10% respectively

Comparing the t-calculated value of 2.47 to the t-tabulated value of 1.960 led to the rejection of the null hypothesis ($\gamma = 0$) of no inefficiency of profit. The decision is that $\gamma \neq 0$.

This means that there was profit inefficiency among yam farmers in the study area as confirmed by the significance of the gamma (γ) estimate. The estimated gamma parameter (γ) of MLE model of 0.997 in Table 2 was highly significant at 99 percent level of confidence. This implies one-sided random inefficiency component strongly outweighs the measurements error and other random disturbance. This means that about 99.7 percent of the variation in actual gains from profit frontier which represents maximum profit among farmers mainly arose from differences in farmers' practices rather than random variability.

Determinants of profit efficiency of yam producers

The parameters estimate for determinants of profit efficiency using the stochastic Cobb Douglass profit function are presented in Table 3. However, critical analysis of inefficiency models reveals that the signs and significance of the estimated coefficient in the inefficiency model have significant impact on the profit efficiency of the farmer. Based on this, the variables in the inefficiency model which have negative coefficient, meaning that as these variables (sex, household size, educational level, extension access and land ownership) increase, the profit efficiency of the farmer increases, hence increase in profit. Whiles the variables (age, farming experience and credit access) are positive and hence has negative impact on the profit efficiency of yam farmers in the study area. The positive coefficient of age is in agreement with the work of Abdulai and Huffman (1988) while the inverse coefficient of educational level was in conformity with Kumbhakar and Bhattacharya (1992b), Ali and Flin (1989), Abdulai and Huffman (1988) and Huffman (1974). The results from the stochastic profit frontier analysis has indicated that their profit efficiency was directly or positively influenced by sex, household size, educational level, extension access and land ownership. These findings have important policy implications in improving production efficiency among farmers in Northern Ghana. Nevertheless, government should make it a priority to encourage both men and women to go into yam farming in an attempt to bridge the gap between them. Ensuring effective extension delivery program with the key aim of investing in farmers' education especially, rural sector in the current political and economic environment in Ghana will provide farmers with skills essential to increase efficiency. In conclusion, the result of this study has clearly shown that employing the stochastic profit frontier paves way for detailed analysis of the determinant of specific farm efficiency.

Averagely, profit efficiency of 0.5675 suggest that considerable amount of profit is gained among maize producers in the sampled area. The inefficiency associated with controllable decisions is about 99.7% hence government through MOFA should educate farmers on how to reduce controllable inefficiency in their production. Farmers need to be educated and young men and women should be encouraged to go in to farming. The study examined the performance of micro and small agribusinesses in Northern Ghana. Two objectives were set and these include; assess the profit efficiency of micro and small agribusinesses (yam producers), and determine the factors that influence profit efficiency. The stochastic profit frontier analysis was used to assess the profit efficiency of yam farmers.

Determinants of profit efficiency among the small-scale maize farmers were identified using stochastic Cobb-Douglas profit frontier model. The parameters estimated using the Cobb-Douglas profit frontier indicate that majority of the inputs have positive signs on the profitability of yam farming in Northern Ghana except few. The negative sign of cost of farm tools may be due to the high cost of fuel leading to excessive cost of the use of such equipment's by the farmers, thus leading to extra cost incurred on the part of the producers. Profit efficiency distributions has shown that yam farmers were fairly efficient in their resource allocation, judged by the fact that more than half of the farmers having profit efficiency of 60% and above with an average profit efficiency of 56.75% suggesting that considerable amount of profit is gained due to the relative level of efficiency observed in the sample area.

