Technical Efficiency of Maize Production in Chikun Local Government Area of Kaduna State, Nigeria

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***Abstract*:- This study examined the technical efficiency of maize production in Chikun Local Government Area of Kaduna State , Nigeria. Primary data were collected for this study using a multistage sampling technique to select 100 maize farmers from the study area. The data were analysed using descriptive statistics and stochastic production frontier. The socio-economic characteristics of respondents as evident from the data analysis revealed that 87% were males with 99% of the farmers in their working age group of between 21-60 years. Most (81%) of them were married with 52 % of the maize farmers having household size of more than 5 people . Also, 52.0% had post primary school education and 72 % of the farmers had 2hectares of farm size and above while only 34 % of the farmers had above 5years of experience in maize farming. The result also revealed that all the variables measured positively influenced maize output but those that were significant are farm size (α0.01) and fertilizer (α0.01) while those factors that significantly affecting inefficiency were age(α0.01), extension services (α0.01),maize variety (α0.01), access to credit (α0.01) and educational level (α0.01). However access to credit was positively signed which negate *a priori expectation*. Mean technical efficiency level of the farmers is estimated to be 54%, indicating that the possibility of increasing maize output in the study area given the current state of technology and inputs level can be achieved in the short run by increasing the technical efficiency level of the farmers by 46% through the adoption of practices of the best maize farmer. The study recommended that provision should be made by governments and other stakeholders in the agricultural sector to provide farmers with access to affordable inputs such as seed, pesticides, herbicides, as well as making provision for alternative source of labour.**

***Keywords*: Technical Efficiency; Maize; production; Output; Inputs; Chikun ;Kaduna State.**

I. INTRODUCTION

Maize is an important cereal crops in the world. It provides staple food to many populations. In developing countries maize is a major source of income to farmers among whom many are resource poor. Maize is one of the most popular oldest and powerful cereals crops, which is popularly used for food, fodder and also for medical purpose in the world. More than 3,500 uses of corn products are identified. It covers health related issues due to presence of nutritional values. Its helps as analgesic, astringent, anti-allergic, emollient, again skin rashes, against store throat, anti-angina, anti-hypertensive, against biliousness, anti -lithiasis, anti diarrheal, urinary disorders including dysuria, cystitis, urethritis, nocturnal enuresis and etc. It also good source of vitamins A, B, E and many minerals. It has reduced hypertension and prevented neural-tube defects at birth. Maize (*Zea mays* L.) is one of the most important cereal crops used in the human diet in large parts of the world and it is an important feed component for livestock. Maize has various health benefits. The B-complex vitamins in maize are good for skin, hair, heart, brain, and proper digestion. They also prevent the symptoms of rheumatism because they are believed to improve the joint motility. The presence of vitamins A, C, and K together with beta-carotene and selenium helps to improve the functioning of thyroid gland and immune system. Potassium is a major nutrient present in maize which has diuretic properties. Maize silk has many benefits associated with it. In many countries of the world such as India, China, Spain, France and Greece it is used to treat kidney stones, urinary tract infections, jaundice, and fluid retention. It also has a potential to improve blood pressure, support liver functioning, and produce bile. It acts as a good emollient for wounds, swelling, and ulcers. Decoction of silk, roots, and leaves are used for bladder problems, nausea, and vomiting, while decoction of cob is used for stomach complaints (Kumar and Jhariya, 2013). *Zea mays* is the most important cereal fodder and grain crop under both irrigated and rainfed agricultural systems in the semi-arid and arid tropics (Alvi *et.al*., 2003). Maize is very important because of good source of minerals, vitamins, fiber and oil present in maize (rich in embryo). This oil is used for cooking and soap making companies. Maize starch is famous in pharmaceutical industries as diluents and also used in cosmetics. Its seeds used to make alcohol while stem used for paper manufacturing. Small scale farmers are engaged with maize forming, because of its highly nutritional values and affordable source of vitamins and minerals for people living in rural areas.

