The nexus between production input factors and technical efficiency among maize farmers in various regions in Ghana; stochastic frontier approach.

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Abstract

The gap between domestic supply and demand of maize in recent years is on increase in Ghana, resulting in food insecurity since maize is a major cereal. This study aims at studying the relationship between production inputs factors and technical efficiency of maize farmers in Ghana to help improve the productivity of maize. The stochastic frontier production function was adopted to estimate the relationship between production input and technical efficiency. It was found that, the technical efficiency for the pooled sample was 59.1%. The results revealed labour, fertilizer, herbicides, land, capital and pesticides had significant effect whiles, seed was not significant. It was also revealed that, a unit increase in fertilizer, herbicides, capital and land is likely to increase the output of maize since it had a positive relationship. On the other hand, an increase in labour (paid labour) is likely to reduce output of maize because it had a negative relationship. Based on these results, it was recommended that, the government should subsidies the price of fertilizers, herbicides, and pesticides and also provide loans facilities as capital for farmers. Land policies should also be flexible to encourage farmers have easy access to them.

Keywords: Production input factors. Technical Efficiency. Stochastic Frontier. Ghana.

1. Introduction

In Africa, agricultural still remains the most feasible option for promoting growth, overcoming poverty, and also to improve food security. As a result, a very significant factor to help sustain an increase in agricultural production is an increase in agricultural productivity, driven by the use of agricultural production technologies as well as ensuring good soil management. Anticipated increase in demand for agricultural products together with population growth and growing per-capita incomes calls for a continuous rise in agricultural productivity. Currently, the average global crop output growth of the world's major cereals varies between 0.9% and 1.6% per annum, and the rate of increase has experience deep fall in the past two decades (Grafton, Daugbjerg, & Qureshi, 2015). In most cases agricultural productivity fluctuates due to variations in technology employed by farmer, variations in the environment in which the production occurs and differences in production efficiency process.

According to (Wolter, 2009), though the natural conditions in Ghana are suitable for agricultural production, it is realized that local supply still lags behind demand, rendering the country food insecure. In Ghana, farmers mainly depend on rain-fed system of farming with inadequate mechanization and insufficient use of modern technologies such as high yielding crop varieties, good agricultural practices, fertilizers, herbicides pesticides and other agro-inputs. These together with other factors has led to the low levels of productivity in the agricultural sector (Chamberlin, 2007). Also, there is no or little soil fertility management by farmers in term of organic and inorganic fertilizer application. Even though fertilizer use in Ghana has improved over the years (from 8kg ha^{-1} in to 12 kg ha^{-1}), it is still below the target of 50kg /ha^{-1} needed to increase crop productivity (Danso-Abbeam, Armed, Baidoo, & Science, 2014).

In African, maize is graded as the first cereal grain of greatest economic importance, with wheat and rice ranking second and third respectively (Thobatsi, 2009). Maize was identified among other crops as the panacea to food insecurity and poverty in Africa, during the Abuja Summit held on December 2006 on Food Security in Africa., The summit therefore admonished countries in Africa, the African Union Commission (AUC), the New Partnership for Africa's Development (NEPAD) as well as regional economic communities (RECs) to assist in the advancement of maize production on the African continent so as to help achieve self-sufficiency by the year 2015 (AUC, 2006).

Notwithstanding, all the economic importance of maize in Ghana, there exist a gap between domestic supply and demand of maize, which force the country to still depend on import of maize rendering the country's food insecure (Wolter, 2008). It was estimated that the shortfall between domestic production and domestic consumption would reach 267,000 metric tons by 2015 in case there is no improved method of cultivation (Akramov & Malek, 2012).With maize production being a major source of food for most Ghanaians, a decline in maize production could threaten household food security. As a result, there is a crucial call for measures to be taken to improve productivity and aggregate production of maize, so as to meet the unending demand for maize in Ghana and to ensure food security in general (MiDA, 2010).

This study unlike other studies which concentrate on one ecological zone in Ghana, for instance the studies of (Abatania, Hailu, & Mugera, 2012; Kuwornu, Amegashie, & Wussah, 2012; Wongnaa, Ofori, & Informatics, 2012), which were all based on examining the efficiency of one or few agro-ecology, this studies use data based on four (4) regions (the Northern, Brong-Ahafo, Eastern and Central regions) which cut across all the ecological zones of Ghana. This allows a comparison between the regions in terms of production input factors and the technical efficiency of smallholder maize farmers in these regions. Also unlike other studies on efficiencies which looks at economic efficiencies (technical, resource, and scale efficiency) this studies was concentrated on only the technical efficiency of smallholder maize farmers. Thus the major objective of the paper is to estimate the relationship between the production input factors and technical efficiency of maize farmer in various regions in Ghana.

2. Technical Efficiency among Smallholder Farmers

Technical efficiency among smallholder farmers is a component of economic efficiency and reflects the ability of a farmer to maximize output from a given level of inputs (e.g. output-orientation). The factors that impact technical efficiency can be grouped into, Improved inputs (such as, Seeds, fertilizers, herbicides/fungicides, zero tillage, soil fertility management practices pesticides), Internal factors (Such as, educational level, age, gender and family size), External characteristics (such as, area cultivated, input and output prices, climatic factors, membership of a farmer association as well as access to credit, information and infrastructures like storage facilities and roads) and other factor inputs including land and labour (Pingali & Rosegrant, 1995). One can trace back the beginning of theoretical developments in measuring technical efficiency to the works of (Farmer & Geanakoplos, 2009). Since then, there has been growing literature on the technical efficiency of smallholder agriculture with notable works focusing on smallholders (Basnayake & Gunaratne, 2011; Duvel, Chiche, & Steyn, 2003). There are conflicting results on the influence of socio-economic variables such as gender on technical efficiency, whiles some studies in Ghana reported that gender of the farmer has no significant influence on technical efficiency (Bempomaa, Acquah, & Commerce, 2014; Wongnaa et al., 2012), other studies found that gender plays an important role (Abawiera, Dadson, & Sciences, 2016; Abdulai, Nkegbe, & Donkoh, 2013; Effah, 2013).

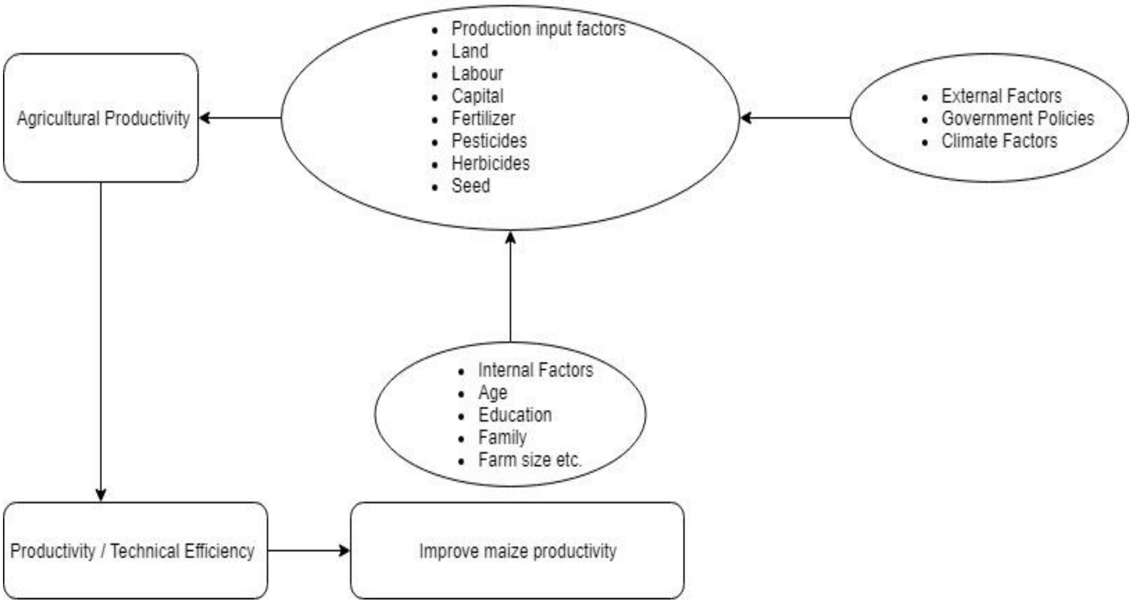

Diagram 1: Input Production Factors and Productivity.

