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Technical Efficiency Analysis of Rainfed maize production in Yola North and Yola South Local Government Areas of Adamawa State, Nigeria

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ABSTRACT
The study analyzed the technical efficiency of rainfed maize production in Yola North and Yola South Local Government Areas of Adamawa State, Nigeria. Purposive and simple random sampling techniques were used to select 128 respondents. Data collected were subjected to descriptive and inferential statistics. Results from socio-economic variables revealed that 76.56% of the respondents were below 50 years with mean age of 39 years and 72% of the farmers were male. Farmers' literacy level was high, as 85.12% of them had some form of formal education with house hold size of 9 persons. The farmers cultivated an average of about two hectares of land and used personal savings as their major source of finance. The results of the maximum likelihood estimate of the parameters of production function revealed that all the independent variables were significant in varying levels except family labour. The technical efficiency indices ranged from 0.38 to 0.98 with a mean value of 0.77 implying that an average farmer in the area has the scope for increasing technical efficiency by 23% given the existing technology. Major problems identified were insufficient fund, high cost of labour and high cost of fertilizer among others. The study recommends provision of adequate farm inputs and essential services to rainfed maize farmers.
Keywords: Technical efficiency, rainfed, maize production, Yola, Adamawa, Nigeria

INTRODUCTION
Developing the agricultural sector that will ensure food security should be an interesting global issue. Food security is one of the critical elements that project the economic well beings of a nation. Today, most developing countries have become importers of food item, and their dependence on it increases day-by-day despite the growing concern of the local producers (Abdul, 2015). The increasing demand for food and jobs in urban and sub-urban areas, has made it necessary for employed wage earning urban and sub-urban dwellers to practice part-time farming as a means of filling the food demand and supply gap and providing income to supplement their wages (Amodu, 2010). One of the major challenges facing urban cities and towns in Nigeria is the provision of an adequate and well-stable food supply to meet the requirement of their growing population. It is possible to have two firms within an industry to use the same inputs and the same technology in their production but having differences in the quantities of their outputs. The implication is that, atleast one of the firms is operating below the production frontier, thereby signifies the presence of inefficiency in production.

Study has shown that most urban dwellers engage in one form of agricultural production or the other (Amodu *et al.*, 2011). Most farmers tend to prefer maize cultivation to crops like sorghum probably because of the availability of streak resistance maize varieties for all ecological zones in Nigeria (Fakayode *et al.*, 2006). Despite the economic importance of maize to the teeming populace in Nigeria, it has not been produced adequately to meet food demand and industrial needs of the country. One of the problems cited as constraint to

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maize production in Nigeria is stagnant production technology (Buba, 2005). The reason for this could be attributed to inefficiency in resource utilization as study confirmed inefficiency in resource productivity in both food and cash crops in Nigeria (Olagoke, 1991).

An attempt to maximize profit or output in production requires efficient use of farm resources (Umoh, 2006). This is because the scope of agricultural production can be expanded and sustained by farmers through efficient use of resources (Ali, 1996; Udoh 2005). According to Iken and Amusa (2004), research on methods of cultivating maize to a large extent is secondary since designing of efficient farming system was given a priority. Umoh (2006) also concluded that efficiency has remained an important subject of empirical investigation particularly in developing economies where majority of farmers are resource-poor. It has been observed that maize has not been produced to meet the demand of the people within and around Yola metropolis in Adamawa State, Nigeria. For this reason, the study was conducted to analyze resource productivity and efficiency of rainfed maize farming in Yola North and Yola South Local Government Area of Adamawa State. The specific objectives are to: (i) describe the socio-economic characteristics of the respondents; (ii) estimate the technical efficiency of the maize farming in the study area; and (iii) identify major constraints associated with maize farming in the study area.

