



EFFICIENCY ANALYSIS OF YAM PRODUCTION IN YORRO LOCAL GOVERNMENT AREA OF TARABA STATE, NIGERIA

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ABSTRACT

*The study examined efficiency of yam (*Dioscorea spp.*) production in Yorro Local Government Area of Taraba State, Nigeria. The objectives of the study were to determine technical, allocative and economic efficiencies of yam farmers in the study area. Multistage random sampling methods were employed to select 247 yam farmers in the area. Data collected were analyzed using stochastic frontier production model. The results of the maximum likelihood estimate of production function showed that, farm size, seed/setts, and fertilizer were significant inputs utilized for production among farmers in the study area. The mean technical efficiency of yam farmers was 0.94. Similarly, the results of the maximum likelihood estimate of the cost function indicated that cost of seed/setts, fertilizer, agrochemicals and labour were the significant cost associated with yam production in the study area. The mean allocative and economic efficiencies were 0.95 and 0.89 respectively. The study therefore concluded that majority of yam farmers in Yorro Local Government Area of Taraba state, Nigeria operated at the maximum efficiency level indicating that there was little efficiency gap hence there is still scope for improvement of yam production in the study area. The study recommends investments by individuals, private organizations and government in yam production so that farmers could increase output through more intensive and efficient use of available resources given the current state of technology.*

Keywords: Efficiency, Yam production, Yorro Local Government Area

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INTRODUCTION

Yam (*Dioscorea spp*) is a staple food that can be grown in almost all tropical countries with sufficient water, it is extensively cultivated in Nigeria's coastal regions up to Latitude 12°N, an area characterized by its rainforest, wood savanna, and southern savanna belts (Olutumise, 2020). Recent observations indicate a decline in the production of yam, a critical food crop with high consumer demand (Ariyo *et al.*, 2020). More than 54 million tonnes of yams are produced in Sub-Saharan Africa annually on 4.6 Million hectare. Over

95% of this production lies in a five-country “yam belt” that includes Nigeria, Benin, Togo, Ghana, and Côte d’Ivoire (Africa Yam Project [AYP], 2016).

According to the National Root Crops Research Institute (NRCRI, 2023), Nigeria alone in 2023 accounted for over 70% of the world’s yam production in 1.5 million hectares of land. But despite huge potential for yam production in the country, its cultivation still depends largely on crude farm tools like hoes, cutlasses and axe ((Sagoe *et al.*, 2016). The use of local farm technologies in yam production according to Akerele *et al.* (2019) is likely to decrease farm productivity and efficiency.

Efficiency is a very important factor of productivity growth especially in developing agrarian economies, where resources are meager and opportunities for developing and adopting better technologies are dwindling (Akinola *et al.*, 2019). Inefficient use of inputs can jeopardize food availability and its security (Chisonum *et al.*, 2021 and Adeshina *et al.*, 2020). Bidzakin *et al.* (2014) assert that every profit oriented organization is said to be technically efficient when it produces greater output with a given amount of inputs or produces a specified output with little amount of a given resources.

A lot of studies were conducted on efficiency analysis of agricultural production in Nigeria. For instance Moyofolorun *et al.* (2024), Ismail and Mahmud (2023), and Ume *et al.* (2020) reported that farmers are not making efficient use of existing input resources. Adamu (2014) found a spacious variation in the estimated technical efficiencies which is believed to be improved through increasing the awareness and educational level of farmers. Toluwase and Sekumade (2017) found that farmers are technically efficient in the utilization of resources in yam production in southern western Nigeria.

Yorro Local Government Area of Taraba state is well known for yam production over the past decades and over 68% of the inhabitants depend on the commodity as their means of livelihood. According to Giroh (2020), farmers in Yorro Local Government Area of Taraba State, Nigeria, need to allocate resources efficiently in order to maximize total gross margin. The documented cosigning yam farmers’ resource productivity in Yorro Local Government Area for the past 20 years needs to be investigated. The specific objectives of this study are to determine the technical, allocative and economic efficiencies of yam farmers in the study area.