Productivity in agricultural especially maize in recent years has been on decreasing side to eradicate this problem of low productivity, farmers has to adopt the use of improved production technologies like improved seeds, fertilizer, herbicides, pesticides, zero tillage etc. The adaptation of these technologies are mostly influence by factors which is grouped into two that is internal factors (like age, educational level, family size, income, access to extension services etc.) and external factors (like, infrastructures, input and output price climate policies etc.) With the adaptation of the improved agricultural technologies, all things being equal, production (technical) efficiency, can be achieved, and the productivity of maize will increase to ensure food security.

3. Materials and Methodology

3.1. Description of the study area

This study was carried out in Ghana, West Africa. Ghana at the time of the study had ten (10) administrative regions (Greater Accra, Ashanti, Brong-Ahafo, Northern, Upper East, Upper West, Central, Western, Eastern, and the Volta regions). Ghana have a total land area of about 23,884,245h out of which 13,600,000 is agricultural land area but only 6,341,930 is under cultivation (MoFA, 2016). Ghana’s annual rainfall amounts range from 600mm to 2800mm. Accord to Barry et al. (2005), relative humidity seems to drop from south to north, which makes a general rise in evapotranspiration in the north relative to the south.

3.2. Sampling technique and size

The multi-stage sampling technique was used in this study. The first stage of the sampling was to select four regions (Northern, Brong-Ahafo, Eastern and Central region) in Ghana purposively to cover all the agro-ecology zones based on their performance in maize production for the year 2014-2017 farming season. Thereafter, four (4) districts/municipalities was randomly selected from each of the four (4) selected regions of Ghana considering the level of maize production of these districts (Diagram 2). In the next stage, three (3) villages or communities were randomly selected from each of the four (4) districts/municipalities representing the regions of selection. In a nutshell, forty-eight (48) villages/communities was selected from sixteen (16) districts which was also selected from the four (4) regions of study. At the last stage, a random selection was done by picking every k^{th} (sampling interval) farmer in a list, where k was obtained by dividing the population of maize farmers in the village/community by the sample size.

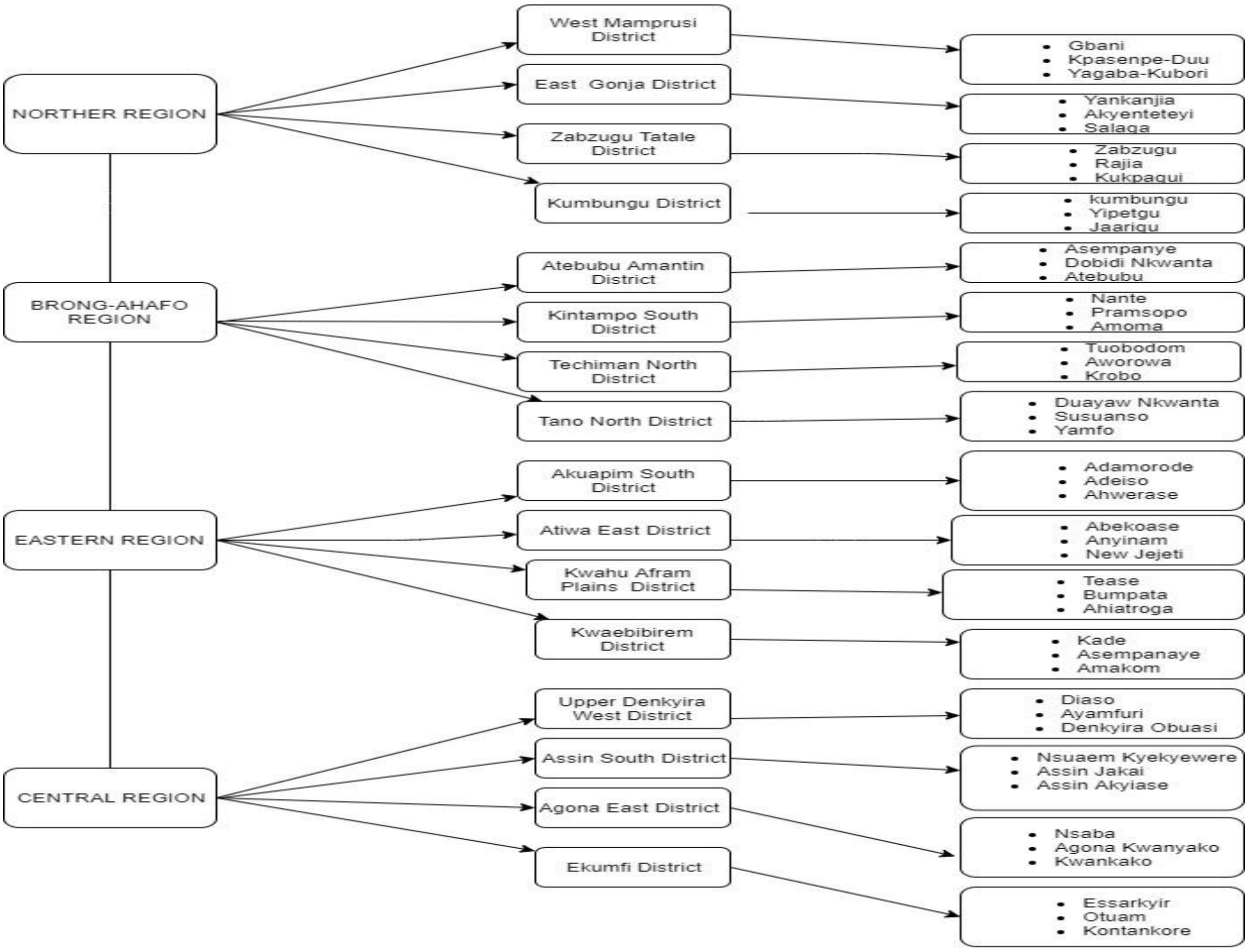

Diagram 2: List of selected regions, district and communities /villages for the studies

The study employed (Bartlett, DeMasi, Quinn, Moxham, & Rousseau, 2001), sample size determination formula in the determination of the appropriate sample size (Eq. 1).

That is

$$n = \frac{t^2(p)(q)}{d^2} \qquad n = \frac{1.96^2 \times 0.516 \times 0.484}{0.05^2} = 384 \qquad (1)$$

Where, n = Sample size,

t = the value for the selected alpha level of 0.025 in each tail which is = 1.96 (the alpha level of 0.05 indicates the level of risk the researcher is willing to take that true margin of error may exceed the acceptable margin of error).

p = the proportion of the population engaged in maize production.

q = the proportion of population not engaged in maize production.

d = acceptable margin of error for proportion being estimated = 0.05 (error researcher is willing to accept).

The studies follwed (Salkind & Rainwater, 2003), recommendation of oversampling by 40%-60% to account for low response rate and uncooperative subjects”. Therefore, the sample for this study was increased by 56.2% to take care of all possible anomalies, resulting in 600 sample size.

3.3. Model specification.

This studies employed the stochastic frontier production function as proposed by (Aigner, Lovell, & Schmidt, 1977), to estimate and analyze the technical efficiency level and the factors influencing it among farmers. The stochastic frontier production function is therefore given as;

$$y_i = f(x_i; \beta) + e_i \text{ , where } i = 1, 2, 3, \ldots\ldots N \quad (2)$$

$$e_i = v_i - u_i \quad (3)$$

Where y_i is the level of output of maize farmer i,

x_i , is the inputs employed by the ith maize farmer,

β is the vector of parameters to be estimated,

e_i is the error term which is made up of v_i = a random error with zero mean associated with factors like, measurement errors in the production and weather factors which is assumed to symmetric and independent from u_i . u_i is the other component of the error term which is connected with the farm characteristics that renders a farmer not to realized maximum production efficiency, it is also linked to the technical inefficiency of maize farmers. N is the number of maize farmers who took part in the cross sectional survey in the study area.

