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PRODUCTIVITY AND EFFICIENCY OF MAIZE *(ZEA MAYS*) FARMERS IN ADAMAWA STATE, NIGERIA

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Abstract

Resource allocation and productivity are important aspect of increased food production which is also associated with the management of the farmers who employ these resources in production. Furthermore, efficiency in the use of available resources is a major pivot for profitable farm enterprise and sustainability. Therefore, inefficiency in the use of resources, wrong choice of enterprise combination and cropping system constitute the major constraints to increased food production in Nigeria. Adamawa State has favourable ecology for both rainfed and irrigated maize production, but the increasing demand for maize lags behind supplies. This study was therefore conducted to examine Productivity and Efficiency of Maize (Zea mays) Farmers in Adamawa State. Socio- economic characteristics of respondents; allocative, technical and economic efficiencies of maize production and factors of inefficiencies of production among respondents were specifically examined . Data were collected from 337 maize farmers and subjected to descriptive statistics and inferential statistics. Results showed that respondents had a mean age of 44 years, attained one form of formal education or the other with mean of nine years of schooling, mean household size of eight people, well experienced with mean experience of 21 years and mostly small scale farmers cultivating an average of 1.89 hectares. The stochastic production frontier analysis indicated that 84.01% of the variations in the technical efficiencies were jointly explained by the production variables in the model. Seeds, fertilizers and farm size were statistically significant (p≤0.01) and positively related with maize output. Education and extension contact were statistically significant (p≤0.05) and increase technical efficiency among respondents. Furthermore, the stochastic cost function analysis indicated that 80.24% variations in allocative efficiencies were as a result of the variables included in the model. Cost of fertilizers, seeds and herbicides were statistically significantly (p≤0.01) whereas labour was statistically significant (p≤0.10). Extension contacts increase allocative efficiency significantly. The mean values obtained were 0.79, 0.88 and 0.69 for Technical Efficiency (TE), Allocative Efficiency (AE) and Economic Efficiency (EE) respectively. High cost of inputs, inadequate credit facilities, Striga infestation and drought were the major constraints of maize production. It is concluded that farmers are not fully efficient in the allocation of resources for production. Formation of cooperative association by farmers and training of farmers by both government and non governmental agencies were some of the recommendations made in the study.

Key words: *efficiency, productivity, stochastic frontiers, maize*

INTRODUCTION

Maize (*Zea mays L*) is the first most cultivated in Nigeria in terms of area (12,403,330 ha) and with a production of about 12.40 MMT in the year 2020 making the country the second largest producer in the continent, after South Africa with 16 MMT [17, 23]. Production statistics shows an average of 1.8 MT/Ha which is very low when compared to Egypt and South Africa where the yields are 7.7MT/Ha and 5.3MT/Ha [16]. In Nigeria, the largest volumes of maize are produced in the Northern region, particularly in Kaduna, Borno, Niger, Adamawa and Taraba and in the South-Western States of Ogun, Ondo and Oyo [5].

According to [3], maize exists in colours, shapes, sizes, textures with 50 different species. When eaten fresh form, it provides A, C, and E. It is a rich source of carbohydrate, essential protein, minerals, and dietary fibre. Maize stover produces an average of 6.89 t/ha of dry matter is used for livestock feeds [25]. Maize production has the potential to mitigate the present food insecurity and alleviate poverty [5].

Adamawa State is predominantly agrarian with agriculture contributing 53.70% of the State Gross Domestic Product, GDP. Most production is done by small scale and subsistence farmers with high dependence on rainfed agriculture only a paltry 5% is irrigated agriculture out of the huge potential of the over 200,000 hectares of irrigable land in the state. About 2.87 million hectares out of 3.9 million hectares is arable land that support Agricultural development where 67% of the farmers are classified as small holder with farm size of between 0.8 ha- 3.5 ha whereas others belong to medium – large scale farms with farm holding of 3.5 – 4.5 hectares and above 5 hectares respectively. The use of fertilizer for production is very low (5.95 kg per hectare which is about two times lower than the West Africa regional average [13]. Maize is one of the major staples in the state in high demand but production has been low with average yield ranging from 941 kg/ha to 1.1ton/ha lower than 1.8ton/ha national average attributed to poor resource management, low and erratic rainfall and security challenges in the North East. Maize ranks first among all crop cultivated in the State with 178,000 ha or 6.2%, followed by sorghum with 124,000 ha or 4.3% [19].

