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Original Article

Smallholder rural women rice (*Oryza sativa*) farmers' decisions making process, agricultural intensification and poverty status, Abuja, Nigeria

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ABSTRACT

This study evaluated smallholder rural women rice (*Oryza sativa*) farmers' decisions making process, agricultural intensification, and poverty status in Abuja, Nigeria. The study was designed specifically to achieve the objectives as follows: Determine the socio-economic profiles of smallholder rural women rice farmers, analyze the costs and returns of smallholder rural women rice production, evaluate factors influencing smallholder rural women rice farmers' decision to adopt agricultural intensification, evaluate factors influencing output of rice among smallholder rural women rice farmers, determine poverty status of smallholder rural women rice farmers, evaluate factors influencing poverty status of smallholder rural women rice farmers, and determine the constraints facing the smallholder rural rice women farmers. Multi-stage sampling method was used. Total sample size of 100 smallholder rural women rice farmers was obtained and used. Data used were of primary sources. The statistical and econometric tools used were descriptive statistics, gross margin, financial analysis, Heckman-two stage model (which involves Probit model and ordinary least squares regression model), Foster, Greer, and Thorbecke (FGT) poverty model, Logit regression model, and principal component analysis. The results show that 75% of smallholder rural women rice farmers were <50 years of age. Factors influencing adoption of agricultural intensification include age ($P < 0.05$), sex ($P < 0.10$), educational level ($P < 0.01$), household size ($P < 0.05$), membership of cooperatives ($P < 0.01$), experiences in farm activities ($P < 0.01$), and access to credit facilities ($P < 0.01$). The poverty line was 4990.07 Naira (12.79 USD). FGT poverty index shows that poverty incidence (P_0), poverty depth (P_1), and poverty severities (P_2) were 0.5178, 0.2866, and 0.1956, respectively. Factors statistically and significantly reducing poverty include educational level ($P < 0.05$), access to credit facilities ($P < 0.05$), membership of cooperatives ($P < 0.05$), and farm income ($P < 0.05$). Constraints facing smallholder rural women rice farmers were lack of fertilizer input, lack of credit facilities, bad road infrastructures, lack of improved seeds input, lack of labor inputs, and inadequate extension officers. This retained components explained 87.59% of all variables included in the model. The study recommends policy that will improve access of women rice farmers to productive resources such as improved seeds, land credit, fertilizers, chemicals, and appropriate new technologies to increase food production and consumption.

Keywords: Abuja, agricultural intensification, decision-making process, Nigeria, poverty status, smallholder women rice farmers

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INTRODUCTION

Rice (*Oryza sativa*) is an important food crop in the diet of most Nigerians. The consumption of rice has outpaced production thus making Nigeria the highest leading importer of rice in the world.[1] Rice can be grown in all agro-ecological zones in Nigeria. In 2019, Nigeria target rice production of 7.2 million metric tonnes.[2] The local production of rice was 3.7 million metric tonnes. The local supply gap of 3.5 million metric tonnes must be filled by rice importation to avoid famine, food insecurity, poverty, hunger, and diseases. Rice production can improve rural farmer's livelihood, alleviate poverty, and increase food security. Smallholders provide 80% of the food production in sub-Saharan Africa. Many of the households in sub-Saharan Africa are extremely poor; the highest incidence of working families below poverty line relies on agriculture for employment. Smallholders in Africa are exercising and living under considerable pressure.

Agricultural intensification is one of the great pillar for agricultural and growth of the economy in sub-Saharan Africa. Agricultural intensification is a concept that increases the inputs of capital such as machinery in the agricultural activities, increase the inputs of labor to raise the output or yields of a land area during a fixed period of time. Agricultural intensification in sub-Saharan Africa occurs where there is population growth, and land constraints. Conventionally, agricultural intensification has three definitions, first, yields are increased per hectare, second, crop intensity are increased per unit hectare of land or other farm inputs, third, changing the land use of low valued crops or agricultural commodities to those that will receive higher market prices. Agricultural intensification relative to production is situation whereby yields or outputs are increased without any adverse impact on environment and without the cultivation of more hectares of land. Sustainable intensification enhances agricultural production, conserve, and protect the environment.[3] Sustainable agricultural intensification can both address the issues of food security needs in Africa and smallholder agriculture to have its meaning which has a great role in feeding the populations in developing countries.[4] There is the need to intensify smallholder agriculture in a sustainable way in poor and labor abundant economies as it is practical solutions that can provide food for both rural and urban residents and reduce poverty.[5-7] Sub-Saharan Africa needs smallholder agriculture that is intensive and sustainable which can optimize and manage environment and natural resource use, ensure food security, reduce poverty, generate increased output, and income for farmers. Agricultural intensification is a developing strategy suggested for sub-Saharan Africa by World Bank.[8] The basic aim is to increased agricultural productivity, growth of export crops, growth that will spread from agricultural sector to other sectors that will support global growth.[8] Food and Agriculture Organization[9] defines agricultural intensification as an increase in agricultural production per units of inputs such as land, labor, fertilizer, seeds, feeds, time, and cash. This can bring about agricultural development which can change the lives of farmers, the farmers ability to adopt are dependent on their living standard. Agricultural intensification has been defined to be increase average inputs of capital or labor on a smallholding, on cultivated and grazing land, cultivated land alone, basically for the purpose of increasing the value of output per hectare. Agricultural intensification involves greater use of non-land resources such as labor input for a given land area, the aim is to have higher output produced. It involves replacement of agricultural commodities of traditional crops with high yielding varieties that requires improved technology.

