



## ANALYSIS OF TECHNICAL AND RESOURCE USE EFFICIENCY AMONG SMALLHOLDER YAM FARMERS IN TARABA STATE, NIGERIA

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### ABSTRACT

The study examined the technical and resource-use efficiency among smallholder yam farmers in Taraba State, Nigeria. Multistage sampling technique was used to select cross-sectional data from 244 smallholder yam farmers in Jalingo, Yorro and Zing local government areas of Taraba State, Nigeria. The stochastic frontier analysis (SFA) was used to analyse the driving factors of yam output and measure the technical efficiency level of farmers while the marginal value product – marginal factor cost (MVP-MFC) approach was used to estimate the efficiency of resource use in yam production. The study found out that the mean technical efficiency of the yam farmers was 76.31 %, which means that 23.69% of the technical output was not achieved. Moreover, the study also revealed that level of education and numbers of extension visit exert a positive and significant effect on the technical efficiency at 1 % level. Likewise the study shows that age, farming experience, years in cooperative membership and the amount of credit received were positive and significant at 5 % level while family size was positive and exert a significant effect on the technical efficiency at 10 %, Finally, the result of the resource use efficiency showed that farm size (29.37), yam set/seed (1.52) and agrochemicals (1.15) were found to be under-utilized while fertilizer (0.047) and labour (0.08) was found to be over-utilized. In general, the study revealed that elasticity of production is greater than unity (2.221). It can be concluded that yam farmers in the study area were operating at increasing returns to scale. The study recommends that policies and strategies should place more emphasis on strengthening the existing agricultural extension service provision through providing incentives, short and long-term training, and upgrading educational level, providing non-overlapping and congruent responsibilities to extension workers. The study also recommended that to achieve optimum resource use efficiency and hence maximum profit in yam production in the study area, farmers should be encouraged to maximise the use of land, yam set/seed and agrochemical and minimize the use of labour and fertilizer respectively in order to improve the farmers' productivity and income in the study area. This can be achieved through appropriate policy options that would encourage the reallocation and redistribution of these inputs

**Keywords:** Technical, Resource-use, Efficiency, Smallholder, Farmers and Yam

### INTRODUCTION

Yam is a fundamental staple in Nigeria's diet, offering potential not only for human consumption but also as livestock feed and a source for industrial starch production (Adifon, 2020). Given factors such as cultivated land area, production volume, and economic value, yam holds a prominent position among Nigeria's tuber crops (Azeteh *et al.*, 2019). Its significance extends beyond the culinary realm, with yam playing a vital role in the religious and cultural heritage of various tribes (Ajibefun *et al.*, 2020). The diverse culinary uses of yam, including preparations such as fufu, boiled, pounded, fried, and roasted, underscore its status as a primary staple for Nigerians (Aliyu and Shelleng, 2019). The entire yam value chain, including production, transportation, processing, and marketing, contributes to rural economies, particularly benefiting smallholder farmers, often women, who serve as aggregators and marketers. Additionally, yam contains dioscorine, a pharmacologically active compound, and is medicinally associated with heart stimulation (Ariyo *et al.*, 2020).

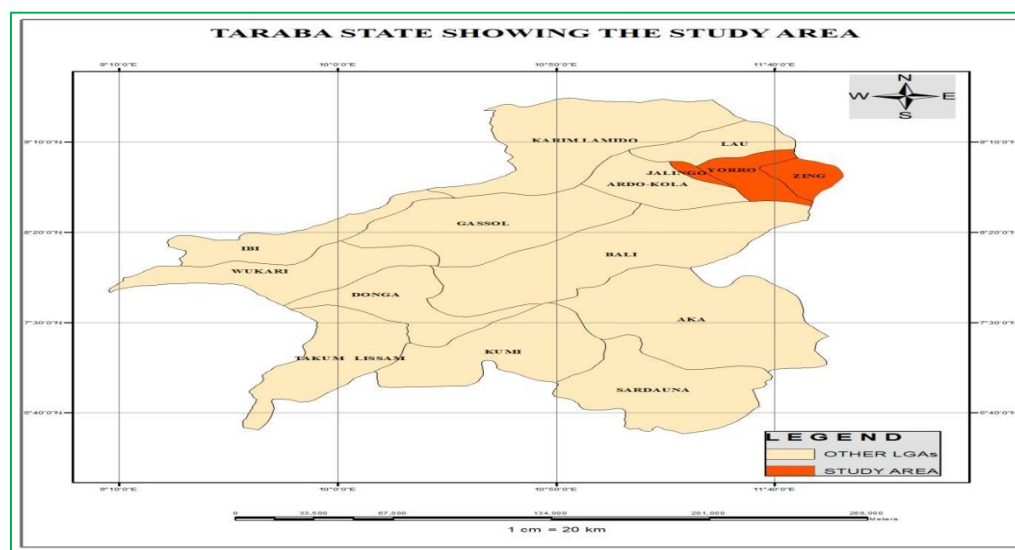
Resource use efficiency involves the allocation of the scarce farm inputs efficiently to generate an optimum yield (Iroegbu *et al.*, 2022). Resource efficiency in yam therefore refers to a