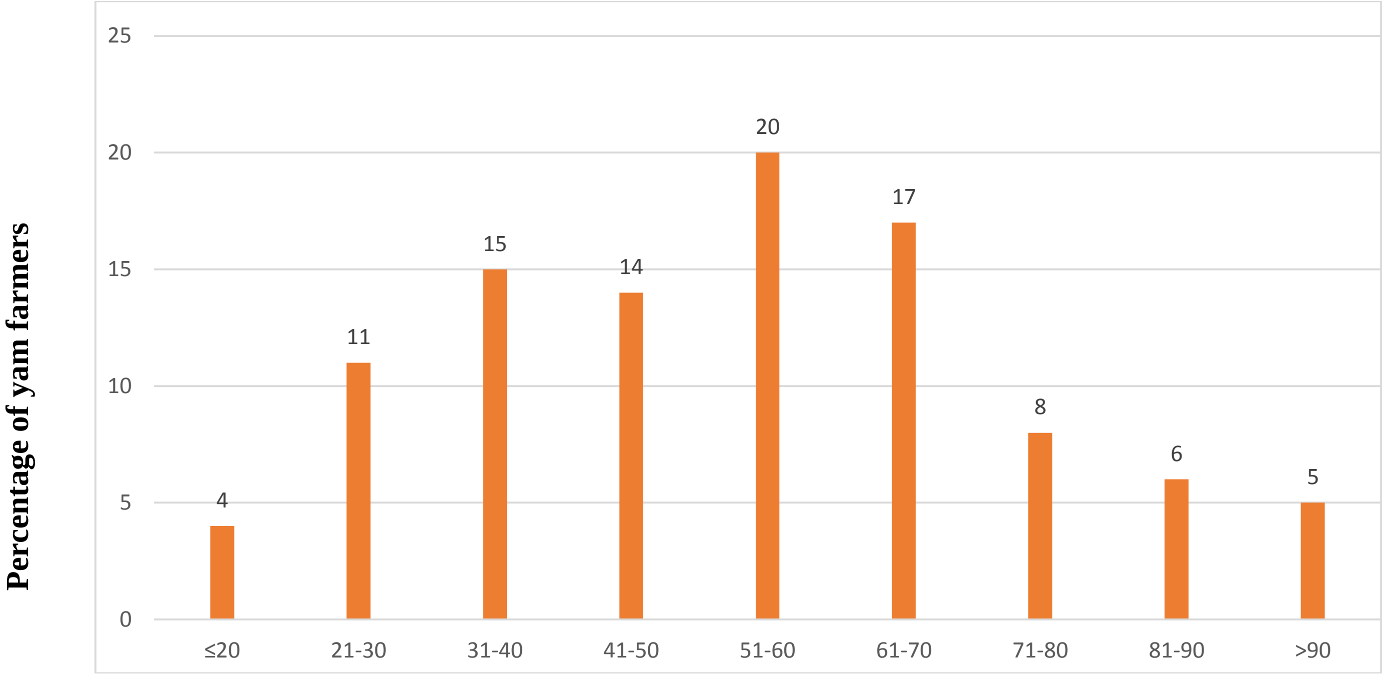
Variable	Parameter	Estimate	Stand. Error	t-ratio
Constant	α_0	0.6732	0.0046	11.385
Age	α_1	0.3884***	0.0059	4.8483
Sex	α_2	-0.0473**	0.0084	-6.273
Household size	α_3	-0.0138	0.0003	-2.458
Education level	α_4	-0.0847	0.0022	-3.589
Farming experience	α_5	0.0182**	0.0021	5.483
Extension Access	α_6	-0.7820***	0.0067	-7.2322
Credit Access	α_7	0.4892**	0.0061	6.2378
Land Ownership	α_8	-0.0674	0.0016	4.2983

Table 3: Maximum Likelihood Estimates of the Profit Inefficiency Model

Source: Authors` computation of field data, 2015 *** , ** and * denote 1%, 5% and 10% respectively

Profit Efficiency Analysis

The research reveals that profit efficiency varies widely among producers, ranging from a minimum of 20.12% to a maximum of 99.97%. The wide variation in the profit efficiency estimates can be associated with differences in efficient allocation and use of inputs among the producers. The mean estimated profit efficiency of 56.75% means that yam producers in the study areas have the scope of increasing their profit by 43.25% by adopting the available production techniques used by the most efficient farmer.



Range of Profit Efficiencies
Mean Profit Efficiency = 56.75%
Figure 1: Distribution of profit efficiencies of yam farmers.
Source: Authors` computation of field data, 2015

In Figure 1, it is observed that majority (20%) of the yam producers have profit efficiency scores ranging from 51 to 60, followed by 17% of yam producers having their profit efficiency score between 61 and 70. Out of the 225 producers 40% have their profit efficiency score ranging from 21 to 50. Forty-five percent of yam producers have their profit efficiency score ranging from 51 to 80. About 19% yam producers have their scores ranging from 71-90, If the least efficient yam producer is to achieve the efficiency status of the most efficient yam farmer, then that yam farmer must reduce their cost by 96%. On average, for a yam farmer to achieve the optimal profit efficiency, he/she must reduce cost by 43.25%.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results arrived, the following conclusions and policy recommendations are made. The results from the stochastic profit frontier analysis showed that yam farmers in the study area profit efficiency was positively influenced by sex, household size, educational level, extension access and land ownership. These findings have critical policy implications in improving production efficiency among farmers in Northern Ghana. Policy makers and government of Ghana should make it a priority to encourage both men and women to go into yam farming in an attempt to bridge the gap between gender discrimination. The investments in rural education on the path of effective delivery of extension program in the current political and economic environment in