In sub-Saharan Africa women are the backbone of the agricultural sector. Women accounted for 60% of agricultural production, 70% of agricultural labor, and 80% of food production.[10] The roles of women, the main actor in sub-Saharan African agriculture have not been recognized. The lack of appropriate policy recommendations and program strategies made the contributions of women to agriculture invisible. Furthermore, there are no qualitative and quantitative data on the role of women in sub-Saharan agriculture and rural development. The absence of statistical data information on the role and status of women is a significant factor constraint to understanding their situations.[10]

Food insecurity, poverty, no access to clean water, no adequate nutrition, and lack of basic needs to meet standard physical well-being of women in sub-Saharan Africa. Women illiteracy rates are twice as high as men further demonstrating their disadvantage position and hence cannot access information. Women work more hours on the farm than men regardless of the season and they are engaged in both farming and non-farming activities. High labor women input include manual labor for farms, households, and non-farm activities. Women are involved in wide range of agricultural businesses around their farms and they are also involved in income generating activities than men. Rural women in sub-Saharan Africa provide most of the agricultural labour, constitutes majority of smallholder farmers, manage many of their farms on a daily basis and are mostly the head of the households.[10] Rural women run most of their farm operations themselves, with supplementary help from family members of hired labor, and women are heavily involved in land clearing activities. Both women and men in rural farming households make agricultural decisions about how to farm, what crops to farm, and how to dispose proceeds from their farms. These farm decisions are usually specific to the farms they manage and the revenue from the farm plots. Both men and women grow cash and food crops, on more regular basis women are engaged more than men in all farm and agricultural activities.[10]

Objectives of the Study

The broad objective is to evaluate smallholder rural women rice (*O. sativa*) farmers' decision-making process, agricultural intensification and poverty status, Abuja, Nigeria. Specifically, the study was designed to achieve the following objectives:

i. Determine the socio-economic profiles of smallholder rural women rice farmers,
ii. Analyze the costs and returns of smallholder rural women rice production,
iii. Evaluate factors influencing smallholder rural women rice farmers adoption of agricultural intensification,
iv. Evaluate factors influencing output of rice among smallholder rural women farmers,
v. Determine the poverty status of smallholder rural women rice farmers,
vi. Evaluate factors influencing poverty status of smallholder rural women rice farmers, and
vii. Determine the constraints facing the smallholder rural women rice farmers.

Justification of the Study

In sub-Saharan Africa, increase in agricultural production will have to be based on adding values to products and intensification. Rural women are the fore front of meeting this agricultural challenge. The primary domain of rural women is agricultural production. Rural women faced food insecurity, poverty, the basic needs, and the right to survive not assured. Africa face the world's highest hunger problems.[11] Developing Countries like Nigeria faces acute food insecurity, poverty, and malnutrition. Food poverty is the inability to afford, or have access to food that make up a healthy diet.[12] Farming households including rural women in Nigeria are poor and food insecure.[13] Food insecurity is rooted in poverty and has a long term impacts on the ability to farm, communities, and countries to grow, develop, and prosper.[9] Defines agricultural intensification as increase in agricultural production per units of input of land, time, labor, seeds, fertilizer, or cash. Two-third of the laborers are working in agricultural sector and they are small scale, subsistence rural farmers using crude implements such as hand hoes, the female farmers are the poorest among them.[14]

