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Technical Efficiency in Yam Production Among Small Scale Farmers in Federal Capital Territory, Nigeria

[1]Idisi, Park Odojoma (Ph.D), [1]Musa Shehu (Ph.D), [1]Maduekwe, Innocent Maduabuchukwu (Ph.D),
[1]Ogunrinde Happiness, [2]Atteh, Paul Akinwumi [1]Emmanuel, Augustine Uke & [3]Simpa, Ondeku James
[1]Department of Agricultural Economics, University of Abuja, Nigeria
[2]Department of Agricultural Economics and Extension,
Federal University of Lafia, Nasarawa State, Nigeria.
[3]Federal Polytechnic, Nasarawa, Nasarawa State, Nigeria.
E-mail: ugobeauty26@gmail.com akinatteh2016@gmail.com

ABSTRACT

This research work examined the economics of yam production among smallholder farmers in Gwagwalada and Kwali Area Council of Federal Capital Territory, Nigeria. The specific objectives include to: estimate the profitability of yam production and examine technical efficiency in yam production. Multistage sampling was used for this study. Data was analyzed with descriptive Statistics, Stochastic Frontier Production Function, Gross Margin Analysis and Principal Components Analysis. The results showed that, (86.2%) of the respondents were males with average age of 40 years and 17 years farming experience. Also 43.27% of the sampled yam farmers had no formal education with average household size of 6 persons, and also (64.1%) were not members of any farmers association. Also 47.44% of the sampled farmers sourced their capital through personal savings. Whereas, 90.06% of the farmers had access to extension services with average farm size of 2ha. The result of costs and returns reveals that the cost of labour was ₦ 98, 865.74/ha which carried the highest proportion of the total variable cost (TVC). The TVC incurred by the yam farmers was ₦ 202, 544.82/ha and the total revenue obtained was ₦ 410, 879.80/ha with the gross margin of ₦ 208, 334.98 which indicates that yam production was a profitable enterprise in the study area. The factors that influence the total output were farm size ($P<0.05$), Agro chemical ($P<0.01$). The factors influencing technical efficiency were educational level of farmers ($P<0.05$), access to credit facilities ($P<0.05$), extension contact ($P<0.05$), farming experience ($P<0.05$), household size ($P<0.05$) and cooperative membership of ($P<0.05$). The mean technical efficiency was 51.1%. Yam farmers encountered the following constraints; high cost of transportation, inputs, seed material, inadequate finances and lack of storage facilities. The following recommendations were made: since yam production is a profitable enterprise it should be encouraged to increase their scale of production to earn more profit that could improve their welfare and livelihood. Farm input such as agro-chemical, improved seed varieties should be provided to yam farmers at subsidized rate and timely by government or non-governmental agencies.

Keywords: Technical Efficiency, Yam Farmers, Yam Production, Farm Management

Key words: Source Documents, Credibility, Financial Reports, Accounting Circle

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1. INTRODUCTION

Yam (*Dioscorea species*) are annual root tuber-bearing plants with more than 600 species out of which six are socially and economically important in terms of food, cash and medicine (International Institute of Tropical Agriculture (IITA), 2009. Out of these, *Dioscorea rotundata* (white yam) and *Dioscorea alata* (water yam) are the most common species in Nigeria. Yams are perennial herbaceous vines cultivated for the consumption of their starchy tubers in Asia, Africa, Central and South America and Oceanni (Apu, Ani, Agbareo, Ugboaja, Ekwe & Obbina, 2020). Yams hold immense significance for subsistence farmers in Africa and contribute significantly to the overall African economy. Approximately 90% of Africa's total agricultural production is managed by small-scale farmers (Apu et al., 2020).

A report by FAO in 2018 presented data showing the top 10 yam producing countries in the world. Nigeria topped the list, with 47,532,615 tons, followed by Ghana with 7,858,209 (Food and Agriculture Organization of the United Nation (Food and Agricultural Organization, 2018). In 2019, global yam production reached 74.32 million tons, with Nigeria taking the lead at 67.34%. The total agricultural area dedicated to yam cultivation in Nigeria was 6.24 million hectares, constituting 70.03% of the world's total yam cultivation area of 7.43 million hectares (FAO, 2019). The top yam producing States in Nigeria are: Benue, Cross River, Delta, Taraba, Nassarawa, Ebonyi, and Anambra. Yam plays a crucial role in ensuring food security for the population in Nigeria. It serves as a primary staple for the majority of Nigerians, valued for its taste and cultural significance (Ariyo et al., 2020). Its significance in the dietary habits of the Nigerian people cannot be overstated, providing over 200 dietary calories per capita daily for more than 150 million individuals in West Africa. Additionally, yam serves as a vital source of income for the people (Asala & Ebukiba, 2016).