METHODOLOGY Study Area

The study was conducted in Yorro Local Government Area of Taraba State, Nigeria. It has a land mass of 1275km² with a population of 89, 410 and projected to 146, 785 in 2022 based on 2.3% annual growth rate (National Population Commission (NPC), 2006). It lies between latitude 8^o 54`N and 8^o45`N with longitude 11^o 22`E and 11^o38`E with annual rainfall ranging between 1500 -1700mm per annum , temperature ranges between 22.7^oC -38^oC and relative humidity range between 35% and 65% (Taraba State diary, 2015). The major activity of the people is farming and yam is the major crop produced by over 75% of the people (Giroh, 2020). The major tribe in the LGA area is Mumuye comprising of about 70-85% of the total population with other minority tribes such as the Yandang, Fulani and Hausa who settled in the area for cattle rearing, trading and

marketing activities. The LGA has two major traditional chiefdoms; the Mumuye and Kwajji districts.

Sources of Data

Primary data collected through the administration of questionnaires were used mainly for this study.

Sampling Procedure

Multi-stage and random sampling methods were adopted for the selection of wards and sample from the respondents. The first stage includes proportionate selection of 4 wards from the Mumuye district and 1 ward from Kwajji district making a sum of 5 wards sampled for the study. The registered numbers of yam farmers in the 5 out of the 11 wards in the local government area was 2015 as sourced from the Taraba Agricultural Development Programme (TADP) unit in the local area council. The second stage involved the selection of 334 samples out of the population of two thousand and fifteen (2015) farmers using Yamane (1967) simplified methods of sampling size determination as adopted by Nteranya and Adiel (2015) (equation 1). The third stage involves random selection of 62 farmers in Nyaja A Ward, 21 from Kassa A Ward, 82 from Nyaja B, 89 and 80 from Pupule C and Pantisawa wards, respectively in proportionate to the number of farmers in each of the wards. However, 247 questionnaires were correctly retrieved and used for data analysis.

$$n = \frac{N}{1+N(e)^2} \text{----- (1)}$$

where; n = sample size, N = population of the study, e = magnitude of sample error (5% sampling error was adopted).

Analytical Techniques

Data generated were analyzed using stochastic frontier production model. The stochastic frontier production model was proposed by Aigner *et al.* (1977). It employs a Cobb – Douglas production function to simultaneously estimate the random disturbance term (Vi) which is outside the control of the production unit and the inefficiency effect (Ui) as proposed by Battese and Coelli (1995). The farm frontier production function is written as:

$$Y_i = f(X_i; \beta) \exp (V_i - U_i) \text{----- (2)}$$

where; Y is the quantity of yam output (kg)

X_i, is a vector of input quantities and β is a vector of parameters.

The empirical model for yam farmers in Yorro Local Government Area of Taraba State, Nigeria is expressed as: $\ln Y_{ij} = \beta_0 + \beta_1 \ln X_{1ij} + \beta_2 \ln X_{2ij} + \beta_3 \ln X_{3ij} + \beta_4 \ln X_{4ij} + \beta_5 \ln X_{5ij} + \beta_6 \ln X_{6ij} + V_{ij} - U_i$ -----(3)

Where Subscript ij refers to the jth observation of the ith farmers, ln = logarithm to base e, Y = Output of yam farmers (Kg) per/ha, X₁ = Farm size (in hectares) , X₂ = Quantity of seeds/setts used (in kg/ha), X₃ = Labour used in production (in man-days/ha), X₄ = Agrochemicals (liters), X₅= Fertilizer (Kg) and X₆= Stake used (Number)

It is assumed that the technical inefficiency effects are independently distributed and U_i arises by function (at Zero) of the normal distribution with, U_{ij} and Variance δ^2 , where U_i is defined by: $U_{ij} = \delta_0 + \delta_1 Z_{1ij} + \delta_2 Z_{2ij} + \delta_3 Z_{3ij} + \delta_4 Z_{4ij} + \delta_5 Z_{5ij} + \delta_6 Z_{6ij}$ -----(4) where; U_{ij} = Technical inefficiency of the i^{th} farmer

Z_1 = Age (years), Z_2 = Farming Experience (years), Z_3 = Household size (number of person in farmer’s household), Z_4 = Education (years of Formal education), Z_5 = Sex (Male=1 or otherwise 0), Z_6 = Access to credit facilities (loan) (yes=1 or otherwise 0) and $\delta_1 - \delta_9$ = Are parameters to be estimated.