The maximum likelihood estimation (MLE) was chosen ahead of the corrected ordinary least squares (COLS) for this study because, it make use of specific distribution of the disturbance terms. The stochastic frontier and inefficiency model was jointly estimated using

Limdep (H Greene, 2002). Theoretically, the stochastic frontier trans log production function is given as;

$$\ln y_i = \beta_0 + \sum_{k=1}^{n} \beta_k \ln x_{ki} + \frac{1}{2} \sum_{k=1}^{n} \sum_{j=1}^{n} \beta_{kj} \ln x_{ji} \ln x_{ji} + v_i - u_i \qquad (4)$$

Where, $\ln$ = Natural logarithm,

y_i = Total quantity of out,

x_i = Vector of inputs,

ij = Positive integers (where $i \neq j$),

$\beta's$ = Vector of parameters to be estimated

and v_i and u_i = the error terms,

$$u_i = \delta_0 + \sum_{k=1}^{m} \delta_k z_i \quad (5)$$

z_i = Vector of farmer characteristics,

δ = Vector of parameters to be estimated.

An empirical stochastic frontier translog production function was estimated as;

$$\begin{aligned}
&\ln OUTPUT_i = \beta_0 + \beta_1 \ln LAB_i + \beta_2 \ln SED_i + \beta_3 \ln FET_i + \beta_4 \ln HEB_i \\
&+\beta_5 \ln LAD_i + \beta_6 \ln PET_i + \beta_7 \ln CAP_7 + \beta_8 \ln(LAB)_i^2 + \beta_9 \ln(SED)_i^2 + \beta_{10} \ln(FET)_i^2 \\
&+\beta_{11} \ln(HEB)_i^2 + \beta_{12} \ln(LAD)_i^2 + \beta_{13} \ln(PET)_i^2 + \beta_{14} \ln(CAP)_i^2 + \beta_{15}(\ln LAB \times \ln SED)_i \\
&+\beta_{16}(\ln LAB \times \ln FET)_i + \beta_{17}(\ln LAB \times \ln HEB)_i + \beta_{18}(\ln LAB \times \ln LAD)_i \\
&+\beta_{19}(\ln LAB \times \ln PET)_i + \beta_{20}(\ln LAB \times \ln CAP)_i + \beta_{21}(\ln SED \times \ln FET)_i + \beta_{22}(\ln SED \times \ln HEB)_i \qquad (6) \\
&+\beta_{23}(\ln SED \times \ln LAD)_i + \beta_{24}(\ln SED \times \ln PET)_i + \beta_{25}(\ln SED \times \ln CAP)_i + \beta_{26}(\ln FET \times \ln HEB)_i \\
&+\beta_{27}(\ln FET \times \ln LAD)_i + \beta_{28}(\ln FET \times \ln PET)_i + \beta_{29}(\ln FET \times \ln CAP)_i + \beta_{30}(\ln HEB \times \ln LAD)_i \\
&+\beta_{31}(\ln HEB \times \ln PET)_i + \beta_{32}(\ln HEB \times \ln CAP)_i + \beta_{33}(\ln LAD \times \ln PET)_i \\
&+\beta_{34}(\ln LAD \times \ln CAP)_i + \beta_{35}(\ln PET \times \ln CAP)_i + v_i - u_i
\end{aligned}$$

Also, an empirical inefficiency model was estimated as;

$$\begin{aligned} u_i &= \delta_0 + \delta_1 AGE_i + \delta_2 GENDER_i + \delta_3 GOVSDY_i + \delta_4 HOUSIZ_i + \delta_5 EDU_i \\ &+ \delta_6 EXP_i + \delta_7 MEMGRO_i + \delta_8 LADSIZ_i + \delta_9 ACCEXT_i + \delta_{10} ACCRDT_i \\ &+ \delta_{11} CAPT_i + \delta_{12} BENGO_i + \delta_{13} PESTuse + \delta_{14} HERBuse \\ &+ \delta_{15} FETuse \end{aligned} \tag{7}$$

Where,

OUTPUT = the dependent variable, measured in kilogramme per hectare (kg/ha) of total production by a farmer,

LAB = Quantity of labour used in the cultivation of maize, measured in days,

SED = Quantity of improved planting materials used, measured in kilogramme per hectare (kg/ha),

FET = Quantity of fertilizer used in the production, measured in kilogrammes per hectare (kg/ha),

HEB = Quantity of herbicides used, measured in liters per hectare (litres/ha),

LAD = Total land area used in the cultivation of maize, measured in hectares,

PET = Quantity of pesticides used in the maize farm, measured in litres per hectare (litres/ha),

CAP = Capital invested in the farm, measured in monetary terms Ghana cedis.

The technical efficiency of maize farmers was estimated by the use of the formula below;

$$TE_i = \frac{y_i}{y_i^*} \tag{8}$$

Technical inefficiency = 1-TE_i Where, TE = Technical efficiency, y_i = the actual output of the farmer, $y\overset{*}{i}$ = the highest predicted value for the farmer $f(x_i;\beta)$.

3.4. Test for data adequacy, variables validity and reliabilty

The Kaiser-Meyer-Olkin (KMO) was used to tests how the constructed variable data are suited for factor analysis and also to estimate the sampling adequacy for each variable in the model. The KMO values ranges between 0 and 1. According to rule of thumb, 0.8 and above KMO value means the sampling is adequate(Hair, Black, Babin, Anderson, & Tatham, 2006)

The reliability and internal consistency for the data used for this studies was tested by the use of the Cronbach's Alpha (α). The Cronbach's alpha value ranges between 0 and 1, the rule of thumb states that a 0.7 or higher value of a Cronbach's alpha means the data is reliable and internally consistent (Hair et al., 2006)

3.4.1. Data adequacy and consistency results.

The collected data was tested for data adequacy and internal consistency as indicated in (Levendag et al., 2007). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett test of Sphericity was adopted to assess the suitability of the data for modeel development (Table4). The results revealed that, the KMO values for the variables ranged between 0.705 and 0.860 (Table 1) which is higher than the minimum cut-off value of 0.5. This indicates that, there was sufficient data available for factor analysis (Hair et al., 2006; Kaiser, 1974). The internal consistency for the constructed variable was tested using Cronbach's alpha reliability. The Cronbach's alpha for the constructs and items ranged from 0.812 - 0.907 (Table 1). The results of Bartlett's test of sphericity revealed high significant values (p<0.0001) which signifies appropriate factor analysis. The results indicates that the surveyed data was reliable, adequate, and had an excellent internal consistency (Hair et al., 2006).

Table 1: Data adequacy and consistency of measurement of the constructs.

Factors	**No. of Items**	**Cronbach's Alpha (α)**	**Determinant Value**	**KMO**	**Bartlett's Test**		
					x^2	**DF**	**Sig.**
Fertilizer	4	0.898	0.377	0.798	979.25	6	***
Herbicides	4	0.901	0.121	0.842	789.70	6	***
Pesticides	3	0.907	0.130	0.809	873.01	3	***
Seed	5	0.813	0.140	0.705	1403.00	10	***
Labour	3	0.812	0.264	0.781	798.74	6	***
Capital	5	0.863	0.188	0.821	781.83	10	***
Land	4	0.878	0.301	0.807	697.34	6	***
Model	28	0.858	0.000009	0.860	5660.00	310	***

Note: *** Significant at p<0.0001 significant level.