Ghana will provide farmers with skills essential to increase efficiency. This research has clearly shown that employing the stochastic profit frontier does not restrict detailed analysis of the determinant of specific farm efficiency. The profit efficiency of 0.5675 suggest that considerable amount of profit is gained among yam producers in the sampled area. The inefficiency associated with controllable decisions is about 99.7% hence government through MOFA should educate farmers on how to reduce controllable inefficiency in their production. Farmers need to be educated and young men and women should be encouraged to go in to the production of yam.

REFERENCES

Abdulail, A. and Huffman, W.E. (1988) An Examination of Profit Inefficiency of Rice Farmers in Northern Ghana. Working Paper in Department of Economics Iowa State University, Ames, USA.

Aidoo, R. (2009) An analysis of yam consumption patterns in Ghanaian urban communities, Ph.D thesis submitted to the Department of Agricultural Economics, Agribusiness and Extension, Kwame Nkrumah University of Science & Technology, Kumasi, Ghana.

Aigner, D. J., Lovell, C. A. K., and Schmidt, P. (1977) Formulation and estimation of stochastic frontier production function models. Journal of Econometrics, 6, 21-37.

Ali, M. and Flin, J.C. (1989) Profit efficiency among basmatic rice producers in Pakistan Punjab. American Journal of Agricultural Economics. 71: 303-10.

Bancroft, R. D. (2000) Relieving post-harvest constraints and identifying opportunities for improving the marketing of fresh yam in Ghana, Crop Post Harvest Programme, Final Technical Report, No: R6505; ZB No: ZB0016.

Battese, G.E and Coelli, T.J. (1995) A Model for Technical Inefficiency Effect in Stochastic Frontier Production for Panel Data. Empirical Economics. 20: 325-345.

Bidzakin, J. K; Fialor, S. C and suming-Brempong, D. A (2014) Small Scale Maize Production in Northern Ghana: Stochastic Profit Frontier Analysis, ARPN Journal of Agricultural and Biological Science, VOL. 9, NO. 2, FEBRUARY 2014.

Bonilla et al. (2001). Determinants of Growth and Profitability in Small Entrepreneurial Firms. International Journal of Behaviour and Research. 4(1): 18-27.

Bravo-Ureta, B. E., and Pinheiro, A. E. (1993) Efficiency analysis of developing country agriculture: A Review of the Frontier Function Literature. Agriculture and Resource Economics Review, 22, 88-101.

Bravo-Ureta, B. E., and Pinheiro, A. E. (1993) Efficiency analysis of developing country agriculture: A Review of the Frontier Function Literature. Agriculture and Resource Economics Review, 22, 88-101.

Chukwu, G. O. and Ikwelle, M. C. (2000) Yam: Threats to its Sustainability in Nigeria, PALAWIJA NEWS, The CGPRT Centre Newsletter, Volume 17, Number 1 March 2000.

Coelli, V. J. (1991) Guide to Frontier Version 4.1. A Computer programme for stochastic frontier production and cost function estimation. Dept. of Economics, University of New England, Arm dale, Australia.

Daviron, B., and Gibbon, P. (2002) Global Commodity Chains and the African Export Agriculture. Journal

De Janvry, A., and Sadoulet, E. (2005) Achieving Success in Rural Development: Toward Implementation of an Integral Approach. Agricultural Economics 32 (1): 75-89.

Ellis, H. (1988) Cost and Profit Efficiency in European Banks. Journal of International Financial Markets, Institutions and Money. 12: 33-58

FAO (1996) Food for consumers: marketing, processing and distribution, Technical background document presented at the World Food summit, 13-17 Nov, 1996, Produced by: Economic and Social Development Department, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Fare C. H, Anyiro, C. O., and Chuku, J. A. (1997) The measurement of productive efficiency. Journal of the Royal Statistical Society. Series A, 120 (3) 253-290.

