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Econometrics analysis of rural livelihoods and income inequality among yam (*Discorea alata*) farming households' in Abuja, Nigeria

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Abstract

This study analyzed econometrics of rural livelihoods and income inequality among yam (Discorea alata) farming households' in Abuja, Nigeria. Multi-stage sampling was adopted and employed. Primary data were collected through well-structured and well-designed questionnaire. Total sample sizes of 100 rural yam producers were selected. Data were coded, and analyzed using the following statistical and econometrics tools: descriptive statistics, gross margin analysis, financial analysis, Gini-coefficients, Multinomial Logit model, Probit model, Simpson index of income diversification, principal component analysis, and t –test analysis. The result shows that 73% of rural yam farmers were less than 51 years of age. The mean age was 45.8 years. The livelihood activities were farming, non-farming and off-farming activities. The Gini-coefficient of 0.7413 revealed severe income gap or high inequality in income among rural yam farmers. Factors influencing livelihood income diversification among rural yam farmers were gender($P < 0.01$), age ($P < 0.05$), marital status ($P < 0.10$), household size ($P < 0.10$), level of education ($P < 0.01$), membership of cooperatives($P < 0.05$), access to credit ($P < 0.10$), contact with extension agents ($P < 0.05$), income generating farm assets ($P < 0.05$), and farm income ($P < 0.05$). Principal component analysis used in analyzing constraints or problems facing rural yam producers show that six (6) constraints were retained for having Eigen-value greater than one. The retained constraints were lack of credit facilities, inadequate extension agents, poor storage facilities, bad feeder roads, lack of farm inputs, and lack of market centers. The retained constraints explained 84.79% of components included in the model. The study recommends that credit facilities and farm inputs should be made available to rural yam farmers. Also, extension agents should be employed and appropriate storage facilities should be made available for rural yam farmers.

Keywords: Rural Livelihood, Income Inequality, Yam Farmers, Multinomial Logit Model, Probit Model, Nigeria.

Introduction

Yam (*Discorea species*) belongs to the class of tuber crop. Yam is a very good source of carbonhydrate. Yam requires high energy input for its production, it is labourious in its production activities. Nigeria is recorded to be the highest producer of yam in West Africa, and accounts for 70 percent of the production in the whole world (FAO, 2006). Yam is used for food, traditional ceremonies, for economic, social, cultural, and religious activities. Human labour is the main source of labour available to rural farmers in the production of yam. This may accounted for 88% of all total labour utilized on the farm (Ajibefun *et al*, 2000). Other forms of labour that can be used include: exchange labour and family labour. Operations of the farms such as preparation of land, planting, staking of yam, and harvesting of yams were performed by men. Women and also children can perform operations like weeding, and fertilizer applications. About 47 million metric tonnes of yam were produced globally, and Africa accounted for 95 percent of the global yam production (FAO, 2006). There is a high demand for yam by households for consumption. The production of yam by rural farmers cannot meet the local demand. Livelihood can be defined as ways, activities and resources of rural farmers used in making a living. Livelihood activities include: farm, non-farm, and off- farm activities. Farm activities include: crop farming, and livestock farming (fish and aquaculture, birds including poultry birds, cattle, goats, and pigs,).

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Access to farm assets, labour, education, human capital, skill capacity building by rural farmers in addition to climate and weather situations in the agro-ecological ones, seasonality of rainfall, social capital were important criteria or phenomena in livelihood activities. Rural farmers' exhibit different lifestyles and they have different ways of meeting their needs. Off-farm activities can be defined as those activities of rural farmers performed outside its own personal farm. Off-farm activities involve those activities performed in other people's farm and activities performed outside agricultural sector. Non- farm activities are operations performed by rural farmers outside agricultural sector. Rural farmers diversified into non-farm activities such as: barbing, tailoring, laundry services, mechanics, transport operations, and trading. Non-farm income accounted for 35-50% of total income of rural farmers. The non-farm income provides a substantial share of income to total income of rural farmers. The off-farm income also reduces the constraints in terms of budget share for rural farmers' households. Non-farm sector plays a significant role in rural development, this sector has the potentials to absorb excess labour coming from agriculture. Diversification into non-farm activities by rural farmers provides desirable options to improve livelihoods and standard of living of rural farming households. Non-Farm sector can improve equal distributions of income among rural farmers, it can also negatively affect rural farmers' income by reducing the likelihood to engage in farming activities which may lower food production and hence reduce agricultural production. Diversifications of rural farmers from farm into non-farm activities also have the potentials of improving rural farmers' income, reducing poverty and improve equitable distributions of income. There are evidences to show an increase in the proportion or shares of income of both off-farm income and non-farm income to total income from rural farming households in Africa (Gecho, 2017). Livelihood income diversification has the potentials of solving the constraints of growth from income, addressing failures from crops and provides opportunity for investment and re-investment (Birthal *et al*, 2014).