Dual cost frontier production function adopted in the estimation of total cost of production as used by Ismail and Mahmud (2023) is specified as follows:

$$\ln C_i = \beta_0 + \beta_1 \ln F_1 + \beta_2 \ln F_2 + \beta_3 \ln F_3 + \beta_4 \ln F_4 + \beta_5 \ln F_5 + \beta_6 \ln F_6 + V_i + U_i \quad \text{----- (5)}$$

Where; C_i = Total cost of production of the i^{th} farmers (₦), F_1 = Cost of yam seed/setts (₦), F_2 = Cost of fertilizer (₦), F_3 = Cost of labour (₦), F_4 = Cost of stake (₦), F_5 =Cost of Agrochemicals (₦), F_6 =Transport Cost (₦), Y_i = is the output of i^{th} farmer (kg), V_i = Random disturbance tern, U_i = inefficiency effects. The inefficiency model is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 \quad \text{----- (6)}$$

where; U_i = Cost of efficiency effect, Z_1 = Age of farmer (in years), Z_2 = Farming experience (in years), Z_3 = Year of formal education, Z_4 =family size (number), Z_5 = access to credit (yes=1 or otherwise 0), Z_6 =marital status (yes=1 or otherwise 0), Z_7 = membership of association (yes=1 or otherwise 0) and Z_8 = access to extension services (yes=1 or otherwise 0)

The Economic Efficiency (EE) was computed as the product of technical and allocative efficiencies.

$$EE = TE * AE \quad \text{----- (7)}$$

Where; EE= Economic Efficiency, TE= Technical efficiency, AE= allocative efficiency

RESULTS AND DISCUSSION Table 1: Maximum Likelihood Estimate of Stochastic Frontier Production Functions for Yam Farmers in the Study Area

| Variables | Parameters | Coefficient | Standard | t-ratio | Error |
|-----------------------|---------------|-------------|----------|------------|-------|
| Constant | b_0 | 2.6219 | 0.1069 | 24.5181*** | |
| Farm size | X_1 | 0.1301 | 0.0192 | 6.7812*** | |
| Seed/setts | X_2 | 0.1891 | 0.0460 | 4.1114*** | |
| Labour | X_3 | 0.0438 | 0.0359 | 1.2178 | |
| Agrochemicals | X_4 | -0.0076 | 0.0106 | -0.7209 | |
| Fertilizer | X_5 | 0.1492 | 0.0378 | 4.2898*** | |
| Stake | X_6 | 0.0079 | 0.0247 | 0.3183 | |
| Inefficiencies | Effect | | | | |
| Constant | Z_0 | 1.0273 | 0.2384 | 4.3097*** | |
| Age | Z_1 | -0.4630 | 0.1854 | -2.4961** | |
| Farming experience | Z_2 | -0.1337 | 0.7087 | -0.1887 | |
| Family size | Z_3 | 0.0863 | 0.0087 | 9.9181*** | |
| Education | Z_4 | -0.1337 | 0.7087 | -0.1887 | |
| Sex | Z_5 | -0.0458 | 0.0181 | -2.5289** | |
| Access to credit | Z_6 | 0.0052 | 0.0119 | 0.4328 | |
| Sigma-square | δ^2 | 0.0057 | 0.0006 | 9.3840*** | |

| | | | | |
|--------------|----------|---------------|---------------|-------------------|
| <u>Gamma</u> | <u>Y</u> | <u>0.5901</u> | <u>0.0426</u> | <u>13.8506***</u> |
|--------------|----------|---------------|---------------|-------------------|

***, **, *=significant at 1%, 5% and 10% probability levels
Source: Field Survey, 2020

Technical efficiency of yam farmers

The Maximum Likelihood Estimates of stochastic frontier production (Table 1) indicated that the estimate of sigma square of 0.0057 was significantly at 1% level. The estimated gamma parameters of 0.59 indicated that 59% of the variation in yam output was due to differences in the technical efficiencies of the farmers. Farm size, yam seed/setts and fertilizer were found to be significant. Farm size has a positive coefficient of 0.13 and significant at 1% probability level. This implies that increasing the farm size by 1% will bring about 13% increase in the output of yam farmers and confound with apriori expectations that output increases with increase in farm size. Yam seed/setts has coefficient of 0.19 and significant at 1%. This shows that 1% increase in the quantity of seed/setts use will lead to increase in output of yam by 19%. This finding also collaborate that of Idumah *et al.* (2014) who found positive relationship between the quantity of yam seed/setts used and output.