The examination of efficiency in agriculture relies on specific economic theories outlining diverse approaches to utilizing production resources for achieving the highest possible output. Among these theories is technical efficiency, an engineering principle used to assess system performance within the constraints of available resources. Technical efficiency is linked to the behavioral goal of maximizing output (Ndubueze-Ogaraku et al., 2021). Efficiency is commonly linked with the potential to achieve an optimal level of output from a specific set of inputs at the lowest cost (Ume, Kaine & Ochiaka, 2020). It can be categorized into three types: technical, allocation, and economic efficiencies. Technical efficiency pertains to a firm's ability to employ the most effective practices or technology in the production process, ensuring that the least amount of resources is utilized to attain the best or optimal output level (Ume et al., 2020).

Statement of the Problem

Successive government in Nigeria have put some policies and programmes in place for example Operation Feed the nation, Green Revolution programmes, ATA, GES, all these programmes are to make agriculture more robust and making farmers to use the resources they are using effectively and efficiently. But you will see that there is a gap between demands and supply in Yam production, and this gap can partly be due to inefficiency on the part of the farmers growing Yams, this inefficiency is as a result of some factors, socio-economic factors, fertilizers, agro-chemicals, yam seedlings etc. In Nigeria, yam is becoming more expensive and relatively unaffordable in urban areas, especially in the Federal Capital Territory as production has not kept pace with population growth leading to demand exceeding supply.

From my own research, medium sized yam tuber currently costs ₦1, 300 in Nigeria. According to (Ariyo *et al*., 2020), yam yield is consistently declining principally due to low productivity associated with poor soil fertility as well as inappropriate cropping systems and practices. Yam production is constrained by several factors with planting material rated to about one third (1/3) of the total cost of production. Challenges in yam production involve making suboptimal decisions regarding resource allocation, insufficient utilization of associated production inputs, and farmers not adequately adopting improved technologies.

Additionally, farmers may use resources reasonably but not at an economically optimal level (Idisi, Ebukiba & Anthony, 2019). Small-scale farmers encounter challenges such as price instability, fluctuations, pests and diseases, inadequate storage facilities, and inefficient resource utilization. These factors contribute to low production levels (Alabi et al., 2020).

Research Questions

The following research questions will guide this study:

1. What is the cost, returns and profitability of Yam production among small-farmers in the Federal Capital Territory, Nigeria?
2. What is the technical efficiency of Yam production in the study area?
3. What are the determinants of technical efficiency of Yam production in the study area?
4. What are the constraints militating yam production in the study area?

Objectives of the Study

The broad objective of this study is to determine the economics of yam production among small-scale farmers in Federal Capital Territory, Nigeria. The specific objective Were to:

1. estimate the profitability in yam production among small-scale farmers in Federal Capital Territory.
2. estimate the technical efficiency in yam production in the study area.
3. identify the factors that influence the technical efficiency of yam production in the study area.
4. identify the constraints militating against yam production in the study area.

Hypotheses of the Study

To achieve these objectives, the following null hypotheses will guide the study:

Ho_1: Yam production is not profitable in the study area

Ho_2: Yam farmer are not technically efficient in the study area

Ho_3: There is no significant relationship between technical efficiency level of yam production and farm specific and institutional factors in the study area.

Justification of the Study

The prevailing inability of food crop production to meet up with the demand of food in Nigeria caused by inadequate utilization of resources by farmers and the challenge of high cost of inputs and inadequate supply of the inputs to farmers calls for improvement in food crop production. There is need to know the technical efficiency level of yam production in Nigeria as a whole which will help in policy design and formulation in order to meet food demand. As the campaign for household food security gains momentum all over the world that extreme hunger and poverty must be eradicated by year 2020, as part of its 2020 Vision for food, Agriculture, and the Environment Initiative, the International Food Policy Research Institute (IFPRI) has articulated a vision of what the world should look like in 2020, It should be free from poverty, hunger, malnutrition, and unsustainable natural resource management. This vision has come and gone yet eradication of food insecurity, malnutrition, hunger and poverty has not been attained in Nigeria.

2. METHODOLOGY

Study Area

This research work was conducted in the Federal Capital Territory. The areas of focus are Gwagwalada and Kwali Area Councils of Federal Capital Territory (FCT). It is located between Latitudes 8.25' and 9.20' north of the equator and Longitudes 6.45' and 7.39' of the Greenwich Meridian. The city is surrounded by the following States; Niger to the West and North, Nasarawa to the East and South, Kogi to the West and Kaduna to the North-east. It covers a land mass of approximately 7,315km^2 and is home to about 3,000,000 people. It has six (6) Area Councils, namely Abaji, Abuja Municipal Area Council (AMAC), Bwari, Gwagwalada, Kuje, and Kwali. Although Federal Capital Territory (FCT) popularly described as no man's land, the FCT is originally home of Gbagyi heritage. Federal Capital Territory has an estimated population of 316, 001, 467 people (NPC, 2022).

Gwagwalada area council was created in 1986, the area council has a population of 158,618 people (NPC 2006) with land mass of 1069, 589Km^2. The original settlers are Gwari, Koro, Bassa, Gade and the Hausa Fulani. Gwagwalada area council has ten wards, Dobi, Giri, Gwako, Ibwa, Paiko, Kore, Kutunku, Tunga and Quarters and Central. Kwali area council was created in 1996, the area council has a population of 85,837 (NPC 2006) with land mass of 1,206Km^2. Kwali area council, share boundary with Gwagwalada and Abaji area councils, the land in Kwali supports the growth of crops that is are grown in Gwagwlada area council. Kwali area council has ten wards, and they are Ashara, Dafa, Kundu, Pai, Wako, Gumbo, Kilankwa, Kwali, Yangoji and Yebu.