The broad objective analyzed econometrics of rural livelihoods and income inequality among yam (*Discorea alata*) farming households' in Abuja Nigeria. The study was designed specifically to provide answers for the following objectives:

(i) describe the socio-economic profiles or characteristics of rural yam farmers,
(ii) describe the livelihood profiles of rural yam farmers,
(iii) analyze the costs and returns of yam production by rural farmers,
(iv) determine the income inequality or distributions among rural yam farmers,
(v) evaluate factors influencing livelihood income diversifications into various activities among rural yam farmers,
(vi) evaluate factors influencing income inequality or distributions among rural yam farmers, and
(vii) determine the constraints or problems facing rural yam farmers.

Methodology

The Study Area

The study was conducted in Kwali Area Councils, Abuja, Nigeria. Kwali Area council is located in the South Western part of the Abuja and lies between Latitudes 8.9 degrees south and Longitudes 78 degrees east. The council has a total land area of about 1,700.400 square kilometers. The observed population of the council is about 250,000 people (NPC, 2006). The people settled in disperse pattern, the settlement was in indigenous cluster type in: Kwali town, Yebu, Leda, Sheda,Dangana, Pai Ashara, Dabi. The major ethnic groupings were: Ganagana, Gbagis, Basa, Fulani, Hausa, and other ethnic groups. Majority of people were farmers. Crops grown include: yam, maize, sorghum, garden egg, millet, cassava, pepper, rice. They are also involve in livestock farming and other non-agricultural activities like tailoring, barbing, mechanics.

Sampling Techniques and Sample Size

The study employed and adopted multi-stage sampling technique. First stage, Kwali area council was selected through simple random sampling technique using ballot-box raffle draw method. Second stage, 10 wards were randomly selected in the area council using ballot-box raffle draw method. Thirdly, 10 villages were randomly selected in the area council, one village per ward, using ballot-box raffle draw method. Fourth and final stage, 10 rural yam farmers were randomly selected per village from the area council using ballot-box raffle draw method making a total sample size of 100 rural yam farmers.

Method of Data Collection

Primary data were obtained and employed. Questionnaire was the instrument used for the study. Also, personal and group interviews were included in situations where the rural yam farmers were not educated or have instances of language barrier. The data obtained were: price of yam tubers, quantity of fertilizer inputs, yam seed input, amount or volume of chemical input, labour input, income earned from farm, off-farm and non-farm activities, market information, gender, credit access, age, farm experience, family size, type of farm organizations, educational level, and constraints to yam production. Data were also obtained on quantity of yam sold, transportation and marketing costs. Questionnaire was pretested and validated. Results of validity and reliability test conducted were used in designing and re-designing of the questionnaire.

Method of Data Analysis

The following statistical and econometrics tools were employed to achieve specific and broad objectives:

(i) Descriptive Statistics
(ii) Gross Margin Analysis
(iii) Financial Analysis
(iv) Gini-Coefficient,
(iv) Multinomial Logit Model,
(v) Probit Model Analysis,
(viii) Simpson Index of Income Diversification
(ix) Principal Component Analysis, and
(x) t-Test Analysis.

Descriptive Statistics

This involves or encompasses the use of frequency distributions, mean, and percentages. Descriptive statistics was used to have a summary statistics of data obtained from the field. This was specifically used to achieve objectives one (i), two (ii) and seven (vii) which identifies the socio-economic profiles or characteristics of rural yam farmers, rural livelihoods and constraints or problems facing rural yam farmers.

Gross Margin Analysis

Gross Margin Analysis is defined as the difference between the observed gross farm income (GFI) and total variable cost (TVC) (Olukosi and Erhabor, 2005). It was used to determine the potentials profitability of rural yam farmers. The tools were used to achieve specific objective three (iii).

Gross margin model (GM) is expressed as follows:

$$GM = TR - TVC \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

GM = Gross Margin (₦),

TR = Total Value of Output or Total Revenue from rural yam production (₦),

TVC = Total Variable Cost (₦), and

TR = P.Q (₦).

Where: -P = Price of yam produced in Naira per Kilogram, Q = Output of yam in Kilogram.

Net Farm Income (NFI) is stated thus:

$$NFI = \sum_{i=1}^{n} P_1 Y_i - \sum_{j=i}^{m} P_j X_j - \sum_{k=1}^{k} GK \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

NFI = Net Farm Income (Naira Per annum)

P_i = Unit Price of Product (Naira/Unit)

P_j = Price per Unit Variable Input (Naira/Unit)

GK = Cost of all Fixed Inputs (where, k = 1,2,3, ……. k fixed input)

$\sum$ = Summation or Addition signs.