3.4.2. Reliability validity and correlation matrix test

From table (2) the Composite Reliability (CR) result shows the reliability of the established construct whiles the Average Variable Extract (AVE) measures the amount of variance captured by construct through its items in comparison to the amount of variance captured due to the measurement error (Fornell & Larcker, 1981). The results revealed that the CR value of constructs ranges from 0.799 to 0.910 These result are higher than the recommended CR cut-off value (0.7) which suggest reliability of the dat is assured. (Gefen, Straub, & Boudreau, 2000). The AVE values of the constructed variables ranges between 0.528 and 0.872 (Table 2), which is higher than the recommended 0.5 or higher, this results suggest there is adequate convergence (Hair et al. 2010; Malhotra and Dash 2011). The discriminant validity also verified by the comparing the Average Variance Extracted (AVE), Average Shared Variance (ASV), Maximum Shared Variance (MSV), Correlation Matrix and Square-root of Average Variance Extracted (SQR-AVE) parameters as indicated in Hair et al., (2010) and Malhotra and Dash (2011). the results from (Table 2) revealed that, the MSV is less than AVE as well as SQR-AVE is greater than inter-construct correlations which means there are no discriminant concerns to develop the model.

Table 2 : Reliability, validity, and correlation matrix test.

Factors	CR	AVE	MSV	Correlaton Matrix and SQR AVE						
				Fertilizer	Herbicide	Pesticide	Seed	Land	Labour	Capital
Fertilizer	0.902	0.693	0.105	**0.832**						
Herbicides	0.896	0.655	0.034	0.116 (0.013)**	**0.809**					
Pesticides	0.881	0.528	0.044	0.118 (0.014)*	0.177 (0.023)**	**0.727**				
Seed	0.910	0.558	0.130	0.324 (0.109)***	0.226 (0.024)**	0.327 (0.101)*	**0.747**			
Land	0.885	0.675	0.041	0.308 (0.032)**	0.182 (0.039)*	0.182 (0.053)***	0.201 (0.071)**	**0.822**		
Labour	0.817	0.872	0.202	0.421 (0.022)***	0344 (0.081)**	0.211 (0.300)*	0.412 (0.044)*	0.322 (0.100)**	**0.934**	
Capital	0.799	0.712	0.144	0.200 (0.080)***	0.193 (0.022)*	0.109 (0.324)***	0.101 (0.071)**	0.411 (0.257)*	0.510 (0.071)*	**0.844**

Note: *=p<0.05, **=p<0.01, ***=p<0.001; CR is Composite Reliability, AVE is Average Variance Extract, and MSV is Maximum Shared Variance; The bolded diagonal text is the Square root of the AVE and square correlation in parenthese.

3.4.3. Variance parameters of the stochastic frontier production function

For the fact that, the lambda (λ) values are significantly different from zero implies good fits and correct specified distributional assumptions. Also, the estimated sigma square (σ^2) parameters in the stochastic frontier production functions for maize farmers in the pooled sample and the four regions under study were also all significantly different from zero and significant at 10% for each, suggesting a good fits of the models and the correctness of the specified distributional assumptions. The Variance Inflation Factor (VIF) was used to test for multicollinearity, and the result revealed 2.2539, 1.6582, 2.1342, 1.8325, and 2.5216 for the pooled sample, Northern region, Brong-Ahafo region, Eastern region and the Central region respectively (Table 3). The results shows that the values of the VIFs are small which designates the absence of multicollinearity in the models (Edriss, 2003). The Breusch Pagan (BP) tests revealed statistically insignificant at 0.6445, 0.9658, 0.4895, 1.8325 and 0.9565 for pooled sample, Northern region, Brong-Ahafo region, Eastern region, and Central region respectively (Table 3), this result show safety of heteroscedasticity.

Table 3: Variance parameters for the stochastic frontier production function.

Variable	Pool Sample	Northern Region	Brong-Ahafo Region	Eastern Region	Central Region
	Coefficient.	Coefficient	Coefficient.	Coefficient.	Coefficient.
Gamma $\gamma = \sigma_u^2 / \sigma^2$	0.99999	1***	0.99999***	1***	1***
Lambda $\lambda = \sigma_u / \sigma_v$	4754019***	2017294***	2558464***	535212***	263927***
Log likelihood	-237.4120	19.18630	20.2719	34.3075	68.8804
Wald	$3.2\times10^{10***}$	$9.27\times10^{8***}$	1738.4***	$3.50\times10^{7***}$	$8.74\times10^{6***}$
Mean VIF	2.254	1.6582	2.1342	1.8325	2.5216
Breusch Pagan stat	0.6445	0.9658	0.4895	0.7195	0.9565

Source: Author Survey 2018 Note: The asterisks indicate levels of significance. *** is significant at 1%, ** is significant at 5% and * is significant at 10%.

4. Results and Discussion

4.1. Farm and farmers characteristics

The table below present the distribution and descriptive statistic of farmer's characteristics in the study areas. The pooled sample revealed that, majority of maize farmers in the study area are males (449) representing 74.8% as against 151 females representing

25.2%. Male dominance in maize farming runs through all the four (4) regions of study, male maize farmers percentages were recorded as follows, 75.7%, 70.1%, 84.0%, and 69.2% as against females, 24.2%, 29.9%, 16.0%, 30.8% in the Northern, Brong-Ahafo, Eastern and Central regions respectively (Table 4). This results can be attributed the perception some people have for farming, most people in Ghana percieve farming as an occupation for men not women. This result is in agreement with the work of (Sadiq, Yakasai, Ahmad, Lapkene, & Abubakar, 2013) who found 67% male maize farmers dominance as against 33% female maize farmers in the studies of Profitability and Production Efficiency of Small-Scale Maize Production in Niger State of Nigeria.

The result from the pool sample shows that majority of the famers were between the ages of (18-40) with a percentage of 58.3%, whiles very few farmers were above 60 years with a percentage of 12.3%. Farmers within the ages of 41 and 60 were second to those within the ages of 18 and 40 years. In all the regions of study, farmers within the ages of 18 and 40 recorded the highest percentage with those above 60 years recording the least percentage. The result revealed an average age of 45.84, 47.13, 44.70, 46.1and 45.41 for the pooled sample, Northern, Brong-Ahafo, Eastern and Central regions respectively (Table 4). This result means most maize farmers in Ghana are in their youth stage for that matter has an effect on productivity. This result is consistent with the studies of (Ojiako & Ogbukwa, 2012) that found mean age of 44.8 years for farmers.

Most of the maize farmers in the pooled sample were found to have Junior High School (JHS) and Senior High School (SHS) education with percentages of 35.2% and 31.3% respectively. The number of farmers with no formal education had a percentage of 28.2% whiles farmers with tertiary education was very few having 5.3%. This result can be attributed to the fact that, in Ghana most of the educated youth are willing to work for the government in their office and see farming as a job for school drop outs. Farmers with no formal education in the northern region was very high, recording 60.4% as compared to other regions like the Brong-Ahafo, Eastern and Central who recorded 12.5%, 8.3% and 32.7% respectively (Table 4). Averagely, maize farmers in Ghana have 6 years of formal education or schooling. The average number of years of schooling in the Brong-Ahafo region was high (7 years) with the other regions recording 4 years each. Majority of maize farmers in Ghana are literate as compared to those with no formal education. In Ghana agricultural (farming) especially small scale farming is seen an occupation for illiterates, the well educated youth would rather wish to work in Ghana institution than to become farmers. This result is in agreement of the studies of (Oladejo & Adetunji, 2012) who also found out that most maize farmers in Oyo state of Nigeria (82.3%) had received formal education.

The studies revealed that, a greater number of the maize farmer (56.9%) do not belong to farmers association or groups. The same results was revealed across all the four regions of studies with as high as 56.9%, 68.1%, 84.0% and 69.9% for the Northern, Brong-Ahafo, Eastern and the Central regions respectively (Table 4). This result was obtain probably because maize farmers in the study areas do not see how beneficial it is to be a member of farmers' associations. It can also be attributed to the non-existence of farmer groups in the areas studied.

Table 4: Characteristics of maize farmers interviewed.