Technical efficiency is defined as the ability to operate on the isoquant frontier or production frontier (Greene, 2008). To support this definition, this study is adopted the model of Farrel (1957) that explains the measure of technical efficiency in simplicity. According to Farrel (1957), a firm is considered to have successfully achieved technical efficiency if it has produced a large amount of output from a given set of inputs. According to Carlson (1968), technical efficiency is the ability of a firm to employ the 'best practice' in an industry, so that no more than the necessary amount of a given sets of inputs is used in producing the best level of output. Technical

efficiency is defined as the physical ratio of product output to the factor inputs. The greater the ratio, the greater the size of the technical efficiency. This implies the existence of variation in technical efficiency among firms or farms. The production function pre-supposes technical efficiency, whereby maximum output is obtained from a given level of inputs combination; hence it is a factor product relationship. Generally, technical efficiency is the ability to minimize input use in the production of an output vector, or the ability to obtain maximum output from an input vector (Kumbhakar et al., 2000). An important assumption underlying efficiency concept is that firms operate on the outer bound of production function (i.e., on their efficiency frontier). Developments in cost and production frontiers are attempts to measure productive efficiency. The frontier defines the limit or boundary to a range of possible observed production (cost) levels and identifies the extent to which the firm lies below (above) the frontier (Farrell, 1957). It means that firms or farms become technically inefficient when they fail to operate on the outer bound of their production function and according to Amaza *et al.* (2001) such firms or farms can improve their technical efficiency through: (a) a simultaneous improvement in both production techniques and technology and (b) improved production techniques, which implies a change in factor proportions through factor substitution under a given technology, thus representing a change in the production function itself in a way that the same amount of resources produce more output, or the same amount of output is derived from smaller quantities of resources than before. Olayide and Heady (1982) refers to technical efficiency as the ability of a firm to produce a given level of output with minimum quantity of inputs under a given technology while Ogundari and Ojo (2007) describe the technical efficiency of individual farmers as the ratio of observed output to the corresponding frontier's output, conditional on the level of input used by the farmers. Efficiency can as such be seen as a vital determining factor of productivity growth of an individual farmer. This study is carried out to examine the technical efficiency of maize farmers in Chikun Local Government Area of Kaduna State, Nigeria.

II. MATERIALS AND METHODS

A. Study Area

The study was carried out in Chikun Local Government Area of Kaduna State. The local government covers area of about 4456.59km and lies between the latitude 10˚N and longitude 90˚E. and situated in the Northern Guinea Savannah Zone. It shares boundary with Igabi and Kaduna South Local Government Area to the North - East and with Kajuru to the East, Birnin Gwari and Giwa Local Government Area to the North - West and Kachia Local Government Area to the South East. The ethnic group in the study area comprises of Gbagyi predominantly, with other tribes like Hausa, Kataf, Igbo, Fulani and Yoruba. Their occupation is farming and crops cultivated include groundnut, rice, yam, maize, guinea corn, millet and cassava. They also reared livestocks such as goat, sheep, pig, cattle and poultry bird.

B. Methods of Data Collection

The data used for this study were obtained from primary and secondary sources. The primary data were collected from maize farmers in Chikun Local Government Area of Kaduna State using copies of structured questionnaire. The questionnaires were administered to 100 maize farmers in the study area with the help of Extension Agents. Multi-stage and random sampling techniques were adopted to select the respondents for the study. In the first stage five (5) wards namely; Rido, Kakau, Chikun, Kujama and Gwagwada were selected purposively due to high concentration of maize farmers in the wards. In the second stage two villages each from the five (5) wards were also purposively selected which includes; Rido, Karji. Kakau, Buwaya, Chikun, Kugo, Kujama, Kafari, Gwagwada and Dutse because of their predominance and intensively cultivation of maize. In the third stage random sampling was used to select ten (10) maize farmers in the selected villages in the study area which gave a total of one hundred (100) respondents respectively. Specifically, data collected on the maize farmers in Chikun Local Government Area were on their demographic and socio-economic characteristics, quantity of labour used, farm size, amount of fertilizer used and amount of planting materials used. Secondary data were obtained from past research reports, texts, Journals, Food and Agricultural Organisation. Federal Office of statistics, National Population Commission and other relevant published and unpublished materials.