The study of productive efficiency started with the pioneering works of Michael Farrell in 1957 where three measures of efficiency; technical, allocative and economic efficiencies were identified. Technical Efficiency (TE) is the achievement of the maximum potential output from a given quantity of inputs under a given technology. It is the attainment of production goal without wastage [15]. Allocative efficiency on the other hand has to do with the extent to which farmers make efficient decision by using inputs up to the level at which their marginal contribution value is equal to the factor cost. Economic efficiency combines both technical and allocative efficiency. Economic efficiency occurs when a firm chooses resources and enterprises in such a way as to attain economic optimum [9, 20]. The analysis of efficiency is generally associated with the possibility of farms producing a certain optimal level of output from a given bundle of resources or certain level of output at least cost. Efficient use of resources for increased production has shifted attention from technology adoption among farmers in Nigeria.

A good number of researchers have used the stochastic frontier production function analyses in their studies on maize production in Nigeria (26, 14, 4, 11).

However, [1] analyzed production efficiency and the factors influencing technical efficiency (TE), allocative efficiency (AE) and economic efficiency (EE) as well as the returns to scale of maize production in some selected communities of Orlu Local Government Area of Imo State.

Despite this, efforts have not been made to examine Productivity and Efficiency among Maize (*Zea mays)* Farmers in Adamawa State, Nigeria. Socio- economic characteristics of the respondents; allocative, technical and economic efficiencies in maize production, factors of inefficiencies of production and constraints were specifically examined in the study area.

MATERIALS AND METHODS

Study Area

The research was carried out in Adamawa State located at the North-Eastern part of Nigeria. It lies between latitude 7^0 and 11^0N of the equator and longitude 11^0 and 14^0E of the Greenwich Meridian. It shares boundary with Taraba State in the South and West, Gombe in the North-West and Borno to the North. It also has an international boundary with the Cameroon Republic along its eastern border. The State has a land area of about 38,741km^2 projected population of 4.2 million people where an estimated 60% reside in the rural areas [28]. Adamawa state has a tropical wet and dry climate. Dry season lasts for a minimum of five months (November-March) while the wet season spans April to October. The major agro ecological formation of the state includes, the Guinea Savannah divided into Southern and Northern Guinea Savannah, and Sudan Savannah. The mean annual rainfall ranges from 700 mm to 1,050 mm [2, 13]. The state is blessed with River

Benue, Kiri, Kilange, Mayo Inne, Chouchi and Lake Gerio, Tallum, Dwam and Kiri Dams. The major occupation of the people is farming as reflected in their two notable vegetation zones - Sub-Sudan and Northern Guinea Savannah - known for cotton and groundnut production as the main commercial crops while the food crops produced in the State include maize, yam, cassava, guinea corn, millet and maize. Other important crops grown include cowpea, wheat, millet, sweet potato, Bambara nuts and vegetables such as onion, pepper, tomato and garden egg. Agriculture is the dominant means of livelihood of citizens of the State where it accounted for 70- 80%. Communities living on the banks of the rivers engage in fishing while others are herdsmen [19].

Source of Data and Sampling Procedure

Primary data were collected for this study using structured questionnaire. The data were collected on the 2022/ 2023 cropping season from December 2022 and January 2023.