Variables	Pooled Sample		Northern Region		Brong-Ahafo Region		Eastern Region		Central Region	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Age (years)										
18-40	350	58.3	89	61.8	80	55.5	78	50.0	103	66.0
41-60	194	29.5	32	22.2	57	39.6	64	41.0	41	26.3
Above 60	56	12.3	23	16.0	7	4.9	14	9.0	12	7.7
Total	600	100	144	100	144	100	156	100	156	100
Gender										
Male	449	74.8	109	75.7	101	70.1	131	84.0	108	69.2
Female	151	25.2	35	24.3	43	29.9	25	16.0	48	30.8
Total	600	100	144	100	144	100	156	100	156	100
Education Level										
No Formal Education	169	28.2	87	60.4	18	12.5	13	8.3	51	32.7
Basic school/JHS	211	35.2	31	21.5	54	37.5	73	46.8	53	34.0
Secondary/High School	188	31.3	18	12.5	61	42.4	62	39.7	47	30.1
Tertiary Education	32	5.3	8	5.6	11	7.6	8	5.2	5	3.2
Total	600	100	144	100	144	100	156	100	156	100
Member of Association										
Yes	180	30.0	62	43.1	46	31.9	25	16.0	47	30.1
No	420	70.0	82	56.9	98	68.1	131	84.0	109	69.9
Total	600	100	144	100	144	100	100	100	156	100
Beneficiary of NGO										
Yes	289	48.2	98	68.1	74	51.4	48	30.8	69	44.2
No	311	51.8	46	31.9	70	48.6	108	69.2	87	55.8
Total	600	100	144	100	144	100	156	100	156	100
Government Subsidy										
Yes	170	28.3	92	63.9	30	20.8	27	17.3	21	13.5
No	430	71.7	52	36.1	114	79.2	129	82.6	135	86.5
Total	600	100	144	100	144	100	156	100	156	100
Access to Extension										

Service										
Yes	273	45.5	77	53.5	84	58.3	55	35.3	57	36.5
No	327	54.5	67	46.5	60	41.7	101	64.7	99	63.5
Total	600	100	144	100	144	100	156	100	156	100
Access to Credit										
Yes	158	26.3	32	22.2	44	30.6	24	15.4	58	37.2
No	442	73.7	112	77.8	100	69.4	132	84.6	98	62.8
Total	600	100	144	100	144	100	156	100	156	100

Source: Author Survey, 2018.

Table 4: Descriptive statistics of maize farmer interviewed characteristics.

Variables	Pooled Sample			Norther Region			Brong-Ahafo Region			Eastern Region			Central Region		
	Min	Max	SD	Min	Max	SD	Min	Max	SD	Min	Max	SD	Min	Max	SD
Age (years)	18	79	11.24	18	79	10.62	22	73	12.16	19	78	11.07	25	70	17.67
Education (years)	0	18	4.76	0	16	6.03	0	18	3.76	0	17	4.01	0	16	1
Experience (years)	1	54	11.81	1	54	12.34	1	48	11.27	1	45	7.45	1	50	2.01
Household size	1	37	5.32	1	37	5.76	1	29	5.18	1	22	3.81	1	18	2.01
Extension Visit	0	17	4.56	0	6	1.61	0	11	2.12	0	10	2.41	0	17	0

Source: Author's Survey 2018.

Farmers who are beneficiaries of Non-governmental organization were few as compared to those who have been enjoying some benefits with percentages of 48.2% against 51.8% in the pooled sample. The pooled sample result was consistent with the results of Eastern and the Central regions who also recorded small percentages of non- beneficiaries as compared to beneficiaries (30.8% and 44.2%) respectively. On the other hand, it was contrary to the results from the Northern and the Brong-Ahafo regions who recorded high percentages of beneficiaries of NGOs than non-beneficiaries 68.1% as against 31.9%. The results also revealed that, very few maize farmers had benefited from government subsidies in the pooled sample with percentages of 28.3% as against 71.7% (Table 4). This result runs through all the four (4) regions of study with very few farmers benefitting from government subsidy.

The average household size of maize farmers in Ghana was 7.14 as showed by the pooled sample results. The household size ranges from 1 to 37 peoples (Table 4). The Northern region recorded the highest household size and the highest mean of 8.92, the other regions recorded a mean of 5.18, 6.90 and 6.08 for the Brong-Ahafo, Eastern and Central regions respectively. These results was consistent with the work of (Oladejo & Adetunji, 2012) who found an average household size of 8 among maize farmers in Oyo state of Nigeria.

The average year of experience of maize farmers in the pooled sample was 13.68 years, meaning farmers interview in the study areas have spent much time in maize cultivation.

Averagely farmers in the Norther region had a high number of years in terms of experience (19.41), the Central region followed with an average experience years of 14.73. The Eastern region and the Brong-Ahafo region recorded an average experience years of 8.8 and 11.8 years respectively (Table 4).

The results from the studies shows that, slight majority of farmers in the pooled sample had no access to extension with the percentage of 54.5% as against 45.5% farmers who had access to extension services. Majority of farmers in the Northern and Brong-Ahafo region had contact with extension officers recording 53.5% and 58.3% as against 46.5% and 41.7% respectively (Table 4). On the other hand, most farmers in the Eastern and Central regions had few access to extension officers recording 35.3% and 36.5 respectively. Considering, those who had access to extension service, the average number of times extension agents visited them was revealed as, 2.84 time for the pooled sample. The individual region recorded 1.31, 2.83, 1.01, and 6.24 for the Northern, Brong-Ahafo, Eastern and Central regions (Table 4). Generally, it was noticed that, there was poor extension contact with maize farmers which could affect their adoption and use of improved farming practices.

A very low percentage was recorded for maize farmers who have access to credit with a percentage of 26.3% as against 73.7% who don't have access to credit. This trend runs through all the regions of study, where low percentages were revealed for farmers who have access to credit with percentages of, 22.2, 30.6, 15.4 and 37.2 for the Northern, Brong-Ahafo, Eastern and Central regions respectively (Table 4). This trend may be probably because of the rain-fed farming characterizing production systems in the area resulting in high risk associated with farming. As a results most farmers are not able to pay back their credit facilities. In view of this most financial institutions are also reluctant in supporting agricultural production with credit facilities.

4.2. Technical efficiency of maize farmers in Ghana.

From the table (5) below, the mean technical efficiency estimate for maize farmers in the pooled sample was 59.1% with minimum technical efficiency of 1.6% and maximum technical efficiency of 99.9%, and standard deviation of 23.9%. The average technical efficiency of maize farmers in Ghana was 59.1% and a technical inefficiency rate of 40.9%. The Northern region recorded a minimum and maximum technical efficiency of 12.8% and 99.9% respectively, with a mean technical efficiency of 60.3% and a standard deviation of

25.6%. This results means, maize farmers in the northern region produce at an average of 60.3% technical efficiency, and they have an inefficiency rate of 39.7%, implying maize farmers in the Northern region can increase their output by 39.7%.

Table 5: Technical efficiency of maize farmers in study regions of Ghana

Regions	Minimum	Maximum	Mean	Standard deviation
Pooled Sample	1.6	99.9	59.1	23.9
Northern Region	12.8	99.9	60.3	25.6
Brong-Ahafo Region	6.4	99.9	71.4	21.5
Eastern Region	9.8	99.9	51.9	25.3
Central Region	2.6	99.9	68.1	21.2

Source: Author's survey, 2018.

The Brong-Ahafo region recorded the highest average technical efficiency among the regions of study 71.4% with a minimum and maximum technical efficiency of 6.4% and 99.9% respectively. This means maize farmers in this region were on an average of 71.4% technical efficiency on the use of the improved production technologies and 28.6% inefficient. This implies that maize farmers can increase their output by 28.6%. Among all the regions of study, the Eastern region had the least average technical efficiency of 51.9% with a standard deviation of 21.5% and (minimum and maximum) technical efficiency of 9.8% and 99.9% respectively. Maize farmers in this region have room to improve their output by 48.1%. The result also revealed that, farmers in the Central region are 68.1% efficient, with a minimum and maximum technical efficiency of 2.6% and 99.9% respectively. This means maize farmers in this region can improve their output by 31 .9%. These results are in agreement with the work of (Abdulai et al., 2013) who obtained a mean technical efficiency estimate of 74% with minimum and maximum values of 12% and 98% respectively in a study into the technical efficiency of maize production in Northern Ghana.