C. Methods of Data Analysis

The data collected in this study were analysed using descriptive statistical tools such as mean, percentages, frequency distribution, standard deviation, minimum and maximum values. Inferential statistics such as Stochastic Frontier Production function was also employed to study the technical efficiency of the maize farmers.

D. Measurement of Variables

Age: This was measured in years

Farm size: This was the total area of farmland under maize production in hectares.

Education: This indicated the highest educational attainment of the respondents in years.

Family labour: This was measured in terms of mandays of family labour used for production. Eight hours of work equals one manday.

Hired labour cost: This was the total cash expenditure on hired labour in naira.

Fertilizer quantity: This was the total amount of

fertilizer used for production in kilograms

Maize seed quantity: This was the total amount of

maize seed used for production in kilograms

Pesticides/ Herbicides quantity: This was the total amount of pesticides/ herbicides used for production in litres.

Maize variety: A dummy variable, which takes the value one for improved maize variety and the value zero for local variety.

Extension services: A dummy variables, which takes the value zero for non access to extension services and the value one for access to extension services.

Maize output: This was the total amount of maize production per annum in kilograms.

Access to credit: A dummy variable when taken the value of zero for non-access to credit facilities and the value of one for access to credit facilities.

E .Model Specification

Cobb-Douglas Stochastic Frontier Production Function is assumed to be appropriate model for the analysis of the farm data collected from the maize farmers in the study area. The model estimated is defined as

$$\text{Ln } Y=\beta_o + \beta_1 \text{ Ln } X_1 + \beta_2 \text{ Ln}x_2 + \beta_3 \text{ Ln}X_3 + \beta_4 \text{ Ln}X_4 + \beta_5 \text{ Ln}X_5 + \beta_6\text{Ln}X_6 + V_1 + U_1 \quad \text{----------(1)}$$

Where

Ln = denotes natural logarithm to base

Y = represents the total maize output of the farmers in kilograms

β = represents the unknown parameters associated with explanatory variables in the production function (i = 1,2,3,4,5).

X_1 = represents the total quantity of labour in man-days.

X_2 = represents the total amount of farm size under maize production in hectares.

X_3 = represents the total amount of fertilizer used for production in kilograms.

X_4 = represents the total amount of maize grain/seed as planting materials in kilograms.

X_5 = represents the total quantity of herbicide/pesticide use in litres.

V_i = represents random errors, which are assumed to be independently and identically distributed as $N(\delta^2 v_i)$ independently distributed of the U_i.

U_i = represents non-negative random variables, associated with technical efficiency of production which we assumed to be independently distributed, such that U_i is obtained by truncation (at zero) of the normal distribution with variance $\delta^2 U$ and means μ where the mean is defined by

$$\mu = \delta_0 + \delta_1 Z1 + \delta 2 + \delta 3 + \delta 4 Z4 + \delta 5 Z5 + \text{-------- ---------- (2)}$$

Where

δ = a (5 x 1) vector of unknown parameter to be estimated (i = 1,2,3,4,5) are factors contributing to inefficiency:

Z_1 = Age of farmers in years.

Z_2 = Extension Service (a dummy variable) access to extension services = 1 non-access to extension services = 0.

Z_3 = Maize variety planted (a dummy variable) improved variety = 1, local variety =0.

Z_4 = Access to credit (a dummy variable) non-access to credit facilities = 0 and access to credit facilities = 1

Z_5 = Education background of maize farmers \ measured in terms of highest level attained primary = 1 secondary = 2, post-secondary = or no education at all = 4.

The maize output is expected to be affected positively by quantity labour used, farm size, amount of fertilizer used, quantity of maize seeds/ grains planted and quantity of herbicide/pesticides used.

The age of the farmers is expected to have a positive effect on the size of the technical inefficiency effects. This is because as the farmers begin to age they will become less efficient in production.

