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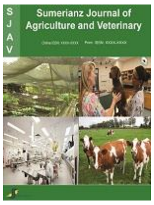

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Measuring Efficiency of Farm Productive Resources Used in Yam Production in Benue State of Nigeria: Implication for Sustainable Farm Economy

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Abstract

The present research empirically determined efficiency of productive resources committed to yam production in Benue State, Nigeria using cross-sectional data elicited from 120 active farmers via multi-stage sampling design. The ex-post data for 2016 cropping season were collected during the years 2016/2017. Structured questionnaire complemented with interview schedule were the instruments used for data collection and the collected data were analyzed using descriptive, pseudo-inferential and inferential statistics. The results revealed an economic viable farming population with adequate literacy level which is healthy for yam value chain if enable environment is provided. However, the farm families in the studied area were unproductive given that it is composed of weak and vulnerable people, thus draining farmers' income stream. The enterprise is found to be profitable both from the accounting and economic point of view. Findings further showed that the farmers were operating at stage I of the production surface which is the reason for under-utilization of almost all the productive resources employed in yam production. The study recommends provision of viable extension services in order to enhance rationalization of yam farm resources by the farmers in the studied area.
Keywords: Efficiency; Farm resources; Yam production; Farm economy; Nigeria.

1. Introduction

Over the past 50 years yam production in Nigeria has shown a tremendous improvement from 3.2 million tonnes per annum in 1960 to 26.2 million tonnes in 2000 and to 45 million tonnes in 2014 [1]. Similarly, area under yam cultivation has increased from 1.3 million hectares in 1960 to 2.6 million hectares in 2000 and to 5.4 million hectares in 2014. Despite the fact that Nigeria is the highest producers of yam in the world, the production is attributed to area increase rather than increase in productivity. This trend of increase output at the expense of area rather than productivity has become a source of concern to policy makers' over time. IITA [2] also reported that yam production is declining in some traditional producing areas due to declining soil fertility, increasing pest pressures and high cost of labour, and they advocated that smallholders need access to innovations to reduce labour and improve productivity.

Numerous agricultural policies and programmes both at national and state levels were developed to support and stimulate agricultural growth in the face of low and declining yield of crops. Notable in the subject of this research are Root and Tuber Crops Extension Programme in 2003, National Root Crops Research Institute (NRCRI), International Institute of Tropical Agriculture (IITA) for research on improved yam seed technology, credit policy through Bank of Agriculture and Agricultural Credit Guarantee Scheme Fund (ACGSF), National Special Programme for Food Security Programme (NSPFS), Fadama World Bank Project, ADPs and other interventions. Moreover efforts to increase yield through these programmes proved abortive especially with the persistent scarcity and high cost of seed yam, on-farm harvest and post-harvest losses and high labour demand for production.

Despite this remarkable lead in the production of yam, Nigerian yam farmers still suffer from poverty and this could be as a result of inefficient use of available resources. Studies have shown that 60% of Nigerian farmers produce yam as a primary source of livelihood [3]. This is the major problem of the present day agriculture, because issues surrounding efficiency of farm productive resource utilization are the vital elements of sustainable crop production of small-scale farming activities. Inefficient use of inputs can seriously jeopardize and interfere with production and food security. If more attention is given to efficient use of resources, improving of farming system

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and technology through proper and adequate extension service delivery, farmers' incomes are likely to increase which will definitely lead to positive change in their standard of living. Therefore, in the light of the foregoing issues it become pertinent to re-examine the efficiency of the resources used at the subsistence level given that yam production in the country has added a new fold-export dimension. Doing so will give an insight on whether the farm productive resources were judiciously and efficiently used in the study area since this set of farmers account for the bulk of the yam production which is vital to food security and sustenance of the rural economy. The present research will assist in enlightening farmers' on how to obtain remunerative profit from yam production *viz.*, educating them on appropriate utilization of resources in the face of available technology which in turn will help them to break the vicious cycle of poverty. Also, agricultural organizations, policy makers, program designers and extension workers will benefit on how to make proper decisions on yam production that will assist farmers to upgrade their earnings and standards of living in the study area. In addition it will add to the already existing knowledge on resource-use efficiency in the studied area in particular and the country in general. The present research aimed at measuring the efficiency of productive resources committed to yam production in Benue State of Nigeria. The specific objectives were to describe the socio-economic profile of the farmers; evaluate income distribution among the farmers; estimate costs and returns to yam production; determined efficiency of farm productive resources committed to yam production; and, investigate the problems affecting yam production in the studied area.

2. Research Methodology

The study area is located in the North central part of Nigeria with a total population of 4,780,389 based on the 2006 census [4]. The state is located between latitude 6°25'N and 8°8'N and longitude 7°47'E and 10° 0' E Greenwich meridian. The state has an estimated landmass of 5.09 million hectares, representing 5.4% of the national landmass and about 3.8 million hectares is arable. The state has a tropical climate and is situated in the southern guinea savanna with about 1723mm of rainfall annually and an average temperature of 27.2 degree Celsius. Agriculture is the major occupation of the natives with over 70% of the populace engaged mostly in arable crop farming while others engaged in occupations such as fishing, cloth weaving, white collar jobs, businesses, arts and crafts, Ayurvedic medicine among others.