situation where farmers make use of the scarce resources efficiently for the production of yam optimally (Okoh *et al.*, 2022). Despite its many uses yam production still suffers set back largely due to the fact that it is dominated by small scale farmers who lack the necessary inputs, capital and extension services required to boost their production. The small scale yam farmers are also known to be poor resource use efficient because of the lack of ability to allocate the available resources efficiently enough to generate the required output. Small scale farmers underutilized resources in addition to poor extension services, use of low yielding varieties, inadequate incentives and amenities, which give rise to low output and hence low farm income. To achieve optimum production level, resources must be used efficiently. Successful planning and result-oriented policies require the technical knowledge of the productivity of farm resources to know the necessary adjustment to achieve a correct input mix (Assa *et al.*, 2020). Consequently, there is an urgent need to evaluate the technical and resource use efficiency of yam production in the study area in order to support evidence based planning and agricultural policy formulation. Thus, this study aimed to determine technical and resource-use efficiency among smallholder yam farmers in some selected LGAs of Taraba state, Nigeria. This study was carried out to determine the technical efficiency and estimate the resource use efficiency among smallholder yam farmers in the study area.

## **MATERIALS AND METHODS**

### **The Study Area**

Taraba State is located in northeastern Nigeria and lies between latitude 7°27'N and 11°28'N and longitude 9°19'E and 11°39'E (Figure 1). It covers a land area of approximately 54,473 square kilometers (Taraba State Government, 2021). As at 2024 the State projected population (based on the 2006 National Population Census) was about 3.77 million (NPC, 2006). The State is home to various ethnic groups including the Jukun, Fulani, Mumuye and Kuteb. The State has a tropical climate characterized by distinct wet and dry seasons. The region experiences a bimodal rainfall pattern, with the main rainy season occurring from April to October, while the dry season extends from November to March. These climatic conditions, with annual rainfall ranging from 1,200 to 2,000 mm, favor yam production, providing sufficient moisture for the crop's growth and development (Federal Ministry of Environment Nigeria, 2021). The state's soil types are varied, with the predominant soil groups being Ferrasols, Acrisols, and Luvisols. These soil types are generally fertile and suitable for agriculture, including yam cultivation. The Ferrasols are particularly well-drained, which is beneficial for yam tuber development (Federal Ministry of Environment Nigeria, 2021). Yam is a significant source of livelihood for rural dwellers in the State. It generates employment and income among adults and youth, thereby reducing poverty and creating/strengthening of competitive advantage.



**Figure 1:** Map of Taraba State Showing the Study Area



### Sampling Procedure and Sample Size

The study considered yam farmers engaged in yam production in the selected LGAs during the period of the study (2021-2022) as the target population. Multi stage sampling procedure was employed for this research. In the first stage, a purposive selection process was employed to choose three Local Government Areas (LGAs) - Jalingo, Yorro, and Zing - out of the total of 16 LGAs in the State. This selection was based on the prevalence of smallholder yam farmers within these specific areas and security. In the second stage, a simple random sampling techniques through the use of card method was employed in selecting three (3) communities from each LGAs. These communities selected were Kasuwan Runfa, Wuro Musa, Kona, Kassa, Nyaja, Puppule, Munkin, Kakulu and Yakoko respectively. In the last stage, 25 % of the sampling frame was randomly sampled from each of the local government area selected and this gave a total of 244 yam farmers as sample size of the study. The breakdown of the sampling procedure is given in Table1

**Table 1: Sample Size and Sampling Frame**

LGAs	Communities	Sampling frame*	Sample size (25%)
Jalingo	Kasuwan Runfa	87	22
	Wuro musa	100	25
	Kona	107	27
Yorro	Kassa	132	33
	Nyaja	119	30
	Puppule	100	25
Zing	Munkin	121	30
	Kakulu	97	24
	Yakoko	112	28
Total	9	975	244

### Method of Data Collection

Primary data was used for the study. A cross-sectional data for major cropping season of 2021/2022 (which covered December through to July) was collected from the selected farmers by administering a well-structured questionnaire in the area through the help of well-trained enumerators. The questionnaires were designed to capture a range of information from the farmers, including socioeconomic characteristics such as age and sex, farming experience, educational attainment, household composition, size of the farmland, frequency of interaction with extension services, amount of credit received, participation in farmer associations, engagement in land renting, availability and costs of inputs, labour sources and quantities, output along with corresponding prices.