Conceptual Framework

Poverty is a multidimensional framework and has intensive adverse impacts on developing societies like Nigeria and on human conditions ranging from moral, physical, and psychological.[15] Poverty in rural areas is severe and affects farming households in the agricultural sector, where infrastructure and social services are non-existent or limited. About 80% of domestic food producers in sub-Saharan Africa are women.[10] Africa relies on more than 47 billion USD worth of food imports to supplement domestic supply to feed its citizens.[16] Rural women farmers are important when discussing households' food and nutrition security in sub-Saharan Africa.[10] Furthermore, 80% of farm labors in Sub-Saharan Africa are provided by rural women.[17] Understanding the concept of agricultural intensification technologies is important as a form of production wherein the yields are increased without adverse environmental impact and without cultivation of more land.[18] Sustainable agricultural intensification is most often regarded as technologies to address food security needs.[4] Agricultural intensification as a model has two internal concepts. First is the increase of inputs of capital like machinery, improved seeds, biotechnology, fertilizers, and energy. Second is to increase inputs of labor. The core concept is to increase the inputs of capital or labor to raise the output or yields of crops of a land area during a fixed period of time.[19] Intensification of agricultural production is one of the strategic pillars for agricultural, economic growth, and development in sub-Saharan Africa.[20]

METHODOLOGY

This research study was conducted in Abuja, Nigeria. Abuja is located within Latitudes 9° 4^{l} 20^{ll} North and Longitudes 7° 29^{l} 28^{lll} East. Abuja experiences two weather conditions within the year. The rainy season around March to October, and the dry season this begins from October to March. The rainy season daytime temperature reach 28°C and the dry season reach 40°C. There is a short period of harmattan with northeast wind within the period. Abuja has a population of 776,298 people.[21] Abuja has a rich soil for agriculture. Crops grown include rice, millet, garden egg, groundnut, sorghum, maize, yam, and cassava among others. Livestock reared include cattle, goats, sheep, and rabbit. Data used were of primary sources. Cross-sectional data were obtained with the use of well-designed and well-structured questionnaire. The questionnaire was administered to 100 smallholder rural women rice farmers. Multi-stage sampling method was used. First stage involves the simple random selection of Abuja through ballot-box raffle draw method. Second stage involves the simple random selection of Gwagwalada area council through raffle draw ballot-box method. Third and fourth stages involve simple random selection of five wards and two villages per ward using ballot-box raffle draw method. Fifth stage involves using[22] a proportionate-random selection of 100 smallholder rural women rice farmers within the villages. The sample frame comprises 133 smallholder rural women rice farmers.[21] Formula for calculating sample size is stated thus:

$$n = \frac{N}{1 + N(e)^2} = 100 \quad (1)$$

Where,
n= Sample Size (Units)
N=Sample Frame (Units)
e=Level of Precision (5%)

Method used in analyzing data collected were.

Descriptive Statistics

This involves the use of frequency distributions, percentages, and mean. Descriptive statistics will be used to have a summary statistics of data collected. This was specifically used to achieve objectives one and seven.

Gross Margin Model

Farm Gross Margin Model following[23] is stated as follows:

$$FGMM = \sum_{j=1}^{m} P_j Y_j - \sum_{j=1}^{n} P_i X_i \quad (2)$$

Where,
P_j = Unit price of rice product (output)
Y_j = Quantity of output (kg)
P_i = Unit price of variable inputs used in rice production
X_i = Quantity of variable inputs $i, j \ldots . n, m$

$$Net\ farm\ profit\ (NFP) = \left[\sum_{j=1}^{m} P_j Y_j - \sum_{j=1}^{n} P_i X_i\right] - K \quad (3)$$

Where,
K = Fixed Costs

This will be used to achieve specific objective two.

Financial Analysis

Gross Margin Ratio (GMR) following[24] was used to calculate the profitability of rice production.

$$Gross\ margin\ ratio = \frac{Gross\ margin}{Total\ revenue} \quad (4)$$

This will be used to achieve specific objective two.

Heckman Two-stage Model

Probit model analysis

The Probit Model is stated thus:

$$\begin{aligned} Y_i = {} & b_0 + b_1 X_1 + b_2 X_2 \\ & + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 \\ & + b_8 X_8 + b_9 X_9 + b_{10} X_{10} + e_i \end{aligned} \quad (5)$$

$$Y_i = b_0 + \sum_{i=1}^{10} b_i X_i + e_i \quad (6)$$

The explicit function is stated thus:

Where,
Y_i = Dichotomous adoption of agricultural intensification (1, adopt; 0, otherwise)
X_1 = Age (years)
X_2 = Sex dummy (1, male; 0, female)
X_3 = Educational level (1, formal education; 0, otherwise)
X_4 = Household size (number of persons)
X_5 = Membership of cooperatives (1, member; 0, otherwise)
X_6 = Experiences in farm activities (years)
X_7 = Access to credit facilities dummy (1, access; 0, otherwise)
X_8 = Fertilizer input (Kg)
X_9 = Labor input (Mandays)
X_{10} = Improved seed input (Kg)
b_0 = Constant term
b_1–b_{10} = Regression coefficients
e_i = Error Term

This will be used to achieve specific objective three.