Sampling Technique and Sample Size

Multi-stage sampling technique was adapted and used to select the respondents (yam farmers). In the first stage, Purposive sampling was used to select farmers, in the second stage, two area councils were selected by using simple random sampling using ballot-box raffle draw method. Third stage, five (5) wards were selected from each area council by simple random sampling technique using ballot-box method making a total of ten wards to be covered, in fourth stage, ten (10) farming communities were selected from each area council, two (2) communities per each ward making a total of twenty (20) farming communities.

Fifth and last stage, proportionate-random sampling technique was used to select three hundred and twelve (312) yam famers (Table 3.1) following Yamane (1967) equation stated in (3.1), the sample frame of 1421 was obtained from the farmers register in Agricultural Development Programm (ADP) Federal Capital Territory, Nigeria.

Determination of sample size was carried out as used by Yarmane (1967)

$$n = \frac{N}{1 + N(e^2)} \text{..............................} (3.1)$$

Where
n = Sample Size
N = Sample Frame
E = Level of Precision (0.05%)
N= 1421

$$n = \frac{1421}{1+1421(0.05)} = 312$$

Method of Data Analysis

The following tools of analysis was applied to achieve the specific objectives of the study

(i) Descriptive Statistics
(ii) Stochastic Frontier Production Function
(iii) Gross Margin Analysis
(iv) Principal Components Analysis

Descriptive Statistics

Statistical tools such as percentages, means, standard deviations, variances, minimums, and maximums were used in this study. The descriptive statistics were used to summarize the data and draw out the socioeconomic characteristics of the small-scale yam farmers. The descriptive statistics was used to analysed the objective four (iv).

Model Specification

Stochastic Frontier Model.

This study applied stochastic frontier production function model developed by Aigner, et al., (1977), which was also used by Alabi *et al.,* (2020; Ebukiba, et al., 2020) which is stated as follows.

The Stochastic Frontier (Cobb Douglas Production Function) Mode is stated thus:

$$Y_i = F(X_i, \beta) + \epsilon_i \dots \dots \dots \dots (3.2)$$

$$Y = f(X_1, X_2, X_3, X_4, X_5, , V - U_i) \dots \dots \dots . (3.3)$$

$$LnY_i = \beta_0 + \sum_{i=1}^{5} \beta_i \, LnX_i + \cdots \beta_n LnX_n + V - U_i \dots \dots \dots . . (3.4$$

The explicit function is stated thus:

$$LnY_i = \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 lnX_4 + \beta_5 LnX_5 + V_i - U_i. \ (3.5)$$

Where,
LnY_i = Output of Yam (Tubers/Kg)
X_1= Seed Input (Kg)
X_2 = Farm Size (Hectares)
X_3 = Quantity of Fertilizer (Kg) Stochastic Production Function
X_4 = Chemical Input (Litres)
X_5 = Labour Input (Man-days)

The Technical Inefficiency Component of the Stochastic Frontier Model is stated thus:

$$-U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 + \alpha_8 Z_8 + \alpha_9 Z_9 \dots\dots (3.6)$$

Where,
$-U_i = Technical\ Inefficiency\ Component$

Z_1= Stand for sex (1 for Male; 0 otherwise)

Z_2= Represent the Age of farmers (Years)

Z_3= Denote the education level of Farmers (Years Spent Schooling)

Z_4= Signifies access to credit (Amount borrowed)

Z_5= Extension Contact (Number of Contact per Month)

Z_6= Relate to farming Experience (Years)

Z_7= Household Size (Number of persons)

Z_8= Non- Farm income (Naira)

Z_9= Cooperative membership (1, yes; 0, Otherwise)

α_0 = Constant Term

$\alpha_1 - \alpha_9$ = Regression Coefficients

This was employed to analyse objective (iii)

Gross Margin Analysis

The Gross Margin Analysis was used to determine the profitability of yam production among the small-scale farmers it is defined as the difference between the gross farm income (GFI) and Total Variable Cost (TVC) this tool is mostly used to estimate the profitability or cost and returns of farm enterprise. This was used to achieve the specific objective three (ii).