### Methods of Data Analysis

#### The stochastic production frontiers

The Stochastic Frontier Production model originated from works done by economists such as Meeusen and van den Broeck (1977), Aigner *et al.* (1977) and Battese *et al.* (1977). This model has the error component which is separated into the random component and inefficiency effect. Hence, this approach to technical efficiency analysis seeks to explain that displacements away from the highest possible output may be due to other additional external factors other than only from the inefficiency of the production agent. Other factors which contribute to variations may be external shocks outside the control of the producer (Kamau *et al.*, 2019). These random or external shocks include effects of weather as well as diseases, economic and institutional shocks, population growth and other uncertainties.

The stochastic frontier function can be written as;

$$Y_i = f(X_i, \beta) \cdot \exp(v_i - u_i) \text{-----1}$$

Where:

$Y_i$  = Quantity of output of the  $i^{\text{th}}$  farm

$X_i$  = Vector of the inputs used by the  $i^{\text{th}}$  farm



$\beta$  = A vector of the parameters to be estimated

$e_i$  = Composed error term

$v_i$  = Random error outside farmer's control

$u_i$  = a non-negative error component that measures the endogenous sources of technical inefficiency effects on the part of the producer.

$(X_i, \beta)$  = A suitable function of the vector

The composed error term is  $e_i = [v_i - u_i]$ , where captures the effect of pure noise in the data attributed to measurement error, extreme weather conditions etc. and the one-sided inefficiency effects are denoted as  $u_i$ . A single firms' technical efficiency from the stochastic frontier is expressed as a proportion of the actual output to its own analogous stochastic frontier output, with respect to the input levels used by the firm. Therefore, a firm's technical efficiency using the function of the stochastic production frontier which is given by;

$$TE = \frac{f(x_i, \beta) \cdot \exp(-u_i)}{f(x_i, \beta) \cdot \exp(v_i)} = \exp(-u_i) \text{-----2}$$

### Resource Use Efficiency

Resources, these resources should be used in a manner such that their marginal value product (MVP) is equal to their marginal factor cost (MFC) under perfect competition, according to Alabuja *et al.* (2022). Consequently, the resource use efficiency parameter was calculated using the ratio between the MVP of inputs and the MFC. According to Ariyo *et al.* (2020), the efficiency of resource use can be calculated as follows:

$$RE = \frac{MVP}{MFC} \text{-----3}$$

Where:  $RE$  is the resource efficiency coefficient,  $MVP$  is the marginal value product, and  $MFC$  is the marginal factor cost of inputs.

$$MFC = P_x \text{-----4}$$

Where:  $P_x$  is the unit price of the input, say  $X$ .

$$MVP_x = MPP_x \times P_y \text{-----5}$$

Where  $y$  is the mean value of output,  $x$  is the mean value of input employed in the production of a product,  $MPP_x$  is the marginal physical product of input  $X$ , and  $P_y$  is the unit price of yam output.

Taking into consideration the Cobb-Douglas production function (Eq. 5)

$$\beta_x = \frac{\delta \ln Y}{\delta \ln X} = \frac{\delta Y}{\delta X} \times \frac{Y}{X} \text{-----6}$$

$$MPP_x \frac{\delta Y}{\delta X} = \beta_x = \frac{Y}{X} \text{-----7}$$

Where  $MPP_x$  is the marginal physical product of input  $X$  and is a measure of input  $X$ 's technical efficiency, and  $\beta_x$  is the output elasticity of input  $X$ .

Hence,

$$MVP = \frac{\delta Y}{\delta X} \times P_y = \beta_x \frac{Y}{X} \times P_y \text{-----8}$$



Where  $Y$  represents the value of the output,  $X$  represents the value of the input and  $P_y$  represents the unit price of the output.

The MVP of a particular input resource is consequently computed by the product of output elasticity of that input, the ratio of mean output to mean input values, and the unit output price. The MFC of input was attained from the data composed on that input's unit price. To decide whether or not an input is used efficiently, we used the following convention. If  $r=1$ , it implied the input was used efficiently,  $r>1$  meant the input was underutilized, so the output would be increased if more of that input were employed. Finally,  $r<1$  means that the input is over-utilized, so both the production and profit would be maximized if less input were utilized (Alabuja *et al.*, 2022).

### Model Specification

The empirical stochastic frontier production model used for the study is specified in a Cobb-Douglas functional form as follows

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + (V_i + U_i) \text{-----} 9$$

Where

$\ln$  = The natural logarithm

$Y$  = Yield of harvested yam (kg)

$\beta_0$  = Constant term

$\beta_1$ –  $\beta_5$  = regression coefficients

$X_1$  = Farm size (ha)

$X_2$  = Quantity of yam set/seeds used (kg)

$X_3$  = Quantity of inorganic fertilizer used (kg)

$X_4$  = Total labour used (man days)

$X_5$  = Quantity of agrochemical used (litres)

$V_i$  = assumed independently distributed random error or random shock having zero mean. It is associated with random factors such as measurement errors in production and weather which the farmer does not have control over.