Ordinary least square model (OLS)

The OLS regression model is stated thus:

$$Y = b_0 + \sum_{i=1}^{10} b_i X_i + e_i \quad (7)$$

The explicit function is stated:

$$\begin{aligned} Y_i = {} & b_0 + b_1 X_1 + b_2 X_2 + \\ & b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 \\ & + b_8 X_8 + b_9 X_9 + b_{10} X_{10} + e_i \end{aligned} \quad (8)$$

Where,
Y_i = Output of Rice Production (Kg)
X_1 = Age (Years)
X_2 = Sex Dummy (1, Male; 0, Female)
X_3 = Educational Level (1, Formal Education; 0, Otherwise)
X_4 = Household Size (Number of Persons)
X_5 = Membership of Cooperatives (1, Member; 0, Otherwise)
X_6 = Experiences in Farm Activities (Years)
X_7 = Access to Credit Facilities Dummy (1, Access; 0, Otherwise)
X_8 = Fertilizer Inputs (Kg)
X_9 = Labor Input (Mandays)
X_{10} = Improved Seed Inputs (Kg)
b_0 = Constant Term
b_1–b_{10} = Regression Coefficients
e_i = Error Term

This will be used to achieve specific objective four.

Foster, Greer and Thorbecke (FGT) Poverty Model

The most widely used poverty indices are measures proposed by Foster *et al.*[25] as used by Duniya and Sanni.[26] These three poverty indices measures were: The poverty headcount ratio, the poverty gap, and squared poverty gap. These poverty indices measure the basic desirable property of poverty. The FGT model is specified thus;

$$P_{\alpha i} = \frac{1}{N}\sum_{i=1}^{q}\left[\frac{Z - Y_i}{Z}\right]^{\alpha} \quad (9)$$

Where:
$P_{\alpha i}$ = FGT Poverty Index for the ith Sub-Groups,
N = Total Number of Smallholder Rural Women Rice Farmers in the Population,
Y_i = Per Capital Expenditure of ith Women Farmers,
Z = The Poverty Line,
q = The Number of the Sampled Women Rice Farmers in the Population below the Poverty Line
α = The Degree of Aversion and take on the Value of 0, 1, 2.

Poverty head count ratio

The headcount ratio measures the incidence of poverty and it is obtained as:

$$FGT_{\alpha} = \frac{1}{N}\sum_{i=1}^{q}\left[\frac{Z - Y_i}{Z}\right]^{\alpha} = P_0 = \frac{H}{N} \quad (10)$$

when ($\alpha = 0$)
P_{α} = P= Poverty Incidence or Head Count Ratio

Where,
H = The Number of Individuals below Poverty Line
N = The Number of Individuals in Reference Population.

Poverty Gap

When α is equal to 1, it shows uniform concern and equation becomes

$$P_1 = \frac{1}{N}\sum_{i-1}^{q}\left[\frac{Z - y_i}{Z}\right]^{1} \quad (11)$$

This measure the depth of poverty (the proportion of expenditure shortfall from the poverty line) according to Hall and Patrinos,[27] it is otherwise called the poverty gap or expenditure gap- the average difference between the income and the poverty line. The poverty gap index P_1 will be used to measure the depth of poverty of the women rice farmers

Square poverty gap

When α is equal to two distinctions is made between the poor and the poorest, that is, the severity of poverty Foster *et al.*[25] and Assadzadeh and Paul.[28] The equation becomes.

$$P_2 = \frac{1}{N}\sum_{i-1}^{q}\left[\frac{Z - Y_i}{Z}\right]^{2} \quad (12)$$

The equation gives a distribution sensitive FGT index of the distribution of expenditure among the poor. This measure takes into consideration the incidence of poverty, depth of poverty, and the inequality among the poor. Two-third of mean per capital household expenditure MPCHE will be estimated as the poverty line, the extreme poor (those spending <1/3 of MPCHE, moderately poor (those spending <2/3 of MPCHE) and the non-poor (those spending >2/3 of MPCHE).

This will be used to achieve part of specific objective five.

Logit Model Analysis

The Logit model is stated thus:

$$Y_i = \alpha_0 + \sum_{i=1}^{8}\alpha_i X_i + U_i \quad (13)$$

The explicit function is stated thus:

$$Y_i = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \alpha_7 X_7 + \alpha_8 X_8 + U_i \quad (14)$$

Where,
Y_{ij}= Poverty Status of Smallholder Rural Women Rice Farmers (1, Poor, 0, Otherwise)
X_1 = Age (Years)
X_2 = Sex (1, Female; 0, Otherwise)
X_3 = Educational Level (Number of Years in in School).
X_4= Household Size (Units)
X_5 = Marital Status (1, Married; 0, Otherwise)
X_6 = Access to Credit Dummy (1, Access; 0, Otherwise)
X_7 = Membership of Cooperatives (1, Member; 0, Otherwise)
X_8 = Farm Income (Naira)
α_0 = Constant Term
α_0–α_8 = Regression Coefficients
U_i = Error Term

This will be used to achieve specific objective six.

