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Profit Efficiency of Smallholder Maize Farmers in Niger State, Nigeria

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Abstract

Inability of the smallholder farmers to operate on the profit frontier given farm specific prices and resource base continue to undermine sustainable production level and its attendant loss of farm profit over the years. Therefore, the analysis of profit efficiency of smallholder maize farmers was investigated. A cross section of 173 smallholder maize farmers in Niger State was selected through multistage random sampling procedure. Data were analyzed using descriptive statistics, budgetary technique and stochastic profit frontier function. Result showed that majority of the respondents were male with mean age of 43.5 years. Majority of the farmers had no formal education. Analysis of costs and returns showed the gross margins of ₦52,232.66 was realized per hectare per production cycle and return on investment of 0.62 was estimated suggesting viable and profitable maize enterprise. Maximum likelihood estimate (MLE) of the profit model revealed that profit efficiency ranged between 12% and 98% with a mean profit efficiency level of 74.2% suggesting that average smallholder farmer lost 25.8% of their profit due to inefficiencies in production. Result revealed further that age, sex, extension contact and access to credit were the relevant and significant factors that positively influenced profit efficiency while farm size and experience negatively affected profit efficiency of smallholder maize farmers. It is recommended that credit institution and extension delivery system should be strengthen, adult education that offered training of ageing farmers on new innovation, better method of resources combination and optimal use of available land to achieve maximum output and improved profit efficiency level should be given adequate attention by policy makers.

Key words: Profit efficiency, profitability, Stochastic frontier, smallholder, maize-farmers

Introduction

Maize *(Zea mays)* is a member of the grass family (gramineae). It originated from South and Central America and introduced to West Africa by the Portuguese in the 10th century. Africa is a minor producer of maize by world standard, accounting for only 7% of global production (FAO, 2012). It is estimated that in 2012, the total world production of maize was 875,226,630 tons with the United States, China, and Brazil harvesting 31%, 24%, and 8% of the total production of maize, respectively (FAO, 2012). Maize is highly yielding, easy to process, readily digested and cost less than other cereals. It is also a versatile crop, allowing it to grow across a range of agroecological zones (IITA, 2001). Nigeria is the tenth largest producer of maize in the world, and the first largest maize producer in Africa, followed by South Africa (IITA, 2012; FAO, 2014). While maize is grown in the entirety of the country, the North Central region is being observed as the main producing area (NBS/FMARD, 2011).

In the southwestern part of Nigeria, about 30% of the crop land has been devoted to small-scale maize production under various cropping systems (Ayeni, 1991). Increase in maize production in Nigeria has been achieved greatly by expansion in area harvested rather than increase in yield. The area harvested increased from 2.8 million hectares in 1986 to over 3 million hectares in 2000 and over 6 million hectares in 2011(Olaniyan, 2015). The average yield of maize in Nigeria has increased over the years, its yield's level (1.695 ton/ha) is still low when compared to the world average of 18.3 ton/ha. It is even lower when compared to average yield from other African countries like Cameroon, South Africa and Egypt with average yield of 1.923 ton/ha, 2.876 ton/ha and 8.123 ton/ha, respectively (FAO, 2012). Among different income generating crops, maize is relatively becoming an important 'cash crop' to smallholder farmers and constitutes a major source of calories for the poorer proportion of consumers who cannot afford more expensive foods such as bread, milk or meat (Mafongoya and Sileshi, 2003).

According to the Mundi Index, maize consumption in Nigeria in 2017 stood at 10.9 million metric tonnes (Olaniyan, 2015). In view of the importance of maize in Nigeria, efforts are continuously made to increase maize yield per unit area of land and to extend areas where it can be grown especially the cultivation of dry areas has improved through irrigation. The major goal of any production system is the attainment of an optimally high level of output with a given amount of input (Rahman, 2013). It is estimated that by 2050, the demand for maize in developing countries will double. By 2025, it will become the crop with the greatest production globally and in developing countries (CIMMYT, 2009 and IITA, 2010).

In Nigeria, maize production farming system is characterized by smallholder farms. The smallholder farming systems function under a broad array of biophysical, climatic, and socio-economic settings, and their improvement is often hindered by inadequate access to land, fertile soil, capital, and labour (Giller *et. al*., 2006; Chatterjee *et.al.,* 2015). The interactions among these factors affect resource use efficiency and the ability to produce optimal yield. Despite the economic importance of maize to the large population of Nigeria, it has not been produced to meet food and industrial needs of the country and this could be attributed to low productivity from maize farms or that farmers have not adopted improved technologies for its production (Onuk *et al.*, 2010).

Among the various factors responsible for the low productivity of these farmers are; the use of obsolete cultural practices, scanty plant stands, poor weed control, non-usage of fertilizer, organic manures and other improved agricultural inputs including the management of the crop under degraded soil condition, climate change and their consequences which resulted in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa (UNFCCC, 2007; FAO, 2003). Increase in agricultural productivity resulted in agricultural growth and can help to alleviate poverty in poor and developing countries, where agriculture often employs the larger portion of the population (De Janvry and Sadoulet, 2002; OECD,2006). Agricultural policies tend to focus more on fostering productivity through technological change than through better use of the existing technology.