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

Financial Analysis

Gross Margin Ratio (GMR) following Ben-Chendo, Lawal, Osuji, Osugiri, and Ibeagwa (2015) was used to determine the profitability of rural yam production. This was used to achieve part of specific objective three (iii)

$$Gross\ Margin\ Ratio = \frac{Gross\ Margin}{Total\ Revenue} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

In order to evaluate the strength and financial positions of rural yam enterprises, operating ratio and rate of return per naira invested were considered. An operating ratio (OR) according to Olukosi and Erhabor (2005) is stated thus:

$$OR = \frac{TVC}{GI} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where,

OR = Operating Ratio (Units),

TVC= Total Variable Cost (Naira),

GI= Gross Income (Naira).

An Operating Ratio (OR) that is less than one (1) implies that the total revenue obtained from rural yam production was able to pay for the cost of variable inputs used in the enterprise (Olukosi and Erhabor, 2005). The rate of return per naira invested (RORI) in rural yam production enterprise is stated thus:

$$RORI = \frac{NI}{TC} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where,

RORI = Rate of Return per Naira Invested (Units),

NI = Net Income from Rural Yam Production (Naira),

TC = Total Cost (Naira).

The financial analysis was used to achieve part of specific objective three (iii).

Gini- Coefficients

Gini-Coefficient is defined as:

$$G.C = 1 - \sum_{i=1}^{K} X_i Y_i$$

Where,

G.C = Gini-Coefficient

X_i = Percentage of Yam Sellers in the i^{th} Class,

Y_i = Cumulative Percentage of Yam Sellers in the i^{th} Class,

K= Numbers of Classes.

According to Todaro and Smith (2009), Gini-Coefficient can be classified as:

0.20 – 0.35 = Relatively Equitable Income Distributions,

0.50 – 0.70 = Highly Unequal Income Distributions.

Furthermore, Gini-Coefficient can be classified into:

< 0.2 = Perfect Income Equality,

0.2 – 0.3 = Relative Income Equality,

0.3 – 0.4 = Adequate Income Equality,

0.4 - 0.5 = Large Income Gap, and

> 0.5 = Severe Income Gap.

This will be specifically used to achieve objective four (iv).

Multinomial Logit Model

The multinomial Logit model is stated thus:

$$\text{Prob}\,(A_i = j) = \frac{e^{\beta_k X_i}}{\sum_{k=1}^{j} e^{\beta_k X_i}}, \quad j = 0,2 \ldots\ldots\ldots j, \beta_0 = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$\text{Marginal Effects} = \frac{\partial P_j}{\partial X_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k \beta_k\right] = P_j\left(\beta_j - \bar{\beta}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + U_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where,

Z_i = Rural Farmers Income Inequality Distributions (1, Low, 2, Medium, 3, High)

β_0= Constant Term,

$\beta_1 - \beta_{10}$= Regression Coefficients,

X_1= Age (Years),

X_2= Marital Status (1, Married; 0, Otherwise)

X_3 = Household Size (Total Number of Person),

X_4= Level of Education (0, Non-Formal; 1, Primary; 2, Secondary; 3, Tertiary),

X_5 = Access to Credit (1, Access; 0, Otherwise),

X_6= Contact with Extension Agent (1, Contact; 0, Otherwise),

X_7 = Access to Market (1, Access; 0, Otherwise),

X_8 = Membership of Cooperative Organization (1, Membership; 0, Otherwise),
X_9 = Income Generation Farm Assets (1, Access; 0, Otherwise),
X_{10} = Farm Income (Naira),
U_i= Error Term.
This will be used to achieve specific objective six (vi).

Probit Model Analysis

A Probit model following Alabi, Lawal, Awoyinka, and Coker (2014) was used. Probit model is stated as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + U_i \dots\dots\dots (8)$$

Where,
Z_i= Simpson Index of Income Diversification (1, if Diversified; 0, Otherwise),
i = Number of Independent Variables,
β_0= Constant Term,
$\beta_1 - \beta_8$= Regression Coefficients,
X_1= Gender (1, Male; 0, Otherwise),
X_2 =Age (Years),
X_3 = Marital Status (1, Married; 0, Otherwise)
X_4 = Household Size (Total Number of Person),
X_5= Level of Education (0, Non-Formal; 1, Primary; 2, Secondary; 3, Tertiary),
X_6 = Membership of Cooperative Organization (1, Membership; 0, Otherwise),
X_7 = Access to Credit (1, Access; 0, Otherwise),
X_8= Contact with Extension Agent (1, Contact; 0, Otherwise),
X_9 = Income Generation Farm Assets (1, Access; 0, Otherwise),
X_{10} = Non-Farm and Off-Farm Incomes (Naira),
U_i= Error Term.
This will be used to achieve specific objective five (v)