Gross margin Model (GM) is stated thus.

$$GM = TR - TVC \ldots\ldots (3.9)$$

$$GM = \sum_{i=1}^{n} P_i Q_i - \sum_{i=1}^{n} P_j X_j \ldots\ldots (3.10)$$

Where, GM = Gross Margin (₦/ha); TR= Total revenue from the sales of yam output (₦); TVC= Total Variable Cost (₦).
P_i = Price of Yam Out Produced (₦/Kg)
Q_i = Quantity of Yam Output Produced (kg/ha)
P_j= Price of Input (₦/kg)
X_j = Quantity of Input Used (kg/ha)

This was used to achieve part of specific objective three (i)

Financial Analysis
The following financial ratios were used to determine the profitability of yam production by small scale farmers as used by (Ben Chendo (2015) in Alabi, *et al.*, 2020). This was used to achieve part of specific objective one (iv)

$$Gross\ Margin\ Ratio = \frac{Gross\ amargin}{Total\ Revenue}$$

Operating ratio and rate of return per naira invested in yam production was estimated following (Ebukiba *et al.*, 2020; Alabi *et al.,* 2020; Olukosi & Erabor, 2005). The operating ratio (OR) is stated thus:

$$OR = \frac{TVC}{GI} \ldots\ldots. (3.11)$$

Where, OR= Operating Ratio (Units); TVC= Total Variable Cost (Naira); GI= Gross Income (Naira).
Any Operating Ratio that is less than one (1) according to Alabi *et al.,* 2020) signifies that the total revenue realized from production will be unable to cover the cost of variable inputs utilized in the production cycle. The rate of return invested per naira is stated thus;

$$RORI = \frac{NI}{TC} \ldots\ldots\ldots (3.12)$$

Where, RORI= Rate of Return per Naira Invested (Units); NI= Net income from yam Production (Naira); TC= Total Cost (Naira). (Fixed cost is negligible on a short run). This was used to achieve part of specific objective three (ii).

Five-Point Likert Scale
The constraints facing small-scale yam farmers farming was examined using 5-point Likert scale rating: 5=strongly agree, 4=agree, 3=undecided, 2=disagree and 1=strongly disagree.

The mean score was calculated using the formula:

$$MS = \frac{\sum(RP \times O)}{\sum f} \ldots \ldots \ldots . (3.13)$$

Where,
MS=Mean Score (Units)
RP = Rating Point (Units)
O=Number of Observations (Units)
$\sum$f =Total Number of Sampled Respondents (Units)

This was used to achieve part of specific objective five (iv)

Principal Component Analysis
Constraints faced by small-scale yam farmers were subjected to factor analysis using as the extraction method.

The principal Component Analysis is stated thus:

$$x = (x_1, x_2, x_3, \ldots, x_p \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.14)$$
$$\alpha_K = \left(\alpha_{1k}, \alpha_{2k}, \alpha_{3k}, \ldots \alpha_{pk}\right) \ldots \ldots \ldots \ldots (3.15)$$
$$\alpha_k^T X = \sum_{j=1}^{p} \alpha_{kj} X_j \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (3.16)$$
$$Var = \left[\alpha_k^T X\right] \text{ is Maximum} \ldots \ldots \ldots . . (3.17)$$

Subject to:

$$\alpha_k \alpha_K = 1 \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.18)$$

and

$$cov\ [\alpha_1^T X - \alpha_2^T X] = 0 \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.19)$$

The variances of each of the principal components are:

$$Var\left[\alpha_k^T X\right] = \lambda_k \ldots \ldots \ldots \ldots \ldots . (3.20)$$

$$S = \frac{1}{n-1}(X - X)(X - \overline{X})^{T} \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.21)$$

$$S = \frac{1}{n-1}\sum_{i=1}^{n}(X_i - \overline{X_i}\ (X_i - \overline{X}_i)^{T} \ldots \ldots \ldots \ldots . (3.22)$$

Where,
X= Vector of p Random Variables
α_k = Vector p Components
λ_K = Eigen Value
T = Transpose
S = Covariance Matrix
This was used to achieve specific objective (iv)

3. RESULTS

Socioeconomic Characteristics of Yam Farmers in the Study Area

Table 4.1 presents the results socioeconomic characteristics of the sampled yam farmers in the study area. The results show that 13.8% of the sampled yam farmers were female while majority 86.2% of the respondents were male yam farmers this implies that yam production is dominated by male farmers in the study area this could be due to the energy requirement in yam production that female farmers might not be able to engage in drudgery that is involved in the process of yam production, this is line with Ochi, Sani and Idefoh, (2015), table 4.1 also depicts that majority 89.71% of the sampled yam farmers were married while 5.13% were single and 3.35% were divorced.

The study further show that 14.42 % of the sampled yam farmers were within the age range of 21-30 years while majority 64% were within the age range of 31-50 years which indicates that yam farmers in the study area were young and energetic and still in their age of productivity, the average age of the sampled yam farmers was 40% this confirms that the yam farmers are youths that still have more energy to lift soil and make ridges for yam production in the study area. This result is consistent with Ochi *et al,* 2015) which indicates that roots crop production is gender exclusive, mostly carried out by the male folk.

More so, the study also indicated that majority 59.62% of the sampled farmer had about 6-10 years farming experience while 17.63 had 1-5 years farming experience with an average of about 17 years farming experience in yam production in the study area, this implies that the yam farmers had enough experience in yam production, experience enables farmers to acquire more knowledge in the production process.

The study further discovered that about 43.27% of the sampled yam farmers had no any form of formal education while 34.62% of spent about7-12 years in school the implication of this results is that this category of yam farmers had attained either primary and secondary level of education, 20.55% of the sampled farmers had attained school for 13 years and above meaning that this class of farmers had attained one form of tertiary level of education, education of the farmer plays a very important role in determining their ability of resource use efficiency they adopt innovation and technology faster than non-educated farmer, This result is consistent with Ariyo *et al*, (2020) and Idisi *et al,* (2019) who found that the ability and readiness with which a particular producer accepts or rejects an innovation or technology depends on his or her level of educational background.