A multi stage, purposive and random sampling technique was employed in selecting the sample**d** farmers. First, the study area was stratified based on the four Adamawa Agricultural Development Programme (AADP) agricultural zones where Maiha LGA (Zone1), Girei LGA (Zone II), Ganye and Yola LGAs (Zone III) and Demsa LGA (Zone IV) were purposively selected. The second stage was the purposive selection of villages based on their relative importance in maize production. A total of 14 villages were selected from the five Local Government Areas. A population of 3563 farmers was obtained from farmers' association register where 366 were randomly selected proportionate to their population size (Table 1) and served with structured questionnaire to collect the desired data Out of this number, 337questionnaires were correctly filled and used for analysis.

Table 1. Sample Selection from Sampling Frame

Zone	Selected LGAs	Selected Villages	Registered Farmers	10% of Registered Farmers
Zone I	Maiha	Mayo Nguli	343	34
		Jalingo Maiha	300	30
Zone II	Girei	Jabbi Lamba	164	16
		Murke	153	15
		Dumne	401	40
Zone III	Ganye	Sugu	408	41
		Gurumpawo	305	31
		Bakari Guso	285	29
	Yola South	Namtari	114	11
		Gongoshi	205	21
		Rumde Mallum	257	26
Zone IV	Demsa	Kpasham	351	35
		Tagombali	144	11
		Ngbekindawe	225	23
			3,655	366

Source: Field Survey 2023.

Analytical Techniques

The use of the stochastic frontier production function has some conceptual advantage in that it allows for the decomposition of the error term into random error and inefficiency effects rather than attributing all errors to random effects [27, 20].

The specification after Battese, *et al* [8] is:

$$Ya = f(Xa\colon\beta) + (V - U) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

where:

Y_a = Production of the ith firm

X_a = Vector of input quantities of the ith firm
β = Vectors of unknown parameters
V = Assumed to account for random factors such as weather, risk and measurement error. It has zero mean, constant variance, normally distributed and independent of U. It covers random effects on production outside the control of the decision unit.
U = is non negative error term having zero mean, and constant variance [27]. It measures the technical inefficiency effects that fall within (because the errors could be controlled with effective and adequate managerial control of the firm), the control of the decision unit [6]. The production technology of the farms was assumed to be specified by the Cobb- Douglas functional form. Bravo-Ureta and Pinheiro [9] and Ogundari [20] reported that the stochastic frontier models are better estimated using the Cobb- Douglas functional form because of its simplicity and wider use in farm efficiency analyses in both developing and developed countries.
The Stochastic Frontier Cost Function is specified as:

$$Ln\ Ca = f(Pa, Ya{:}\ \beta) + (V + U) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where:
C_a = total cost of production of the ith firm
P_a = input prices
Y_a = Output of the i^{th} firm
β = parameters to be estimated
V = systematic component which represents random disturbance cost due to factors outside the scope of the firm.
U = one sided disturbance term used to represent cost inefficiency and is independent of V. The cost efficiency of an individual firm is defined in terms of the ratio of observed cost (b) to the corresponding minimum cost ($c^{\mathbf{min}}$) under a given technology.

$$CE = \frac{cb}{(cmin)} = \frac{f(PXi{:}Y*X;\beta)+(V+U)}{f(PXi*Y*X;\beta)+(V)} = exp(U) \ldots\ldots\ldots\ldots\ldots \quad (3)$$

where:
CE = Cost efficiency,
Cb = the observed cost and represents the actual total production cost;
C^{min} = the minimum cost and represents the frontier total production cost or least total production.
Stochastic frontier production function analysis was used in the estimation of technical, allocative and economic efficiencies of maize production.