However, rebalancing the focus of agricultural policies towards improving efficiency is necessary in the context of limited availability of natural resources, such as land and water, and given the necessity to limit the environmental footprint of agricultural production. The measurement of efficiency relies on the definition of the production frontier which, given the heterogeneity of conditions and the diversity of environments in which farmers operate, does not have to be unique. It is likely to vary across agroclimatic environments and types of farms or type target markets. According to Kelly *et al.* (1996), an agricultural farm reaches economic efficiency when the marginal value of the inputs is equal to their respective unit costs: if the marginal value is higher, the farm can earn higher profits by producing more, thereby becoming more efficient. If the marginal value is lower, the farm should reduce its production to increase its profits. Efficiency measurement has received considerable attention from the theoretical and applied economists. From theoretical point of view, there has been a spirited exchange about the relative importance of various components of firm efficiency. From an applied perspective, measuring efficiency is important because this is the first step in an agricultural production process that might lead to substantial resource saving. Resource saving has important implication for both policy formulation and farm management (Sadiq *et al*., 2009). The pivotal role of efficiency in increasing agricultural output and productivity has been applauded and investigated by various researchers. However, many of these studies in efficiency are based on the premises that, if farmer are not making efficient use of existing technology, then their efforts designed to improve efficiency would be most cost effective than introducing new technologies as a means of increasing agricultural output (Bellase and Graborisks 1985, Bravo-Ureta and Pinheiro, 1993). An improvement in the understanding of the source of inefficiency in production and its relationship with factors at both the individual and farm-levels can greatly aid policy makers in enhancing policy reforms in the agricultural sector.

Previous studies on efficiency measurement were focused on technical efficiency with little attention given to profit efficiency. However, the ability of maize farmers to adopt new technology and achieve sustainable production depends on their level of profit efficiency, mostly determined by variable inputs and output prices as well as cost of fixed factors of production. Some factors would operate to cause changes in farm level profit efficiency. Determining these factors and their effects on farm level profit efficiency constitutes the research questions which this study sought to answer. The major objective of this study is to analyze the profitability and profit efficiency of smallholder maize farmers in Niger state. Specifically, the study profile the socioeconomic characteristics of smallholder maize farmers, analyze the costs and return of maize farms to assess their profitability level, examine the profit efficiency of smallholder maize farmers and determine farmers-specific factors associated with profit inefficiencies.

Materials and methods

Study area

Niger State is in the North-central part of Nigeria and lies in between longitude 3^{o} 30^{1} and 7^{o} 20^{1} east of the Greenwich Meridian and latitude 8^{o} 20^{1} and 11^{o} 30^{1} north of the equator. The North-central part of the country lies in the tropical region of the country, with agricultural system of farming been rainfed. The land area is about 80,000 square kilometers with varying physical features like hills, lowland and rivers. The state enjoys luxuriant vegetation with vast Northern Guinea Savannah found in the north, while the fringe (Southern Guinea Savannah) in the southern part of the state. It is characterized by woodland and tall grasses interspersed with tall dense species of trees. However, within the Niger trough and flood plains, there occur taller trees and few oil palm-trees. In some areas, traces of rainforest species can be seen. The people are predominantly peasant farmers cultivating mainly food crops such as yam, cassava, maize and rice for family consumption and markets.

Type and Sources of Data

The study employed primary data. Primary data were collected with the aid of structured questionnaire. Data were collected on different household and farm characteristics of maize farmers. Household characteristics include age, education, farming experience, marital status, gender of the head of household, farm income and non-farm income. Farm characteristics include farm size, area of land planted for maize, the labour used for farm activities and their costs. Others include the quantities of maize harvested, consumed and sold and their costs; and various costs of inputs such as seeds, fertilizer and herbicides/pesticides.

Institutional factors include access to extension services and access to credit.

Sampling procedures

A multistage sampling procedure was employed for the study. The first stage was the purposive selection of four Local Government Areas (Lapai, Gbako, Mashegun and Magama) with record of highest maize production in the state. In the second stage, 5 villages were randomly selected from each LGA and lastly 184 maize-based farming households were randomly selected from the list of maize producing farmers obtained from ADP of each LGAs in a proportionate sampling method. Although a total of 184 questionnaires were administered on the respondents, 11 of these were found unsuitable for analysis and consequently, data from 173 questionnaires were analyzed for the study.

Table 1: Sampling procedure for the selection of maize farming Households in Niger State

State	Selected LGAs	Selected villages	Number of Questionnaire distributed	Number of Questionnaire retrieved	State total
Niger	Lapai	Nassarawa	11	10	
		Unguawan Basso	15	14	
		Ebbo	11	10	
		Zabba	8	7	
		Kpada	6	6	
	Gbako	Ndalabi	18	18	
		Nuwako Senma	23	22	
		Saganuwa	22	15	
		Samanjika	12	12	
		Samanjiki	10	12	
	Mashegu	Babban Rimi	7	6	
		Kaboji	6	6	
		Katanga	5	5	
		Mashegu	5	4	
		Makinra	4	4	
	Magama	Matandi	8	8	
		Yangaru	6	5	
		Nasko	5	4	
		Sanka	4	3	
		Majinga	4	4	173

Source: Niger State Agricultural Development Programme (2015)

Analytical technique

The data collected were analyzed using Descriptive statistic, Budgetary technique and Inferential statistic.

(i). Descriptive statistics: the simple descriptive statistic used includes mean and percentages. This was used to analyze the socio- economic and farm characteristics of the respondents, input and output variables and the distribution of profit efficiency levels.

(ii). Budgetary technique: This was used to analyzed the costs and returns structure of smallholder maize farmers. It includes the use of gross margin analysis. Gross margin is taken as the difference between the total values of production and the total variable cost of production.

GM = TR - TVC

TC = TVC + TFC

ROI = GM/TVC

Where; GM = Gross Margin, TR = Total Revenue, TVC = Total Variable Cost, TFC= Total Fixed Cost, TC = Total Cost, ROI = Returns on Investment.

(iii). Stochastic Profit Frontier (SPF)

The profit function approach combines the concepts of technical and allocative efficiency in the profit relationship and any errors in the production decision are assumed to be translated into lower profits or revenue for the producer (Ali *et.al.*, 1994). Profit efficiency, therefore, is defined as the ability of a farm to achieve highest possible profit given the prices of variable inputs and levels of fixed factors of that farm. Profit inefficiency in this context is defined as the loss of profit for not operating on the frontier (Ali and John 1989). Battese and Coelli (1995) extended the stochastic production frontier model by suggesting that the inefficiency effects can be expressed as a linear function of explanatory variables, reflecting farm-specific characteristics.