Table 3.1: Results of the Socioeconomic Characteristics of the Watermelon Farmers in the Study Area

Variable	Frequency	Percentage	Mean Value
Sex			
Female	43	13.78	
M ale	269	86.22	
Marital Status			
Single	16	5.13	
Married	280	89.74	
Widow	4	1.28	
Divorce	12	3.85	
Age Range			40.20
20	19	6.09	
21-30	45	14.42	
31-40	97	31.09	
41-50	104	33.33	
51 and Above	47	15.06	
Farming Experience			16.99
1-5	55	17.63	
6-10	185	59.62	
11 and Above			
Number of Years in School			8.14
0.00	135	43.27	
1-6	5	1.60	
7-12	108	34.62	
13 and above	64	20.51	
Household Size			5.63
1-5	176	56.41	
6-10	125	40.06	
11 and Above	11	3.53	
Association Membership			
No	250	64.10	
Yes	112	35.90	
Source of Capital			
Personal Savings	148	47.44	
Credits	15	4.81	
Others	149	47.76	
Access to Credit			
No	250	80.12	
Yes	62	19.87	
Extension Services			
No	31	9.94	
Yes	281	90.06	
Farm Size			1.52
1-2	268	85.90	
3-4	26	8.33	
5-6	18	5.77	
Total	312	100	

Source: Computed from Field Data, (2023)

Cost and Returns and Profitability Involved in Yam Production in the Study Area

Table 4.2 showed the results of the analysis of the costs and returns from yam production among the farmers in the study area. The average cost of yam seed planted by the farmers per hectare was ₦41442.31 having a proportion of 20.5% of the total variable cost of yam production while the cost of chemical fertilizer was ₦26184.46 which had 12.9% of the proportion of the total variable costs and the cost of agrochemical was ₦22754.23 per hectare which carries 11.2% proportion. The cost of labour was ₦98, 865.74/ha which had the highest proportion of the total variable cost of production among farmers in the study area, fixed cost was considered negligible at the short-run. This is in line with the findings of Ariyo *et al,* (2020).

The total variable cost incurred by the yam farmers was ₦202,544.82/ha while the total revenue obtained was ₦410879.80/ha with the gross margin of ₦208334.98 which indicates that yam production was a profitable enterprise in the study area the gross margin ratio was 5.07 while the operating ratio was 0.972 with the rate of return on investment of about 1.029 this findings show that yam production yielded a positive returns on investment the financial analysis has shown that a rate of return on investment of about 1.09 implies that every 1 naira invested in yam production 1.09 was gain as profit, which covers cost of production, fees, commissions and profit. This result is in line with the findings of Asala and Ebukiba (2016) and Ariyo *et al,* (2020) who reported that yam enterprise is profitable.

Table 3.2: Statement Costs and Returns of Yam Production in the Study Area

Variable	Average Value ₦/ha	Proportion	Percentage
A. Variable Costs			
Cost of Seed	41,442.31	0.205	20.5
Cost of Chemical Fertilizer	26,184.46	0.129	12.9
Cost of Agro-Chemical	22,754.23	0112	11.2
Cost of Labour	98,865.74	0.488	48.8
Cost of Transportation	7,275.64	0.036	3.6
Cost of Loading/ Offloading	3,448.72	0.017	1.7
Fees and Commission	2,573.72	0.013	1.27
B. Total Variable Cost	202,544.82		
C. Total Revenue	410,879.80		
D. Gross Margin	208,334.98		
E. Gross Margin Ratio D/C	5.07		
F. Operating Ratio B/D	0.972		
G. Rate of Return on Investment D/B	1.029		

Source: Computed from Field Data, (2023)

3.3 Factors Influencing Technical Efficiency of Yam Production in the Study Area

Table 4.3 presents the results of the analysis of the stochastic production frontier using maximum likelihood estimates, the results show that, the first stage of the factors influencing total output yam production in the study area shows that out of the five 5 variables included in the model 3 variables were statistically significant these includes farm size, chemical input and labour input. The coefficient of farm size (0.3174) influences the total output of yam positively and it was statistically significant at (P<0.05) which implies that a unit change in the level of farm size will result in 31.7% increase in the total output of yam output among farmers in the study area, as farm size increase as a result of expansion it will lead to increase in total output, this supports the findings of Ariyo *et al.*, (2020) and Ochi *et al*, (2020) who reported similar results that there is a relationship between inputs and output in yam production.

Chemical input was also statistically significant and influences the total output of yam positively in the study area, the coefficient of chemical input 0.291) was statistically significant at (P<0.05) the implication of this result is that a unit change in the quantity of chemical input applied to yam farm as a result of more usage will result in the increase in the total output of yam by 29.1% in the study area, if chemical is applied properly in weed control it could result in high yield of yam output.