Principal Component Analysis (PCA)

The perceived constraints faced by smallholder rural women rice farmers were analyzed using PCA [Tables 1-3]. This was used to achieve specific objective seven.

RESULTS AND DISCUSSION

Socio-economic Profiles of Smallholder Rural Women Rice Farmers

Table 4 shows that 75% of smallholder rural women rice farmers were <50 years of age. This implies that they were young, active, energetic, and resourceful in their youthful age. They will be able to adopt agricultural innovations easily. About 47% of smallholder rural women rice farmers were married. The have large household sizes with 72% of smallholder rural women rice

Table 1: Units of measurements and Apriori expectations of explanatory variables included in the Heckman two-stage (Probit model)

Variable	Code	Units of measurements	Apriori expectations
Age	X_1	Years (Continuous)	±
Sex	X_2	Dummy (1, Male; 0, Female)	+
Educational level	X_3	Dummy (1, Formal; 0, Otherwise)	+
Household size	X_4	Units (Continuous)	+
Membership of cooperatives	X_5	Dummy (1, Member; 0, Otherwise)	+
Experiences in farm activities	X_6	Years (Continuous)	+
Access to credit facilities	X_7	Dummy (1, Access; 0, Otherwise)	+

Source: Author (2019)

Table 2: Units of measurements and apriori expectations of explanatory variables included in the Heckman two-stage (ordinary least squares model)

Variable	Code	Units of measurements	Apriori expectations
Age	X_1	Years (Continuous)	±
Sex	X_2	Dummy (1, Male; 0, Female)	+
Educational level	X_3	Dummy(1, Formal; 0, Otherwise)	+
Household size	X_4	Units (Continuous)	±
Membership of cooperatives	X_5	Dummy (1, Member; 0, Otherwise)	+
Experiences in farm activities	X_6	Years (Continuous)	+
Access to credit facilities	X_7	Dummy (1, Access; 0, Otherwise)	+
Fertilizer input	X_8	Kg (Continuous)	+
Labor input	X_9	Mandays (Continuous)	+
Improved seeds	X_{10}	Kg (Continuous)	+

Source: Author (2019)

Table 3: Units of measurements and apriori expectations of explanatory variables included in the logit model analysis

Variable	Code	Units of measurements	Apriori expectations
Age	X_1	Years (Continuous)	±
Sex	X_2	Dummy (1, Female; 0, Male)	−
Educational level	X_3	Years (Continuous)	−
Household size	X_4	Units (Continuous)	+
Marital status	X_5	Dummy (1, Married; 0, Otherwise)	−
Access to credit facilities	X_6	Dummy (1, Access; 0, Otherwise)	−
Membership of cooperatives	X_7	Dummy (1, Member; 0, Otherwise)	−
Farm income	X_8	Naira (Continuous)	−

Source: Author (2019)

farmers having <11 members per household. The smallholder rural women rice farmers had an average of six people per household. Furthermore, 72% of smallholder rural women rice farmers had <11 years experiences in farm activities. Furthermore, they are on the average literate farmers as 50% of them had formal education. This means they can easily adopt new innovations, new technologies, and research findings. This research findings are in line with earlier results of Lawal *et al*.,[10] Alabi *et al*.,[29] Alabi *et al*.,[30] Alabi,[31] Alabi *et al*.[32]

Costs and Returns of Smallholder Rural Women Rice Production

Table 5 presented the various cost and revenue involved in rice production by smallholder rural women farmers. The revenue obtained was based on the current prevailing prices at the time the survey was conducted. Smallholder rice production by rural women farmers are profitable with gross margin and net income of 773,600 Naira (1983.59 USD) and 759,400 Naira (1947.18 USD), respectively.