Conceptual and theoretical framework

The most important factor operating to change in agriculture is the sheer need to increase crop yield in order to support the growing population of the world and to supply the higher standards of living which people demand (Adedeji and Ademiluyi, 2009). This can be achieved when resources are efficiently utilized in production. Efficiency in a firm is defined as the proper utilization of available resources to give the highest possible output (Adeyemi, 2005). An empirical investigation of efficiency provides good evidence to fall back to (Coelli, 1995; Ogunjobi, 1999). Three types of efficiency identified in literature are technical efficiency (TE), allocative efficiency (AE) and economic efficiency (EE), (Farell, 1957, Olayide and Heady, 1982). Bhasin (2002) and Rahji (2012) defined technical efficiency in a similar manner as the ability of the farmer to obtain maximum output for a given set of input under a given technology. Allocative efficiency is a measure of degree of success in achieving the best combination of different inputs in producing a specific level of output considering the relative prices of the inputs (Umoh, 2006). It is possible for a firm to achieve either technical or allocative efficiency. However, the occurrence of both technical and allocative efficiency at the same time provides the sufficient condition for the attainment of economic efficiency (Amana, 2000). Economic efficiency is defined as the ability of a producer to use minimum cost to produce the highest possible output, given available technology. Thus, economic efficiency is derived from the product of the mean technical efficiency and allocative efficiency. According to Olayide and Heady (1982), economic efficiency is a product of technical and allocative efficiency.

Udoh (2000) used the maximum likelihood estimation of the stochastic production function to examine the land management and resource use efficiency in South-eastern Nigeria. The study found that a mean output-oriented technical efficiency of 0.77 for the farmers, 0.98 for the most efficient farmer and 0.01 for the least farmer. The study of Kareem *et al.* (2009) concluded that measurement of technical efficiency at the farm level and identification of the important factors associated with efficient production systems are crucial for determining which production systems have the greatest potential. Adebayo (2006) used stochastic production function to conduct a research on the resource use efficiency and multiple dairy pastoralists in Adamawa State. The result shows that labour, potential milking cows, veterinary inputs and feed supplement have significant influence on the output. The result also revealed that pastoralists had mean technical efficiency of 0.87 with possibility of increasing milk output by 13%. The inefficiency analysis also showed that age and experience have positive impact on the pastoralist efficiency while household size had no significant relationship with efficiency.

Kareem *at al.* (2009) make a comparative analysis between concrete ponds and earthen ponds to determine the economic efficiency of fish farming in Ogun State, Nigeria. The parameter estimate of the stochastic production shows that pond size, lime and other material inputs were significant for concrete ponds while for earthen ponds feed, pond size, labour and number of fingerlings were significant. The estimate for the gamma parameter is 0.73 for concrete ponds and 0.76 for earthen ponds which implies discrepancies between the observed and the frontier technical inefficiencies. Onuk *et al.* (2010) used double log production analysis to conduct a research to determine resource use efficiency in maize production in Mangu Local Government Area of Plateau State, Nigeria. The result shows that maize farmers were more efficient in the utilization of maize seeds, fertilizers and agro-chemicals. However, the results further revealed that the ratio of the marginal value product (MVP) to the marginal factor cost (MFC) of the various farm inputs shows that farmers underutilized land while labour and capital were over-utilized and they concluded that farmers in the study area do not achieve absolute efficiency since some input were underutilized while others were over-utilized. The study of Okpeke and Tibi (2011) employed Cobb-Douglas production function to estimate the efficiency of resource use in broiler production in Delta State, Nigeria. The results shows that the overall efficiency of resources ($r<1$) used in broiler production is less than 1 which implied that the production resources were underutilized. The study further indicated that the resources of feed intake was over utilized with $r>1$ in the case of individual resource used.

Amodu *et al.* (2011) conducted a study on resource use efficiency in part-time food production using stochastic frontier approach. The result shows that over 72% of the part-time farmers were above average in resource use efficiency with mean efficiency of 0.65 and a maximum and minimum efficiency of 0.98 and 0.36 respectively. The study also revealed that rising age and household size contribute to resource use inefficiency in part-time food crop farming, while level of education and year of farming experience increased resource use efficiency among the sample farmers. Giroh *et al.* (2012) conducted a study to analyze the factors influencing the technical efficiency of women rubber tappers in rubber belt of Nigeria using production function analysis. The result of the analysis revealed that 91.4% of the variations in technical efficiency were explained by the variations in socio-economic variable used. The result indicated that output, family size, education, man days of labour, total trees tapped and wage had positive and significant effect on the technical efficiency of women tappers in the study area.