Simpson Index of Income Diversification (SID)

Simpson Index of Income Diversification according to Agyeman *et al* (2014), Khan, Tabassum and Ansari (2017), Joshi *et al* (2004), Minot *et al* (2006), and Ali (2015) is defined as:

$$SID = 1 - \sum_{i=1}^{n} P_i^2 \dots\dots\dots (9)$$

Simpson Index of Livelihood Income Diversification can be classified according to Sherf-Ul-Alam, Ahmed, Mannaf, Fatema and Mozahid (2017) as:

≤ 0.01 = No Diversification
0.01– 0.25 = Low Level of Diversification
0.26 – 0.50 = Medium Level of Diversification
0.51 – 0.75 = High Level of Diversification
≥ 0.75 = Very High Level of Diversification

This will be used to achieve specific objective five (v).

Principal Component Analysis (PCA)

The perceived constraints or problems faced by rural yam farmers were analyzed using principal component analysis (PCA). The Model of Principal Component (PCA) is stated thus:

$$x = x_1, x_2, x_3, \dots, x_p \dots\dots\dots (10)$$

$$\propto_k = \propto_{1k1}, \propto_2 K, \propto_3 k, \dots, \propto pk \dots\dots\dots (11)$$

$$\propto_K^T x = \sum_{j=1}^{p} \propto_{KjXj} \dots\dots\dots (12)$$

$$Var = [\propto_K^T X] \; is \; Maximum \dots\dots\dots (13)$$

Subject to

$$\propto_K^T \propto_K = 1 \dots\dots\dots (14)$$

and Cov= $[\propto_1^T \propto -\propto_2^T \propto] = 0 \dots\dots\dots (15)$

The Variances of each of the Principal Component are:

$$Var[\propto_k X] = \lambda_k \dots\dots\dots (16)$$

$$S = \frac{1}{n-1}(X - \bar{X})(X - \bar{X})^T \dots\dots\dots (17)$$

$$S_i = \frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{X}_i)\,(X_I - \bar{X}_i) \dots\dots\dots (18)$$

Where,
X = vector of 'P' Random Variables
$\propto_k$ = Vector of 'P' Constraints
$\searrow_k$= Eigen Value
T = Transpose
S = Sample Covariance Matrix
This was used to achieve specific objective six (vi)

Results and Discussion

Socio-Economic and Livelihood Profiles or Characteristics of Rural Yam Farmers

Table 1 shows the socio-economics profiles or characteristics of yam farmers. About 73% of rural farmers were less than 51 years of age. This means that they were active, youthful and energetic. The activities involved in operations of yam production required active labour force. Activities of yam production that require energy were making mounds, staking, weeding, planting, and harvesting. Rural yam farmers were literate and 94% of them had formal education. Active, young, energetic and educated rural yam farmers would be able to make farm decisions, adopt new innovations, new technologies and research findings. Most (53%) of the rural yam farmers were married. The rural farmers' uses labour from the households for their farm operations and or labour inputs were hired. Furthermore, 70% of rural yam farmers had 20 years experiences in yam production. The household sizes were large. The average values of 5 people were obtained per household. About 72% of rural yam farmers had less than 10 people as household size. Farm land is an asset. The average farm sizes were 1.7 hectares. Also, 56% of rural farmers had less than 2 hectares of yam farms. Dependency ratio can be defined as the proportion of rural yam farmers who were not working members. The average dependency ratio was 1.64. About 65% of rural yam farmers had dependency ratio value less than 2.0. These results were in line with findings of Alabi, Ayoola and Ugbaje (2010), Alabi, Lawal and Oladele (2016), Alabi, Amadi and Ijir (2014), who observed in their various findings that rural farmers were young, energetic, resourceful and in their active ages.