Multi-stage sampling design was used to collect cross-sectional data from 120 selected active yam farmers in the studied area. The first stage involved convenient selection of Otukpo Local Government Area in Benue State due to cost and time constraint of the researchers given that yam is produced in all the agricultural zones in the state. The second stage involved random selection of four (4) villages *viz.* Upu-Entekpa, Otada, Okpanehe and Ogodumu villages. The last stage involved random selection of thirty (30) active yam producers from each of the selected villages, thus giving a total sampling size of one hundred and twenty (120) farmers. Well structured questionnaire complemented with interview schedule were the instrument used for data collection. The content validity of the questionnaire was pre-tested in a pilot survey composed of 20 farmers and the result of the reliability tested gave a Cronbach' Alpha coefficient higher than 0.60 cut-off suggested by Churchill [5] to be appropriate for exploratory research. Therefore, the estimated value indicates the stability and consistency with which the questionnaire measures the concept and help in assessing the goodness of the measure. With the aid of block extension agents, ex-post data for 2016 yam cropping season were collected during the years 2016/2017.

The collected data were analyzed using descriptive, pseudo-inferential and inferential statistics. Objective I and part of objective VI were achieved using descriptive statistics; objective II was achieved using Gini coefficient in conjunction with Lorenz curve; objective III was achieved using cost concepts and income measures adopted by Subba, *et al.* [6], Meena, *et al.* [7], Sadiq and Samuel [8] and Sadiq, *et al.* [9]; objective IV was achieved using ordinary least squares (multiple regression) and allocative efficiency index (AEI); and, Kendal coefficient of concordance (KCC), Friedman's Chi^2 statistic and Exploratory factor analysis were used to achieve part of objective VI.

2.1. Empirical Model

2.1.1. Gini Coefficient

It is a statistical measure of dispersion developed by an Italian statistician named Corrado Gini and published in his paper "Variability and Mutability" (Italian: *Variabilitae mutabilita*). The Gini index is defined as a ratio of the areas on the Lorenz curve. The formula is specified as follows:

$$\boldsymbol{G} = A/0.5 = 2A = 1-2B \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

2.2. Cost Concepts and Income Measures

Cost concepts and income measures are widely used because of their relevance in decision-making process. This means that these costs serve as a basis to expand the size of the farm, to buy the requisite capital assets in the long run and the requisite inputs in the short run. The study adopted the cost concepts used by [6, 10] and are specified below:

a. Cost Concepts

Costs related to paddy rice production are split up into various cost concepts such as A_1, A_2, B, C and D

Opportunity/Implicit cost: costs of self-owned and self-employed resource i.e. imputed cost

Accounting/Explicit cost: costs for purchasing and hiring of inputs and input services i.e. Paid out costs/cash costs/ nominal/money cost

Economic cost: Opportunity cost + Accounting cost

Cost A_1: The following items are included in Cost A_1

Wages of hired labour

Charges of hired machinery

Market rate of fertilizers

Market rate of seeds

Market value of biocides

Land revenue, cess and other tax

Depreciation of farm implements

Interest on working capital

Miscellaneous expenses

Cost A_2: Cost A_1 + rent paid for leased in land

Cost B: Cost A_1 or A_2 + interest on fixed capital excluding land + rental value of owned land

Cost C: Cost B + imputed value of family labour

Cost D: Cost C + 10% of Cost C as management cost (Meena *et al*., 2016)

b. Income Measures

These are the returns over different cost concepts. Different income measures are derived using the cost concepts. These measures are given below:

$$\text{Farm business income} = \text{Gross income} - \text{Cost } A_1 \text{ or } A_2 \ldots\ldots (2)$$

$$\text{Family labour income} = \text{Gross income} - \text{Cost B} \ldots\ldots (3)$$

$$\text{Net income} = \text{Gross income} - \text{Cost D} \ldots\ldots (4)$$

Farm investment income = Farm business income – Imputed value of family labour – Imputed management cost (OR) Net income + Imputed rental value of owned land

$$\text{Return on Naira invested (ROI)} = \frac{\text{Gross margin}}{\text{Total variable cost}} \ldots\ldots (5)$$

$$\text{Rate of return on capital invested (RORCI)} = \frac{Net\ farm\ income}{Total\ cost} \ldots\ldots (6)$$

2.3. Multiple Regression Model

The implicit form is as follow:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7) \ldots\ldots (7)$$

While, the explicit form is:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \varepsilon \ldots\ldots (8)$$

Where:

Y = Yam Output (kg)

X_1 = Farm size (hectare)

X_2 = Yam setts (kg)

X_3 = Fertilizer (kg)

X_4 = Herbicides (litre)

X_5 = Family labour (manhour)

X_6 = Hired labour (manhour)

X_7 = Depreciation on capital items (₦)

α = Intercept

β_{1-7} = Regression coefficients

ε = White noise

The functional forms fitted into the specified equation are as follow:

(a) Linear function

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots + \beta_n X_n + \varepsilon_i \ldots\ldots (9)$$

MPP = β

Elasticity = $\beta * \overline{X}/\overline{Y}$

(b) Semi–log function

$$Y = log\ \alpha + \beta_1 logX_1 + \beta_2 logX_2 .... + \beta_n logX_n + \varepsilon_i .... (10)$$

$MPP = \beta / \overline{X}$

$Elasticity = \beta / \overline{Y}$

(C) The Cobb Douglas (Double Log) Function

$$Log\ Y = log\ \alpha + \beta_1 log\ X_1 + \beta_2 log\ X_2 .... + \beta_n log\ X_n + \varepsilon_i .... (11)$$

$MPP = \beta * \overline{Y} / \overline{X}$

$Elasticity = \beta$

(D) Exponential Function

$$Log\ Y = = \alpha + \beta_1 X_1 + \beta_2 X_2 .... + \beta_n X_n + \varepsilon_i ....(12)$$

$MPP = \beta * \overline{Y}$

$Elasticity = \beta * \overline{X}$

2.4. Determining Technical Efficiency of Resource Use

The elasticity of production was used to estimate the rate of return to scale which is a measure of a firm's success in producing maximum output from a set of variable inputs.