Table 4: Socio-economics profiles of smallholder rural women rice farmers

Socio-economic profiles	Frequency	Percentages	Mean
Age (years)			
31–40	34	34.00	44.6
41–50	41	41.00	
51–60	25	25.00	
Sex			
Male	43	43.00	
Female	57	57.00	
Marital status			
Married	47	47.00	
Single	33	33.00	
Divorced	20	20.00	
Household size (Units)			
1–5	49	49.00	6.95
6–10	23	23.00	
11–15	28	28.00	
Farm experiences (Years)			
1–5	48	48.00	7.05
6–10	24	24.00	
11–15	27	27.00	
16–20	1	1.00	
Level of education			
Primary	29	20.00	
Secondary	30	10.00	
Tertiary	31	10.00	
Non-formal	10	50.00	
Total	100	100.00	

The total variable cost was 124,000 Naira (317.99 USD) which constitutes 89.73% of the total cost of production. The total variable costs consist of labor input (23.52%), improved seeds input (09.19%), capital input (26.63%), and fertilizer input (30.39%). The fixed cost was 14, 200 Naira (36.41 USD) which constitutes 10.27% of the total cost of production. The fixed cost involves taxes, expenses, interest, and depreciation. The GMR of 0.86 means that for every one Naira invested in rice production by smallholder rural women farmers 86 Kobo will covere profits, interest, taxes, expenses, and depreciation. This result is in line with findings of Lawal *et al*.,[10] Alabi *et al*.,[29] Alabi[31]

Heckman First Stage: Factors Influencing Smallholder Rural Women Rice Farmers Adoption of Agricultural Intensification

Factors influencing adoption of agricultural intensification by smallholder rural women rice farmers are presented in Table 3. The statistical and significant exogenous variable included in the model were age ($P < 0.05$), sex ($P < 0.10$), educational level ($P < 0.01$), membership of cooperatives ($P < 0.01$), experiences in farm activities ($P < 0.01$), and access to credit facilities ($P < 0.01$) The likelihood ratio Chi-square was 149.79 and was significant at 1% probability level. The result of marginal effect was presented in Table 6. As smallholder rural women rice farmers acquired formal education bring about 0.366 probability or likelihood to adopt agricultural intensification that is sustainable and environmentally friendly. Furthermore, as smallholder rural women rice farmers have access to credit facilities will bring 0.192 probability or likelihood to adopt agricultural intensification. Furthermore, as rural women rice farmers join members of cooperatives organization will 0.561 increases the probability or likelihood to adopt agricultural intensification technologies. The results is in line with findings of Food and Agriculture Organization[33] who observed

Table 5: Costs and returns analysis of Smallholder Rural women rice production per hectare

Variable	Value (₦)	USD ($)	Percentage
Variable cost			
Labor input	32,500	83.33	23.52
Seeds input	12,700	32.56	09.19
Capital input	36,800	94.36	26.63
Fertilizer input	42,000	107.69	30.39
Total variable cost	124,000	317.95	89.73
Fixed cost (depreciation, interest, expenses, and taxes)	14,200	36.41	10.27
Total cost of production	138,200	354.36	100.00
Total revenue	897,600	2301.54	
Gross margin	773,600	1983.59	
Net income	759,400	1947.18	
Gross margin ratio	0.8618		

Source: Field survey (2019) computed using STATA 14, 390 Naira = 1 USD

Table 6: Heckman two-stage: Factors influencing Smallholder rural women rice farmers adoption of agricultural intensification

Variables	Coefficients	Standard error	Marginal effects
Age (X_1)	0.9765**	0.3727	0.116
Sex (X_2)	0.3291*	0.1567	0.254
Educational level (X_3)	0.8693***	0.2484	0.366
Household size (X_4)	0.2961**	0.1233	0.218
Membership of cooperatives (X_5)	0.6125***	0.1801	0.561
Experiences in farm activities (X_6)	0.3349***	0.0930	0.239
Access to credit facilities (X_7)	0.3441***	0.0956	0.192
Constant	1.2891*	0.6785	
Diagnose statistics			
LR_{χ}^2	149.79		
Prob>χ^2	0.0000		
Pseudo>R^2	0.8269		
Number of observation	100		

Source: Field survey (2019), computed using STATA 14. *, **, ***Significant at 10%, 5% and 1% probability levels

that women have less access to credit facilities, financial services, less access to information regarding agriculture, and agricultural extension services. Women today lack input, credit, market information, and less access to land.[34]

Heckman Second Stage: Factors Influencing Output of Rice Production by Smallholder Rural Women Rice Farmers

Factors influencing output of rice production by smallholder rural women rice farmers are presented in Table 7. The predictor statistical and significant variables included in the Heckman second stage model were age ($P < 0.05$), sex ($P < 0.10$), educational level ($P < 0.05$), household size ($P < 0.10$), membership of cooperatives ($P < 0.01$), experiences in farm activities ($P < 0.05$), access to credit facilities ($P < 0.10$), fertilizer input ($P < 0.10$), labor input ($P < 0.05$), and improved seeds input ($P < 0.05$). The coefficient of multiple determinations (R^2) was 0.8320. This implies that 83.20% of variations in output in rice production by smallholder rural women rice farmers were explained by predictor variables included in the model. The F-value of 156.32 was significant at 1% level of probability. A 1% increase if fertilizer input by smallholder rural women rice farmers would lead to probability of 22.91% increase in output of rice produced. Furthermore, a unit increase in using improved seeds input by smallholder rural women rice farmers will lead to 0.1999 probabilities or likelihood increase in output of rice produced. Furthermore, when rice farmers have access to fertilizer input will 0.4582 increases the likelihood or probability of the yields or output of rice by women rural farmers. This result is in line with World Bank[8] and Chant.[35] The goals of agricultural intensification which is an agricultural development program have been to support poverty reduction, increase food production, and economic growth. The level of poverty in sub-Saharan Africa is higher for women compared to men. A mother with a baby on her back, working on the farm fields with hand–hoe crude implement as her only tool is the common practice in the rural populace of sub-Saharan Africa.