METHODOLOGY

The Study Area

The study was carried out in Yola North and Yola South Local Government Area of Adamawa State in the North-East geopolitical zone of Nigeria. The state has Yola as its state capital. Yola North Local Government area lies between latitude 9° 14″N and longitude 12° 38″E, while Yola South lies between latitude 9° 14″ N and longitude 12° 28″E (Figure 1). Both Local Government Areas have tropical climate marked by distinct rainy and dry seasons. The area has a mean temperature of 34.56°C with maximum temperature of 40°C, while the minimum temperature can be as low as 18°C. The mean annual rainfall is less than 1,000 mm (Adamawa State Government Diary, 2013). Yola North has a land mass of about 1,913km^2 while Yola South has a land mass of about 1,293km^2, both situated in the Sudan savannah vegetation zone of the country. The projected population of Yola North and Yola South Local Government from 2006 population census based on 2.9% annual growth rate were put at 230, 414 and 207, 185 respectively (Adamawa State Primary Health Care Development Agency, 2014). The study area share common boundaries with Fufore Local Government Area to the South-east, Mayo-Belwa Local Government Area to the south-west, Demsa Local Government Area to the North- west and Girei Local Government Area to the North-east. The area has a number of ethnic groups speaking different languages. Fulfulde and Hausa are widely spoken in the area. Agriculture is the dominant occupation of the major inhabitant of the area. Some of the crops produced in the area include Groundnuts, Cotton, Maize, Cassava, Yam, Guinea corn, Millet, Beans, Sweet potato and Rice. Other occupations include Cattle rearing, fruit production and traders (Adamawa State Government Diary, 2013).