$$EP = MPP / APP .... (13)$$

Where:

EP = elasticity of production

MPP = marginal physical product

APP = average physical product

If

EP =1: constant return to scale

EP < 1: decreasing return to scale

EP > 1: increasing return to scale

2.5. Determining The Allocative Efficiency Of Resource Use

The following ratio was used to estimate the relative efficiency of resource use (r)

$$r = MVP/MFC \quad .... (14)$$

Where:

MFC/P_x = unit cost of a particular resource

MVP = value added to millet output due to the use of an additional unit of input, calculated by multiplying the MPP by the price of output. i.e. *MPPxi x Py*

2.6. Rule Of Thumb

If r = 1, resource is efficiently utilized

If r > 1, resource is underutilized

If r < 1, resource is over utilized

Economic optimum takes place where *MVP = MFC*. If *r* is not equal to *1*, it suggests that resources are not efficiently utilized. Adjustments could be therefore be made in the quantity of inputs used and costs in the production process to restore *r = 1* and the model is given as follows:

$$\textbf{Divergence \%} = (1-1/r_i)*100 \text{ or } [(r_i-1)/r_i]*100 \quad ....(15)$$

2.7. Kendall's Coefficient of Concordance (W)

Kendall's coefficient of concordance (*W*) proposed by Maurice G. Kendall and Bernard Babington-Smith is a measure of agreement among several *'m'* variables that are assessing a set of *'n'* objects of interest. In social sciences, the variables are often people, called judges or respondents, assessing different subjects or situations. Kendall's coefficient of concordance (*W*) uses the χ^2 statistic for testing. If the test statistic *W* is 1, then all the survey respondents have been unanimous and each respondent has assigned the same order to the list of subjects or situations. If *W* is 0, then there is no overall trend of agreement among the respondents and their responses may be regarded as essentially random. Intermediate values of *W* indicate a greater or lesser degree of agreement among the various respondents. Following [9] the Kendall's coefficient of concordance developed by Kendall and Smith [11] and Wallis [12] is given below:

$$W = \frac{12S}{k2n\,(n2-1) - kT} \quad \text{.........................}\ \text{........(16)}$$

Where;

S = Sum over all subjects

k = Number of respondents ranking the attributes or objects

n = Number of attributes or objects that is evaluated by respondents

T = Tie-correction factor

$$T = \sum (t_k^3 - t_k) \quad \text{.......................................}\ \text{.........(17)}$$

't_k' is the number of tied ranks in each (k) of g groups of ties. The sum is computed over all groups of ties found in all m variables of the data table. T is 0 when there are no tied values.

The Chi^2 (χ^2) statistic is given as follow:

$$\chi^2 = k\,(n-1)\,W \quad \text{..}\ \text{...(18)}$$

Where;

k = Number of respondents

n = Number of objects or attributes being ranked

W = Kendall's coefficient of concordance (KCC)

2.8. Friedman's Chi-square Statistic

The Friedman's Chi-square statistic proposed by Friedman [13] was developed primarily to test the hypothesis that the ratings assigned to subjects under investigation come from the same statistical population. This is an indirect way of evaluating the extent of agreement among raters. Due to its close mathematical relationship with Kendall's coefficient of concordance (*W*) it is used in studies of inter-judge reliability. The Friedman's Chi-square statistic is given below:

$$\chi^2_r = k\,(n-1)\,W \quad \text{..}\ (19)$$

Where;

χ^2_r = Friedman's chi^2 statistic

k = Number of respondents

n = Number of objects or attributes being ranked

W = Kendall's coefficient of concordance (KCC)

3. Results and Discussion

3.1. Socio-Economic Profiles of Yam Farmers in the Studied Area

The socio-economic profiles of yam farmers in the studied area are presented in Table 1. A perusal of the table depicted an active, economic and productive yam farming population as evident from the mean age of 50 years coupled with the standard deviation value of 13.44. The implication of having an economic viable farming population would be sustainable increase in yam production in the study area. This farmers' category are expected to be more responsive to new agricultural technologies. Rahman, *et al.* [14] stated that farmers' age may influence adoption in several ways. This finding contradicts Salau, *et al.* [15] who reported that old age (above 60 years) farmers dominated yam farming population in Kwara State of Nigeria. The male farmers' population outweighs that of their female counterparts in yam farming in the studied area. This may be connected with the laborious nature of yam production which most females cannot contend with. Similar findings on yam farmers in Kwara State of Nigeria was reported by Salau, *et al.* [15]. The energy demanding activities involved in the production of yam require men who are naturally endowed with enough strength needed for such jobs. This agrees with the submission of Salau, *et al.* [15] who reported that yam production in Kwara State were dominated by male gender. Married farmers dominated yam farming; an indication of the importance of marital status in agricultural production especially when farm labour supply is limited. In addition married farmers are at liberty to benefit from the twin economic and social capitals with respect to financial resource pooling and tacit decision making on allocation of farm resources. The results showed that majority of the farmers' attained one form of formal education or the other. This implies that the community is a literate farming community; thus, there will be an increase in the productivity due to responsiveness of the farming community to new agricultural technologies. Education has been reported to have effects on the speed with which new technologies are been diffused and accepted by the farmers [16]. However, this finding is contrary to what Salau, *et al.* [15] discovered in their study on yam production in Kwara State of Nigeria. The mean household size of 9 persons depict that most of the farmers had large household size, thus given them access to family labour. Large household size is important to yam farmers because it is the main source of unpaid family labour services as yam production is highly labour intensive. Large household size is an asset if most of its members are able bodied people, otherwise a liability if majority of the members are weak people. Ajibefun and Abdulkadri [17] reported similar result confirming that the availability of family labour in small scale farming was greatly influenced by household size and age structure. Also, Ibitoye, *et al.* [18] reported similar finding for yam farmers in Kabba-Bunu Local Government Area of Kogi State.