The coefficient of labour (0.4149) was statistically significant at (P<0.05) probability level, this signifies that a unit change in the number of labour measured in man-days in yam production will lead to increase in the total output of yam production by 41.5% among yam farmers in the study area, labour plays a significant role in yam production when there supply of labour it will enable farmers to increase their farm size which could lead to increase in the total output respectively. This is in consonance with the findings of (Ndubueze-Ogaraku, 2020) who posited that more output of yam would be obtained from the use of additional quantities of these variables, ceteris paribus.

The inefficiency model revealed that there are six variables that were statistically significant influencing the technical efficiency the variables are education level, access to credit, extension contact, farming experience, household size and cooperative association, the negative sign of the variables implies decrease in the technical inefficiency in yam production while the positive sign signifies increase in technical inefficiency.

The coefficient of education level of yam farmers was negative and it was statistically significant at (P<0.05) This implies that as the level of education of farmers increases it will result in the increase in the technical efficiency level and decreases inefficiency by 7.7% level educated farmers adopt innovations easily and they have the ability of sourcing price information easily. Access to credit influences technical efficiency negatively and it was statistically significant at P<0.05 probability level, the negative sign implies decrease in technical inefficiency and increase in technical efficiency level in yam production among yam farmers in the study area.

The coefficient of the access to credit (-3.18) implies that a unit increase in the access to credit results in the increase in the technical efficiency in yam production by 3.18, access to credit facilities helps yam farmers to have the ability to purchase inputs that will lead to increase in technical efficiency in the study area.

Extension contact influences technical efficiency negatively and it was statistically at (P<0.05) probability level, the coefficient of extension contact (-0.584) show that a unit change in the number of contact with the extension agent by the farmers results in the increase in technical efficiency in yam production by 58.4% among yam farmers, extension contact provides farmers with easy access to extension services where they would be taught how to use inputs appropriately and also have access to price information that could lead to increase in technical efficiency in yam production in the study area. This finding is in agreement with Ilesanmi and Akinmusola, (2016) who reported extension agents can use social groups as a medium to effectively disseminate innovation to yam farmers.

Farming experience influences technical efficiency yam production negatively and it was s statistically significant at (P<0.05) probability level the implication of this result is that a unit change in the number of years of farming experience could results in increase in technical efficiency by (3.34), farming experience makes farmers to accumulate knowledge of farming, as the acquire more knowledge over the years it helps them to poses technical know-how to apply and utilizes their limited resources appropriately which could lead to increase in technical efficiency, this result is in consonance with Ebukiba et al, 2022 and Ebukiba et al, (2020) Who posited that Farming experience increases the level of technical efficiency as the farmers accumulate experience in farming results in increase in farm efficiency and productivity.

Household size had positive influence on the technical efficiency in yam production among yam farmers in the study area, this implies that household size decreases technical efficiency and increases technical inefficiency among yam farmers, the implication of this result is that as household size increases technical efficiency decreases this could occur because as the result of the high number of school children in the family that may not be available during farm operation activities and the resources that supposed to be used for purchasing farm inputs could be used for paying school fees and other family problems and immediate needs, this could lead to technical inefficiency in yam production in the study area.

This is contrary to the findings of Ndubueze-Ogaraku et al, (2020) who reported negative sign of the household coefficient implying that as the number of adult persons in a household increases, technical inefficiency would decrease, thereby increasing technical efficiency. Cooperative association influences technical efficiency in yam production negatively and it was statistically significant at (P<0.01) probability level, this implies that a unit change in the chance of being a member of farmers' association results in 45% increase in the level of technical efficiency among the yam farmers in the study area. Cooperative association enables farmers to have access to production inputs and they could also market their produce collectively and negotiate price as a group that could help them make more profit in yam production in the study area this result is in line with the findings of Apu *et al*., (2020).

Table 3.3: Maximum Likelihood Estimates of the Stochastic Production Frontier Function of Yam Farmers in the Study Area

Variables	Parameter	Coefficient	Standard Error	Z-value
Stochastic frontier				
Constant	β_0	1.682519*	0.4023355	4.18
Log Farm Size	β_1	0.3173595**	0.136005	2.33
Log Seed	β_2	0.0564194	0.0720017	0.78
Log Fertilizer	β_3	0.0928534	0.0596898	1.56
Log Chemical	β_4	0.2910011*	0.0869107	3.35
Log Labour	β_5	0.4149616*	0.1235308	3.36
Technical Inefficiency Model				
Sex	Z_1	9.99e-07	1.98e-06	0.51
Age of Farmers	Z_2	5.81e-08	1.25e-07	0.47
Education Level	Z_3	-0.077006**	.0339388	-2.27
Access to Credit Facilities	Z_4	-3.18e-11*	9.72e-12	-3.27
Extension Contact	Z_5	-.0584297**	0.023852	-2.45
Farming Experience	Z_6	-3.34e-07**	1.42e-07	-2.36
Household Size	Z_7	8.37e-07**	4.09e-07	2.05
Non-Farm Income	Z_8	1.56e-06	2.06e-06	0.75
Cooperatives Association	Z_9	-0.4596595*	0.084040	-5.47
Sigma^2	σ^2	0.1077398		
Gamma	γ	0.0090707		
Log likelihood =		-63.112692		
Number of Observation	N	312		