$U_i$  = is one sided component which captures deviation from frontier as a result of inefficiency of the farmer and ranges between zero and one. It is associated with farm-specific factors, which lead to the  $i^{\text{th}}$  firm not attaining maximum efficiency

The technical inefficiency of production  $U_i$  was modeled in terms of the factors that are assumed to affect the efficiency of production of farmers. Such factors were related to the socio-economic and institutional variables of the farmers. The determinant of technical inefficiency is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + e_i \text{-----} 10$$

Where;

$U_i$  = Technical inefficiency effects of the  $i^{\text{th}}$  farmer

$Z_1$  = Age (years)

$Z_2$  = Level of Education (years of formal schooling)

$Z_3$  = Household size (number of people)

$Z_4$  = Years of experience in yam production (years)

$Z_5$  = Membership of cooperative (number of years in cooperative)

$Z_6$  = Extension contact (number of extension contact)

$Z_7$  = Access to Credit (amount of credit received in Naira)

$\delta_0$  = constant

$\delta_1$ –  $\delta_7$  = Parameters to be estimated.

### Efficiency of resource-use

The most widely used measure of efficiency of resource use is the ratio of Marginal Value Product to Marginal Factor Cost. For a firm to optimally maximize a variable input, the ratio of its Marginal Value Product (MVP) to its Marginal Factor Cost (MFC) must be equal to unity. On the



other hand, a ratio less than unity implies over utilization of the variable resource, while a ratio greater than unity implies that the variable resource is under-utilized. Following Sapkota, *et al.* (2018) efficiency of resource (r) was estimated as:

$$r = \frac{MVP}{MFC} \text{-----11}$$

$$MVP = MPP \times P_y \text{-----12}$$

$$MPP = \beta_i Y \text{-----13}$$

$$MFC = P_{xi} \text{-----14}$$

Where:

MPP= Marginal Physical Product

$P_y$  = Unit Price of Output

$P_{xi}$  = Unit price of input Xi

r= Efficiency ratio

Y= Arithmetic mean value of output

X= Arithmetic mean value of input considered

$\beta_i$  = Estimated coefficients of independent variables.

Based on the econometric theory, a firm maximizes profits with regard to resource use efficiency when ratio of marginal product to the opportunity cost is one. The values are interpreted as follows:

If **r is less than 1** = resource was excessively used or over-utilized, hence decreasing quantity use for those resources increases profit.

If **r is greater than 1** – resource is under use or being under-utilized, hence increasing it rate of use will increase profit level.

If **r = 1** it shows the resource is efficiently used, that optimum utilization of resource hence the point of maximization.

The relative percentage change in MVP of each variable input required to achieve an optimal resource efficiency, (r = 1) was calculated as follows;

$$C = \left(1 - \frac{1}{\frac{MVP}{MFC}}\right) \times 100 \text{ or } \left(1 - \frac{1}{r}\right) \times 100 \text{-----15}$$

Where;

C= absolute value of percentage change in MVP of each resource.

## RESULTS AND DISCUSSION

### Analysis of Technical Efficiency of Yam Production in the Study Area

The result in Table 2 presents the stochastic frontier parameter estimates for yam farmers in the study area. From the result the estimated sigma square ( $\sigma^2$ ) parameters in the stochastic frontier production functions is significantly different from zero, indicating good fits of the models and the correctness of the specified distributional assumptions. The gamma ( $\gamma$ ) values of 0.7631 lie between 0 and 1. This implies that about 76.31% of the total variance of composed errors of the production functions for the yam farmers is explained by the variance of the technical inefficiency terms of the respective production functions. The estimated coefficient for farm size (1.543) is positive which conform to a priori expectation and significant at 1% level of probability. The magnitude of the coefficient of farm size (1.543) indicated that the gross margin in yam production is elastic to changes in the level of cultivated land area. This implies that a 1% increase in farm size would result in 1.543% increase in output level in yam production in the study area. This results collaborates Chisonum *et al.* (2021) who found out that if farmers expand their yam farm land, it will lead to increase in yam output in Delta State, Nigeria.



Likewise, the coefficient of yam set/seed input (0.344) and labour (0.231) was observed to be positive and significant at 1% level of probability, while the coefficient of fertilizer (0.045) and agrochemical (0.058) was found to be positive and significant at 5 % level of probability. The magnitude of the coefficient of yam set/seed input (0.344), labour (0.231), fertilizer (0.045) and agrochemical (0.058) in yam production were inelastic to changes in the amount of the respective input used. This implies that a unit increase in each of yam set/seed, labour, fertilizer and agrochemical will lead to a corresponding increase in output by 0.344, 0.231, 0.045 and 0.058 respectively. This agrees with the findings of Shehu *et al.* (2010); Orewa and Izekor (2012); Ani *et al.* (2014) and Toluwase and Sekumade (2017) who reported that the coefficients of seed yam, labour, fertilizer and agrochemicals was positive and significantly influenced changes in yam output in their respective area of their study.