The mean farming experience of 21 years coupled with the standard deviation value of 14.013; indicate widely varied but adequate years of farming experience in yam production among most of the farmers in the study. Based on these findings it can be concluded that most of the farmers in the study area had adequate experience which should enable them to utilize their resources efficiently. The predominant mode of land acquisition in the studied area was through inheritance. This implication is that as household size increases there will be more pressure on land as every adult member of the family would want to have a share of the land. This would lead to fragmentation of land and will discourage large scale farming, cultivation of cash crops and farm mechanization which will result in low productivity, thus, threatening the yam food security in the study area. It was observed that none of the yam farmer in the studied area received or had any extension contact during the study period i.e the last cropping season. The implication is that the yam farmers in the studied area during the last cropping season had no access to recent technologies on the best yam practices and this will greatly affect their output level. This is not a good omen given that effective extension contact is an essential tool for the adoption of modern technologies and effective communication system that encourages increase productivity of any agricultural venture. However, a greater percentage of the farmers (87.5%) did not belong to any co-operative association. The implication is that most of the yam farmers in the studied area do not enjoy benefits of having access to credit, market outlets, marketing information and information about new technologies that accrued to co-operatives association by collective pooling of their social capital together for a better expansion, efficiency and effective management of resources for profit maximization. Majority (99.2%) of the yam farmers did not have access to credit, an indication of likely profit constrain due to paucity of capital. Most of the yam farmers (64.5%) partake in both farming and non-farming activities, an indication that yam farming is not the major source of income generation among the respondents in the studied area. Results showed that most of the farmers (97%) in the studied area cultivated improved variety, depicting that the farmers preferred improved variety over the local variety. However, the case of hybrid cultivation in the studied area was not observed during the study period. The preference could be as result of the respondents past experience with both varieties. Majority of the yam farmers in the studied area had large size of agricultural holding as evident from the mean farm size of 7.06 hectares, but produced yam on a small scale based on operational holding. This showed that the farmers in the studied area engaged in farm diversification as a coping strategy against risk and uncertainty. The operational holding mean farm size of 2.37 hectares, implying that majority of the farmers in the studied area were small and medium scale farmers due to problems such as land ownership, capital and absence of extension agents, thus, affecting their yield. Majority of the farmers combined family and hired labour (60%) and this could be that most of the farmers' family members were vulnerable and could not carry out most of the farm operations due to its rigorous nature. The chi^2 values for each of the socio-economic profiles considered were different from zero at 10% risk level, indicating differences in the proportion of distribution of each variable considered.

Table-1. Socio-economic profiles of the yam farmers

Variables	**Frequency**	**Percentage**	**X ± SD**	**χ^2 test statistic**
Age				
≤ 29	9	7.5		24.92***
30-39	14	11.7		
40-49	37	30.8		
50-59	34	28.3		
≥ 60	26	21.7		
Total	120	100	50 ± 13.44	
Gender				
Male	38	31.7		16.13***
Female	82	68.3		
Total	120	100		
Marital status				
Married	93	8.3		105.95***
Single	10	77.5		
Widower	17	14.2		
Total	120	100		
Educational level				
Informal	17	14.2		13.27***
Primary	42	20.0		
Secondary	37	35.0		
Tertiary	17	30.8		
Total	120	100		
Household size				
≤ 3	2	1.7		53.00***
4-6	23	19.2		
7-9	56	46.7		
≥ 10	39	32.5		
Total	120	100	9 ± 4.18	
Farming experience				
≤ 3	10	8.3		166.20***
4-6	13	10.8		

7-9	6	5.0		
≥ 10	91	75.8		
Total	120	100	21 ± 14.01	
Land acquisition				
Inheritance	84	70.0		606.00***
Purchase	1	0.8		
Borrowed	3	2.5		
Rent	2	1.7		
Communal land	1	0.8		
Multiple source	29	24.2		
Total	120	100		
Extension contact				
Yes	-	-		-
No	120	100		
Total	120	100		
Co-operative membership				
Yes	15	12.5		67.50***
No	105	87.5		
Total	120	100		
Access to credit				
Yes	1	0.8		116.03***
No	119	99.2		
Total	120	100		
Non-farm activities				
Yes	77	64.2		9.63***
No	43	35.8		
Total	120	100		
Yam sett variety				
Hybrid	-	-		45.63***
Improved	97	80.8		
Local	23	19.2		
Total	120	100		
Agricultural holding				
Small scale (< 2)	4	3.3		82.40***
Medium scale (< 4)	32	26.7		
Large scale (≥ 4)	84	70.0		
Total	120	100	7.06 ± 5.53	
Operational holding				
Small scale (< 2)	49	40.8		12.15***
Medium scale (< 4)	49	40.8		
Large scale (≥ 4)	22	18.3		
Total	120	100	2.37 ± 1.82	
Labour source				
Family labour	22	18.3		132.75***
Hired labour	19	15.8		
Family and hired labour	72	60.0		
Family and communal	6	5.0		
Hired and communal	1	0.8		
Total	120	100		