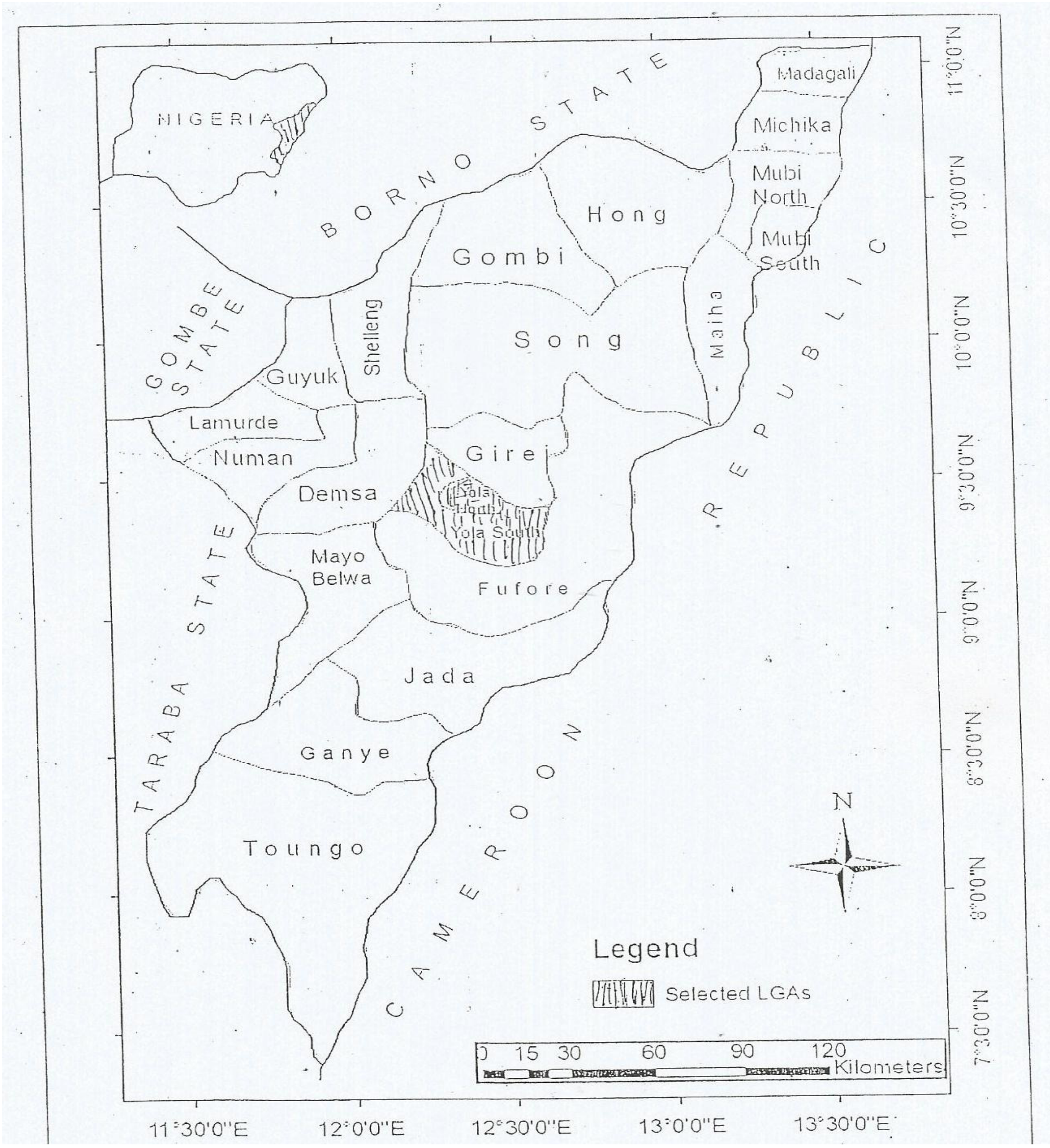

Figure 1: Adamawa State Showing the Selected LGAs.
Source: Adebayo and Tukur 1999.

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Sampling Procedure and Method of Data collection

Data for the study were obtained from primary source through the use of structured questionnaires administered to rainfed maize farmers in the study area. Purposive and simple random sampling techniques were employed in selecting the sampled farmers. The researcher employed the purposive selection of ten (10) wards from the two Local Government Areas (Yola North and Yola South) where maize farming is predominant while a random selection of 160 rainfed maize farmers from the existing sampling frame proportionate to size were sampled, as shown in Appendix I. However, 128 questionnaires were correctly filled and returned and were used for the analysis.

$S = p/P. Q/1$ .... (1)

Where S = Sample size; p = Population of each location; P = Total population; Q = Total number of respondents.

Method of Data Analysis

Descriptive statistics (include percentages, arithmetic mean, and frequency tables) was used to achieve objectives i and iii, while stochastic frontier model was used to achieve objective ii. Stochastic frontier production function was used for assessing technical efficiency in maize production in the study area. Assuming a production technology is specified by Cobb-Douglas production function, the stochastic frontier model is defined as:

$\ln Y_i = \ln \beta_o + \sum \beta_j \ln X_{ij} + v_i - u_i$ .... (2)

Where Y_i= Farm output (dependent variable); X_{ij}= Vector of farm inputs used (independent variables); β_o= Intercept; β_j= Vector of production function parameters to be estimated; i=1, 2, 3…n farms; j=1, 2, 3… m inputs; V_i = Random variable in the production that cannot be influenced by the farmer; U_i = the deviation from the maximum potential output attributed to technical inefficiency of the farmer.

Stochastic frontier production function

Looking at the stochastic frontier production function, the technical efficiency for the i^{th} firm is defined as the ratio of the observed output (Y_i) to the corresponding frontier output (Y^*) conditional to the level of input used by the firm. Thus, measure of technical efficiency (TE) for each firm is calculated as:

$TE_i = Yi/Y_i^*$ .... (3)

$TE_i = \exp [E \{ui/e\}] = \exp. (-u)$ .... (4)

$= f(x_i, \beta) \exp(vi-ui) / f(x_i, \beta) \exp(vi) \exp(-ui)$

TE_i = Technical efficiency of i^{th} farmer; Yi= Observed output from i^{th} farm; and Y^*=Frontier output

Any point on the frontier is referred to as point of maximum efficiency where the gamma has a value of 1.0 and lower value represent less than maximum efficiency in production. So that $0 \leq TE \leq 1$. Hence, efficiency estimates would range between zero and one. The efficiency model was also defined to estimate the influence of socio-economic variables on the technical efficiency of the farmers as employed by Coelli (1994), which gives the variance parameters of the maximum likelihood function in term of $\delta^2 = \delta^2u + \delta^2v$ and $\gamma = \delta^2u / \delta^2$. Considering the value and significance, γ is an important parameter in determining the existence of a stochastic frontier; rejection of null hypothesis H_o: $\gamma = 0$, implies the existence of a stochastic production frontier. Also, $\gamma = 1$ implies that the deviation from the frontier are entirely due to technical inefficiency (Coelli, 1994). The γ (gamma) $= \delta^2u / \delta^2$ which measure the total variation of production (output) from the frontier can be attributed to technical or allocative inefficiency (Battese and Corra, 1977) as adopted from Amodu *et al.*(2011). The main feature of the stochastic production frontier is that the disturbance term is decomposed into two components: a symmetric and a one sided components. The symmetric component v_i captures the random effects due to the measurement error, and the non-symmetric influences outside the control of the firm. Therefore, the stochastic frontier production function model is specified as:

$\ln Y_i = \beta o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + U_i - V_i$ ……….…….(5)

Where Subscript ij refers to j^{th} input of the i^{th} farmer; ln = Natural logarithm to base e;
Y = Output of maize (kg); X_1 = Farm size (ha); X_2 = Quantity of seed used (kg); X_3 =Quantity of fertilizer used (kg); X_4 = Family labour (man days); X_5 = Hired labour (man days); and
X_6 = Quantity of agrochemical used (litres); V_i = Random variable which cannot be controlled by the farmer. They are $N \sim (0, \delta^2_v)$; and U_i = Technical inefficiency effects which explain the deviation from the maximum potential output. They are assumed to be independent of V_i, non-negativity, follows a truncated (at zero) normal distribution- $N \sim / (0, \delta^2 u) /$.

$U_i = f(Z_b: \delta)$

So that $U_i = \delta_o + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7$………………………… (6)

Where Z_b= A vector of farmer specific factors, and δ's and γ (gamma) are coefficients of unknown parameters

Thus:

U_i = Inefficiency effect; Z_1= Age of the farmer (years); Z_2= Farming experience (years); Z_3 = Level of education (years spent in school); Z_4 = Family size (total number of person in household); Z_5 = Extension contact (number of extension visit); Z_6 = Gender of the farmer (dummy: 1 if male and 0 if otherwise); and Z_7=Membership of cooperative society (dummy 1 if yes, 0 if otherwise).

RESULT AND DISCUSSION

Socio-economic Characteristics of the Respondents

The gender distribution of the respondents show that high percentage (71.88%) were male which means that maize production in the study area is mostly undertaken by the male gender, thus agreeing with the findings of Amotsuka (2011) in study of urban agriculture in Warri metropolis of Delta State, Nigeria who reported that 80% of farmers in high income class were dominated by male. Education plays a significant role in skill acquisition and knowledge transfer (Ogundele, 2003). The distribution of the respondent based on educational status as presented in Table 1 reveals that most sample respondents (85.12%) had one form of formal education or the other. The result shows that majority of the respondents were literate and this can enhance their skill acquisition status which could improve their productivity. The distribution of the respondents by the household size as presented in Table 1 shows that almost half of the respondents (45.31%) had household size of 6-10 persons while the mean household size is 9 which is relatively large. Larger household size can serve as source of family labour even though dependency ratio was high. This is in conformity with the report of Tashikalma *et al.* (2014), who report that household member contribute labour for both rainfed and irrigated farm production in Adamawa State. Age of farmers is one of the important socio-economic factors that influence agricultural production. Most farming activities practiced at subsistence level (especially in most Africa countries) require active and energetic labour force; therefore, farmer's effectiveness is partly determined by age of farmers. Tables 1 revealed that majority (76.6%) of the respondents were within productive age (21-49). By implication, the sampled farmers are still very active to engage in maize production that will contribute to household means of sustenance. The finding conform with the finding of Maurice (2012) who reported that there is a significant relationship between farmer's age and efficiency in agricultural production where younger farmers tend to be more productive than older farmers.

Farming experience is a major component of farmer's socio-economic characteristics that influence efficiency in farming activities. Table 1 revealed that majority (78.9%) of the respondents had more than ten (10) years farming experience. The mean farming experience was 21 years. This implies that most of the farmers in the study area are well experienced in maize production. The farmers with more years of experience in maize production are likely to adopt innovations easily and were likely to be technically more efficient in their farming practices. This agree with the study of Onuk *et al.* (2010) who revealed that most maize farmers in Mangu Local Government Area of Plateau state were adult and had several years of experience and this may have positive effect on their output. Farm size is one of the major determinants to the scale of farm. Table 1 shows that majority (77.34%) of the respondents were farmers using a maximum of 2 hectares of land for their maize cultivation with the mean farm size of 2.06 hectares. This implies that maize farmers in the study area are operating at small scale level. The finding of Awoke and Okorji (2004) reported that small scale farmers are farmers who cultivate between 0.1 and 4.99 hectares and produce on subsistent level.