Analysis of the inefficiency parameters (Table 1) further revealed that age of the farmers, family size and sex influence the technical efficiency. Age has a negative coefficient (0.463) and significant at 5%. This means that older farmers were more efficient than younger one and could be result of experience gain through several years in yam farming. This shows that 1% increase in age will bring about 46% increases in technical efficiency. This agreed with the findings of Job and James (2014) and Ani *et al.* (2014) who found positive relationship between age and productivity of yam farmers. Family size has positive coefficient of 0.086 and significant at 1%. This implies that 1% increase in household size will decrease technical efficiency by 0.86%. Sex of the farmers has negative coefficient (-0.0458) and significant at 5%. The implication of this is that male farmers were 0.456% more efficient than their female counterparts. This conform with the findings of Toluwase and Sekumade (2017) and Adamu (2014) who revealed the domination of male farmers' ability's in efficient allocation of resources in yam production than their female.

The results of estimates of cost functions are presented in Table 2. The estimated gamma parameter of 0.7234 indicates that 72.34% of the total variation in yam cost of production was due to differences in their cost efficiency. The variance parameter (δ^2) was 0.0045 and is statistically significant at 1%. This indicates a good model fit and overall correctness of the specified distributional assumption of composite error terms. Cost of seed/setts, fertilizer, labour and agrochemicals were significantly. The coefficient of seeds/setts (1.0579) is significant at 1% which implies that 1% increase in the cost of seeds/setts will increase the cost of yam production by 105%. This shows that seeds/setts are an important input for yam farmers in the area and is in line with the report of IITA (2015) which states that seed yams are accounting as much as 63% of total variable production costs, and are bulky to transport. Cost of fertilizer has coefficient of 0.065 and significant at 1%. This implies that 1% increase in the cost of fertilizer all things being equal will increase the cost of yam production by 0.65%. Cost of labour have coefficient

of 0.084 and significant at 1%. This implies that 1% increase in cost of labour will increase cost of yam production by 0.84%. Similarly, the cost of agrochemicals has coefficient of -0.0991 and significant at 5%. The value of the coefficient indicates decrease in cost of production by 0.99% for 1-unit increase in the cost of agrochemicals ceteris paribus.

Table 2: Maximum Likelihood Estimate (MLE) of Stochastic Cost Function for Yam farmers Variables

| Variables | Parameters | Coefficient | Standard | t-ratio |
|-----------------------------|----------------|-------------|----------|------------|
| Error | | | | |
| Constant | F ₀ | 3.3015 | 0.0547 | 61.0549*** |
| Cost of seed/setts | F ₁ | 1.0579 | 0.0843 | 12.5419*** |
| Cost of fertilizer | F ₂ | 0.0651 | 0.0288 | 2.2601** |
| Cost of labour | F ₃ | 0.0839 | 0.0238 | 3.5165*** |
| Cost of stake | F ₄ | 0.0004 | 0.0035 | 0.1019 |
| Cost of agrochemicals | F ₅ | -0.0991 | 0.03712 | -2.6694** |
| Transport cost | F ₆ | -0.0015 | 0.0051 | -0.2859 |
| Inefficiency Effects | | | | |
| Constant | Z ₀ | 0.3481 | 0.0703 | 4.9485*** |
| Age | Z ₁ | 0.0118 | 0.0025 | 4.7009*** |
| Farming experience | Z ₂ | -0.3206 | 0.0355 | -9.0191*** |
| Years of formal education | Z ₃ | -0.1846 | 0.0439 | -4.1969*** |
| Family size | Z ₄ | 0.0142 | 0.0097 | 1.4669 |
| Access to credit | Z ₅ | 0.0203 | 0.0398 | 0.5095 |
| Marital status | Z ₆ | 0.0314 | 0.0313 | 1.0048 |
| Membership of association | Z ₇ | -0.0289 | 0.0169 | -1.7029* |
| Access to extension | Z ₈ | 0.0094 | 0.0122 | 0.7698 |
| Sigma-square | δ ² | 0.0045 | 0.0012 | 3.8480*** |
| Gamma | Υ | 0.7234 | 0.0856 | 8.4467*** |