Extension services are expected to have a negative effect on technical inefficiency. This is because as the farmer has access to improve extension services, the more knowledge and information they would have about modern farming, and hence, more disposed to adopting improved farm technologies. This will lead to effective utilization of inputs, which in turn, increases the technical efficiency of the farming operations.

The maize variety is expected to have a negative effect on the technical inefficiency. This is because as the farmer adopts planting of improved maize variety, an effective utilization of inputs would be achieved, which in turn , increased the technical efficiency of the farmers

Access to credit is expected to have a negative effect on the technical inefficiency. This is because a good access to credits will boost maize production as well as their moral of farmers. This will resulted in effective utilization of inputs, which in turn, increases the technical efficiency of the farming operations.

Education is expected to have a negative effect on the technical inefficiency. This is because the more educated the

farmers are the more effective they would be in the utilization of inputs. This will invariably increase the technical efficiency of the farming operations.

III. RESULTS AND DISCUSSIONS

A. Socio – Economic Characteristics of the Farmers

1). Distribution of the Respondents based on Age Group: Table 1 shows that respondents (36 %) are within the age range of between 41-50 years, (29 %) of the respondents are within the age range of 31-40 years, (19%) of the respondents are between the range of 51-60 years, (15%) of the respondents are within 21- 30 years, while (1%) of the respondents are 61 years and above. The result shows that most of the respondents are in their youthful age which makes them active in maze production, Taru *et. al.* (2008), opined that eligibility of one's performance in certain activities or role including agricultural activities is determined by the age and too young or too old people are generally inactive or of low productivity on the farm.

Table 1: Distribution of the Respondents based on Age Range

Ages	Frequency	Percentage (%)
21-30	15	15.00
31-40	29	29.00
41-50	36	36.00
51 - 60	19	19.00
61 above	1	01.00
Total	100	100

Source: Field survey, 2019

2). Distribution of the Respondents based on Gender: Table.2 revealed that majority of the respondents (87%) are male while (13%) are female. This implies that male dominated maize production in the study area. This result is in line with the finding of Sadiq *et. a*l. (2013) that reported that majority of maize producers in Niger State of Nigeria are male (67 %).

3). Distribution of the Respondents based on Marital Status: Table 3 shows (81%) of the respondents are married, (13%) of the respondents are single, (3%) of the respondents are widow and divorcee respectively. This implies that majority of the respondents are married people.

4). Distribution of the Respondents based on Religion: Table.4 revealed that majority of the respondents (63%) are Christians, (29%) are Muslims, while very few (8 %) are traditional worshippers. This implies that Christians dominated maize production in the study area. This result is in line with the finding of Ayodele (2019) that most groundnut producers in Chikun LGA of Kaduna State are predominantly Christians.

5). Distribution of the Respondents based on Household Size: Table 5 shows that majority of the respondents (48 %) have household size ranging from 1-5 members, (33%) of the respondents have household size ranging from 6-10 members, (13%) of the respondents have household size that is between 11 – 15 and 6% of the maize farmers have family size that are 16persons and above. This implies that majority of the farmers have over five household members which signifies that labour can be easily sourced from the family members. Alabi *et. al.* (2005) stated that family with high family members is more helpful to their family in terms of agricultural production than family with small family members.

6). Distribution of the Respondent based on Educational Qualification: Table 6 shows that (39%) of the farmers have primary education, (29%) of the respondents have secondary education, (23%) of the respondents have tertiary education, (9%) have non-formal education. This shows that about 52 % of the farmers had secondary school certificate and above while 91% of the farmers can read and write. Murtala *et al* (2004), stated that education plays a important role in farming activities. It gives the farmer an insight about important technology and decision making that determines success of their farming enterprise.

7). Distribution of the Respondents based on Sources of Capital: Table 7 shows that (53%) of the respondents acquire their capital from personal saving, (21%) of the respondents sourced their capital from relations / friends, 14% from banks, and (12%) of the respondents sourced their capital from money lenders. This implies that most of the farmers sourced capital through personal saving which implies that they will have ability to manage their finances well if given credit loan. The result confirmed the assertion of Ayodele (2019) that majority of groundnut farmers in Chikun Local Government Area sourced their capital through personal savings.