The advantage of this model is that it allows the estimation of farm specific efficiency scores and the factors explaining the efficiency differentials among farmers in a single stage estimation procedure.

Following Rahman, *et al.* (2012) this study utilizes the Battese and Coelli (1995) model by postulating a profit function, which is assumed to behave in a manner consistent with the stochastic frontier concept. The stochastic profit function is defined as

$$\pi^* = \frac{\pi}{P} = h(q_{i,}z)\exp(v_i - \mu_i)$$

Where: π^* = normalized profit of i-th farmer; $\frac{\pi}{p}$ = description of the normalized profit, $q_{i,}$=vector of variable inputs; Z = vector of fixed input(s); P = output price used to normalize variables in the model; π = farmer's profit defined as total revenue minus total cost of production $\exp(v_i - \mu_i)$ = composite error term. The profit/economic efficiency (EE) of an individual farmer in the context of stochastic frontier profit function is derived as a ratio of the predicted, observed or actual profit (π) to the corresponding predicted maximum profit (π^*) for the best farm or frontier profit given the price of variable inputs and the level of fixed factor(s) of production of that farmer. Mathematically, it is expressed as:

$$Profit\ Efficiency\ (EE) = \frac{Actual\ profit}{Frontier\ profit} = \frac{\pi_i}{\pi^*}$$
$$= \frac{(q_{i,} z)\exp(v_i - \mu_i)}{(q_{i,}\ z)\exp(v_i)}$$

$$Profit\ Efficiency\ (EE) = \frac{\exp(v_i - \mu_i)}{\exp(v_i)} = \exp(\mu_i)$$

The stochastic disturbance term (ε_i) consists of two independent elements: *"v" and "u"*. The symmetric two-sided error term (*v*) account for random variation in profit attributed to factors outside the farmer's control (random effects, measurement errors, omitted explanatory variables and statistical noise). The one-sided component (μ) is a non-negative error term accounting for the inefficiency of the farmer. This represents the profit shortfall from its maximum possible value that will be given by the stochastic profit frontier. However, when *u* = 0, it implies farm profit lies on the efficiency frontier (i.e. 100% profit efficiency) and *u* < 0 implies that the farm profit lies below the efficiency frontier. Both *v* and *u* are assumed to be independently and normally distributed with zero mean and constant variance.

Model Specification

A multiple regression model based on the stochastic frontier profit function which assumes Cobb-Douglas functional form was employed to determine the profit efficiency of maize producers in the study area. The frontier model estimated following Nganga, *et al.*, (2010) and Kaka *et. al.*, (2016) was therefore specified as follows:

$$ln\pi_i^* = \beta_i + \sum_{j=1}^{4} \beta_j \ln X_{ji}^* + \beta_k lnX_k + v_i - \mu_i$$

$$ln\pi^* = \beta_0 + \beta_1 lnX_1^* + \beta_2 lnX_2^* + \beta_3 lnX_3^* + \beta_4 lnX_4^* + \beta_k X_k + v_i - \mu_i$$

Where

Π* = normalized profit (TR-TVC divided by output price)

X_1^*= price of fertilizer (₦/kg) normalized by output price

X_2^* = price of herbicide (₦/lt) normalized by output price

X_3^*= price of seed(₦/kg) normalized by output price

X_4^*= price of labour(₦/manday) normalized by output price

X_k = land area cultivated for maize (ha)

B_o, $\beta_1 \dots \beta_4$, and β_k are parameters to be estimated, v_i represents statistical disturbance term and u_i represents profit inefficiency effects of i-th farmer

The second stage of this analysis investigates the sources of the profit inefficiency for the study.

The inefficiency model (μ_i) for this study is estimated as:

$$\mu_i = \propto_0 + \propto_1 Z_1 + \propto_2 Z_2 + \propto_3 Z_3 + \propto_4 Z_4 + \propto_5 Z_5 + \propto_6 Z_6 + \propto_7 Z_7 + \propto_8 Z_8 + \propto_9 Z_9 + k$$

Where: μ_i = profit inefficiency of the i^{th} farmer

Z_1 = Sex (Male =1, Female =0)

Z_2 = Age of farmer (years)

Z_3 = Household size (Number)

Z_4 = Level of education (years)

Z_5 = Farm size (hectares)

Z_6 = Farming experience (years)

Z_7 = Distance to market (km)

Z_8 = Extension contact (Number of visits)

Z_9 = Credit access (access=1, 0 otherwise)

$\propto_0 \dots \propto_9$ are parameters to be estimated

$Z_1 \dots Z_9$ are variables explaining the inefficiency effects

k is a truncated random variable

These socio-economic variables are included in the model to indicate their possible influence on the profit efficiencies of the smallholder maize farmers. The variance of the random errors, $\partial^2 v$ and that of the profit inefficiency effect $\partial^2 \mu$ and overall variance of the model ∂^2 are related:

$$\partial^2 = \partial^2 \mu + \partial^2 v$$

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 (γ) as:

$$\gamma = \partial^2 \mu \big/ \partial^2 v + \partial^2 \mu$$

The parameter γ 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, whereas 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 estimated using the program, FRONTIER VERSION 4.1 (Coelli, 1996).

3. Results and Discussions

3.1 Socioeconomic characteristics of Respondents

The result of socioeconomic characteristics of the sampled smallholder maize farmers is presented in Table 1 below. Majority (93.1%) of the respondents were male and 6.9% were female. This indicates that male dominated maize farming in the study area. This may be as a result of tedious and laborious nature of peasant farming and lack of access to productive resources by women folks. Previous studies (Quisumbing, 1994, Akinwumi and Djato, 1996, Okoruwa *et. al.*, 2009) have argued in this respect. About 83.3% of the respondents belonged to the active and productive set of the population. The mean age was 43.5±3.36 years. This indicates that maize farming was in the hands of vibrant young farmers, which may translate to improved productivity. 93.1% of respondents were married with only 6.9% single. This indicates a probable increase in the supply of family labour to increase maize production. Results showed that majority (61.8%) of the sampled farmers had no formal education. 27.3% and 11% had primary and secondary education respectively.