The Empirical Stochastic Frontier Production Model

The stochastic frontier production model used is specified as follows:

$$LogY_1 = \beta_o + \beta_1 logX_1 + \beta_2 logX_2 + \beta_3 logX_3 + \beta_4 log X_4 + \beta_5 logX_5 + V_i - U_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where:
Y_1 = Output (kg of maize) of the i^{th} farmer
X_1 = Maize Seeds(kg)
X_2 = Farm size (Hectares)
X_3 = Fertilizer (kg)
X_4 = Herbicides (litres)
X_5 = Labour (mandays)
V and U as previously defined.
The technical efficiency of maize production is defined as the ratio of observed production to the corresponding frontier production associated with no technical inefficiency.
TE = exp ($-u_i$) so that 0≤ TE 0≤ 1
Variance parameters are: $\sigma^2 = \sigma^2_v + \sigma^2_u$ and $\gamma = \sigma^2_u / \sigma^2$
so that 0≤ γ 0≤ 1.
The inefficiency model is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 \ldots\ldots\ldots\ldots\ldots (5)$$

where:
U_i = Technical inefficiency effect
Z_1 = Age of maize farmer (in years)
Z_2 = Family size
Z_3 = Education (years spent in school)
Z_4 = Extension contact (Number of contacts).

Empirical Stochastic Frontier Cost Production Model

The empirical stochastic frontier cost production model used is specified as follows:

$LogC_1 = \beta_0 + \beta_1 \log P_1 + \beta_2 \log P_2 + \beta_3 \log P_3 + \beta_4 \log P_4 + \beta_5 \log P_5 + V_i + U_i$.......................(6)

where:
C_1 = Total production cost (naira)
P_1 = Cost of maize seeds (naira)
P_2 = Cost of fertilizers (naira)
P_3 = Cost of herbicides (naira)
P_4 = depreciation on fixed cost items (naira)
P_5 = Cost of Labour (naira)
The inefficiency model is defined by:

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4$.................(7)

where:
U_i = Cost inefficiency effect
Z_1 = Age of maize farmer (in years)
Z_2 = Family size
Z_3 = Education (years spent in school)
Z_4 = Extension contact (Number of contacts).
σ^2, δ, γ, βs are unknown parameters that were estimated. The Maximum Likelihood Estimates (MLE) for all the parameters of the stochastic frontier production and cost functions were obtained using the computer program FRONTIER version 4.1c [10].

RESULTS AND DISCUSSIONS

Socio-economic Characteristics of Respondents

Table 2 showed that the average farm size cultivated was 1.89 ha. The least hectarage under cultivation was 0.5hectare with a maximum of 10 hectares. Ndaghu *et al.* [18] reported the preponderance of small scale maize farmers in Adamawa State, Nigeria. The mean age was 44 years with minimum and maximum of 20 and 70 years. The implication is that they are ageing with the consequence of declining productivities. Opaluwa [21] reported a mean age of 49 years among maize farmers in Kogi State, Nigeria. Production is affected when farmers get older Respondents in the study area are well experienced with the average experience of 21 years in maize cultivation. Most of the farmers might have perfected their farming skills over years. Respondents are characterized by large family sizes as evidenced by the mean family size of eight people which is lower than nine people as reported by [14] among maize farmers in Oyo State Nigeria. Adedeji *et al.* [3] found out that large family sizes are sources of labour for production. Furthermore, the mean years spent in formal school was nine years which indicated the preponderance of educated farmers. The ability to deal with or adjust successfully to technological change for better performance is likely to be easy. The result is in agreement with [16] and [3] who reported substantial number of educated maize farmers in rural areas.

Table 2. Summary of Descriptive Statistics of Variables

Variable	Mean	Std. Dev.	Minimum	Maximum
Farm size (hectares)	1.89	1.474315	.5	10
Age (years)	44	10.36763	20	70
Experience(years)	21	11.09805	1	50
Family size (number of people)	8	4.546713	2	30
Education(years spent in school)	8.991667	6.103444	0	19

Source: Field Survey, 2023.