4.3. Maximum likelihood estimates of stochastic frontier production function.

The table below presents the maximum likelihood estimates of the stochastic frontier production for maize farmers. The results from the table revealed that, labour, fertilizer, herbicides, land, capital and pesticides all had statistically significance effects at 1%, 5%, 1%, 10%, 1% and 5% respectively on the output of maize produced by the 600 farmers selected for pooled sample (Table 6). Seed was not statistically significant. Seed, fertilizer, herbicides, land, capital and pesticides all had positive relationship with output of maize whiles labour had a negative relationship. The negative relationship but statistically significant result of labour implies that, an increase in the number of labour would result in a decrease in the output of maize. Thsi result was applicable to labourers who were employed to help farmers in their farms for a fee. Therefore, farmers will be encourage to depend on their families and othere free labourers like farmers associations instead of hiring labourers with cost. This results agrees with the work of (Stephen, Mshelia, Kwaga, & Wildlife Management, 2004) that reported a negative correlation between quantity of labour input and the output of cowpea. In the pooled sample, labour squared, fertilizer squared, herbicides squared, land and seed, labour and land, seed and fertilizer, fertilizer and land, herbicides and capital, were all statistically significant at 1% but had negative relationship with output of maize.

This result implies that an increase in these variables could cause a decrease in the output of maize. On the other hand, (labour and fertilizer), (labour and herbicides), (seed and pesticides) and (fertilizer and pesticides) were all also statistically significant at 1% and had a positive relationship with output of maize, meaning an increase in these variables will result in an increase in output of maize.

Also, land squared, pesticides squared, (labour and pesticides) and (pesticides and capital) had a negative relationship with output of maize but was statistically significant at 5% meaning an increase of these variables will cause a decline in the output of maize (Table 6). (Seed and land) as well as (herbicides and land) on the other hand had a positive significance with maize productivity and was statistically significant at 5%. Variables like Seed square, capital squared, (seed and capital), (fertilizer and capital) as well as (herbicides and pesticides) had a positive relationship but was not statistically significant. Also, labour and capital, seed and herbicides, fertilizer and herbicides land and pesticides as well as land and capital had negative relationship and was statistically insignificant (Table 6).

The results from the northern region revealed that, fertilizer, land, pesticides, and capital were all significant at 1%, 5%, 10%, and 5% respectively, with all having positive relationship with maize output, except capital. Other variables like labour, (seed and capital) had a negative relationship with output of maize. Factors like labour, seed, herbicides, were statistically insignificant (Table 6). Variables like capital squared, (labour and seed), (seed and pesticides), (fertilizer and herbicides) as well as (herbicides and land) were all significant at 5%, (labour and herbicides), (seed and herbicides), as well as (fertilizer and capital) were also significant at 1%, (labour and land) was significant at 10% and all these variables had a positive relationship with maize output. In this region a unit increase in capital will result in a decline in the output of maize but it has a negative relationship.

This result may be attributed to the high interest rate farmers pay on loans they take as start up capitals in their farms. The positive relationship factors, implies that an increase in these variables could result in an increase in the output of maize. On the other side, the following variables had a negative relationship with maize productivity, but was statistically significant, labour squared, herbicides squared, (fertilizer and land), as well as (herbicides and capital) were significant at 1%, fertilizer squared, pesticides, (labour and fertilizer), (land and capital), (pesticides and capital) were significant at 5% this result also mean an increase in these variables will result in a decline in the output of maize. Other variables like land squared, (labour and pesticides), (labour and capital), (seed and fertilizer), (seed and land), (seed and capital), (fertilizer and pesticides), (herbicides and pesticides) as well as (land and pesticides) were all insignificant but had a positive relationship with output of maize. Seed squared was also statistically insignificant and had negative relationship with output of maize (Table 6).

Table 6: Maximum likelihood estimates of the stochastic frontier production function

Variable	Pooled Sample		Northern Region		Brong-Ahafo Region		Eastern Region		Central Region	
	Coeff.	Std. Err	Coeff.	Std. Err	Coeff.	Std. Err	Coeff.	Std. Err	Coeff.	Std. Err
Constant	6.2677		6.9765	0.3622	11.280***	0.6033	12.1767	0.3721	9.8410	
LnLAB	-0.3974***	0.0843	-0.4642	0.0048	-0.2883	0.0025	0.3312	0.4554	-2.5156***	0.2882
LnSED	0.0351	0.0273	-0.3038	0.0043	-10082***	0.0786	2.8061***	0.8253	0.0684**	0.0061
LnFET	0.0459**	0.1998	0.2750***	0.0372	0.4178***	0.0015	0.1274**	0.0227	0.1767***	0.0142
LnHEB	0.3846***	0.0764	0.4358	0.0851	-0.5854**	0.0846	2.4886**	0.7042	0.2957	0.1968
LnLAD	0.8564***	0.1992	0.9081**	0.5381	0.5767***	0.2642	2.5860***	0.3382	-0.0682	0.5138
LnPET	0.0153**	0.0031	0.0345*	0.0035	0.2985***	0.0472	0.1175**	0.0103	0.0891*	0.0038
LnCAP	0.0553*	0.0304	-0.3891**	0.0451	-0.2990***	0.0546	-0.5405	0.4771	-0.2274***	0.0844
lnLAB*lnLAB	-0.0075***	0.0716	-0.0190***	0.0032	0.0216***	0.0126	-0.0008	0.0065	0.0478***	0.0405
lnSED*lnSED	0.0087	0.0129	-0.1718	0.0625	-0.0018	0.0128	-0.0910**	0.1646	-0.0781***	0.0808
lnFET*lnFET	-0.1376***	0.1194	-0.2250**	0.0221	-0.2473**	0.0851	0.1432	0.0849	0.1409***	0.0569
lnHEB*lnHEB	-0.0975***	0.1086	-0.5521***	0.0276	-0.1818**	0.0327	0.4140	0.0107	-0.0951**	0.0458
lnLAD*lnLAD	-0.0184**	0.0025	0.0102	0.0135	-0.0161***	0.0043	-0.0690**	0.1204	0.1402***	0.0125
lnPET*lnPET	-0.01543**	0.0272	-0.1026**	0.0054	-0.2697**	0.1649	-0.0751**	0.0281	-0.0162***	0.0194
LnCAP*lnCAP	0.0067	0.0219	0.0766**	0.0473	-0.1409	0.1094	0.1261**	0.0641	-0.6821***	0.1124
lnLAB*lnSED	-0.1099***	0.0024	0.0193**	0.0045	-0.0135*	0.0153	0.1012	0.0597	-0.1176***	0.0379
lnLAB*lnFET	0.5439***	0.0300	-0.0297**	0.0092	0.0185	0.1075	0.0024	0.0528	-0.0945***	0.0308
lnLAB*lnHEB	0.0154***	0.0016	0.1450***	0.0075	0.0765***	0.0523	-0.1048	0.0145	-0.1105***	0.0384
lnLAB*lnLAD	-0.1323***	0.0690	0.0619*	0.0123	0.1096***	0.0814	-0.0253	0.0213	-0.0186***	0.0394
lnLAB*lnPET	-0.0835**	0.0244	0.1349	0.0193	-0.0847**	0.0139	0.1832	0.2757	0.1430	0.0810
lnLAB*lnCAP	-0.0116	0.0285	0.1178**	0.0056	-0.1092***	0.0104	-0.2132**	0.1692	-0.0136	0.0709
lnSED*lnFET	-0.1748***	0.1341	0.0473	0.0127	0.1032***	0.0202	0.5184**	0.2703	0.5632***	0.0921
lnSED*lnHEB	-0.0006	0.0709	0.0312***	0.0254	0.1979***	0.0281	0.3471	0.1002	0.2049***	0.1524
lnSED*lnLAD	0.1464**	0.0149	0.0192	0.0026	0.2240***	0.0189	0.3917*	0.1406	0.1699**	0.0129