Table 1. Socio-Economic and Livelihood Profiles or Characteristics of Rural Yam Farmers

Socio-Economic Characteristics	Frequency	Percentage	Mean
Age (Years)			
31 – 40	24	24.00	
41 – 50	49	49.00	45.80
51 – 60	27	27.00	
Marital Status			
Single	21	21.00	
Married	53	53.00	
Widowed	19	19.00	
Divorced	07	07.00	
Educational Status (Years)			
Primary	49	49.00	
Secondary	25	25.00	
Tertiary	20	20.00	
Non-Formal	06	06.00	
Experience in Yam Farming (Years)			
1 – 10	53	53.00	
11 – 20	17	17.00	13.70
21 – 30	30	30.00	
Household Size (Units)			
1 – 5	47	47.00	5.75
6 – 10	25	25.00	
11 – 15	28	28.00	
Farm Size (Hectares)			
≤ 1	23	23.00	
1 – 2	33	33.00	1.74
2 – 3	41	41.00	
3 – 4	03	03.00	
Dependency Ratio (Units)			
≤ 0.99			
1 – 1.99	31	31.00	
2.0 – 2.99	34	34.00	1.64
3.0 – 3.99	25	25.00	
	10	10.00	
Total			
	100	100.00	

Source: Field Survey (2019), Computed from STATA Version 14

Livelihoods Activities of Rural Yam Farmers

Livelihood activities are farm activities, non-farm activities and or off-farm activities that rural yam farmers engaged or performed to earned or increase their income.

Table 2. Livelihood Activities of Rural Yam Farmers

Livelihood Activities	*Frequency	Percentage
Crop Farming	45	05.47
Livestock Farming	76	09.23
Tailoring	51	06.20
Carpentry	67	08.14
Barbing	87	10.57
Fish Farming	94	11.42
Laundry Services	56	06.80
Transport Operations	87	10.57
Mechanics	86	10.45
Rural Business or Trading Enterprises	32	03.89
Labour Construction	64	07.78
Hair Dressing	78	09.48
Total	***823**	**100.00**

Source: Field Survey (2019), Computed using STATA Version 14

Multiple Responses

Rural farmers were engaged in the following income generating livelihood farm activities: crop production (05.47%), livestock farming (09.23%), and fish farming (11.42%). The income generating livelihood non-farm activities engaged in by rural yam farmers were tailoring (06.20%), carpentry (08.14%), barbing (10.57%), laundry services (06.80%), and mechanics (10.45%), transport services (10.57%), trading (03.89%), labour construction (07.78%) and hair dressing (09.48%). This result is in line with findings of Sherf-Ul-Alam, Ahmed, Mannaf, Fatema and Mozahid (2017), Ahmed (2012), Okere and Shittu (2013), Khan, Tabassum and Ansari (2017) who reported in their various studies that rural farmers were engaged in farming, non-farming and off-farm activities respectively.

Costs and Returns Analysis of Rural Yam Production

The estimated costs and associated returns for rural yam production were presented in Table 3. Total revenues of rural yam production were estimated based on the prevailing market prices as at the time of the research study. The total variable cost was 90,500 Naira and this accounted for 76.83% of the total cost of production of yam tubers by rural farmers. The items constituting the total variable costs were: land preparation (04.24%), cost of yam seeds (25.47%), cost of chemical (04.24%), labour input (06.37%), fertilizer input (23.77%), cost of weeding (05.52%), cost of staking (02.55%), cost of harvesting (03.40%) and loading and off-loading cost (01.27%).The total fixed cost estimated was 27,300 Naira and this accounted for 23.17% of the total cost of production of yam tubers by rural farmers. The items constituting the total fixed costs were depreciated farm assets (13.58%), costs incurred on land input (02.72%), administrative charges (02.29%), taxes 903.14%) and interest (01.44%). The gross margin and net farm income for yam production were calculated as 860, 370 Naira and 742, 570 Naira respectively. This means that yam production by rural farmers was profitable. The gross margin ratio, operating ratio and rate of return on investment (RORI) were 0.904, 0.105 and 06.30 respectively. The gross margin ratio of 0.904 implies that for every one naira invested in yam production by rural farmers, 90 kobo covered expense, taxes, profits, interest and depreciations. This result is in line with findings of Alabi, Ayoola and Ugbaje (2010), Alabi, Coker and Idigbesor (2013), Alabi and Ajooku (2012) who reported in their findings that yam production by rural farmers are profitable enterprises.

Table 3. Costs and Returns Analysis of Rural Yam Production

Variable	Value (₦)	Percentage
(a) Variable Cost		
Land Preparation	5,000	04.24
Cost of Yam Seed	30,000	25.47
Cost of Chemical	5,000	04.24
Labour Input	7,500	06.37
Fertilizer Input	28,000	23.77
Cost of Weeding	6,500	05.52
Cost of Staking	3,000	02.55
Cost of Harvesting	4,000	03.40
Loading/Offloading	1,500	01.27
Total Variable Cost	**90,500**	**76.83**
(b) Fixed Cost		
Depreciation of Farm Assets	16,000	13.58
Cost Incurred on Land	3,200	02.72
Expenses Spent on Administrative Procedures	2,700	02.29
Taxes	3,700	03.14
Interest	1,700	01.44
Total Fixed Cost	**27,300**	**23.17**
Total Cost of Production	**117,800**	
Total Returns	**950,870**	
Gross Margin	**860,370**	
Net Farm Income	**742,570**	
Gross Margin Ratio	**0.904**	
Operating Ratio	**0.105**	
Rate of Return on Investment (RORI)	**6.30**	**100.00**