Technical Efficiency of Maize Production

Table 3 is the estimates of the parameters for the frontier production function, the inefficiency model and the variance parameters of the model. The variance parameters of the stochastic frontier production function sigma squared (δ^2) and gamma (γ) were significantly different from zero at one percent level. Gamma indicates that the systematic influences that are unexplained by the production function are the dominant sources of random error. The gamma estimate which is 0.9420 shows the amount of variation resulting from the technical inefficiencies of the maize farmers. This means that 94.20% of the variation in farmers output is due to difference in technical efficiency.

The coefficient for seeds (0.3809) is positive and statistically significant ($p \leq 0.01$). A unit increase in quantity of seeds will result to an increase in output by 0.3809 kg. This result is in agreement with [5] who reported seeds have overriding importance in maize production in Nigeria. Idowu and Busayo [14] also reported a significant relationship between seeds and output of maize among farmers in Oyo State, Nigeria.

The estimated coefficient for farm size was 0.1997 and statistically significant ($p \leq 0.01$) and plays a critical role in maize production. Farm size has been found to be one of the most important factors of maize production [22]. This result is in agreement with [14] who examined Technical Efficiency among maize farmers in Oyo State and found out that land was a factor of maize production.

The coefficient for fertilizer was 0.1385 and statistically significant ($p \leq 0.01$). This implies that fertilizer is a positive and significant factor that influences the output of maize farmers. A unit increase in fertilizers will result to an increase in output by 0.1385 kg *ceteris paribus*. This result is in line with [21] who reported that fertilizer was significant in maize production in Kogi State, Nigeria. The coefficient for herbicides is 0.0523 and this was statistically significant ($p \leq 0.1$). This implies that herbicides are a positive and significant factor that influences the output of maize farmers. Herbicides are required in the control of weeds in maize farms. A unit increase in the use of herbicides for weed control in maize farm will give a corresponding increase in maize output by 0.0523 kg ceteris *paribus*. This result is in line with [14] and [3] who reported that herbicide was significant in maize production in Oyo State and Osun State respectively.

The estimated elasticity for labour (0.0687) and this was statistically significant ($p \leq 0.05$). Maize production is labour intensive and is used in combination with herbicides for production. There are production activities that require manual labour such as fertilizer and herbicide application, planting harvesting shelling, bagging loading and off loading. A unit increase in the use of labour will lead to increase in maize output by 0.0687 kg ceteris *paribus*. This result is in line with [3] who reported that labour was significant in maize production in Osun State, Nigeria.

Table 3. Maximum Likelihood Estimate of parameters of Cobb- Douglas Stochastic Frontier Production function for Maize farmers

Variable	**Parameter**	**Coefficient**	**Standard error**	**T. value**
Production factors				
Constant	β_o	0.2639***	0.0817	3.23
Seeds	β_1	0.3809***	0.0411	9.27
Farm size(Hectares)	β_2	0.1997***	0.0290	6.89
Fertilizer	β_3	0.1385***	0.0251	5.52
Herbicides	β_4	0.0523*	0.0289	1.81
Labour	β_5	0.0687**	0.0293	2.34
RTS		0.8401	0.03068	
Inefficiency model				
Constant	δ_0	-0.4786	0.4991	-0.96
Age	δ_1	-0.0112***	0.0034	-3.29
Family size	δ_2	0.3726**	0.1752	2.13
Education	δ_3	-0.8899**	0.3176	-2.80
Extension Contact	δ_4	-0.2454**	0.0981	-2.50
Variance parameters				
Sigma squared	δ^2	0.2458***	0.0778	3.16
Gamma	Γ	0.9420***	0.2100	4.49
Log likelihood function	LLF	15.43		

Source: Field Survey, 2023 *** Significant at 1 percent ** Significant at 5 Percent