8). Distribution of the Respondents based on Farm Size: Table 8 revealed that (57%) of the respondents have farm size of two to less than four hectares of land, (28%) of the respondents have farm size of less than one to less than two hectare, (14%)of the respondents have four to less than six hectares and (1%) of the respondents have six or more hectares of farm size . The result shows that most of the respondents are small scale maize farmers.

9). Distribution of the Respondents Based on their Years of Experience : Table 9 shows that majority of the respondents (35 %) have 1-5 years farming experience in maize production, (31%) of the respondents have less than one years in maize farming experience, (13 %) of the respondents have within 11-15 years of experience in maize farming, (11 %) of the respondents have 16 and above years while 10% of the respondents have between 6 – 10 years experience in maize farming in the study area. According to Alabi *et al* (2005) more years of experience in farming enhance efficiency and productivity in business.

10). Distribution of the Respondents based on Source of Labour: The results in Table 10 shows that sources of farm labour for the respondents were hired labour (19%), Hired labour (20 %) and a combination of both family and hired labour (61%).

11). Distribution of the Respondents based on Maize Output: The result in Table 11 revealed that most of the maize farmers about 49 % got an annual maize output of about 1000 to less than 3000 kg. 29% of them had less than 1000 Kg, 15 % had between 3000 and less than 5000 Kg, 5% had between 5000 and less than 7000 Kg while only 2 % of the farmers had an annual maize output that is equal to or greater than 7000 Kg. This implies that about 93 % of the farmers had an annual maize output that is less than 5000 Kg.

Table 2: Distribution of the Respondents Based on Gender

Religion	Frequency	Percentage (%)
Male	87	87.00
Female	13	13.00
Total	100	100

Source: Field survey, 2019

Table.3: Distribution of the Respondents Based on Marital Status

Marital status	Frequency	Percentage (%)
Single	13	13.00
Married	81	81.00
Divorcee	3	03.00
Widow	3	03.00
Total	100	100

Source: Field survey, 2019

Table 4: Distribution of the Respondents Based on Religion

Religion	Frequency	Percentage (%)
Muslim	29	29.00
Christian	63	63.00
Tradition	8	08.00
Total	100	100

Source: Field survey, 2019

Table 5: Distribution of the Respondent Based on Household Size

Household size	Frequency	Percentage (%)
1-5	48	48.00
6-10	33	33.00
11-15	13	13.00
16 above	6	06.00
Total	100	100

Source: Field survey, 2019

Table 6: Distribution of the Respondents by their Educational Qualification

Education background	Frequency	Percentage (%)
Non-formal education	9	09.00
Primary education	39	39.00
Secondary education	29	29.00
Tertiary	23	23.00
Total	100	100

Source: Field survey, 2019.

Table 7: Distribution of the Respondents Based on Sources of Capital

Sources	Frequency	Percentage (%)
Personal saving	53	53.00
Loan from families/friends	21	21.00
Credit from bank	14	14.00
Money lenders	12	12.00
Total	100	100

Sources: Field survey, 2019

Table 8:Distribution of the Respondents Based on Farm Size

Farm size (ha)	Frequency	Percentage (%)
0.10 to < 2.00	28	28.00
2.00 to < 4.00	57	57.00
4.00 to < 6.00	14	14.00
> = 6	1	01.00
Total	100	100

Source: Field survey, 2019

Table 9: Distribution of the Respondents Based on their Years of Experience

Years of experience	Frequency	Percentage (%)
Less than one year	31	31.00
1-5	35	35.00
6-10	10	10.00
11-15	13	13.00
16 above	11	11.00
Total	100	100

Source: Field survey, 2019

Table 10: Distribution of the Respondents Based on their Source of Labour

Labour source	Frequency	Percentage (%)
Family labour	20	20.00
Hired labour	19	19.00
Both labour	61	61.00
Total	100	100

Source: Field survey, 2019

Table 11: Distribution of the Respondents Based on Annual Maize Output

Annual maize output (Kg)	Frequency	Percentage (%)
<1000	29	29.00
1000 < 3000	49	49.00
3000 < 5000	15	15.00
5000 < 7000	5	5.00
>= 7000	2	2.00
Total	100	100