Source: Field survey, 2017

3.2. Income Distribution of Yam Farmers in the Studied Area

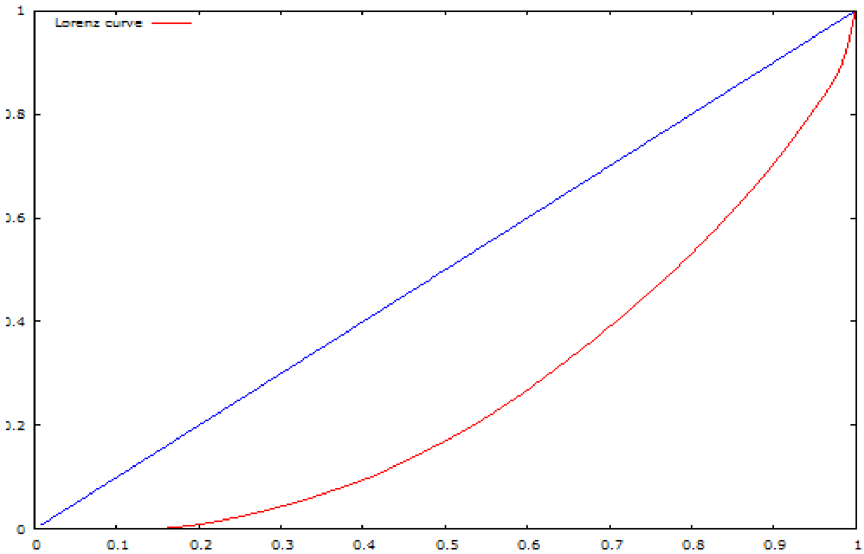
The estimated Gini coefficient index of 0.4672, indicate poor equality in income distribution among the yam farmers in the study area (Table 2) and was justified diagrammatically by the Lorenz curve which was almost far away from the line of equality (Figure 1). Therefore, it can be concluded that yam production in the study area is dominated by farmers who belong to different income categories. Furthermore, it is obvious that most of the yam producers were not fulltime farmers with different resource base to finance production. Therefore, policies aimed at income redistribution should be made effective in the study area so as reduce the income gap.

Table-2. Annual Income distribution of yam farmers

Item	Coefficient
Gini coefficient index	0.4672
Estimate of population value	0.47113

Source: Field survey, 2017

Figure-1.a. distribution oftotal income



3.3. Cost Concepts and Income Measures for a Hectare of Yam

Yam farming may not be for the purpose of only satisfying the household food need or subsistence, the farmers may be interested in selling their output to raise income. Thus, the farmers, like any other entrepreneurs, would be interested in the profitability of the farm enterprise. For this reason, efforts were made to estimate the cost associated with yam farming and the revenue that accrued to the farmers' efforts.

Shown in Table 3 are the cost concepts and income measures per hectare of yam production in the studied area. A perusal of the table showed the total economic and accounting costs of cultivation to be ₦113544.40 and ₦64562.30 respectively. The decomposition analysis showed the share contribution of total economic variable cost (TEVC) and total economic fixed cost (TEFC) in economic cost of cultivation to be 83.20 and 16.80% respectively; while the share contribution of total accounting variable cost (TAVC) and total accounting fixed cost (TAFC) in accounting cost of cultivation were 91.10 and 8.90% respectively. For the return structure, the economic and accounting revenue per hectare were ₦129750.00 and ₦108912.30 respectively. Furthermore, the profitability decomposition results showed the economic gross margin cum net farm income to be ₦35275.48 and ₦16205.61 respectively, while the accounting gross margin cum net farm income were ₦50097.65 and ₦44350.00 respectively. Therefore, at farm level, it can be concluded that yam production was a profitable venture in the studied area. The economic and accounting ROI were 0.37 and 0.85 respectively, implying that for every ₦1 invested in the enterprise, an economic and accounting profit of 37kobos and 85kobos respectively, were gained. This profit margin should stimulate financing from the lending institutions, because if yam farmers in the studied area are funded with ₦87476.41 at an interest rate of 8%, the farmer will return the principal of ₦87476.41, interest of ₦6998.11 and retain ₦35275.48 as profit. The implication of this result is that there is a considerable level of profit in yam farming in the studied area. The rate of return per unit of capital invested (RORCI) indicates what is earned by the business through capital outlay. The results revealed that the economic and accounting RORCIs of 14 and 69% respectively were greater than the prevailing bank lending rate of 8%, thus, further justifying the profitability of yam farming in the studied area. Therefore, if a farmer takes a loan from the bank to finance yam farming, in respect of economic and accounting status he/her will be 6 and 61% respectively better off on every one naira spent after paying the loan at the prevailing interest rate.

Table-3a. Costs and returns estimates of yam production per hectare

Items	Quantity	Unit price (₦)	Amount/Value (₦)
Variable costs			
Family labour	143.31manhours	200	28661.75
Hired labour	104.35manhours	200	20870.18
Seeds	121.25 kg	15	1818.68
Fertilizer	45.61 kg	145	6614.04
Manure	1666.67 kg	14.50	24166.67
Herbicides	2.01 litres	1350	2709.47
Transportation			1238.62
Imputed value of interest on working capital	8% of 87476.41	-	6998.11

Total variable cost			94474.52
Fixed costs			
Depreciation on capital items	20%		2747.65
Contract rent (lease-in)			3000
Imputed contract rent (owned land)	-		3000
Imputed managerial cost	10% of Total cost		10322.22
Total fixed cost			19069.87
Total cost			113544.40
Returns			
Quantity sold	1629.42 kg	65	105912.30
Quantity consumed	225.03 kg	65	14626.95
Quantity gifted	95.55 kg	65	6210.75
Total output quantity	1950 kg	65	126750
Lease-out			3000
Total revenue			129750

Source: Field survey, 2017

Table-3b. Cost concepts

Items	Amount (₦)
Total variable opportunity cost	35659.86
Total fixed opportunity cost	13322.22
Total opportunity cost	48982.08
Total variable accounting cost	58814.65
Total fixed accounting cost	5747.65
Total accounting cost	64562.30
Total variable economic cost	94474.52
Total fixed economic cost	19069.87
Total economic cost	113544.40
Cost A_1	68560.41
Cost A_2	71560.41
Cost B	74560.41
Cost C	103222.20
Cost D	113544.40