#### **Determinants of Technical Efficiency of Yam Production in the Study Area**

The result in Table 2 further shows that the estimated coefficient of age was found to be positive and statistically significant at 5 % level. The result infers those younger farmers are more technically efficient than older farmers. It is not surprising to find that as farmers grow older, their inefficiencies increased. This is contingent on the fact that the elderly farmers are so stuck to their old system of farming that they fail to adhere to the advices of the agricultural extension officers on the need to use improve technology. This is contrary to the findings of Ismail and Mahmud (2023) which found the coefficient of age to be negative and statistically significant to technical inefficiency in yam production in Kwara State, Nigeria. Furthermore, the coefficient of level of education variable is estimated to be negative as expected and statistically significant at 1% level. The implication is that farmers with formal education tend to be more efficient in yam production presumably due to their enhanced ability to acquire technical knowledge, which makes more close to the frontier output. This finding agrees with the findings of Toluwase and Sekumade (2017) who found a negative relation between the level of education and technical inefficiency in their study of resource use efficiency of yam production in Ekiti State, Nigeria.

Moreover, the coefficient of farming experience variable is estimated to be negative and statistically significant at 5% level. Increased yam farming experience may lead to better assessment of importance and complexities of good farming decision, including efficient use of inputs. This proves that farmers with more years of experience in yam farming tend to be more technically efficient than those with lesser years of experience in study area. This is line with the finding of Adeshina *et al.* (2020) who reported a negative correlation between years of yam farming experience and the technical inefficiency in their study on technical efficiency of yam production systems in Ogbomosho Agricultural Zone, Oyo State, Nigeria. In the same vein, the coefficient of years in farmers' cooperative is estimated to be positive contrary the a priori expectation and significant at 5%. The plausible explanation might be that the yam famers would not have reaped the benefits of belonging to cooperatives such as bulk purchasing of farming inputs at reduced cost and guaranteed access to credit as they would not have availed themselves of these opportunities in their cooperative societies. This is contrary to the findings of Shehu *et al.* (2010) who reported a negative relationship that the coefficients of membership of cooperative and technical inefficiency in their study on technical efficiency among yam farmers in Benue State, Nigeria.

Finally, the coefficient of numbers of agricultural extension contact variable as an efficiency factor is estimated to be negative as expected and statistically significant at 1% level. This implies that an increased number of extension services to farmers tend to increase technical efficiency in yam production. The decreased inefficiency level with more number of extension contacts was most probably due in large part adopting the improved and recommended practices of yam production brought to them by extension officers individually or through the farmers' cooperatives. This is line with the finding of Ismail and Mahmud (2023) who reported a negative coefficient of numbers of agricultural extension contact in their study on technical efficiency of yam production in Kwara State, Nigeria.

**Table 2: MLE Results of Stochastic Frontier Production Function for Yam Farmers**

Variables	Parameters	Coefficients	Std. error	T-Value
<b>Production function</b>				
Constant	$\beta_0$	0.362	0.407	0.889
Farm size	$\beta_1$	1.543***	0.416	3.709
Yam set/seeds	$\beta_2$	0.344***	0.056	6.143
Fertilizers	$\beta_3$	0.045**	0.022	2.046
Labour	$\beta_4$	0.231***	0.057	4.053
Agrochemicals	$\beta_5$	0.058**	0.025	2.320
<b>Inefficiency model</b>				
Constant	$Z_0$	0.398	0.506	0.786
Age	$Z_1$	0.614**	0.292	2.102
Level of educational	$Z_2$	-0.473***	0.187	-2.529
Household size	$Z_3$	-0.432*	0.238	-1.815
Years of faming experience	$Z_4$	-0.224**	0.092	-2.435
Years in farmers' cooperative	$Z_5$	0.451**	0.214	2.107
Number of extensions contact	$Z_6$	-0.476***	0.188	-2.532
Amount of credit received	$Z_7$	0.321	0.236	1.360
<b>Diagnostic statistic</b>				
Sigma-squared	$(\sigma^2)$	0.1630***	0.0509	3.2024
Gamma	$(\gamma)$	0.7631***	0.0915	8.3399
Log likelihood function	$L/f$	-154.585		
LR test	$LR$	-82.603		
Total number of observations		244		

Asterisk indicate significance \*\*\*=1%, \*\*=5%, and \*=10%.