The mean education was 4.58±2.14 years. This indicates a low level of education, which may hinder the adoption of new innovation and improved technologies in farming as the farmers may not be receptive to such new ideas. This result is similar to the findings of Sadiq *et. al*. 2013 who reported that 68% of the maize farmers in Niger State had no formal education. The years of farming experience of the respondents showed that 92.4% had above 10 years farming experience.

The mean farming experience was 30.6±10.74 years. The accumulated years of experience may enable them to evolve the farming practices that are most suitable to their fragile environment, which may impact positively on their productivity. This supports the findings of Okoruwa *et. al.*, 2009 who reported average of 23 years farming experience for rice farmers in north central of Nigeria. Majority (83.8%) of the farmers have household size of between 6-15 members. The mean household size was 10 persons. This indicate a large household size, which is typical of farm household settings in northern Nigeria. A large household is a potential for improved labour position on the farm with the capability of increase maize production.

This result is in line with Okoruwa *et. al*., 2009 and Sadiq *et. al.*, 2013 who reported an average of 7 persons respectively in rice and maize farming households in Niger state. Results showed that majority (66.5%) of the respondents cultivated between 1-2 hectares of maize farms and 30.6% of the farmers cultivated between 2.1-5.0 hectares of maize farms. The mean farm land area cultivated for maize production was 1.09ha. This indicates a typical smallholder farming system in the study area. The result of extension contacts with farmers in the study area showed that 50.3% of the farmers were in contact with extension agents once in a month, 32.9% and 16.8% had contact with extension agents twice and thrice in a month respectively. This indicates that farmers' access to extension agents was relatively frequent.

Costs and return of maize production per hectare

Table 3 presents the costs and returns analysis of maize production per hectare in the study area. During the production year, estimated maize yield was 2335.05kg/ha and revenue earned was ₦137,020.73 per hectare. The total cost of maize production per hectare was ₦84,788.07. Labour cost of ₦42,581.40 took the largest share (50.2%) of the total cost of production. This supports the findings of Baruwa and Familusi (2018), Zongoma et. al., (2015), who reported that labour constituted the single most important cost item on the average in crop farming. The gross margin of ₦52,232.66 was realized per hectare per farmer during the production period. The return on investment during the production cycle was 62%, which indicates a return of 0.62kobo on every ₦1.00 invested per hectare. This signifies that maize production is profitable and viable investment in the study area.

able 2: Socioeconomic characteristics of smallholder maize farmers (n=173).

Variable	Frequency	Percentage	Mean	SD
Sex				
Male	161	93.1		
Female	12	6.9		
Age (years)				
21-30	4	2.3	43.5	7.38
31-40	71	41.1		
4-50	69	39.9		
>50	29	16.7		
Marital status				
Married	161	93.1		
Single	12	6.9		
Educational level				
Informal	107	61.8		
Primary	47	27.2		
Secondary	14	11.0		
Tertiary	-	-		
Farming experience (years)				
1-10	6	3.5	30.6	10.79
11-20	29	16.8		
21-30	50	28.9		
>30	88	50.8		
Household size(number)				
1-5	14	8.1	10	3.57
6-10	87	50.3		
11-15	58	33.5		
>15	14	8.1		
Land area cultivated(ha)				
1.0-2.0	115	66.5	1.09	0.68
2.1-5.0	53	30.6		
>5.0	5	2.9		
Extension contacts (no. of visit)				
Once	87	50.3		
Twice	57	52.9		
Thrice	29	16.8		

Table 3. Costs and return of maize production per hectare/farmer

Items	Quantity	Unit price (₦)	Total (₦)
Total revenue			
Maize yield (kg/ha)	2,335.05	58.68	137,020.73
Variable cost			
Fertilizer (kg/ha)	392.39	75.49	31,183.93
Seed (kg/ha)	23.63	88.86	2,099.76
Herbicide (lt/ha)	8.72	864.6	7,359.31
Labour (Man-day/ha)	41.47	1,026.8	42,581.40
Transportation			1,383.67
Total variable cost			84,788.97
Gross margin			52,232.66
ROI			0.62

Summary statistics of variables used in stochastic profit frontier model.

Table 4 presents the summary statistics of the variables used in stochastic profit frontier model.

The average gross margin of ₦52, 232.66 per hectare per farmer was recorded with standard deviation of ₦43,166.78. The observed variability indicates that farmers cultivate different hectares of farmland with majority of them having an average profit that is very close to that recorded in the sampled area. The average farm size cultivated by the farmers was 6.89 hectares. However, the proportion of land area allocated to maize production was 1.09 hectares which indicates that farmers in the study area allocated 15.8% of their land holding to maize production. An average distance of 10.26km were covered by the farmers to transit harvested maize from farm location to the product market. Result showed that mean output of maize harvested was 2,545.2kg during the production year.