Source: Authors' computation, 2017

Table-3c. Income measures

Items	Estimate
Implicit revenue (₦)	20837.70
Explicit revenue (₦)	108912.30
Economic revenue (₦)	129750.00
Accounting gross margin (₦)	50097.65
Accounting net farm income (₦)	44350.00
Accounting return on naira invested (AROI) (Index)	0.85
Accounting rate of return on per capital invested (ARORCI) (Index)	0.69
Account cost of production (₦)	39.62
Farm business income (₦)	58189.59
Family labour income (₦)	55189.59
Economic gross margin (₦)	35275.48
Economic net farm income (₦)	16205.61
Farm investment income (₦)	19205.61
Economic return on naira invested (EROI) (Index)	0.37
Economic rate of return on per capital invested (ERORCI) (Index)	0.14
Economic cost of production (₦)	58.23

Source: Authors' computation, 2017

3.4. OLS Estimates Of Factors Determining Yam Output In The Studied Area

Presented in Table 4 are the four functional forms fitted into the specified regression equation for yam input-output relationship. Of the four functional forms *viz.* linear, semi-log, exponential and double logarithm models fitted into the specified equation, double log was found to be the best fit given that it satisfied the economic, statistical and econometric criteria. Furthermore the consistency and efficiency of the least squares for reliable prediction was subjected to diagnostic test *viz.* heteroscedasticity, multicollinearity and normality tests. The Breusch-Pagan test for heteroskedasticity showed that heteroskedasticity is not present i.e the sum of squares of the error terms is constant-homoskedasticity as evident from the Langrange multiplier (LM) test value of 7.48 which is not different from zero at 10% probability level. The test of multicollinearity between independent variables indicate non-presence of multicollinearity as evident from the variance inflation factors (VIF) values for each of the independent variables which were found to be less than 10.0. The chow test for the structural break showed no evidence of structural break in the model either at 60 or 120 observations as evident from the F-statistic value of 1.33 which is not different from zero at 10% probability level. The test for normality of the residuals indicated that the residuals were not normally distributed as evident from Chi^2 test statistic value of 9.40 which is different from zero at 10% risk level. However, normality test is not considered a serious problem as data in most cases are not normally distributed. All these evidences further justified the robustness of the least squares of the chosen functional form.

The estimated coefficient of multiple determination (R^2) of the best fitted functional form was 0.7940, indicating that approximately 79.4% of the total variation in the dependent variable was explained by the independent variables included in the regression model while the remaining 21.6% is attributed to non-inclusion of some explanatory variables as well as other variables outside the farmers' control. With the exception of family labour all the remaining variables were found to have significant influence on the output of yam in the studied area.

The coefficient of seeds and herbicides; farm size, fertilizer and depreciation; and, hired labour were significant at 1, 5 and 10% respectively; while the coefficient of family labour was not significant. These imply that all the variables except family labour were very important factors influencing yam output in the study area. The significant estimated coefficient of farm size exhibited an inverse relationship with yam output, suggesting that a hectare increase in farm size will lead to a decrease in yam output. This presumption of inverse relationship between farm size and yam output is not only ambiguous and surprising but it is far from the truth because it did not conform to *a prior* expectation. The reason for this inverse relationship of farm size with yam output may be attributed to omission of a collinear independent variable which has inverse relationship with farm size. As suggested by Acharya and Madnani [19] attempts were made to address this anomaly by including predicted variables of related past studies and conduct re-estimation, but dearth of repository cross-sectional database limited our scope. The statistically significant estimated elasticity coefficient of seed (1.44) had direct elastic relationship with yam output, implying that a unit increase in the quantity of seed used by 1% or 1kg would increase yam output by 1.45. The statistically significant estimated elasticity coefficients of fertilizer (0.202), herbicides (0.279) hired labour (0.0996) and depreciation on capital items (0.124) exhibited direct inelastic relationship with the output level of yam, implying that a unit increase in respect of the aforementioned inputs by 1kg, 1litre, 1 manhour and a ₦1.00 investment, would increase yam output by 0.202, 0.279, 0.0996 and 0.124 respectively. However, the estimated coefficient of family labour which also had direct inelastic relationship with output level of yam was not statistically significantly, indicating non-significant effect of used family labour on yam output in the studied area. The reason for this is attributed to the composition of the farm family which is made up of vulnerable and weak people i.e women and children as evidenced from the results in Table 4. The RTS which is the sum of the elasticities of the estimated coefficient was 1.083, implying that the yam farmers in the study area were operating at stage I of the production surface i.e. increasing return to scale.

3.5. Allocative Efficiency of Resources Used in Yam Production

The input with the highest slope coefficient or addition to total output due to extra input used was herbicides, distantly followed by seed and fertilizer; while hired labour and depreciation on capital items had meager contributions (Table 5).

With respect to allocative efficiency of yam farmers in the studied area viz. the ratio of marginal value product (MVP) to marginal factor cost (MFC) (Table 6), results showed the AEI values for seed, fertilizer, herbicides, hired labour and depreciation on capital items to be 70.64, 2.73, 9.18, 0.423 and 3.73 respectively. The implication is that none of the resources were efficiently allocated by the yam farmers in the studied area. The results imply that with the exception of hired human labour resource which was over-utilized all the remaining farm resources were under-utilized by the farmers in the production of yam in the studied area. To optimize profit at least cost combination of inputs used in yam production in the studied area, the farmers should reduce the number of hired labourers employed and increase the utilization levels of all the inputs that were under-utilized. This result suggests that there exists possibility of increasing output under the existing technology through the use of increased level of seed, herbicide and fertilizer in the study area. Therefore, for adjustment purpose, inputs *viz.* seed, fertilizer, herbicides and depreciation on capital items; and, hired human labour should be increased by 95.28%, 63.37%, 89.10% and 73.19%; and, decreased by 136.41% respectively, to be on allocative efficiency index frontier i.e unity. The RTS result of increasing return to scale justified the AEI obtained for yam production in the studied area.