### Summary Statistics and Frequency Distributions of Technical Efficiencies

The result in Table 3 is a frequency distribution table showing the technical efficiency scores of yam farmers in the study area. The minimum, maximum, and the mean technical efficiency scores are 11.9%, 96.7% and 73.5% respectively with standard deviation of 1.236. Based on the findings of the research, there is no farmer who has technical efficient score of 100%. It is not surprising since it is practically impossible to have technical efficiency of 100%. This means in the short run there are opportunities for reducing input used for yam production proportionally by 26.5% to produce the current level of output. If the average farmer in the sample was to achieve the technical efficiencies level of its most efficient counterpart, then the average farmer could realize 23.9%  $[1 - (0.735/0.967) \times 100]$  reduction of inputs use to produce the output of the most efficient counterpart. Similarly, the most technically inefficient farmer was to achieve the technical efficiency level of his most efficient counterpart; then the least efficient farmer could realize 87.7%  $[1 - (0.119/0.967) \times 100]$  reduction of inputs use to produce the output of the most efficient counterpart. This is line with the finding of Chisonum *et al.* (2021) and Ndubueze-Ogaraku *et al.* (2021) who reported a mean technical efficiency of 80% and 95% among the yam farmers in Delta and Ekiti State respectively.



**Table 3:** Frequency Distribution of the Technical Efficiency

Class interval	Technical efficiency score	
	Frequency	Percentage
$\leq 0.20$	83	34.02
0.21-0.40	36	14.75
0.41-0.60	40	16.39
0.61-0.80	60	24.59
0.81-1.00	25	10.25
<b>Total</b>	<b>244</b>	<b>100.00</b>
<b>Minimum</b>	<b>0.119</b>	
<b>Maximum</b>	<b>0.967</b>	
<b>Mean TE</b>	<b>0.735</b>	
<b>SD</b>	<b>1.236</b>	

Note; SD= Standard deviation and TE=Technical efficiency

### Estimation of resource-use efficiency of yam production in the study area

The results of the resource-use-efficiency assessments (i.e., the ratios of the marginal value product to the marginal factor cost) of the various inputs are shown in Table 4. The result revealed that the farm size ratio was (29.37), indicating that farm size had a high MVP as well as resource use efficiency greater than one. This implies that land resource used by the yam farmers in the study area were under-utilised since the marginal value product of land (₦107,129) is higher than the marginal factor cost of land (₦36,481). This inferred that more than profit maximization level of the resource was used. The effects of underutilization of this resource as observed in the study are that farming remains in rudimentary and traditional levels. There is the need to increase the usage of land by 95.11% in order for its MVP and MFC to be equal. This is line with the finding of Chisonum *et al.* (2021), who reported under-utilization of land in cassava production in Delta state, Nigeria. In the same vein, the result in Table 4 also revealed that yam set/seed input ratio was (1.52). This indicated that yam set/seed had a high MVP as well as resource use efficiency greater than unity. This implies that the yam set/seed resource was under-utilized by the farmers in the study area since the marginal value product of land is greater than the marginal factor cost. Hence, the yam output in the study area could have therefore increased if the quantities of yam set/seed were increased. Thus, farmers in the study area need to increase their spending on yam set/seed by 34.10% in order to make the MVP (0.957) equal to MFC (₦119.57) in order to achieve full utilization of the input. This does not agree with the finding of Iroegbu *et al.* (2022) who reported over-utilization of yam seed among the small scale farmers in Imo State, Nigeria.

Likewise, the study found that the fertilizer input ratio was (0.047). This indicate that fertilizer had a high MVP as well as resource use efficiency less than one. This infers that the fertilizer resource was over-utilized by yam farmers in the study area since the marginal value product of fertilizer (0.047) is lower than the marginal factor cost of fertilizer (₦15, 793). The unlimited use of animal manure, particularly from sheep and goat in crop production as fertilizer by farmers from their farms which has no significant cost implication could be the reason for over-utilization of the fertilizer resources in the study area. Therefore, the farmers in the study area will need an adjustment of 31.6% decrease in the usage of fertilizer to make its MFC equals its MVP. This is contrary with the finding of Maikasuwa and Ala (2012) who reported under-utilization of resource usage of fertilizer among the women yam farmers in Niger State, Nigeria. Similarly, the resource use efficiency ratio of labour was (0.08) which indicate that labour had a low MVP as well as resource use efficiency less than one. This implies that the resource use of labour was being over-utilized, indicating that less profit was maximized. The over-utilization of labour resource implied that less of the profit maximization of the resource was used. The possible reason for this was that the employment of large number of family labour that is often neglected in costing total cost of production among farmers in the study area in small sized yam farm could result to over-utilization. Therefore, yam output in the study area could have increased if the usage of labour were reduced. Other things being equal, labour need to be

decreased by 41.58% for efficiency in yam productivity to be ensured. This is also agrees with the finding of Iroegbu *et al.* (2022) who reported over-utilization of labour resources among the small scale yam farmers in Imo State, Nigeria.