Table 4: Summary statistics of variables used in Stochastic Profit Frontier (per ha/farmer)

Variable	Maximum	Minimum	Mean	Std. Deviation
Gross margin (₦)	46,927.50	350,341.24	52,232.66	43,166.78
Age (years)	22	62	43.48	7.35
Education (years)	0	16	4.58	3.15
Farming experience (years)	1	55	30.64	10.79
Farm size (ha)	1.5	34	6.84	5.38
Land area cultivated for maize (ha)	1	4	1.09	0.68
Household size(number)	3	23	10.26	5.42
Extension contacts (no. of visit)	0	3	2.49	2.03
Distant to market (km)	1.0	30	10.26	5.42
Maize output (kg/ha)	750	14,000	2,545.2	2,024.7
Output price (₦ /kg)	50	65	58.68	2.19
Price of seed (₦ /kg)	78.8	112	88.86	5.47
Price of fertilizer (₦/kg)	45	115	79.45	9.62
Price of Herbicide (₦ /kg)	750	1,200	864.60	98.08
Price of labour (man-day/ha)	550	1,800	1,026.80	94.55

Maximum likelihood estimates of profit frontier function

The result of the MLE stochastic profit frontier function is presented in Table 5. The estimated value of sigma-squared (∂^2) is significantly different from 0 at 1% level, indicating the correctness of the specified assumption of the distribution of the composite error term. The estimated value of gamma (γ), which represents the ratio of the variance in the inefficiency and the variance in the composite error is 0.8852 and statistically significant at 1%. This implies 88.52% of variation in actual profit from the optimal profit (frontier profit) among the farmers was mainly due to differences in farmers' practices rather than random errors. This result is confirmed by the likelihood ratio (LR) test statistic. This test is based on the null hypothesis that all parameters of the inefficiency function are equal to 0; therefore, inefficiency is absent in the model. The LR test of the one-sided error is equal to 92.04, and therefore the null hypothesis is rejected at the 1% level of significance. This confirmed the existence of inefficiencies as responsible for the significant part of the variability in profits among smallholder maize farmers.

The results showed that variables of price of seed, price of herbicides, area of land cultivated for maize production are positive and significant. This indicates that as these variables increases, the normalized profit of smallholder maize farmers increases However, the variables of price of fertilizer and price of labour are negatively significant, which indicates that as these variables increases the normalized profit of farmers decreases. The coefficient of the price of fertilizer is negative and significant (-0.534 $p<0.01$). This indicates that as the price of fertilizer increases by 1%, profit of maize farmers decreases by 53.4%.

The reason for the negative correlation may be due to continuous cropping of the same land over the years for maize production with its attendant fertility depletion. Thus continuous use of fertilizer on such exhausted and marginal land would not resulted in yield increase hence reduction in farm's profit. This result is consistent with the findings of Adeleke *et. al.*, (2008), Ogundari (2006), Isaac *et. al.* (2014) and Trong and Napasintawong (2015). The coefficient of price of herbicide is positive and significant (0.153 $p<0.05$). This implies that a 1% increase in the price of herbicide resulted in 15.3% increase in normalized profit of the maize farmers. This agree with the findings of Oladeebo and Oluwaranti (2012) and Kaka *et. al.*, (2016) that reported the important of agrochemicals in increasing farmer's profit efficiency.

The coefficient of seed was positively signed and significant at 1%. This implies that 1% increase in the price of maize seed has the likelihood to increase farm profit by 9.2%. Similar result was reported by Trong and Napasintowong (2015). The coefficient of the price of labour was negatively signed and significant (-0.617 $p<0.05$). This indicates that increase in the unit price of labour influences profit negatively. The implication of this scenario showed that farmers were paying higher wages for labour on maize farms, which have the resultant effect on decreasing farm profit.

This result agrees with the findings of Ogunniyi (2011), Oladeebo and Oluwaranti (2012), Isaac *et. al.* (2014) and Kaka *et. al.*, (2016) and contrary to the findings of Ogundari (2006). The coefficient of area of land cultivated for maize production was positive and significant (0.156 $p<0.05$). This implies that 1% increase in the area of land cultivated for maize production increases maize farm's profit by 15.6%. This is an indication that majority of the maize farmers in our sample are operating under small-scale farms, thus their ability to expand the scale of farm's operating capacity will increase maize output, which in-turn will increase farm profit. This is in agreement with the findings of Ifeanyi and Onyenweaku (2007), Sunday *et. al.*, (2013) and Kaka *et. al.* (2016).

Table 5. Maximum likelihood estimates of Stochastic profit frontier

Variable	Parameter	Co-efficient	Standard error	T-value
Constant	β_0	0.612	0.099	6.181
Price of fertilizer	β_1	-0.534***	0.149	-3.583
Price of herbicide	β_2	0.153**	0.065	2.352
Price of seed	β_3	0.092***	0.028	3.283
Price of labour	β_4	-0.617***	0.148	-4.168
Area of land cultivated	β_k	0.156***	0.069	2.260
Sigma square	∂^2	0.1065***	0.0141	7.539
Gamma	Γ	0.8825***	0.2152	4.112
Log likelihood		-234.429		
LR test		92.04		

Determinants of smallholder maize farmers' profit Inefficiency

Analysis of inefficiency model (Table 6) reveals that the signs and significance of the estimated coefficient in the inefficiency model have significant impact on the profit efficiency of the farmer. The inefficiency model showed the factors that determined farmer's profit efficiency. The variables of sex, age, extension contacts and access to credit have negative coefficients and are significant. This followed the *a priori* expectation of the model. The negative signs of these variables indicate that as these variables increases the profit inefficiency of maize farmers decreases, while profit efficiency increases.

The other variables were not in conformity with *a priori* expectation of the model because they are positively signed, which implies that as these variables increase the profit inefficiency of maize farmers increases thus decreases profit. The coefficient of sex is negative and significant at 1%. This implies that profit inefficiency in maize farms reduces with male farmer. This result is similar to the findings of Tanko and Alidu (2017), Wognaa *et. al*., (2015) and Tasila Konja *et. al.*, (2019) who in their respective studies found that male farmers were more profit efficient than their female counterparts in farming activities.

The coefficient of age is negative and significant (-0.297 $p<0.01$). This indicates that as the age of the farmer increases the profit inefficiency reduces. This result supports the findings of Ogundari (2006) who reported that older farmers are more profit efficient than their younger counterpart. However, the result was contrary to the findings of Kaka et al., (2016) and Tasila Konja et al., (2019) who submitted that profit inefficiency reduces with younger farmers. The coefficient of extension contact with farmers is negative and significant (-0.393 $p<0.05$).