Table 1: Socioeconomic Characteristic of the Respondents (n= 128)

Variables	Frequency	Percentage (%)
Gender		
Male	92	71.88
Female	36	28.12
Educational level		
No Formal of education	19	14.88
Primary education	66	51.56
Secondary education	28	21.88
Tertiary education	15	11.72
Household size		
1-5	32	25.00
6-10	58	45.31
11-15	26	20.31
16-20	12	9.38
Minimum 2		
Maximum 20		
Mean 8.9		
Age range (years)		
20-29	36	28.13
30-39	39	30.46
40-49	23	17.97
50-59	16	12.50
≥ 60	14	10.94
Minimum 21		
Maximum 81		
Mean 39		
Farming experience (years)		
1-10	27	21.09
11-20	42	32.81
21-30	35	27.34
31-40	16	12.50
≥ 40	8	6.25
Minimum 3		
Maximum 51		
Mean 21		
Farm size		
≤ 2	99	77.34
2.1-4.99	21	16.41
≥ 5.0	8	6.25
Minimum 0.5		
Maximum 6		
Mean 2.06		

Source: Field survey, 2014

Technical Efficiency

The maximum likelihood estimates of the stochastic frontier production function for rainfed maize farmers in the study area were presented in Table 2. All parameter estimates of the of production function have the expected sign except family labour. This implies that the output of maize increases by the value of each coefficient as the quantity of each variable input increases by one percent. The return to scale which is the sum of elasticities ($\sum$ of β_1-

β_6) is 1.12 showing an increasing return to scale. This indicates that the farmers were operating at stage I level of production, where an additional unit of input results in a larger increase in production than the preceding unit. This is a situation where input resources were underutilized. The value of gamma (0.7108) as presented in Table 2 was statistically significant at 1% level suggesting the existence of technical inefficiency among the farmers accounts for about 71.08% of variations in maize output. That is, the variation in the output of maize from the production frontier was not only explained by error outside the control of the farmers but also resulted from error due to the technical in-efficiency in production by the farmers. The sigma squared (0.0794) is also statistically significant at 1% level. This indicates a good fit and the correctness of the specified distribution assumption of the composite error term.

The result on Table 2 also revealed that farm size and fertilizer were statistically significant at 1% level with farm size being the most important factor of production having an elasticity coefficient of 0.8159. A 1% increase in hectares of land used in maize production *ceteris paribus*, would increase the total output of maize by about 0.82%. This shows that land is a significant factor that influence maize output. This agrees with finding of Maurice *et al.* (2013) who reported a positive relationship between farm size and output of food crops. Also, the coefficient of fertilizer (0.1248) is positive and conforms to *apriori* expectation as shown in Table 2. Fertilizer is a major input which improves the soil fertility and improves the productivity of the existing land by increasing crop yield per hectare. This indicated that 1% increase in the fertilizer applied on rainfed maize farms *ceteris paribus* would increase the output by 0.12%. Similar finding has been reported by Tashikalma *et al.* (2014) who obtained a positive relationship between quantity of fertilizer applied and yield of selected rainfed and irrigated food crops. The result on table 2 also reveals that seed is the second most important factor, with the coefficient of 0.1445 which is positive and statistically significant at 5% level. This shows that an increase in seed rate planted would result to high crop population and subsequently high yield *ceteris paribus*. A 1% increase in quantity of seed planted would bring about 0.14 increases in yield. This finding is in consonance with Amodu *et al.* (2011) who obtained planting materials to be significant at 5% in food crops production. Table 2 also shows that hired labour and agrochemical were statistically significant at 5% and 10% levels respectively. The positive sign of the coefficients of both hired labour (0.0177) and agrochemical (0.0135) indicates that the output of maize increases with increase in the use of these variable inputs. This suggests that labour is a key factor in improving the maize yield especially in under developed nations where most farmers operating on subsistence level and used manual labour. This conforms to the finding of Hassan (2014) who obtained labour input to be statistically significant at 1% and further suggests its importance in agricultural production.