Table-5. Technical efficiency of yam farmers

Variable	Mean	APP	MPP
Output	3258.68	-	-
Farm size	2.357	-	-
Family labour	340.36	9.57	0.68
Hired labour	247.83	13.15	1.31
Seed	287.96	11.32	16.30
Fertilizer	108.33	30.08	6.08
Herbicides	4.77	683.16	190.60
Depreciation	6525.67	0.499	0.062

Source: Field survey, 2017

Table-6. Allocative efficiency of yam farmers

Variables	MVP	MFC	AEI	Divergence %	Decision
Hired labour	85.15	200	0.423	-136.41	Over-utilization
Seed	1059.57	15	70.64	98.58	Under-utilization
Fertilizer	395.20	145	2.73	63.37	Under-utilization
Herbicides	12389	1350	9.18	89.10	Under-utilization
Depreciation	4.04	1.08	3.73	73.19	Under-utilization

Source; Field survey, 2017

3.6. Problems Affecting Yam Production in the Studied Area

The results in Table 7 identified inadequate extension contacts and high cost of improved agro-inputs as the highly severe problems affecting yam production in the studied area and were ranked 1st and 2nd respectively. Subsequently, limited access to credits, inadequate capital to finance production, high cost of labour and incidence of theft (pilfering) were found to be the severe problems affecting yam production and were ranked 3rd, 4th, 5th and 6th respectively. Price fluctuation, problem of readily available market, problem of low soil fertility, high cost of transportation, land tenure problem, poor road network and problems of pest and disease were identified as the moderately severe problems and were ranked 7th, 8th, 9th, 10th, 11th, 12th and 13th respectively. Inadequate storage facilities and high costs of yam setts were identified as the less severe problems and received rank 14th and 15th respectively; while flood and drought occurrence and high cost of processing were reported as not severe problems and in ascending order they received the least ranks. The Kendall's coefficient of concordance indicated that there is moderate agreement among the respondents with respect to the ranking of the constraints as evident from the Kendall coefficient of 0.552 which is significant at 1%. The Friedman's test indicated that the attributes assigned by the respondents to the constraints comes from the same statistical population as evident from the Chi^2 which is significant at 10% probability level. Based on these findings, it is advisable that policy makers should follow this ranking in solving the constraints faced by the yam producers in the study area.

To reduce the number of research variables and find the common factors affecting yam production in the studied area, the 17 identified problems were subjected to a factor analysis. The Kaiser-Meyer-Olkin (KMO) test which measure the degree of inter-correlation among the variables and the appropriateness of factor analysis [20] has calibration value of 0.888. According to Kaiser and Rice [21], the calibrated MSA is "meritorious", implying that the variables are inter-correlated and are appropriate for factor analysis. Also, Mansourfar [22] stated for items to be suitable for factor analysis, the KMO value for sampling adequacy must be between 0.80 and 1.

The Bartlett's test which test statistical probability of whether the correlation matrix has correlation among variables rejected the hypothesis that the correlation matrix was an identity matrix (at the level of 0.01), indicating a significant relationship between the variables. The result of the latent criterion showed that the 16 variables subjected to factor analysis should be extracted to form six dimensions. These six dimensions explained 62.68% of the variation in the data i.e the factors that met the cut-off criterion with Eigen-values greater than 1; and generally considered satisfactory in social sciences [23, 24] as reported by Maiadua, *et al.* [3]. For reliability measurement, the estimated Cronbach's Alpha values for each of the six dimensions or factors were above the cut-off point of 0.60 suggested by Churchill [5] to be appropriate for exploratory research. All these provide evidence of the appropriateness of the sample for the principal components analysis. The extracted factors and their respective factor loadings exclude those whose absolute loading value was less than 0.40. In labeling the factors that were loaded from two factor loadings, only the highest factor score was considered. The six extracted factors were labeled as market constraint, infrastructure constraint, sustainability constraint, institutional constraint, disaster and agro-input constraint and labour constraint.

The first factor labeled market constraint has an Eigen-value of 2.59, loaded with four items and explained 15.23% variance of the inhibiting factors. The items loaded on this factor shows farmers concern on poor market outlet for their products, and thus, the need for efficient market which will make them earn remunerative prices for their product from the market chain. The second factor labeled infrastructure constraint loaded with four items has an Eigen value of 2.34 and explained 13.75% variance of inhibiting factors. The items on this factor indicate farmers concern on poor and insufficient availability of infrastructural facilities and yearn for adequate provision of good road network, sufficient and appropriate storage facilities in order to enhance market efficiency. The third factor labeled sustainability constraint has an Eigen value of 1.92, loaded on two items and explained 11.29% of variance of the militating factors. This dimension shows farmers worries on paucity of finance and declining soil fertility and call for tacit intervention to sustain the enterprise for yam food security. The fourth factor labeled institutional constraint has an Eigen value of 1.58, loaded on three items and explained 9.30% of variance of militating factors. The items of this factor shows farmers concern on ineffectiveness and poor implementation of existing government policies and call for harmonization, strengthening, monitoring and re-evaluation of policies to ensure efficiency in yam value chain. The remaining two factors *viz.* disaster/agro-input and labour constraints with an Eigen values of 1.16 and 1.07 respectively, collectively explained 13.11% of variance of inhibiting factors, and both made an almost equal contribution in this respect, which points to their equal importance. The items loaded on the fifth factor showed farmers concern on weather vagaries and high cost of agrochemical and call for effective insurance policy and a review of the partial subsidy on agrochemical in order to enhance productivity. The items loaded on labour factor showed farmers concern on high cost of hired labour and call for mechanization supports from government and non-governmental organization to ease-off the excessive cost due to shift of agricultural labour to white collar jobs.