Farrell, M. J. (1957) The measurement of productive efficiency. Journal of the Royal Statistical Society. Series A, 120 (3) 253-290.

Greene, W. (1995) LIMDEP (Version 7): User's Manual and Reference Guide, Econometric Software Inc., New York.

Huffman W.E. (1974) Decision Making: The Role of Education. American Journal of Agricultural Economics. 56: 85-97.

IFAD (2009) The use of cassava wastes to produce energy: outcomes of a feasibility study implemented in Ghana. A presentation made at the Global Consultation on Cassava as a potential bioenergy crop, in Accra from 18-19 October, 2010.

International Institute of Tropical Agriculture (IITA) (2014) Accessed http://www.iita.org/yam (26/12/2014)

Jaforullah M. and Premachandra E. (2003) Sensitivity of Technical Efficiency Estimates to Estimation Approaches: An Investigation Using New Zealand Dairy Industry Data. University of Otago. Economic Discussion Papers. No. 0306.

Kalirijan K. P. and Shand R. T. (1999) Blackwell Publishers Ltd. Cowley Rd., Oxford OX4 IJF, UK and 350 main st, Malden, MA 02148, USA.

Kalirijan K. P. and Shand R. T. (1999) Blackwell Publishers Ltd. Cowley Rd., Oxford OX4 IJF, UK and 350 main st, Malden, MA 02148, USA.

Khem N. G; Ike, P. C., and Ugwumba, C. O. A. (2011) Profitability of Small scale Broiler Production in Onitsha North Local Government Area of Anambra State, Nigeria. International Journal of Poultry Science, 10(2),106-109.

Kumbhakar, M. and Bhattacharyya, F. (1992) Price Distribution and Restricted Profit Function Approach. Review of Economic and Statistics. 74: 231-39.

Kumbhakar, S. C., Ghosh, S., and McGuckin T. (1991) A generalised production frontier approach for estimating determinants of inefficiency in US dairy farms. Journal of Business and Economic Statistics, 9, 279-286.

Mawuli, Y. (2013. Profit Efficiency of Layer Production in Brong Ahafo and Greater Accra Regions of Ghana, Thesis Submitted to the University of Ghana, Legon in Partial Fulfillment of the Requirement for the Award of Master of Philosophy Degree in Agricultural Economics

Meeusen, W., and Van den Broeck, J. (1977. Efficiency estimation from Cobb-Douglas production functions with composed errors. International Economic Review, 18, 435-444.

Meier A. (1995) A generalised production frontier approach for estimating determinants of inefficiency in US dairy farms. Journal of Business and Economic Statistics, 9, 279-286.

MoFA (2010) The State of Agriculture in Ghana in 2009; Published by Statistics, Research and Information Department (SRID) of the Ministry of Food and Agriculture (MoFA), Accra, Ghana.

Norman, J. K; Orkwor, G.C and A.A.Adeniji (1984) Production constraints and available technologies for food yam (Dioscorea spp.) production in Nigeria. In: J. Berthaud, N. Bricas and J. mardand (eds). Yam, old plant and crop for the future. Actes du Seminaire Inter. Cirad Intra- Orstom- Coraf. June 1997. Montpellier, France. : 409-414.

of Agrarian Change 2:137-161

Ogundari K. (2006) Determinants of Profit Efficiency among Small Scale Rice Farmers in Nigeria: A Profit Function Approach. International Association of Agricultural Economist Conference, Australia.

Reardon, T., and Barrett, (2000) Agroindustrialization, Globalization, and International Development. An Overview of Issues, Patterns, and Determinants. Agricultural Economics 23:195-205.

Reifschneider J. and Stevenson W. (1991) Stochastic frontier estimation: a review of the software options. Journal of Applied Econometrics, 14,579-586.

RTIMP (2004) Annual Report for 2003; Root and Tuber Improvement and Marketing Programme, Ministry of Food & Agriculture, Accra, Ghana.

Vanish I. (2001) Determinants of Profit Efficiency among Small Scale Rice Farmers in Nigeria: A Profit Function Approach. International Association of Agricultural Economist Conference, Australia.

World Bank. (2008) Agriculture for Development in World Bank Development Report. World Bank, Pp. 96-136.

Xu Y. and Jeffrey, S. (1998) Technical efficiency of rice farms in Thailand: a non-parametric approach. Paper presented to the 2003 Hawaii International Conference on Business, Honolulu, June, 18-21.