The agrochemical used is statistically significant at 10%. Effective weed and pest control will help in increasing the yield of maize output if the agrochemical is applied appropriately. The finding corroborates the report of Adewuyi (2014) who stated that the use of herbicide had an increasing effect on the output of rice. The inefficiency parameters are specified as those relating to farmer's socioeconomic characteristics and were examined using the estimated delta (δ) coefficients. These are presented in Table 2 to include age, farming experience, education, household size, extension contact, gender and cooperative membership. The negative coefficient on delta shows that the parameter has a positive effect on efficiency and vice-versa. The coefficient of farming experience (δ_2) is estimated to be negative and statistically significant at 5% implying that technical efficiency of farmers increases with increase in years of farming experience. Thus, farmers with many years of farming experiences tend to be more technically efficient than those with lesser experience in farming. This might be due to better understanding of farm operations and resources allocation as a result of annual routine of the farming activities. According to Adebayo (2005), experience is very important, and that the longer a person stays on a particular job, the better the job performance tend to be.

Educational status of the farmers has negative coefficient and statistically significant at 1% level. This implies that farmers with formal schooling tend to be more efficient in maize production due to better understanding and easy adoption of innovation on improved production technology. The finding suggests that there is a direct and positive relationship between education and technical efficiency. This corroborates the finding of Amodu *et al.* (2011) and Tashikalma *et al.* (2014) who reported that education enhances technology adoption and ability of farmers to plan and take or averts risks. The coefficient of extension variable is estimated to be negative and statistically significant at 1% level. This indicates that increased extension services to farmers tend to increase the technical efficiency by reducing the technical inefficiency in maize farm production. Extension visitation plays a vital role on farmer's acquisition of improved production inputs (such as high breed seeds). Similar finding was reported by Maurice (2012). Cooperative membership as one of the variable in the inefficiency model also has negative coefficient and is statistically significant at 5% level. This implies that regular involvement in cooperative membership by the farmers tend to increase the technical efficiency in maize production. The possible explanation to this is that participation in cooperative society may afford the farmers opportunity to acquire information on improved technology and more access to credit facilities, hence, applications of information play vital role in increasing the scale and the output of maize thereby enhancing efficiency in maize production.

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Table 2: Maximum Likelihood Estimate of the Parameters of the Stochastic Frontier Production Function

Variable	Parameter	Coefficient	Standard Error	t-ratio
Production Factors				
Constant	β_0	1.2250	0.0564	21.731***
Farm Size (X_1)	β_1	0.8159	0.0509	16.022***
Seed (X_2)	β_2	0.1445	0.0708	2.0401**
Fertilizer (X_3)	β_3	0.1248	0.0452	2.7625***
Family Labour (X_4)	β_4	0.0049	0.0118	0.4154
Hired Labour (X_5)	β_5	0.0177	0.0078	2.2819**
Agrochemical (X_6)	β_6	0.0135	0.0070	1.9265*
Inefficiency Factors				
Age (Z_1)	δ_1	0.0538	0.0541	1.0472
Farming Experience (Z_2)	δ_2	-0.1879	0.0778	-2.4145**
Education (Z_3)	δ_3	-0.2269	0.0378	-6.0000***
Household Size (Z_4)	δ_4	-0.0194	0.0532	-0.3646
Extension Contact (Z_5)	δ_5	-0.0633	0.0142	-4.4570***
Gender (Z_6)	δ_6	0.0097	0.0050	1.9332*
Cooperative Membership (Z_7)	δ_7	-0.0262	0.0110	-2.3726**
Diagnostic Statistics				
Sigma squared (σ^2)		0.0794	0.0111	7.1511***
Gamma (γ)		0.7108	0.2510	2.8318***
Log likelihood function		130.82		

Source: Computer output from Frontier 4.1

*Significant at 10% level, **Significant at 5% level, and *** Significant at 1% level

Distribution of efficiency indices of the respondents

The distribution of farmers' technical efficiency indices as derived from the analysis of the stochastic production function is presented on table 3. And it is less than one (1) which shows that the sampled respondents were operating below the maximum efficiency frontier. The technical efficiency of these farmers ranges from 0.38 to 0.98 with a mean value of 0.77. This implies that on the average, the maize farmers have the capacity of increasing their output by 23% given the existing technology. The least efficient maize farmer (TE=0.38) has a scope for increasing the technical efficiency by 60% to attain the level of the best practiced farmer. Consequently, the average farmer (TE=0.77) has the scope of increasing technical efficiency by 21% to attain the level of the best practice farmer. This result shows that rainfed maize farmers are relatively technically efficient in their agricultural practices.