Source: Field Survey (2019), Computed using STATA Version 14

Income Inequality or Income Distributions among Rural Yam Farmers

Gini-Coefficient was employed to estimate or calculate the income inequality or income distributions among rural yam farmers. Gini-Coefficient values ranges from zero (0) to one (1).The value zero (0) means that there are perfect equalities in income distributions among rural yam farmers. The value one (1) means that there are perfect inequalities in income distributions among rural yam farmers. As the calculate Gini-Coefficient get closer to zero (0) the greater the degree or level of equalities in income distributions among rural yam farmers. Likewise, as the calculated Gini-Coefficient get closer to one (1) the higher the degree or level of inequality in income distributions among rural yam farmers. The result as presented in Table 4 shows that the calculated Gini-Coefficients were 0.7413. This means a severe income gap or high inequality in income distributions among rural yam farmers. Also, the results show that 27% of the yam producers who happen to be within the ranges of 300,001 to 400,000 Naira control 14% of the shares of the total income earned by the rural yam producers.

Furthermore, 18% of the yam producers who happen to be within the ranges of 400,001 to 500,000 control 42% of the total income earned by rural yam producers. This study is in line with earlier findings of Igbal, Abbas, Ullah, Ahmed, Sher and Akhtar (2018), Abah, Anjeinu and Iorhon (2015) who observed in their research findings inequality distributions among rural farmers.

Table 4. Gini-Coefficients of Measuring Income Inequality or Distributions

Range of Income (Naira)	No of Yam Farmers (Freq.)	Prop. Of Yam Farmers (X)	Cumm. Prop.	Cumm. Freq.	Sum of Income Within Ranges (Naira)	Prop. Of Total Income	Cumm. Prop (Y)	XY
≤ 300,000	36	0.36	0.36	36	256,300	0.11	0.11	0.0396
300,001- 400,000	27	0.27	0.63	63	330,700	0.14	0.25	0.0675
400,001 – 500,000	18	0.18	0.81	81	420,660	0.17	0.42	0.0756
500,001 – 600,000	15	0.15	0.96	96	568,800	0.24	0.66	0.036
≥ 600,001	04	0.04	1.00	100	832,400	0.34	1.00	0.040
Total	**100**	**1.00**			**2,408,800**			**0.2587**
G.C = 1 -0.2587 =	0.7413							

Source: Field Survey (2019), Computed using STATA Version 14

Simpson Index of Income Diversification

Table 5 presented the Simpson income of diversification among rural yam farmers. About 35% of rural yam farmers belong to medium level of diversified group. Furthermore, 90% of rural yam farmers belong to diversified group, while 10% of rural yam farmers belong to non-diversified group. This means that 90% of rural yam farmers earned their incomes from farm, non-farm and off-farm and other livelihood activities. This result is in line with findings of Sherf-Ul-Alam, Ahmed, Mannaf, Fatema and Mozahid (2017), Khan, Tabassum and Ansari (2017).

Table 5. Simpson Index of Income Diversification for Rural Yam Farmers

Simpson Index of Income Diversification	Frequency	Percentage
≤ 0.01	10	10.00
0.01 – 0.25	15	25.00
0.26 – 0.50	35	35.00
0.51 – 0.75	25	25.00
≥ 0.75	15	15.00
Total	100	100.00

Source: Field Survey (2019), Computed using STATA Version 14

Factors Influencing Diversification into Livelihood Activities among Rural Yam Producers

Factors influencing livelihood income diversification among rural yam farmers were examined using Probit model (Table 6). The Log-Likelihood value was -108.211, the Likelihood ratio Chi square was 69.51 and they were statistically significant at 1% level of probability. This means that the model is of good fit. The exogenous variables included in the model were age, marital status, household size, level of education, membership of cooperatives, access to credit, contact with extension agents, farm assets, and farm income. The exogenous variables that were statistically significant in influencing livelihood income diversification among rural yam farmers were gender ($P < 0.01$), age ($P < 0.05$), marital status ($P < 0.10$), household size ($P < 0.05$), level of education ($P < 0.01$), membership of cooperatives ($P < 0.01$)·access to credit ($P < 0.10$), extension agent ($P < 0.05$), income generating farm asset ($P < 0.05$), and farm income ($P < 0.05$).The coefficient of age was positive, an in increase in rural yam farmers age by one year would 11.28% increases the likelihood or probability to diversified into livelihood activities. This result is in line with findings of Sanusi, Dipeolu and Momoh (2016). The marginal probability of Probit model implies that rural yam farmers who have access to credit would 10.18% increases the likelihood or probability to diversified into livelihood activities. This results is in line with findings of Bushway, Johnson and Slocum (2007) and Astatike and Gazuma (2019). Also, a unit increase in farm income would be 13.73% increases the likelihood or probability of rural yam farmers of diversifying into livelihood activities. This result is in line with findings of Osundu, Obike and Ogbonna (2014) and Astatike and Gazuma (2019) who reported in their various research studies that socio-economic factors influence livelihood diversifications among rural farmers.