This implies that increase in the number of visits to maize farmers by the extension agents to update their knowledge on new innovations and technologies that improve farming reduce inefficiencies in profit level of farmers. This result agrees with the findings of Tanko and Alidu (2017) and Tasila Konja *et. al.* (2019) who reported that increase in extension contacts resulted in an increase in profit efficiency level of yam and certified groundnut seed production respectively. The coefficient of access to credit is negatively signed and significant (- 0.539 $p<0.01$). This indicates that having access to credit would increase the profit efficiencies of maize farmers.

The implication of this is that profit inefficiencies in maize farms will reduce as farmers have access to credit to expand their scale of operation and purchase modern equipment to improve their farming activities. However, the coefficients of experience and farm size were positive and significant at 5% and 10% respectively.

The result indicates that as years of farming increases, profit efficiency of maize farmers decreases suggesting that, the older the farmer, the lower their profit efficiency level. This may be due to inability of the aged farmers who have been in maize farming for years to adopt new innovation and modern technologies that could improve their productivity. This is contrary to the findings Sodiq and Singh (2015), Dessale (2019) and Tasila Konja et al., (2019) who reported that farmers with more years of experience tend to operate at a significantly higher level of profit efficiency.

Similarly, the coefficient of farm size has a positive and significant relationship with profit efficiency level. This indicates that as farm size increases, the profit efficiency of maize farmer decreases. The possible reason could be that as farm size increases, it becomes more difficult to manage by smallholder farmers thus resulted in production inefficiencies that could translate to lower profit efficiency level.

It was widely reported in literatures that small farms are more productive on a per hectare basis than large farms. This is because small farms use fixed resources such as household labour and other inputs over a smaller area than large farms. Similar results by Ajetomobi *et al.* (2011), Coster and Adeoti (2015) showed that there is inverse relationship between farm size and productivity indicating the reductive importance of small farm holding.

Distribution of smallholder maize farmers' profit efficiency

Table 7 presents the frequency distribution of profit efficiency of smallholder maize farmers in the study area. The profit efficiency varies widely among the smallholder maize farmers, ranging from 20% to 98%. This wide variation in the profit efficiency estimates was due to differences in efficient allocation and use of input resources among the maize producers in the study area.

Table 6. Maximum likelihood estimates of profit inefficiency model

Variable	Parameter	Co-efficient	Standard deviation	T-value
Constant	$\propto_0$	0.327	0.074	4.419
Sex	$\propto_1$	-0.816***	0.148	-5.514
Age	$\propto_2$	-0.297**	0.119	-2.496
Household size	$\propto_3$	0.024	0.019	1.263
Education	$\propto_4$	0.011	0.010	1.113
Farm size	$\propto_5$	0.033*	0.019	1.736
Farming experience	$\propto_6$	0.032**	0.014	2.286
Distant market	$\propto_7$	0.012	0.013	0.923
Extension contacts	$\propto_8$	-0.393***	0.167	-2.353
Access to credit	$\propto_9$	-0.539***	0.144	-3.743

The observed wide variation in profit efficiency is similar to the findings of Rahman (2003), Adeleke *et al*., (2008), Tanko and Alidu (2017) and Tasila Konja *et al*., (2019). Majority of the smallholder maize farmers (34.7%) fall between the efficiency class of 0.71-0.80. About 12.1% of the farmers were in the efficiency class of between 0.81-0.99, while 10.4% were in the lower efficiency class of 0.2-0.3 category. Result showed that about 62.4% of the smallholder maize farmers were operating close to the frontier. The mean profit efficiency of 74.2% implies that on average, smallholder farmers are wasting 25.8% of their potential profit due to combination of technical and allocative inefficiencies in maize production. This is an indication that in relative term, larger percentages of the farms were fairly efficient in allocating their cost structure in maize production.

This result is similar to the findings of Rahman (2003), Olaadebo and Oluwaranti (2012), Isaac *et. al.*, (2014) and Kaka *et. al.* (2016) who found mean profit efficiency of 77% (rice farms in Bangladesh), 79% (cassava farms in southwestern Nigeria), 89% (maize farms in Ghana) and 73.2 % (rice farms in Malaysia) respectively. Profit efficiency in maize production in the study area could be increased by improving the technical and allocative efficiency. This could be achieved through farmer specific factors which includes sex, age, extension contacts and access to credit. The economic implication of this scenario is that, if the average smallholder maize farmer in the sample is to achieve the profit efficiency level of his most efficient counterpart, then the average farmer must reduce cost by 24.3% (1 – 0.742/0.98). Similarly, the most profit inefficient farmer must reduce cost by 79.6% (1 – 0.2/0.98) to achieve the efficiency level of the most profit efficient maize farmer.

Table 7. Decile frequency distribution of efficiencies of maize farmers

Decile range of profit efficiency	Frequency	Percentage
0.21-0.30	18	10.4
0.31-0.40	9	5.2
0.41-0.50	25	14.5
0.51-0.60	10	5.8
0.61-0.70	30	17.5
0.71-0.80	60	34.7
0.81-0.99	21	12.1
Total	173	100.0
Mean efficiency	0.742	
Minimum efficiency	0.20	
Maximum efficiency	0.98	

Conclusion and recommendation

The study revealed that maize production in the study area was dominated by male farmers who were relatively younger with great deal of farming experience. Gross margins of ₦52, 232.66 per hectare/farmer were earned during the production year. Returns on investment of ₦0.62kobo on every ₦1.00 invested per hectare showed that maize production is viable and profitable. Results of MLE of stochastic profit frontier revealed that prices of seed, herbicide and area of land cultivated for maize positively and significantly influenced the profit level of maize farmers. The mean profit efficiency of 74.2% implies that smallholder maize farmers could increase profit efficiency by 25.8% by improving their technical and allocative efficiency. Results showed that age, sex, extension contact, access to credit, farm size and farming experience were the major significant determinants of profit efficiency among smallholder maize farmers.