The result in Table 4 further revealed that resource use efficiency ratio of agrochemical was (1.15), indicating that agrochemical had a high MVP as well as resource use efficiency greater than unity. This infers that the usage of agrochemicals were underutilized by yam farmers in the study area. The possible reasons for the underutilization of the resources, could be because of the inability of farmers to allocate their resources efficiently as a result of lack of technical-know-how. Thus, for an optimal resource to be achieved, there should be an increase of 73.7% of agrochemical in order to make its MVP of (17.014) equals its MFC of (₦15,793). This agrees with the finding of Iroegbu *et al.* (2022) who reported over-utilization of agrochemical among the small scale yam farmers in Imo State, Nigeria.

**Table 4:** Ratio of Marginal Value Product to Marginal Factor Cost

Variables	E	MPP	MVP	MFC	R	% diver.	Decision
Farm size	1.543	6824.3	10529	36,481	29.37	95.11	Under-utilized
Yam set/seed	0.344	725.78	245.66	119.57	1.52	34.10	Under-utilized
Fertilizer	0.045	834.53	0.9689	1,476.9	0.76	-31.60	Over –utilized
Labour	0.231	52.31	12.085	787,25	0.08	-41.58	Over –utilized
Agrochemical	0.058	293.34	17.014	15,793	1.15	73.70	Under-utilized

**Note:** E=Elasticities, MPP = Marginal Physical Product, MVP = Marginal Value Product, MFC = Marginal Factor Cost, r = Efficiency Coefficient

#### Input elasticities and return to scale of yam farmers

The elasticity values obtained from the first order maximum likelihood error (MLE) estimates as shown (Table 5) indicate the relative importance of every factor used in yam production. The result showed that output is inelastic to all inputs except the farm size which is elastic; that is, an increase by 1% of each input (yam set/seed, labour, fertilizer and agrochemical) results in a less than one percent increase in output. The result further shows that yield has the highest responsiveness to farm size, followed by yam set/seed rate, labour, agrochemicals and fertilizer respectively. Similarly, the study further revealed that the summation of all elasticities coefficients of the conventional inputs used was 2.221 representing an increasing return to scale of yam production in the study area. This implies that production was in the irrational zone of production (stage I of the classical production function), where resource uses and production is believed to be inefficient, which buttresses the fact that productive resource were being under-utilized. Therefore, 1% increase in all inputs proportionally would increase the total production by 2.221%. This result was consistent with the finding of Iroegbu *et al.* (2022) and Maikasuwa and Ala (2012) who estimated the returns to scale of 2.234 and 1.906 respectively in Imo and Niger State, Nigeria.

**Table 5:** Elasticity and Returns to Scale of the Parameters in the Production Function

Variables	Elasticities
Farm size	1.543
Yam set/seeds	0.344
Fertilizers	0.045
Labour	0.231
Agrochemicals	0.058
<b>Return to scale</b>	<b>2.221</b>



## CONCLUSION AND RECOMMENDATION

Based on the findings of the study, the study concluded that the yam farmers were not allocatively efficient in the use of their farm resources, indicating that the farmers operated in region one of production function. Another important conclusion stemming from the findings of the efficiency of yam production is that, age, level of education, years of farming experience, years of farmers' cooperative, number of extension contact and amount of credit received were variables that exerted positive effects on technical efficiency of the yam farmers in the study area. Furthermore, the study concluded that the wide gap between the actual and the potential frontier is due to inefficiency in yam production and this gap can be reduced by adopting superior production techniques that enhances efficiencies of the farmers.

Based on the research findings the following recommendations are proposed to enhance the efficiency and productivity of yam farmers.

- i. Farmers should collaborate with extension agents and other relevant agencies to assist in organizing workshops, field works and training to improve the level of farmers efficiency and productivity.
- ii. To achieve optimum resource use efficiency and hence maximum profit in yam production in the study area, farmers should be encouraged to use more of land, yam set/seed and agrochemical and use less of labour and fertilizer respectively in order to improve the farmers' productivity and income in the study area. This can be achieved through appropriate policy options that would encourage the reallocation and redistribution of these inputs