Source: Field Survey Data, (2022) * Significant P<0.01 ** Significant P<0.05 *** Significant P<0.1

3.4 Distribution of Technical Efficiency Score Level of Yam Production in the Study Area

Table 4.4 shows the results of the distribution of technical efficiency level in yam production among yam farmers in the study area, the study revealed that about 30.77% of the sampled yam farmers have attained 0.21-0.4 technical efficiency level while 46.79% attained 0.41-0.6 technical efficiency level, 2.88% and 16.35% of the sampled yam farmers attained 0.61-0.8 and 0.81-1.0 technical efficiency level. The minimum level of technical efficiency attained by individual farmer was 0.01 while the maximum technical efficiency level attained by individual yam farmer was 0.999 technical efficiency level.

The average technical efficiency obtained by yam farmers was 0.511 implying that on average an individual yam farmer was able to attain 51.1% level of technical efficiency in yam production and having a technical efficiency gap 49% that need to be filled up by applying the existing technology and innovation to attain the maximum level of technical efficiency in yam production in the study area. This is consistent with Ebukiba et al, (2022) who reported a gap of 50% of inefficiency that need to be filled up to attain the level of perfection in technical efficiency by adopting innovation, new technology and the use of modern method of agricultural practices by farmers.

Table 3.4 Distribution of Technical Efficiency Level among Yam Farmers in the Study area

Cost Efficiency Score	Frequency	Percentage
0-0.2	10	3.21
0.21-0.4	96	30.77
0.41-0.6	146	46.79
0.61-0.8	9	2.88
0.81-1.0	51	16.35
Minimum	0.010	
Maximum	0.9990	
Mean TE	0.5113	

Source: Field Survey Data, (2023)

3.5 Principal Component Analysis of the Constraints Faced by Yam Farmers in the Study Area

Table 4.5 shows the results of the principal components analysis of constraints faced by yam producers in the study area, PCA is a statistical technique that transform interrelated data with many variables into few number of uncorrelated variables. From the results the number of principal components retained using the Kaiser Meyer criterion were four (5 based on the Eigen values that is greater than 1. The retained components explained about 83% of the variation in the components included in the model analyzed.

The Kaiser-Meyer-Olkin measures of sampling adequacy (KMO) of 0.360 and Bartlett test of sphericity of 5292.255 and was statistically significant at 1 % probability level which demonstrated that the variables were feasible for principal component analysis. High cost transport and inadequate finance had an Eigen value of 6.57938 and 2.96624 and it was ranked 1st and 2nd in the order of importance based on perception of the yam farmers. High cost of inputs, High Cost of Seeds and Lack of Storage Facilities with Eigen values of 1.48887, 1.26879 and 1.01694 were ranked 3rd ,4th and 5th respectively in the order of occurrence based on the perception of the farmers. This is in line with Ariyo et al., 2010 and Alabi *et al*. (2020). This result is also in line with Parveen et al, (2016) who reported similar crop production challenges faced by farmers in their study area.

Table 3.5 Results of the Principal Components for Constraints Faced by Yam Farmers in the Study Area

Constraints	Eigenvalue	Difference	Proportion	Cumulative
High cost transport	6.57938	3.61314	0.4112	0.4112
Inadequate finance	2.96624	1.47737	0.1854	0.5966
High cost inputs	1.48887	.220082	0.0931	0.6897
High Cost of Seeds	1.26879	.251844	0.0793	0.7690
Lack of Storage Facilities	1.01694	.132105	0.0636	0.8325
Bartlett Test of Sphericity				
Keiser-Meyer-Olken	0.360			
Rho	1.000			
Chi-square	5292.255			

Source: Computed from Field Data, (2023).

Hypotheses Tested

Ho_1: The hypothesis is presented in Table 4.6. The null hypothesis was rejected and the alternative hypothesis accepted. The null hypothesis was rejected simply because the calculated t-value was 21.093 which is greater than 1.96. This shows that, there are significant differences between the costs and returns of yam production implying that yam production is profitable in the study.

Table 3.6 Results of the t-test Statistics of cost and returns of Yam Production in the study area

Variables	Mean	Std. Deviation	Std. Error
Total Revenue	202,544.82	344076.96198	19479.52210
Variable Cost	410,879.80	180221.42066	10186.71698
T-Calculated	21.093; 19.769		
T-Tabulated	1.96		

Source: Field Survey Data (2023)

Ho_2: The hypothesis that stated there is no significant relationship between technical efficiency in yam production and farm specific and institutional factors in the study area was tested, the results of the maximum likelihood estimate revealed that the following farm specific and institutional factors had a significant relationship with technical efficiency the farm specific factors influencing the total output of yam production in the study area were farm size ($P<0.05$), Agro chemical ($P<0.01$), and Labour ($P<0.01$). The institutional factors influencing the technical efficiency in yam production in the study area were educational level of farmers ($P<0.05$), access to credit facilities ($P<0.01$), extension contact ($P<0.05$), farming experience ($P<0.05$), household size ($P<0.05$), and cooperative association ($P<0.05$). Therefore, the null hypothesis is rejected and the alternative hypothesis was accepted.