Table 7: Heckman two-stage: Factors influencing output of rice among smallholder rural women farmers

Variables	Coefficients	Standard error
Age (X_1)	0.2867**	0.1147
Sex (X_2)	0.1179*	0.0589
Educational level (X_3)	0.2784**	0.1071
Household size (X_4)	0.5734*	0.2730
Membership of cooperatives (X_5)	0.8217***	0.2348
Experiences in farm activities (X_6)	0.1179**	0.0453
Access to credit facilities (X_7)	0.7521*	0.3581
Fertilizer input (X_8)	0.4582*	0.2291
Labor input (X_9)	0.6503**	0.2409
Improved seeds input (X_{10})	0.5398**	0.1999
R^2	0.8320	
Adjusted R^2	0.8002	
Prob>F	0.0000	
F-Value	156.32	
Number of observations	100	

Source: Field survey (2019), computed using STATA 14. *, **, ***Significant at 10%, 5%, and 1% probability levels

FGT Poverty Model of Smallholder Rural Women Rice Farmers

The result of FGT measures of poverty among smallholder rural women rice farmers is presented in Table 8. The poverty line used for this research study was collected from monthly maximum and minimum per capital expenditure (MPCE) of the sampled smallholder rural women rice farmers. Two-third (4, 990.07 Naira or 12.79 USD) of the monthly per capital expenditure of the sampled rural women rice farmers was used as a poverty line an index used by Omonona and Agoi.[36] The poverty of the smallholder rural women rice farmers which include poverty head count or incidence (P_0), poverty gap or depth (P_1), and squared poverty severity (P_2) was analyzed using FGT index. The (P_0) for the entire smallholder rural women rice farmers was 0.5178. This implies that 51.78% of the smallholder rural women rice farmers were poor and 48.22% of the smallholder rural women rice farmers were non-poor. This means that 52 out of 100 smallholder rural women farmers sampled were poor. The poverty gap index (P_1) usually referred to as the depth of average poor women from the poverty line was 0.2866 which implies that 28.66% of the smallholder rural women rice farmers were poor. The poverty severity (P_2) which measures the distance of each poor woman to one another was found to be 0.1956. This implies that among the smallholder rural women rice farmers, 19.56% were severely poor.

Table 8: Poverty status of Smallholder rural women rice farmers

Poverty status	Value
Poverty line (N)	4,990.07
Poverty incidence (P_0)	0.5178
Poverty depth (P_1)	0.2866
Poverty severity (P_2)	0.1956

Source: Field survey (2019), computed using STATA 14

Factors Influencing Poverty Status among Smallholder Rural Women Rice Farmers

Factors influencing poverty status of smallholder rural women rice farmers are presented in Table 9. The predictor variables were statistical and significant in influencing poverty status among smallholder rural women rice include age ($P < 0.01$), sex ($P < 0.05$), educational level ($P < 0.05$), household size ($P < 0.10$), marital status ($P < 0.05$), access to credit facilities ($P < 0.05$), membership of cooperatives ($P < 0.05$), and farm income ($P < 0.05$). The Wald Chi-square shows that all the variables included in the model fit to explain the factors influencing poverty status among smallholder rural women rice farmers. Furthermore, the probability of Chi-square revealed the significance of the overall model at 1% probability level. The marginal effect of education indicates that as smallholder rural women rice farmers acquired formal education, will lead to the probability or likelihood of 0.3340 decreases in poverty. The marginal effect of the coefficient to access to credit facilities shows that access to credit will likely and significantly reduces poverty by 31.04% among smallholder rural women rice farmers. This result corroborates the findings of Omonona and Agoi,[36] Bigsten *et al*.,[37] Ubokudom *et al*.,[38] Igbalajobi *et al*.,[39] and Aboaba *et al*.[40]

Constraints Facing Smallholder Rural Women Rice Farmers

The constraints facing smallholder rural women rice farmers were subjected to PCA [Table 10]. Factors with Eigen-values