It is recommended that to significantly reduced inefficiency in maize production government policy focus should be the improvement and strengthening of the extension systems and credit institutions in the rural areas. Also, women should be encouraged to actively participate in maize farming and the ageing farmers should be adequately supported in cash and kind. Adult education that offered training of ageing farmers on new innovations and optimum resources combination to attain their profit potential and avoid wastages should be given attention

References

Adeleke, O. A., Matanmi, H.M and Ogunniyi, L.T (2008). Application of the Normalized profit function in the estimation of the profit efficiency among smallholder farmers in Atiba local government area of Oyo State. *Journal of economics theory* 2(3): 71-76.

Ajetomobi, J, Abiodun, A., and Rashid, H. (2011). Impact of Climate Change on Rice Agriculture in Nigeria. Tropical and Subtropical Agroecosystems, 14, 30-40

Akinwumi, A., and Djato, K.K. 1996. Farm size, relative efficiency and agrarian policy in Cote d'Ivoire: Profit function analysis of rice farms. *Agricultural Economics*, 14: 93-102.

Ali F, P. A, Shah, M. K (1994). Measurement of profit efficiency using behavioral and stochastic frontier approaches. *Applied Economics*, 26: 181-188.

Ali, M., and Flinn, J. C. (1989). Profit Efficiency among Basmati Rice Producers in Pakistan Punjab. *American Journal of Agricultural Economics, 71*(2), 303-310.

Ayeni, A.O. (1991) Maize Production in Nigeria: Problems and Prospects. *Journal of Food and Agriculture*, 2, 123-129.

Baruwa, I.O and Familusi, G.I (2018). Comparative analysis on the profitability of sole maize cropping and maize/melon intercrop in Osun State, Nigeria. *Journal of Agricultural Sciences* 63, 3, 309-322

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.

Battese, G.E., Corra, G.S. (1977). Estimation of a production frontier model: with application tothe pastoral zone of Eastern Australia. *Australian Jourrnal of Agricultural Economics*, 21 (3), 169---179.

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.

Belbase, K. and Grabowski, R (1985). Technical efficiency in Nepalese agriculture. *Journal of Developing Area*, 19, 515-528

Chatterjee S, Goswami R and Bandopadhyay, P (2015). Methodology of identification and characterization of farming systems in irrigated agriculture: case study in west Bengal State of India. *Journal of Agricultural Science and Technology*; 17(5):1127–1140.

Chukwuji, O.C. (2008). Comparative analysis of enterprise combination costs and returns in Cassava-based food crop farming systems in Delta State, Nigeria. *ARPN Journal of Agricultural and Biological Science, 3* (4), 27-32

CIMMYT (International Maize and Wheat Improvement Centre) (1999)."People and Partnerships: Medium-Term Plan of the CIMMYT".

Coelli, T., (1996). A guide to FRONTIER version 4.Ic: A computer programme for stochastic frontier production and
cost function Estimation, mimeo. Department of Econometrics, University of New England. Armidale, Australia.

Coster, A.S. and Adeoti, A. I. (2015). Effects of Climate Change on Maize Production and Farmers' Adaptation Strategies in Nigeria: A Ricardian Approach. *Journal of Agricultural Science;* 7, 5; 67-84

Cranfield, J., Preckel, P. and Hertel, T. (2007). Poverty Analysis Using an International Cross-Country Demand System (Policy Research Working Paper 4285). Washington, DC: *The World Bank, Development Research Group.*

De Janvry A. and Sadoulet E. (2002). World Poverty and the Role of Agricultural Technology: Direct and Indirect Effects. *Journal of Development Studies*, 38(4), 1-26.

Dessale, M (2019). Analysis of technical efficiency of smallholder wheat-growing farmers of Jamma district, Ethiopia. *Agriculture and Food Security, 8:1, 2-8*

FAO. (2003). The digital soil map of the world (DSMW) CD-ROM. Food and Agriculture Organization, Italy, Rome. Available at http://www.fao.org/AG/agl/agll/dsmw.stm

FAO (Food and Agriculture Organization) 2011. Nigeria General Information. Food and Agriculture Organization of the United Nations

FAO (2012). Economic and Social Department: The statistical Division. http://faostat.fao.org/site/567/. Accessed 14/08/2018

FAO (2014). The Food and Agriculture Organization production statistics for 2012. http://www.fao.org/docrep/014/i2215e/i2215e.pdf. Accessed 22/02/2019

FAO (2017). Productivity and Efficiency Measurement in Agriculture: Literature Review and Gaps Analysis. A Publication prepared in the framework of the Global Strategy to improve Agricultural and Rural Statistics. February, 2017

Giller K. E, Rowe, E. C, de Ridder, N and van Keulen, H (2006). Resource use dynamics and interactions in the tropics: scaling up in space and time. *Agricultural System*; 88:8–27.

Ifeanyi, N.N. and Onyenweaku, C.E (2007). Economic efficiency of Fadama telfairia production in Imo State Nigeria: A translog profit function approach. Available http://mpra.ub.uni- muenchen.de/13469, 2007.

IITA (International Institute of Tropical Agriculture) (2001). *Annual Report* on Maize production.

IITA (International Institute of Tropical Agriculture) (2010). Annual Report on Maize production.

IITA (International Institute of Tropical Agriculture) (2012). http://www.iita.org/maize. Accessed 21/08/2018

IITA (International Institute of Tropical Agriculture) (2014). http://www.iita.org/maize. Accessed 11/12/2018.