lnSED*lnPET	0.3258***	0.0081	0.0850**	0.0110	-0.1550**	0.0395	-0.0312	0.0690	0.0733**	0.0931
lnSED*lnCAP	0.0403	0.0153	0.0421	0.1624	0.2749***	0.0281	-0.2192	0.1854	-0.3215***	0.0643
lnFET*lnHEB	-0.1092	0.0094	0.0584**	0.0158	-0.0163	0.0191	-0.0704	0.0375	-0.0297*	0.0287
lnFET*lnLAD	-0.1046***	0.0065	-0.1890***	0.0140	-0.1015	0.0172	0.1465	0.0481	0.0260	0.0527
lnFET*lnPET	0.0249***	0.0229	0.4363	0.0385	0.2093***	0.1082	0.0172	0.0429	-0.0152***	0.0347
lnFET*lnCAP	0.0040	0.0265	0.0981***	0.0129	0.1154**	0.0061	-0.0340	0.0205	0.0325**	0.0102
lnHEB*lnLAD	0.0183**	0.0595	0.1092**	0.0286	-0.0251**	0.0322	-0.2851	0.0241	-0.0776	0.0049
lnHEB*lnPET	0.0141	0.0809	-0.0642	0.0252	-0.0544***	0.0828	-0.3291**	0.1005	-0.0291	0.0396
lnHEB*lnCAP	-0.1064***	0.0083	-0.0473***	0.0512	-0.1530***	0.0184	-0.0132**	0.1709	-0.3431***	0.0443
lnLAD*lnPET	-0.0346	0.0037	0.0201	0.0108	-0.0135	0.0072	-0.1055**	0.0139	-0.1267***	0.0304
lnLAD*lnCAP	-0.0429	0.0209	-0.0489**	0.0185	-0.1740***	0.0087	-0.0081**	0.0208	0.0138**	0.0004
lnPET*lnCAP	-0.0027**	0.1014	-0.2192***	0.0162	-0.0142***	0.0082	-0.0153*	0.2038	-0.0085*	0.0009

Source: Authors survey, 2018. Note: The asterisks shows the levels of significance. *** is significant at 1%, ** is significant at 5% and * is significant at 10%.

In the Brong-Ahafo region, variables like seed, fertilizer, herbicides, land, pesticides, and capital were all statistically significant at 1%, 1%, 5%, 1%, 1%, and 1% respectively, with seed, herbicides, capital having negative relationship with output of maize this implies a unit increase in these input factors will cause a decline in the output of maize. This result can be attributed to the high cost of heebicides and maize seed in the region and alos the high rate of interest charged by banks on the loans farmers take as capital to start their farms. On the other hand fertilizer, land and pesticides having positive relationship so need to be increase because a unit increase is likely to cause an increase in maize output. Labour was insignificant and had negative relationship with maize output. The results show that, seed squared, capital squared, (fertilizer and herbicides), (fertilizer and land), (land and pesticides) as well as (labour and fertilizer) were all statistically insignificant and all the variables had negative relationship with output of maize except labour and fertilizer who had positive relationship (Table 6). Statistically the following variables were significant, labour squared, (herbicides and pesticides), (herbicides and capital), (land and capital), as well as (pesticides and capital) were significant at 1%, also herbicides squared, pesticides squared, (labour and pesticides), (labour and capital), (seed and pesticides), (herbicides and land) were significant at 5% whiles (labour and capital) was significant at 10%. These variables also had a negative relationship with productivity of maize, this result means if there is an increase in the said variables, it’s likely the out of maize will decline. At the other side, labour squared, (labour and herbicides), (labour and land), (seed and pesticides), (seed and herbicides), (seed and land), (seed and capital), (fertilizer and pesticides), as well as (fertilizer and capital) had positive relationship with output of maize and were all significant at 1%, except fertilizer and capital which was significant at 5% (Table 6).

In the Eastern region of Ghana, the result shows that all the individual variables had positive relationship with output of maize with exception of capital, which had a negative relationship. Seed, fertilizer, herbicides, land and pesticides were all significant at 1%, 5%, 5%, 1% and 5% respectively but labour and capital were statistically insignificant. This result means an increase in all the variables accept capital will cause an increase in the output of maize but same increment in capital will cause a decrease in the output of maize (Table 6). Capital squared as well as (seed and fertilizer) were significant at 5% and (seed and land) was also significant at 10% with all having positive relationship with maize output. This means an increase in (capital, seed and fertilizer as well as seed and land) will cause an increase in output of maize. Other variables like seed squared, land squared, pesticides squared, (land and capital), (herbicides and pesticides), (land and pesticides) as well as (land and capital) were significant at 5% whiles (pesticides and capital) was significant at 10%. But they had a negative relationship with output of maize meaning an increase in these variables will cause a decline in the output of maize. The other variables like fertilizer squared, herbicides squared, (labour and seed), (labour and fertilizer), (labour and pesticides), (seed and herbicides), (fertilizer and land) as well as (fertilizer and pesticides) were all not significant but ha a positive relationship with output of maize. On the other hand, variables like labour squared, (labour and herbicides), (labour and land) (seed and pesticides), (seed and capital), (fertilizer and herbicides), (fertilizer and capital) as well as (herbicides and land) were also statistically insignificant and had a negative relationship with output of maize (Table 6). This result means an increase in these variables will cause a decline in the output of maize.

The results from the central region shows that, labour, seed, fertilizer, pesticides, and capital were all significant at 1%, 5%, 1%, 10%, and 1% respectively, with seed, fertilizer and pesticides having positive relationship with output of maize, but labour had a negative relationship with output of maize. Variable like, herbicides and land were insignificant with herbicides having positive relationship whiles land had negative relationship. In this region variables like (labour and pesticides) as well as (fertilizer and land) were insignificant but had a positive relationship with output of maize whiles (labour and capital), (herbicides and land) as well as (herbicides and pesticides) were also not significant and had a negative relationship. Statistically significant variables were, labour squared, fertilizer squared, land squared, (seed and fertilizer), as well as (seed and herbicides) were significant at 1%, also (seed and land), (seed and pesticides), (fertilizer and capital) as well as (land and capital) were significant at 5% (Table 6). These variables had a positive relationship with maize output which means an increase in these variables will result in an increase in the output of maize. Other variables which were statistically significant but had negative relationship with output of maize were, seed squared, pesticides squared, capital squared, (labour and seed), (ladour and fertilizer), (labour and herbicides), (labour and land), (seed and capital), (fertilizer and pesticides), (herbicides and capital) as well as (land and pesticides) all significant at 1% and herbicides squared, (fertilizer and herbicides) as well as pesticides were also significant at 5%, 10% and 10% respectively (Table 6). This result means that an increase in these variables will cause a decline in the output of maize.

5. Conclusions and Recommendations.

This study employed primary data obtained from a cross section of 600 maize farmers in forty-eight (48) farming communities selected from sixteen (16) Districts in four (4) regions. Majority of the maize farmers were found to be males (74.8%) with few of them been females (25.2%). Most of them were also in their youthful ages between 18-40 years and few of them above 60 years. A greater number of the farmers were found to have formal education but their level of education was low, with most of them as JHS and SHS graduates and few farmers had tertiary education. Most of the farmers were found not to be members of any farmer-group or association. Few farmers had benefited from government subsidies and the average household size of Ghanaian maize farmers was found to be 7.14 members. Slightly majority of the farmers had access to extension services especially farmers in the Northern and the Brong-Ahafo regions. Access to credit facilities was also found to be a major constraint to farmers since banks and other financial institutions were not willing to give out credit to farmers.

Farmers from all the regions of study were found to have inefficiencies in their production. The Brong-Ahafo region had the heighest efficiency in production 71.4%, followed by the Central, Northern, and the Eastern regions with percentages of 68.1%, 60.3%, and 51.9% respectively. In general maize farmers in Ghana are 59.1% efficient in production, meaning there is more room of improvement in maize production by employing all the improved production technologies available to maize farmers.

The results from the pooled sample revealed that, imput factors like, fertilizer, herbicides, land, capital and pesticides had a positive relationship with output of maize and its was statistically significant, for that mater an increase in these output have a high tendency of increasing the out of maize. It is therefore recommende that the government should subsidies or supply these imput to maize framers for free, so as to boost their productivity to ensure food security in the country. Policies makers should also target on how to encourage maize farmers to ues fertizer, herbicides, pesticides in their cultivation. Again, land policies in the country should be made felexible, so that farmers can get easy access to them for cultivation. The number of paid labour employed to work in the farm should be decreased, because it had a negative relationship although it was statistically significant. This suggest that, farmers should depend on their families and other free labour to help them in their farmes, since the paid labour may cost them a lot.