Table 3: Distribution of Efficiency indices of the Maize Crop Farmers

Efficiency level	Range		Frequency	percentage
Technical Efficiency	≤ 0.49		7	5.47
	0.50 – 0.59		14	10.94
	0.60 – 0.69		13	10.15
	0.70 – 0.79		25	19.53
	0.80 – 0.89		54	42.19
	0.90 – 0.99		15	11.72
	Total		128	100
	Mean	0.77		
	Minimum	0.38		
	Maximum	0.98		

Source: Field survey, 2014

Constraints and challenges to maize producers

The finding revealed some notable challenges which limit the productivity of maize in the study area and these had been presented in Table 4. The table indicated multiple responses and these were ranked in order of severity. Insufficient fund (79.68%) was found to be the major constraint identified by the farmers as it ranked first among the constraints. The implication is that insufficient fund can make it difficult for some maize producers with small capital to increase their scale of production. This is in consonance with the finding of Fakayode *et al.* (2006) who reported that inadequate fund is a problem in fadama maize production that denied the fadama users the opportunity to capitalize their fadama enterprise. High cost of fertilizer which constitutes (72.66%) of the sample farmers was another identified constraint ranking as the second challenge in maize production in the study area. Other major challenges of maize production to the sampled farmers were lack of government supports, high cost of labour, high interest rate on loan and high cost of hiring tractor which were ranked to be 3rd, 4th, 5th and 6th sequentially in order of severity. These may undermine the crop yield and efficiency of the maize farmers in the study area. Similar case was reported by Onuk *et al.* (2010) who revealed that maize farmers are faced with constraints that can limit their production.

Table 4: Constraints and Challenges in Maize Production

Constraints and challenges	Frequency	percentage (%)	Ranking
High cost of fertilizer	93	72.66	2nd
Pest and diseases	40	31.25	8th
High cost of hiring tractor	62	47.44	6th
Poor market outlet	51	39.84	7th
Insufficient fund	102	79.68	1st
High cost of labour	80	62.50	4th
Poor storage facilities	32	25.00	9th
Lack of government support	84	65.63	3rd
High interest rate	78	60.94	5th
Total	**622** **		

Source: Field survey, 2014
**Multiple responses

CONCLUSION

The study concluded that maize production in the study area is mostly undertaken by the men that are in their active age of 39 years on average who are experienced, had one form of education or the other and were small scale farmers having an average farm size of about 2 hectares of land. The analysis showed that a significant relationship exist between output and farm size, seed, fertilizer, hired labour and agrochemical. The mean technical efficiency of the respondents was 0.77, indicating that there is a scope for raising maize yield by 23% through efficient utilization of existing inputs given the current state of technology. The respondents were relatively technically efficient and some of the variables that reduced their in-efficiency were farming experience, educational status, extension contact and cooperative membership. Hence, they operated 23% below the production frontier.

However, insufficient fund, high cost of fertilizer and lack of government support affect production efficiency of farmers.

Recommendations

Based on the findings of the study, the following recommendations are made: The finding shows that farm size is a major factor that limited the scale of farming in the study area; hence, it is recommended that government should improve policies on land use act that will give more access land for crop production. Farming experience and education enhanced the farmer's efficiency. Therefore, policy measures such as increasing access of farmers to quality education and skill acquisition programme through extension agents is recommended to improve production technology and in will lead to increase in their efficiency. Provision of adequate faming inputs such as funds in the form of credit and fertilizer at a subsidized rate and at appropriate time by the financial institutions, government and private organizations will help in curtailing the problem of insufficient fund, high cost of inputs.

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Appendix 1

Table 1: Selection of Respondents

Local Government Area	Ward sampled	Population of Farmers	No. of Selected Respondents
Yola North	Doubeli	26	14
	Gwadabawa	26	14
	Jambutu	32	17
	Karewa	30	16
	Rumnde	26	14
	Sub-Total (i)	140	75
Yola South	Bole/Yolde Pate	28	15
	Makama A	26	14
	Mbamba	25	13
	Namtari	38	20
	Ngurore	43	23
	Sub-Total (ii)	160	85
	Total	**300**	**160**

Source: Field survey, 2014