The empirical results show that, from the estimates of the Cobb-Douglas production function model, the estimated elasticities of mean maize output with respect to, seeds, farm size, fertilizer, herbicides and labour at mean input values were 0.3809, 0.1997, 0.1385, 0.0523 and 0.687 respectively. This indicates that, if land under maize production with the required quantities of seeds, fertilizer, herbicides and labour individually increased by one per cent, then the mean production of maize is estimated to increase by 0.3809, 0.1997, 0.1385, 0.0523 and 0.687 percent respectively. This is because the estimated output elasticity with respect to all the variables was found to be positive. The returns to scale (RTS) of 0.8401 shows a decreasing returns to scale. Abubakar and Onwujiobi [1] obtained a much lower RTS of 0.216 among maize farmers in some selected communities of Orlu Local Government Area of Imo State, Nigeria. This implied that the value reported in this study is not an isolated case, thereby further underscoring the need to expand the scope of maize production by reduction in wasteful use of resources in Adamawa State to meet the growing demand for the crop both for food and formulation of livestock feeds.

Determinants of Technical Inefficiency among Respondents

Variables of the technical inefficiency effect estimated in the model and the result is presented in Table 3. The result of the inefficiency model shows that the coefficients of the efficiency variables with the exception of age and family size had the expected signs. The coefficient for age was positive and statistically significant ($p \leq 0.05$) and increases inefficiency among farmers. Declining productivity is usually observed among older farmers especially for direct production activities except for decision making where they are best decision makers. The coefficient for family size was positive and statistically significant ($p \leq 0.05$) and increases inefficiency among farmers.

The coefficient for education was - 0.8899 and statistically significant ($p \leq 0.05$) and increases the technical efficiency of the respondents. Educated farmers are innovative and the transformation processes by extension agents are likely to be easier among them. This result is in agreement with the work of [20] that identified education as a catalyst in the improvement of technical efficiency of farmers in Nigeria. Education obviously will improve production efficiency as it will enable farmers to access improved technology and best practices available to them. The estimated coefficient for extension contact is -0.2454 and is statistically significant ($p \leq 0.05$). Extension contact will lead to increase in the efficiency of the farmers. The implication of this is that increasing the number of contacts with extension agents through efficient extension delivery system can bridge the gap between the efficient and inefficient maize farmers in the study area. Such approaches stimulate farmers' adoption of agricultural technologies which in the long run shifts the farmers' production frontier upward. The main function of extension agents is to disseminate the latest research results to the farmers. They provide farmers with information on improved production practices. It must be emphasized that the effectiveness of extension agents does not only depend on the frequency of their visits but also on the maize farmers' attitude and receptivity. This result is consistent with the findings of [3, 12] who found a positive correlation between extension visits and yield of maize among smallholder maize farmers in Osun State and Kwara State, Nigeria.

Allocative Efficiency of Maize Production

The Maximum Likelihood Estimate (MLE) of the parameters of the stochastic cost frontier model for maize farmers is presented in Table 4. The diagnostic statistics of the variance parameters of the stochastic frontier cost (sigma squared (δ^2) and gamma (γ) were significantly different from zero at one percent level. The gamma estimate which is 0.8024 shows the amount of variation resulting from the allocative inefficiencies among farmers which means that 80.24% of the variations among the respondents is due to differences in allocative inefficiency. The estimates of the parameters of stochastic cost frontier model of the maize farmers were all positive and imply that the variables used in the analysis have direct relationship with total cost of maize production. The estimated coefficients for the specified function can be explained as the elasticities of the explanatory variables which is typical of the Cobb-

Douglas production function. A unit increase in the cost of maize production would be increased by the value of each of the coefficients.

The estimated coefficient for cost of seeds was 0.3862 and statistically significant ($p \leq 0.01$). This implies that the variable is a positive and significant factor that influences cost of production among maize farmers. The estimated coefficient for cost of fertilizers was 0.1248 and statistically significant ($p \leq 0.01$). This implies that the variable is a positive and significant factor that influences cost of production among maize farmers. An increase of one percent in the cost of fertilizers will result to an increase in the total cost by 0.1248 percent depending on the management of maize farms. The coefficient of the variable associated with cost of herbicides was 0.1304 and is statistically significantly ($p \leq 0.05$). The estimated coefficient for was 0.1011 and is statistically significant ($p \leq 0.10$). The implication of this is that maize farmers incur more cost as output or production of maize increases. This result is in conformity with the works of [25] and [7] who found out that maize farmers incur more costs when they produce more.