4. Conclusions and Recommendations

Based on these findings the following inferences were drawn:

- The yam farming population in the studied area was economically viable, literate but with an unproductive household size due to most farm family members been weak and vulnerable i.e. dependants.
- From the economic and accounting point of views the enterprise was found to be profitable in the studied area.
- The farmers were not judicious in the utilization of their farm resources which is due to financial constraint.

Sequel to these the following recommendations were made:

- Farmers should be encouraged to increase the utilization of their farm resources but need to be rational in doing so.
- Farmers should be provided with adequate credit facilities at reasonable interest in order to enhance yam food security and farm family income.
- Government policies on increase yam production for export should be harmonious in order not to endanger the biodiversity and yam food security of the nation.
- The dearth of extension services in the studied area is a source of concern; as such both government and non-governmental organizations should immediately intervene in order to enhance efficiency of yam value chain in the studied area.

Farmers should be enjoined to form and join effective self-help groups so that they can use their joint social and economic capitals to enhance their yam farming business.

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Table-4a. Functional forms fitted into yam production function of the studied area

Variables	Double logarithm (+)		Semi-logarithm		Exponential		Linear	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Constant	-2.531(2.741)	0.92^{NS}	-27435.7(14649.4)	1.87*	7.117(0.095)	74.8***	-324.50(353.56)	0.918^{NS}
Farm size	-1.133(0.510)	2.22**	-2102.24(2723.66)	0.77^{NS}	-0.345(0.207)	1.67*	-609.19(769.03)	0.792^{NS}
Family labour	0.071(0.047)	1.51^{NS}	365.27(252.45)	1.45^{NS}	6.36E-05(0.0002)	0.27^{NS}	0.534(0.869)	0.614^{NS}
Hired labour	0.0995(0.057)	1.74*	758.99(305.97)	2.48**	-0.0001(0.00028)	0.45^{NS}	0.856(1.027)	0.833^{NS}
Seed	1.441(0.538)	2.68***	2534.96(2874.68)	0.88^{NS}	0.0046(0.0018)	2.56***	8.925(6.704)	1.331^{NS}
Fertilizer	0.202(0.083)	2.44***	1024.77(441.39)	2.32**	0.0017(0.00085)	1.98*	15.092(3.169)	4.76***
Herbicides	0.279(0.098)	2.83***	1525.17(525.45)	2.90***	0.0085(0.0138)	0.62^{NS}	32.549(51.384)	0.63^{NS}
Depreciation	0.124(0.053)	2.31**	640.97(285.20)	2.25**	3.85E-06(9.9E-06)	0.27^{NS}	0.042(0.037)	1.14^{NS}
RTS								
R^2	0.794		0.70		0.76		0.83	
Adjusted R^2	0.781		0.68		0.74		0.82	
F-statistic	61.65***		37.3***		49.31***		76.68***	
Heteroskedasticity	7.477[0.381]							
Normality test	9.401[0.0091]							
Chow test (60)	1.33[0.239]							
Chow test (120)	0.142[0.867]							

*, **, *** means significance at 10%, 5% and 1% respectively

Note: ( ): values in parenthesis are standard error; [ ] values in square brackets are probability levels

Table-4b. Multicollinearity test for double logarithm and technical efficiency

Variable	VIF
Farm size	9.215
Family labour	1.383
Hired labour	1.434
Seed	8.316
Fertilizer	4.493
Herbicides	4.997
Depreciation	1.812

Source: Field survey, 2017

Table-7. Constraints affecting yam farmers in the studied area

Constraints	Mean	Market constraint	Infrastructure constraint	Sustainability constraint	Institutional constraint	Disaster/Agro-input constraint	Labour constraint
Limited access to credit	5.10 (3rd)	0.513					
Market problem	4.40 (8th)	0.733					
Price fluctuation	4.49 (7th)	0.637					
Theft/pilfering cases	4.73 (6th)	0.769					
Poor road network	4.01(12th)		0.666				
Storage problem	3.27 (14th)		0.684				
High transportation cost	4.19 (10th)		0.454				
Processing problem	1.79 (17th)		0.621				
Paucity of capital	5.03 (4th)			0.838			
Low soil fertility	4.23 (9th)			0.806			
Problem of land tenure system	4.09 (11th)				0.554		
Inadequate extension services	5.86 (1st)				0.771		
High cost of yam setts	3.18 (15th)				0.641		
Flood and drought	1.80 (16th)					0.538	
Pest and diseases	3.91 (13th)					0.619	
High cost of agro-input	5.77 (2nd)					0.685	
High cost of hired labour	4.88 (5th)						0.877
Kendall's coefficient (KCC)	**0.552**						
Chi2 (χ^2)	**1059.80*** **						
Friedman's Chi2 (χ^2)	**1059.80*** **						
Eigen-value		**2.59**	**2.34**	**1.92**	**1.58**	**1.16**	**1.07**
% of variance		**15.23**	**13.75**	**11.29**	**9.30**	**6.83**	**6.28**
Cronbach's Alpha		**0.642**	**0.695**	**0.684**	**0.683**	**0.654**	**0.667**
Kaiser-Meyer-Olkin test	**0.888**						
Bartlett's Test of Sphericity (χ^2)	**416.47*** **						

Source: Field survey, 2017