4. SUMMARY OF FINDINGS

This study evaluated economics of yam production among small scale farmers in federal capital territory Nigeria the specific objectives were to: Estimate the profitability in yam production among small-scale farmers in Federal Capital Territory; estimate the technical efficiency in yam production in the study area; evaluate the factors that influence the technical efficiency of yam production in the study area; Identify the constraints militating against yam production in the study area. The following tools of analysis were used to achieve the specific objectives of the study. Descriptive Statistics, Stochastic Frontier Production Function, Gross Margin Analysis, Financial Analysis, Five Point Likert Scale, Principal Components Analysis.

The study show that majority 86.2% of the respondents were male yam farmers this implies that yam production is dominated by male farmers in the study area the study further revealed that majority 64% were within the age range of 31-50 years which indicates that the yam farmers in the study area were young and energetic and still in their age of productivity, the average age of the sampled yam farmers was 40 years, the farmers had an average of about 17 years farming experience in yam production in the study area, the study further discovered that about 43.27% of the sampled yam farmers had no any form of formal education, 20.55% of the sampled farmers had attained school for 13 years and above meaning that this class of farmers had attained one form of tertiary level of education, the average household size among the yam farmers was 6 members per family majority 64.1% were not members of any farmers association. The findings of this study also revealed that 47.44% of the sampled farmers source their capital through personal savings and other sources respectively 90.06% of the sampled yam farmers had access to extension services, about 85.9% of the respondents had a farm size ranging from 1-2 hectares of farm land, the average farm size under cultivation by the yam farmers is about 2ha in the study area this implies that the yam farmers are small scale producers operating on a small scale basis.

Table 4.2 shows the results of the analysis of the costs and returns from yam production among the farmers in the study area. The study indicates that the cost of labour was ₦98, 865.74/ha which carries the highest proportion of the total variable cost of production among farmers in the study area, fixed cost was considered negligible at the short-run. The total variable cost incurred by the yam farmers was ₦202,544.82/ha while the total revenue obtained was ₦410, 879.80/ha with the gross margin of ₦208,334.98 which indicates that yam production was a profitable enterprise in the study area. The analysis of the stochastic production frontier revealed that the statistically significant factors influencing the total output of yam production in the study area were farm size ($P<0.05$), Agro chemical ($P<0.01$), and Labour ($P<0.01$). The technical inefficiency component shows that the statistically significant factors influencing the technical efficiency in yam production in the study area were educational level of farmers ($P<0.05$), access to credit facilities ($P<0.01$), extension contact ($P<0.05$), farming experience ($P<0.05$), household size ($P<0.05$), and cooperative association ($P<0.05$). The mean technical efficiency obtained by yam farmers in the study area was 51.1%, yam farmers encountered the following constraints in the course of yam production in the study area; high cost of transportation, inadequate finance, high cost of inputs, high cost of seed material, and lack of storage facilities in the study area.

5. CONCLUSION

This study examined economics of yam production among small scale farmers in the federal capital territory, Nigeria. Based on the findings emanating from this research work the study concludes that yam production is mostly dominated by male farmers, and they were young and energetic in their active years of productivity, and they were operating on the small-scale basis cultivating on average farm size of 2 hectares of land, the study further revealed that yam production is profitable in the study area with the gross margin of ₦208,334.98 with the gross margin ratio of 5.07, operating ratio of 0.972 with the rate of return on investment of about 1.029 this findings show that yam production yielded a positive returns on investment the financial analysis has shown that a rate of return on investment of about 1.09 implies that every 1 naira invested in yam production ₦1.09 was gain as profit, which covers cost of production, fees, commissions and profit.

The statistically significant factors influencing total output of yam production in the study area includes; farm size, agrochemical, and labour inputs while the statistically significant factors influencing technical efficiency were education level, access to credit facilities, extension contact, farming experience, household size, and cooperative association. Yam farmers were 51% technically efficient lagging behind with 49% inefficiency that needs to be scalp with the existing technology to reach perfection, yam farmers were faced with the following constraints, high cost of transport, inadequate finance, high cost of inputs, high cost of seeds, and lack of storage facilities in the study area.

5. RECOMMENDATIONS

Based on the findings emanating from this study the following recommendations were suggested;

1. Simple farm machineries and implements should be provided to yam farmers by the government to help them minimize the cost of labour and reduce the drudgery involve in making ridges manually in order to improve their production capacity and earn more profit
2. Farm inputs such as agro-chemical, improved seed varieties should be provided to yam farmers at subsidize rate and timely in the study area either by government or non- governmental agencies
3. Credit facilities should also be made available to yam farmers at lower interest rate to enable them acquire farm inputs at appropriated time to improve productivity and their profit level in the study area, extension services should be provided to farmers at when due and training should be organized for them to know more about the use of inputs.
4. Farmers should be encouraged to join cooperative organization and good infrastructures like good roads, storage facilities and marketing facilities should be made available to farmers.

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