Table 4. Maximum Likelihood Estimate of parameters of Cobb- Douglas Stochastic Frontier cost function for Maize farmers

Variable	Parameter	Coefficient	Standard error	t. value
Cost factors				
Constant	β_o	2.3474***	0.1185	19.81
Cost of seeds	β_1	0.3862***	0.0526	7.34
Cost of fertilizers	β_2	0.1248***	0.0362	3.45
Cost of Herbicides	β_3	0.1304**	0.0452	2.88
Depreciation on fixed cost items	β_4	0.0439	0.0327	1.34
Cost of labour	β_5	0.1011*	0.0574	1.76
Inefficiency model				
Constant	δ_0	0.0679	0.1376	0.49
Age	δ_1	-0.1425	0.1442	- 0.98
Family size	δ_2	-0.4245	0.0379	- 1.12
Education	δ_3	- 0.0269	0.1024	- 0.26
Extension Contact	δ_4	- 0.2544**	0.0965	- 2.64
Variance parameters				
Sigma squared	δ^2	0.0657***	0.0054	12.17
Gamma	Γ	0.8024***	0.1568	5.12
Log likelihood function	LLF	15.22		

Source: Field Survey, 2023 *** Significant at 1 percent ** Significant at 5 Percent

Determinants of Allocative Inefficiency among Respondents

The determinants of allocative inefficiency among maize farmers as presented in Table 4 revealed that inefficiency variables have the expected signs. The estimated coefficient for extension contact was -0.2544 and is statistically significant ($p \leq 0.01$). This implies that regularity in extension contact by farmers will lead to increase in efficiency and they will become more efficient in the allocation of resources in maize production. The finding agree with the study of [25] who observed that extension visit enhances farm productivity and efficiency in their study of Analysis of Allocative Efficiency of Small Scale Maize Production in the Guinea Savannah Region of Borno State, Nigeria.

Efficiency Measurement of Maize farmers

Table 5 shows the efficiency indices estimated from the stochastic frontier analysis (SFA).The estimated efficiency scores ranged between 0.39 and 1.00 for Technical Efficiency (TE), Allocative Efficiency (AE) and Economic Efficiency (EE) respectively. The mean, minimum and maximum TE was 0.79, 0.27 and 0.96 respectively. The mean values obtained were higher as compared to 0.52 reported by [26] but was lower to 0.98 in the case of [1].

Frequency distribution based on TE indices revealed that 18.69% of the respondents fall to the range of 0.39 – 0.69 while 81.31% were those in the range of 0.70 – 1.00.

Table 5. Efficiency Indices of Respondents

Efficiency Score	Technical Efficiency	Allocative Efficiency	Economic Efficiency
≤ 0.39	8(2.37)	15(4.45)	12(3.56)
0.40 – 0.49	13(3.86)	10(2.97)	24(7.12)
0.50 – 0.59	18(5.34)	43(12.76)	41(12.17)
0.60 – 0.69	24(7.12)	58(17.21)	69(20.47)
0.70 – 0.79	57(16.91)	192(56.97)	105(31.16)
0.80 – 0.89	95(28.19)	12(3.56)	77(22.85)
0.90 – 1.00	122(36.20)	7(2.08)	9(2.67)
Total	**337(100)**	**337(100)**	**337(100)**
Mean	0.79	0.88	0.69
Maximum	0.96	0.94	0.91
Minimum	0.27	0.33	0.26

Source: Researchers own computation 2023. Note: Figures in parentheses are percentages.

If the average farmer in the sample were to reach the technical efficiency level of its most efficient counterpart, then the average farmer could experience a cost savings of 65.82% [i.e. 1-(.27/.79)].