Source: Field survey, 2019

B. Estimated Production Function.

The maximum likelihood estimate (MLE) of the stochastic frontier model of maize farmers is presented in Table 12. The sigma-square (δ^2) estimate of 30.57 (α0.01) attests to the good fit and correctness of the model. Also, the gamma (γ) estimate of 0.99 (α0.01) shows the amount of variation in output resulting from the technical inefficiencies of the farmers. This means that 99% of the variation in farmer's output was due to technical efficiency. The results reveal that the variables such as labour, farm size, fertilizer, maize seeds and pesticide/herbicide quantity were factors which positively influenced the quantity of outputs of maize in the study area. This factors were also reported by Ayinde *et.al.*(2015) to influenced maize output positively in Ogun State. Farm size and fertilizer were significant (α0.01) factors influencing maize output in the study area and they have positive signs with estimated elasticity of 0.65 and 0.16 respectively implying that unit increase in these variables will also increase the quantity of maize produced by 0.65 and 0.16 respectively. The seed variable had a positive sign. This indicated that a unit increase in the quantity of seed planted would result in 0.01 increases in maize output. This finding agrees with Ayinde *et.al.*(2015) and Oyewo (2011). These two authors reported the importance of the seed in maize production in their works. The estimated coefficient of pesticide/ herbicides also had a positive sign. This means that an increase in the quantity of pesticide/herbicide used by the maize farmers will lead to increase in the quantity of output of maize produced by the farmers. Labour is also positively signed with an elasticity of 3.70 which signifies that for every unit increase in labour usage will lead to 3.70 unit increases in maize output. The mean technical efficiency of the farmers was estimated at 0.54 as shown in Table 13 indicating relatively high efficiency of maize production within the ambit of production resources available in the study area. However, given that only the coefficients of fertilizer and farm size were statistically significant, it shows low use of maize inputs.

C. Sources of Inefficiencies.

The sources of inefficiency were examined simultaneously and the results as specified by the maximum likelihood parameter estimates are presented in Table 12. The results of the inefficiency model show age (α0.01), extension service (α0.01), maize variety (α0.01), access to credit (α0.01) and educational level (α0.01) of the respondents are significant determinants of technical inefficiency. The sign of the variables in the inefficiency model is very important in explaining the observed level of technical efficiency of the farmers. A negative sign implied that the variable had the effect of reducing technical inefficiency, hence increasing farmers' production efficiency, while a positive coefficient indicate that the variable has the propensity of increasing inefficiency, thus reducing farmers' production efficiency. This indicates that increase in age would significantly increase production efficiency. This may be so because it is expected that as farmer's age increases their experience in maize production increases which should resulted in increase in maize output. The coefficient of education variable was estimated to be negative as expected and statistically significant at 1% level. This implies that farmers with more years of education tend to be more efficient in maize production, presumably due to their enhanced ability to acquire technical knowledge. This result negates the finding of Ayinde *et.al.*(2015) who reported a positively signed significant educational level in their study. The negative signs and significant levels of extension services and maize variety shows that this variables contributed greatly to increase maize output as they positively improve the technical efficiency of the farmers. Access to extension services enable the farmers to acquire technical knowledge as well as have access to improve technology that will make him more efficient in production. Planting a good quality maize variety i.e. hybrid maize seeds that are more resistant to pest and diseases will increase the technical efficiency of the farmers in maize production. However the result revealed that access to credit which also is significant but positively signed does not conform to *a priori* expectation. Farmers that have access to credit facility are expected to be more technically efficient than those that lack access to credit facility, but in this study the result showed that access to credit decrease the technical efficiency of the maize farmers in the study area which should not be. However Ng'ombe and Kalinda (2015) reported a statistically significant and negatively signed access to loan of – 0.126 fo smallholder farm household in Zambia.