In the Northern region capital, fertilizer, land, pesticides were all statiscally significant and had positve relatioship, for that matter these factors should be increase so as to increase the productivity of maize in the region. Capital was also statistically significant but had a negative relation. This results means an increase in capital in this region will reduce the technical efficiency of maize farmers. This situation can be attributed to the high interest rate charged by banks on loans farmes takes to start their farmers. Other factors like, labour, seed, and herbicides were not significant. The Brong-Ahafo region also needs to increase fertilizer, land, and pesticides use because they were are signifcant and had positve relationship. Factors like seed, herbicides, and capital should not be increased because it had negative relationship though it was statistical significant. The central region also needs to increase improved planting materials, fertilizer, pesticides and herbicides to increase productivity. Finally, for maize farmers in the Northern region variables like fertilizer, land, herbicides, pesticides and improved planting materials should be increased while capital and labour should be reduced in order to increase productivity of maize.

Another recommendation to the government and nongovernmental organizations is that, they should assist maize farmers to increase their use of fertilizer, pesticides and improved seeds by subsidizing the price of these inputs to make them more affordable to the maize farmers. Government could also set up an agricultural fund that would provide farmers with credit through which production inputs, especially those mentioned above would be purchased.

6. References

ABATANIA, L. N.; HAILU, A.; MUGERA, A. W. *Analysis of farm household technical efficiency in Northern Ghana using bootstrap DEA.* Paper presented at the 56th annual conference of the Australian Agricultural and Resource Economics Society, 2012.

ABAWIERA, W. C.; DADSON, A.-V. J. D. J. O. A.; SCIENCES, F. Technical Efficiency of Maize Farmers in Ghana. *v. 4, n.* 3, p. 17-20, 2016.

ABDULAI, S.; NKEGBE, P. K.; DONKOH, S. A. J. A. J. O. A. R. Technical efficiency of maize production in Northern Ghana. *v. 8, n.* 43, p. 5251-5259, 2013.

AIGNER, D., LOVELL, C. K.; SCHMIDT, P. J. J. O. E. Formulation and estimation of stochastic frontier production function models. *v. 6, n.* 1, p. 21-37, 1977.

AKRAMOV, K.; MALEK, M. J. G. S. S. P. W. Analyzing profitability of maize, rice, and soybean production in Ghana: Results of PAM and DEA analysis. *28, 2012*.

BARTLETT, J. A., DEMASI, R., QUINN, J., MOXHAM, C., & ROUSSEAU, F. J. A. Overview of the effectiveness of triple combination therapy in antiretroviral-naive HIV-1 infected adults. *v. 15*, *n.* 11, p. 1369-1377, 2001.

BASNAYAKE, B.; GUNARATNE, L. J. S. L. J. O. A. E. Estimation of technical efficiency and it's determinants in the tea small holding sector in the Mid Country Wet Zone of Sri Lanka. *4*, *2011*.

BEMPOMAA, B.; ACQUAH, H. J. A. A. S. I. A.; COMMERCE. Technical efficiency analysis of maize production: evidence from Ghana. *v. 8, n.* 2-3, p. 73-79, 2014.

CHAMBERLIN, J. Defining Smallholders Agriculture in Ghana: Who are smallholders, what do they do and how are they linked with markets?, 2007.

DANSO-ABBEAM, G.; ARMED, M.; BAIDOO, F. J. I. J. O. E.; SCIENCE, S. Determinants of consumer preference for local rice in Tamale Metropolis, Ghana. *v. 1, n.* 2, p. 114-122, 2014.

DUVEL, G.; CHICHE, Y.; STEYN, G. J. S. A. J. O. A. E. Maize production efficiency in the Arsi Negele farming zone of Ethiopia: a gender prespective. *v. 32, n.* 1, p. 60-72, 2003.

EDRISS, A. A Passport to Research Methods.(Research Skills-Building Approach). Int. In: Publishers and Press (IPP), Las Vegas, 2003.

EFFAH, E. S. *Determinants of Cocoa Production in the Ashanti Region, 2013.*

FARMER, J. D.; GEANAKOPLOS, J. J. C. The virtues and vices of equilibrium and the future of financial economics. *v. 14, n.* 3, p. 11-38, 2009.

FORNELL, C.; LARCKER, D. F. J. J. O. M. R. Evaluating structural equation models with unobservable variables and measurement error. *v. 18, n.* 1, p. 39-50, 1981.

GEFEN, D.; STRAUB, D.; BOUDREAU, M.-C. J. C. O. T. A. F. I. S. Structural equation modeling and regression: Guidelines for research practice. *v. 4, n.* 1, p. 7, 2000.

GRAFTON, R. Q.; DAUGBJERG, C.; QURESHI, M. E. J. F. S. Towards food security by 2050. *v. 7, n.* 2, p. 179-183, 2015.

H GREENE, W. Econometric analysis. In: Prentice Hall, 2002.

HAIR, J. F.; BLACK, W. C.; BABIN, B. J.; ANDERSON, R. E.; TATHAM, R. L. Multivariate data analysis (Vol. 6). In: Upper Saddle River, NJ: Pearson Prentice Hall, 2006.

KAISER, H. F. J. P. An index of factorial simplicity. *v. 39, n.* 1, p. 31-36, 1974.

KUWORNU, J. K.; AMEGASHIE, D. P.; WUSSAH, C. E. J. D. C. S. Productivity and resource use efficiency in tomato and watermelon farms: evidence from Ghana. *v. 2, n.* 2, p. 23-37, 2012.

LeVENDAG, P. C.; TEGUH, D. N.; VOET, P.; VAN DER EST, H.; NOEVER, I.; DE KRUIJF, W. J., . . . Oncology. Dysphagia disorders in patients with cancer of the oropharynx are significantly affected by the radiation therapy dose to the superior and middle constrictor muscle: a dose-effect relationship. *v. 85, n.* 1, p. 64-73, 2007.

OJIAKO, I. A.; OGBUKWA, B. C. J. A. J. O. A. R. Economic analysis of loan repayment capacity of smallholder cooperative farmers in Yewa North Local Government Area of Ogun State, Nigeria. *v. 7, n.* 13, p. 2051-2062, 2012.

OLADEJO, J.; ADETUNJI, M. J. A. S. R. J. Economic analysis of maize (zea mays l.) production in Oyo state of Nigeria. *v. 2, n.* 2, p. 77-83, 2012.

SADIQ, M.; YAKASAI, M.; AHMAD, M.; LAPKENE, T.; ABUBAKAR, M. J. I. J. O. A. P. Profitability and production efficiency of small-scale maize production in Niger State, Nigeria. *v. 3, n.* 4, p. 19-23, 2013.

SALKIND, N. J.; RAINWATER, T. *Exploring research*: Prentice Hall Upper Saddle River, NJ, 2003.

STEPHEN, J.; MSHELIA, S.; KWAGA, B. J. D. O. F.; WILDLIFE MANAGEMENT, F. U. O. T. Y., Nigeria. Resource-use Efficiency in Cowpea Production in the North-Eastern zone of Adamawa state, Nigeria, 2004.

THOBATSI, J. T. *Growth and yield responses of maize (Zea mays L.) and cowpea (Vigna unguiculata L.) in an intercropping system.* Citeseer, 2009.

WOLTER, D. J. O. J. G. P. Agriculture is Becoming a Business. 9, 2008.

WOLTER, D. J. O. J. G. P. Ghana: agriculture is becoming a business. *v. 2009, n.* 2, p. 9-32, 2009.

WONGNAA, C.; OFORI, D. J. A. O.-L. P. I. E.; INFORMATICS. Resource-use efficiency in cashew production in Wenchi Municipality, Ghana. *v. 4*, *n.* 2, p. 73, 2012.