Isaac, G. K. A., Hayford, O and Awuah, L. O (2014). A Comparative Analysis of Profit Efficiency in Maize and Cowpea Production in the Ejura Sekyedumase District of the Ashanti Region, Ghana. *Research in Applied Economics*, 6, 4, 106-125

Kaka, Y., Shamsudin, M.N., Radam, A and Abd. Latif, I (2016). Profit efficiency among paddy farmers: A Cobb-Douglas stochastic frontier production function analysis. *Journal of Asian Scientific Research,* 6(4): 66-75

Kelly, V.A., Hopkins, J., Reardon, T., and Crawford, E.W. (1996). Improving the measurement and analysis of African agricultural productivity promoting complementarities between micro and macro data. Technical Paper No. 27. Office of Sustainable Development. Bureau for Africa. USAID publication, Washington, D.C.

Mafongoya P. L., Sileshi, G (2003). Effect of rotational fallow on abundance of soil insect and weed in maize crop in eastern Zambia. *Applied Soil Ecology*: 23, 211-222.

NBS/FMARD (2012). National Bureau of Statistics/ Federal Ministry of Agriculture and Rural Development collaborative survey on National Agriculture Sample Survey (NASS), 2010/2011 Draft report.

Nganga, S.K., Kungu, J., De Ridder, N and Herrero, M (2010). Profit efficiency among Kenyan smallholder milk producers: A case study of Meru-South District, Kenya, *African Journal of Agricultural Research*, 5, 332–337.

OECD (2006). Promoting Pro-Poor Growth: Agriculture, DA.C Guidelines and Reference Series, Paris. http://www.oecd.org.

Oladeebo, J.O and Oluwaranti, A.S (2012). Profit efficiency among Cassava producers: Empirical evidence from South Western Nigeria. *Journal of Agricultural Economics and Development*, 1, 46–52.

Olaniyan, A.B (2015). Maize: Panacea for hunger in Nigeria. *African Journal of Plant Science*. 9, 3, 155-174

Ogundari, K (2006). Determinants of profit efficiency among small scale rice farmers in Nigeria: A profit function approach. *Research Journal of Applied Sciences* 1,1, 116-122.

Ogunniyi, L.T (2011). Determinants of profit efficiency among small scale maize farmers in Oyo State, Nigeria. *ARPN Journal of Agricultural and Biological Sciences* 6,1, 11-17.

Okoruwa, V.O., Akindele, A.O., Salimonu, K.K (2009). Relative economic efficiency of farms in rice production. A profit function approach in North Central Nigeria. *Tropical and Subtropical of Agroecosystem, 10:279-286*

Onuk, E. G., Ogara I. M., Yahaya H. and Nannim N. (2010). Economic Analysis of Maize Production in Mangu Local Government Area of Plateau State, Nigeria. *PAT Journal*, *6* (1): 1 – 11.

Quisumbing, A.R. (1994). Gender differences in agricultural productivity: A survey of empirical evidence. The World Bank: Washington D.C. (Paper Series No. 36) Education and Social Policy Department.

Rahman, S (2003). Profit efficiency among Bangladeshi rice farmers. *Journal of Food Policy* 28(5–6), 487- 503.

Rahman, K.M.M., Mia, M.I.A and Bhuiyan, M.K.J (2012). A stochastic frontier approach to Model technical efficiency of rice farmers in Bangladesh: An empirical analysis. *Agriculturists,* 10, 9–19.

Rahman, S. A. (2013). Farm production efficiency: The scale of success in agriculture. *Fourth Inaugural Lecture,Nasarawa State University*, Keffi, Nigeria.

Sadiq, M.S., Yakasai, M.T., Ahmad, M.M., Lapkene, T.Y and Mohammed Abubakar (2013). Profitability and production efficiency of small-scale maize production in Niger State, Nigeria. *IOSR Journal of Applied Physics* 3, 4, 19-23.

Sadiq, M. S., and Singh, I. P. (2015). Application of stochastic frontier function in measuring profit efficiency of small-scale maize farmers in Niger State, Nigeria. *Journal of Agricultural Economics, Extension and Rural Development,* 3, 1, 229–239.

Sunday, A.B., Uwemedimo, O.E., Elizabeth, J.N, Kesit, N.K., Daniel, J.E., and Akwa, I (2013). Economic efficiency of cassava-based farmers in Southern Wetland Region of Cross river State, Nigeria: A translog model approach. *International Journal of Humanities and Social Science*, 3, 173–181

Tanko, M and Alidu, A. F (2017). Profit efficiency of small-scale yam production in northern Ghana. *International Journal of Development and Economic Sustainability*. 5,1, 69-82.

Tasila Konja, D., Franklin N. M. and Richard O. F (2019). Profitability and profit efficiency of certified groundnut seed and conventional groundnut production in Northern Ghana: A comparative analysis, *Cogent Economics and Finance*, 7:1, 1-20

Trong, P.H and Napasintawong, O (2015). Profit inefficiency among rice farmers in Central Vietnam. 1st International Conference on Asian Highland Natural Resources Management, AsiaHiland. *Agriculture and Agricultural Science Procedia* 5, 89-95

Ujah, O. C., and Okoro, D. (2009). Agricultural expenditures; budget tracking and investment analysis of the agricultural sector in Nigeria. Reports on food security by Civil Society Coalition for Poverty Eradication, Abuja.

UNFCCC (United Nations Framework Convention on Climate Change) (2007). Climatic Change Impact, Vulnerabilities and Adaptation in Developing Countries UNFCCC Secretariat, Martin - Luther-King-Straat 853175 Bonn, Germany. www.unfccc.int

Wongnaa, C.A., Awunyo-Victor, D., and Mensah, A. (2015). Profit efficiency of Ghana's maize farmers. 10th International Conference of Agricultural Economist. International Association of Agricultural Economics (IAAE), Canada, No. 559. July 28-August 2, 2018/VANCOUVER.