## REFERENCES

- Adeshina, W. O., Ologbon, O. A. C., Idowu, A. O., Oyebanjo, O. & Saliu, I. A. (2020). Technical efficiency of yam production systems in Ogbomosho agricultural zone, Oyo State, Nigeria. *FUW Trends in Science and Technology Journal*, 5(2): 421–425.
- Adifon, A. A. (2020). Socio-economic and cultural determinants of yam farmers' income in the Republic of Benin. *Annals of Agricultural Economics and Rural Development*, 7(2): 226-237.
- Ajibefun, I.A., Battese, G.B., and Daramola, A.G. (2020). Determinants of technical efficiency in small holder food crop farming in Nigeria, application of stochastic frontier production function, *Journal of International Agriculture*, 1(1): 25-241.
- Aliyu, A. & Shelleng, A. B. (2019). Analysis of technical, allocative and economics efficiencies of yam producers in Ganye local government area of Adamawa State, Nigeria. *International Journal of Engineering Technologies and Management Research*, 6(7):129-143.
- Ani, A. O., Ezeaku, P. I. & Ugwuoke, E. O. (2014). The Role of yam tubers in Igbo traditional religion and culture: An Appraisal. *International Journal of History and Cultural Studies*, 1(1): 18-29.
- Assa, O. S., Suleiman, R. Emeghara, U. U. Yahaya, U. F. Olagunju, O. E. Onwuegbunam, N. E. Akanni-John, R. Ganiyu, L. Omodona, S. & Olukotun, O. (2020). Resource use efficiency among Maize Farmers in Lere Local Government Area of Kaduna State, Nigeria. *Asian Journal of Advanced Research and Reports*, 14(1): 1-9
- Azeteh, I. N., Onoja, A. O., and Ocheja, O. (2019). Technical efficiency of yam production in Benue State, Nigeria. *Annals of Agricultural Economics and Rural Development*, 6(2): 17-123.
- Chisonum, M., Onyemekonwu, C. R., and Anarah, E. S. (2021). Technical efficiency of resources use in yam production among small scale farmers in Delta State, Nigeria. *Issues in Agriculture*, 1(1): 27-32.
- FAOSTAT. (2021). Food and Agriculture Organization of the United Nations Statistical Database. Retrieved from <http://www.fao.org/faostat/en/#data>
- Federal Ministry of Environment Nigeria. (2021). "Climate Information for Taraba State." Retrieved from <https://www.naijaclimatemediacom.ng/state/taraba-state>
- Iroegbu, I., Okidim, I. A. & Ekine, D. I. (2021) Resource use efficiency amongst selected small scale yam farmers in Rivers State, Nigeria. *International journal of creative research thought*, 9(3): 23-28.



- Ismail, U. O. & Mahmud, H. U. (2023). Determinant factors of technical efficiency in yam production in Moro LGA, Kwara State, Nigeria. *Journal of Agriprenurship and Sustainable Development*, **6**(2): 2651-6144.
- Maikasuwa, M. A. & Ala, A. L. (2012). Determination of profitability and resource-use efficiency of yam production by women in Bosso Local Government Area of Niger State, Nigeria. *Journal of Agriculture and Environmental Sciences*, **1**(1): 19- 25.
- National Bureau of Statistics (NBS). (2022). Agriculture in Nigeria: A Comprehensive Economic Analysis. Nigeria: National Bureau of Statistics.
- National Population Commission. (2006). "National Population Commission of Nigeria." Retrieved from <https://population.gov.ng/>
- Ndubueze-Ogaraku, M. E., Adeyoola, O. A. & Nwigwe, C. A. (2020). Determinants of technical efficiency of smallholders' yam farmers in Nigeria. *Review of Agricultural and Applied Economics*, **24**(1): 13-20.
- Ochi, J. E., Sani, R. M. & Idefoh, F. K. (2015). Economic analysis of resource use efficiency among small scale cassava farmers in Nasarawa State, Nigeria: Implications for Agricultural Transformation Agenda. *International Journal of Research in Agriculture and Forestry*, **2**(2): 14-21.
- Okoh, T. C., Opata P. I. and Umaru, I.I. (2022). Determinants of resource use efficiencies among lowland rice farmers of Enugu State, Nigeria. *Agro-Science*, **21**(1): 61-67.
- Orewa, S. I. & Izekor, O. B. (2012). Technical Efficiency Analysis of Yam Production in Edo State: A Stochastic Frontier Approach. *International Journal of Development and Sustainability*, **1**(2): 516-526
- Sapkota, M., Joshi, N. P. R., Katte, R. & Bajracharya, M. (2018). Profitability and resource use efficiency of maize seed production in Palpa District of Nepal, *Journal of Agriculture*, **16**(2): 157-168.
- Shehu, J. F., Iyortyer, J. T, Mshelia, S. I. & Jongur, A. A. U. (2010). Determinants of yam production and technical efficiency among yam farmers in Benue State, Nigeria. *Journal of Social Science*, **24**(2): 143 –148.
- Taraba State Government (2021). "About Taraba State." Retrieved from <http://tarabastate.gov.ng/about-taraba-state>.
- Toluwase, S. O. W. & Sekumade, A. B. (2017). Resource use efficiency of yam production in Ekiti State, Nigeria. *Advance in Social Science Research Journal*, **4**(2): 20–34.