***, **, *=significant at 1%, 5% and 10% probability levels

Source: Field survey, 2020

Analysis of cost inefficiencies (Table 2) revealed that age, farming experience, education and membership of association were significant. Age has a coefficient of 0.0118 and significant at 1%. This implies that 1% increase in age will increase cost inefficiency by 11%. Farming experience has coefficient of -0.3206 and significant at 1%. This implies that 1% increase in farming experience will decrease cost inefficiency by 32%. Years of formal education has coefficient of -0.1846 and significant at 1%. This signifies that 1% increase in the years of formal education of the respondents will bring about cost efficiency by 18%. Membership of association has coefficient of -0.0289 and significant at 10%. This implies that 1% increase in number of farmers who belong to association will increase the likelihood of maintaining cost efficiency in yam production by 0.29%.

The distribution of technical efficiency of yam farmers (Table 3) showed that the mean technical efficiency was 0.94 implying that the average farmers were able to obtain 94%

potential output from the given combination of inputs. The most efficient farmer has 0.99 (99%), while the least efficient farmer has 0.61 (61%) technical efficiency in yam production. Therefore, the least performing farmer will need 39% cost saving or increase in output to be efficient. This is in conformity to the findings of Toluwase and Sekumade (2017) and Ani *et al.* (2014) whom revealed average technical efficiency of yam farmers above 0.80 in the study conducted in Ekiti and Benue States of Nigeria respectively.

Table 3: Technical Economic and Allocative Efficiencies Distribution of Yam Farmers

| Efficiency levels | Technical | | Allocative | | Economic | |
|-------------------|------------|------------|------------|------------|------------|------------|
| | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage |
| 0.3-0.39 | - | - | 15 | 6.07 | - | - |
| 0.4-0.49 | - | - | 26 | 10.53 | - | - |
| 0.5-0.59 | - | - | 22 | 8.91 | 6 | 2.43 |
| 0.6-0.69 | 22 | 8.91 | 17 | 6.88 | 17 | 6.88 |
| 0.7-0.79 | 1 | 0.41 | 34 | 13.77 | 2 | 0.81 |
| 0.8-0.89 | 3 | 1.21 | 59 | 23.89 | 54 | 21.86 |
| 0.9-0.99 | 221 | 89.47 | 74 | 29.95 | 168 | 68.02 |
| Total | 247 | 100 | 247 | 100 | 247 | 100 |
| Min | 0.61 | | 0.37 | | 0.54 | |
| Max | 0.99 | | 0.99 | | 0.99 | |
| Mean | 0.94 | | 0.95 | | 0.89 | |

Source: Field survey, 2020

The mean allocative efficiency (Table 3) of the sample is 0.95, with a minimum of 0.37 and maximum of 0.99. This result implies that if an average yam farmer in Yorro Local Government Area of Taraba State was to achieve the AE level of its most efficient counterpart, then that average farmer could realize about 58% cost savings or increase in production.

The economic efficiency was thus computed as the products of technical and allocative efficiencies. The mean Economic Efficiency (Table 5) was 0.89 while the minimum and maximum EE were 0.54 and 0.99 respectively. This shows that the least efficient yam farmer in the study area will need 35% cost savings to be efficient.

CONCLUSION AND RECOMMENDATIONS

The study therefore concluded that majority of yam farmers in Yorro Local Government Area of Taraba state, Nigeria operated at the maximum efficiency level indicating that there was little efficiency gap hence there is still scope for improvement of yam production in the study area. The study recommends investments by individuals, private organizations and government in yam production so that farmers could increase output through more intensive and efficient use of available resources given the current state of technology.

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