Table 6. Parameter Estimates of Probit Model of Factors Influencing Livelihood Income Diversification among Rural Yam Farmers.

Variables	Coefficient	Standard Error	Marginal Effects
Gender (X_1)	0.141***	0.171	0.0141
Age (X_2)	0.168**	0.371	0.1128
Marital Status (X_3)	0.156*	0.148	0.3051
Household Size (X_4)	0.134**	0.146	0.5948
Level of Education (X_5)	0.168***	0.168	0.5473
Membership of Cooperatives (X_6)	0.148**	0.178	0.3291
Access to Credit (X_7)	0.081*	0.136	0.1081
Contact with Extension Agent (X_8)	0.109**	0.161	0.1326
Income Generating Farm Assets (X_9)	0.28**	0.19	0.3051
Farm Income (X_{10})	0.561**	0.39	0.1373
Constant	14.81		
LR Chi Square	69.51***		
Pseudo $-$ R^2	0.8961		
Log-Likelihood	-108.211		
Prob $>$ Chi^2	0.0000		

Source: Field Survey (2019), Computed using STATA Version 14. ***-Significant at P <0.01, **-Significant at P <0.05, **-Significant at P <0.10

Factors Influencing Income Inequality or Income Distributions among Rural Yam Farmers

Factors influencing income inequalities or income distributions among rural yam farmers were examined using multinomial Logit model and were presented in Table 7. The explanatory or regressor variables examined in the model were age, marital status, household size, level of education, access to credit, contact with extension agents, access to market, membership of cooperatives, income generating farm assets, non-farm and off-farm income. The Log-Likelihood ratio was -289.230 and the Log-Likelihood ratio Chi Square was 89.41 and was statistically significant at 1% probability level. This means that the model is of good fit. Non-farm income and off-farm income were statistically significant in influencing income inequality or income distributions of low income earners at ($P < 0.10$) and high income earners at ($P < 0.05$) respectively. The marginal probability of non-farm and off-farm income for low income earners was 0.393. This means a one percent increase in non-farm and off-farm income would 39.3% increases the likelihood or probability of wide income gap or income inequality among low income earners of rural yam producers. This result is in line with findings of Mat *et al* (2012), Adams (2001) and Iqbal, Abbas, Ullah, Ahmed Sher and Akhtar (2018). Income generating farm assets statistically and significantly influence the income inequality or distributions of low income earners at ($P < 0.05$) and high income earners at ($P < 0.10$) respectively. Household size is a socio-economic factor of rural yam producers, household size influence the income inequality of low income earners at ($P < 0.10$) and high income earners at ($P < 0.10$) respectively. An increase in household size by one person would lead to increases of 0.381 likelihood or probability of wide income gap or inequality among rural yam farmers. This result is in line with findings of Khan, Kamal, Ramazan, Khan, Ali and Ahmed (2018).

Table 7: Estimates of Multinomial Logit Model of Factors Influencing Income Inequality or Distributions among Rural Yam Farmers.

Variables	Low Income			High Income		
	Coefficient	Std. Error	Marginal Effects	Coefficient	Std. Error	Marginal Effects
Age (X_1)	0.181**	0.016	0.162	0.717	0.416	0.218
Marital Status (X_2)	0.191**	0.012	0.251	0.314*	0.271	0.351
Household Size (X_3)	0.015*	0.077	0.381	0.211*	0.361	0.181
Level of Education (X_4)	0.113*	0.237	0.071	0.146**	0.262	0.266
Access to Credit Facilities (X_5)	0.361**	0.137	0.368	0.213**	0.359	0.313
Contact with Extension Agent (X_6)	0.018*	0.214	0.214	0.368**	0.032	0.018
Access to Market (X_7)	0.148**	0.129	0.189	0.189**	0.146	0.116
Membership of Cooperative Organization (X_8)	0.082*	0.134	0.274	0.124*	0.841	0.116
Income Generating Farm Assets (X_9)	0.021**	0.1441	0.425	0.225*	0.118	0.167
Non-Farm and Off-Farm Incomes (X_{10})	0.125*	0.371	0.393	0.215**	0.219	0.151
Constant	0.114*	0.161	-------	0.231	0.211	0.191
LR Chi Square	89.41***					
Pseudo $-$ R^2	0.790					
Log-Likelihood	-289.230					
Prob $>$ Chi^2	0.0000					