The result suggests that the farmers in the study area are not able to achieve optimal production as 21 % of the inputs were wasted relative to the best practiced farms producing the same output facing the same technology in the study area.

The implication is that the overall technical efficiency of the maize farmers could be increased by 21% (i.e. 1.00- 0.79) through the reduction in the wasteful use of production inputs that would occur if production was to occur at the technically efficient point in the short – run under a given technology.

The mean Allocative efficiency among respondents was 0.88 with the minimum and maximum values of 0.33 and 0.94 (Table 6). The mean value was higher as compared to 0.45 reported among maize farmers in Orlu Local Government Area of Imo State by [1]. From Table 5, 62.61 % of the maize farmers fall to the range of 0.70 – 1.00 and those in the range of 0.39 – 0.69 accounted for 37.39% respectively. This result indicates that maize farmers in the study area are fairly allocatively efficient in maize production. For the average farmer in the sample to reach the allocative efficiency level of the most efficient farmer, then the average farmer could experience a cost savings of 62.50% [i.e. 1-(.33/.88)].

In other words, 12% of the resources are inefficiently allocated relative to the best-practiced farms producing the same output and facing the same technology in the study area.

This implies that the allocative efficiency among respondents could be increased by 12% through better utilization of resources in the optimal proportions given their respective prices and given the current technology.

This would enable the farmers to equate the marginal revenue product (MRP) of input to the marginal cost of input thereby improving farm income.

The frequency distribution of respondents based on Economic Efficiency indices (Table 5) shows that 43.32% of the respondents fall to the range of 0.39 – 0.69 whereas 56.68% were those in the range of 0.70 – 1.00.

The mean, maximum and minimum efficiencies were 0.69, 0.91 and 0.26 respectively.

If the average farmer in the sample were to reach the economic efficiency level of its most efficient counterpart, then the average farmer could experience a cost savings of 62.32% [i.e. 1-(.26/.69)].

The result suggests that the farmers in the study area are not able to minimize the cost of production as 31% of the production costs were wasted relative to the best practiced farms producing the same output facing the same technology in the study area.

The implication is that the overall economic efficiency of the maize farmers could be increased by 31% (i.e.1.00 - 0.69) through the reduction in production costs that would occur if production were to occur at the allocatively and technically efficient point in the short – run under a given technology.

This would enable the respondents to minimize production costs thereby maximizing income and profit. Substantial variations were observed in farmer- specific efficiency in maize production as reported by scholars such as [1, 14, 26, 5, 21].

The results showed that farmers still have room for improvement of their efficiency in maize production in the State.

Constraints to Maize production

Analysis in Table 6 shows that high cost of inputs (94.36%), Striga infestation (89.32%), inadequate credit facilities (86.35%), drought (76.85%), pests and disease (75.37%) and flooding (71.22%) were the major constraints to maize production.

Table 6. Distribution based on Constraints of Maize Production

Constraints	Frequency	Percentage
High cost of inputs	318	94.36
Pests and diseases	254	75.37
Striga infestation	301	89.32
Adulteration of agrochemicals	239	70.92
Poor road	140	41.54
Inadequate credit facilities	291	86.35
Theft of produce	127	37.69
Drought	259	76.85
Flooding	240	71.22

Source: Field survey: 2022.

The result is in agreement with the works of [1, 22, 11, 18] who identified some of these constraints affected maize production in various parts of the country.

CONCLUSIONS

Farmers are not fully efficient in the use of resources for maize production in the State with room to improve their efficiency of production if the identified constraints are addressed by and stakeholders in the maize industry should support programmes that can lead to increase production through efficient allocation of resources.

This can be achieved through training of the farmers on resource allocation by the government and nongovernmental organization in the State. The use of early maturing and drought resistant varieties should be adopted by farmers. Formation of cooperative association by farmers will help them access credits to purchase inputs for maize production.

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