D. Distribution of Technical Efficiency of Maize Farmers in Chikun Local Government Area.

Results of the distribution of technical efficiency scores of maize farmers in the study area are reported in Table 13. Column (1) shows the interval of technical efficiency scores in which farmers lie. Column (2) shows the number of farmers under each interval while column (3) shows their respective percentages. Results indicate that 41% of the maize farmers were between 41 and 60 percent technically efficient. 24 % of the farmers were between 61- 80% technically efficient, 18 % were less than 21% technically efficient, 16% were 21 – 40% technically efficient while only 1% of the farmers were between 81-100% technically efficient. The distributions of the technical efficiency scores are fairly normal. The model results show that on average; at least 54 percent of the maize farmers were technically efficient in Chikun Local Government Area of Kaduna State. The estimated range of technical efficiency scores for the model distribution is 90 percent (0.01 to 0.91 percent). The predicted mean technical efficiency of the farmers is 0.54 which indicates that the maize farmers in the study area produced 54% of the potential stochastic frontier output based on the present state of technology as well as the level of inputs. The implication is that the 46% of potential output is not realized. This indicates that technical efficiency in maize production in Chikun Local Government Area of Kaduna State could be increased by 46% through better use of available resources, given the current state of technology. This can be achieved through farmer –

specific factors, which include access to improve maize varieties, access to credits, good education and access to improved extension services. This mean technical efficiency of 0.54 obtained in this study is similar to findings of Kuwornu *et.al.* (2013) that reported mean technical efficiency of 0.51 for maize farmers in the Eastern Region of Ghana in 2010 production year.

Table 12: Maximum Likelihood Estimate for the Parameter in the Stochastic Production Function Model for the maize Farmers in Chikun Local Government Area, 2019.

Variables	Parameters	Coefficients	Standard-error	t-ratio
Production variable				
Intercept	β_0	7.68	0.12	80.31**
Labour	β_1	3.70	0.04	115.68
Farm size	β_2	0.65	0.07	7.83**
Fertilizer	β_3	0.16	0.01	10.46**
Maize seeds	β_4	0.01	0.02	1.20
Pesticides/herbicide	β5	0.01	0.01	0.34
Inefficiency variable				
Intercept	δ_0	-7.80	3.07	2.65**
Age	δ_1	-5.62	0.47	-10.45**
Extension services	δ_2	-7.13	1.82	-4.02**
Maize variety	δ_3	-5.40	2.42	-2.68**
Access to credit	δ_4	3.46	0.95	3.60**
Education	δ_5	-4.19	0.81	-5.21**
Sigma squared	σ^2	30.57	6.10	4.61**
Gamma	Γ	0.99	0.11	475.52**
Log likelihood function		- 385.76		

Sources Field Survey, 2019.

** t-ratio is significant at 1% level.

Table 13: Distribution of maize farmers in Chikun Local Government Area by Technical Efficiency Estimates

Technical efficiency	Frequency	Percentage
<0.21	18	18.00
0.21 – 0.40	16	16.00
0.41 – 0.60	41	41.00
0.61 – 0.80	24	24.00
0.81 – 0.100	1	1.00
Total	100	100.0
Mean efficiency	= 0.54	
Minimum efficiency	= 0.01	
Maximum efficiency	= 0.91	

Source: Field Survey, 2019

IV. CONCLUSION

The study concluded that maize farmers in Chikun Local Government Area of Kaduna State, Nigeria are technically efficient in their production with a mean technical efficiency of 0.54 indicating that the farmers are 54% technically efficient in maize production and the empirical results from the inefficiency model reveal that age, extension services, maize variety and education level were the major determinants of the farmers' technical efficiency level. However, technical efficiency in maize production in Chikun Local Government Area of Kaduna State could be increased by 46% through better use of available resources such as seeds, labour, pesticides and herbicides given the current state of technology. This can be achieved through farmer – specific factors, which include access to improve maize varieties, access to credits, good education and access to improved extension services. The study therefore recommended that provision should be made by governments and other stakeholders in the agricultural sector to provide farmers with access to affordable inputs such as seed, pesticides, herbicides, as well as making provision for alternative source of labour.

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