Source: Field Survey (2019), Computed using STATA Version 14. ***-Significant at P <0.01, **-Significant at P <0.05, **-Significant at P <0.10

Constraints or Problems Facing Rural Yam Farmers

The problem facing rural yam farmers was subjected to principal component analysis as presented in Table 8. Principal component analysis transformed many interrelated variables into smaller important ones. Six (6) variables that had Eigen-values greater than one were retained in the model. The six (6) retained variables explained 84.79% of all variables included in the model. Lack of credit facilities with Eigen-value 3.9644 was ranked first (1st). Inadequate extension agents with Eigen-value 2.9605 was ranked second (2nd).Poor storage facilities with Eigen value of 2.7640 was ranked (3rd).The Kaiser-Meyer-Olkin (KMO) which measures sampling adequacy gave a value of 0.673, the Chi square of 3061.328 was observed and found to be statistically significant at 1% level of probability.

Table 8. Results of the Principal Component Analysis of Constraints or Problems Facing Rural Yam Farmers

Constraints	Eigen-Value	Difference	Proportion	Cumulative
Lack of Credit Facilities	3.9644	0.2469	0.1541	0.1541
Inadequate Extension Agents	2.9605	0.5421	0.1160	0.2701
Poor Storage Facilities	2.7640	0.3210	0.1694	0.4395
Bad Feeder Roads	2.1146	0.3040	0.1342	0.5737
Lack of Farm Inputs	1.8970	0.2890	0.1531	0.7268
Lack of Access to Market Centers	1.3420	0.1490	0.1211	0.8479
Bartlett Test of Sphericity KMO 0.673 Chi-Square 3061.328*** Rho 1.00000				

Source: Field Survey (2019), Computed using STATA Version 14

Conclusion

The rural yam farmers were young, energetic and in their economic youthful age. The mean age of rural yam farmers was 45.80 years. Most farmers had formal education and were literate. The average experiences in yam farming were 13.70 years. The household sizes were large, averages of 6 people were observed per household. Dependency ratio on the average gave a value of 1.64. Livelihood activities of rural yam farmers were farming, non-farming and off-farming activities. The farm activities were livestock farming, crop farming and fish farming. The non-farming activities were tailoring, carpentry, barbing, laundry services, transport operations, mechanics, trading enterprises, labour construction works and hair dressing. Yam production by rural farmers were profitable enterprises with a gross margin of 860,370 Naira and net farm income of of 742,570 Naira. The gross margin ratio, operating ratio and rate of return on investment were 0.904, 0.105 and 6.30 respectively. The gross margin ratio of 0.904 means that for every one naira invested in yam production enterprise 90 kobo will covered taxes, expenses, interest, profits and depreciation. The Gini-coefficient of 0.7413 revealed severe income gap or high-income inequality among rural yam farmers. Factors that were statistically and significantly influencing livelihood income diversification among rural yam farmers were gender, age, marital status, household size, level of education, membership of cooperative organization, access to credit, contact with extension agents, income generating farm assets, and farm income. Factors that were statistically and significantly influencing income inequality or income distributions among low income earners were age, marital status, household size, level of education, access to credit facilities, access to market, membership of cooperative organizations, income generating farm assets, non-farm and off-farm income. Principal component analysis is a method that reduces many inter-correlated variables into smaller and important variables. The constraints or problems facing rural yam farmers were subjected to principal component analysis. Six (6) constraints facing rural yam farmers with Eigen values than greater one were retained. The retained problems or constraints were lack of credit facilities, inadequate extension agents, poor storage facilities, bad feeder roads, lack of farm inputs, and lack of access to market centers. The retained components explained 84.79% of all variables included in the model.

Recommendations

The following policy recommendations were made based on the findings of this study:

(i) Credit facilities should be made available to rural yam farmers at low interest rate.

(ii) Adequate storage facilities for their yam produce should be provided for rural yam producers.

(iii) Extension officers should be employed to disseminate research findings from research institutions to rural yam farmers

(iv) Feeder road infrastructures should be constructed to move agricultural produce from farms to market centers.

(v) Rural yam farmers should form cooperative organizations in other to access farm inputs at subsidized rate, and access credit at low interest rate.

Conflict of Interest

Author declare no conflict of interest.

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