Table 9: Factors influencing poverty status among Smallholder rural women rice farmers

Variables	Coefficients	Standard error	Marginal effects
Age (X_1)	−0.9732***	0.2780	−0.1130
Sex (X_2)	−0.6704**	0.2579	−0.2193
Educational level (X_3)	−0.2303**	0.0921	−0.3340
Household size (X_4)	0.4501*	0.2250	0.2891
Marital status (X_5)	−0.6291**	0.2330	−0.3109
Access to credit facilities (X_6)	−0.7620**	0.2931	−0.3104
Membership of cooperatives (X_7)	−0.6122**	0.2355	−0.3301
Farm Income (X_8)	−0.3421**	0.1316	−0.1910
Constant	1.2102*	0.6051	
Diagnose statistics			
Wald$_{\chi}^2$	149.72		
Prob>$_{\chi}^2$	0.0000		
Pseudo>R^2	0.7103		
Number of observations	100		

Source: Field survey (2019), computed using STATA 14. *, **, ***Significant at 10%, 5%, and 1% probability levels

Table 10: Constraints facing smallholder rural women rice farmers

Constraints	Eigen-value	Difference	Proportion	Cumulative
Lack of fertilizer input	3.1012	0.2234	0.2671	0.2671
Lack of credit facilities	2.8211	1.2471	0.2012	0.4683
Bad road infrastructures	2.7631	2.2763	0.1137	0.5820
Lack of improved seeds input	2.5300	2.5209	0.1570	0.7390
Lack of labor input	2.2676	0.2289	0.1046	0.8436
Inadequate extension officers	2.1132	0.1056	0.0323	0.8759
Bartlett test of sphericity				
KMO	0.7201			
Chi-square	2276.101***			
Rho	1.0000			

Source: Field survey (2019), computed using STATA 14

>1 were retained in the model. The retained components explained 87.59% of all variables included in the model. The Chi-square of 2276.01 was significant at 1% probability level. Lack of fertilizer input with Eigen value 3.1012 was ranked first based on the perceptions of smallholder rural women rice farmers. Lack of credit facilities and bad road infrastructures with Eigen values 2.8211 and 2.7631 were ranked second and third based on the perceptions of smallholder rural women rice farmers, respectively.

CONCLUSION

The low agricultural productivity of millions of rural households who depend on agriculture for food and farm income was in chronic food insecurity and poverty. Agriculture is sub-Saharan Africa underperformed. Majority of small scale farmers in rural sub-Saharan Africa, poverty and food insecurity and struggle to feed farm family is the issue. In sub-Saharan Africa, 50% of the work force engaged in agriculture are women (FAO, 2011). Agricultural intensification identifies the extent of input intensification through the use of improved seeds, mineral fertilizers, labor input, herbicides, pesticides, fungicides, rodenticide, and other chemicals together with machineries. The rice production by smallholder rural women farmers was profitable with gross margin and net income of 773,600 Naira (1983.59 USD) and 759,400 Naira (1947.18 USD), respectively. Smallholder rural women rice farmers were young, active, energetic, and resourceful with an average age of 44.6 years. Household sizes were large with average of six people per household. Averagely, they have formal education and therefore literate. The GMR was 0.8618 which implies that for every one Naira invested in rice production by smallholder rural rice farmers 86 Kobo covered profits, expenses, taxes, interest, and depreciation. Factors statistically and significantly influencing adoption of agricultural intensification were age, sex, educational level, household size, membership of cooperatives, experiences in farm activities, and access to credit. Determinants of output of rice among smallholder rural women farmers that were statically significant include age, sex, educational level, household size, membership of cooperatives, experiences in farm activities, access to credit facilities, fertilizer input, labor input, and improved seeds input. The poverty line of smallholder rural women rice farmers was 4,990.07 Naira (12.79 USD). FGT poverty model used to analyze poverty status of smallholder rural women rice farmers' shows that poverty incidence (P_0) was 0.5178, poverty depth and poverty severities were 0.2866 and 0.1956, respectively. Factors statistically and significantly reducing poverty among smallholder rural women rice farmers were educational level, access to credit, membership of cooperatives, and increase in farm income. PCA of constraints facing smallholder rural women rice farmers shows that factors with Eigen values >1 were retained in the model. Such factors include lack of fertilizer input, lack of credit facilities, bad road infrastructures, lack of improved seed input, lack of labor input, and inadequate extension officers. The retained component explained 87.59% of all variables included in the model.

Recommendations

The following policy recommendations were made:

I. Improved women access to productive resources such as land, credit, fertilizer inputs, improved seeds input, chemical, and appropriate technologies to enhance and increase production and consumption.
II. Encourage capacity buildings for rural women informs of training, workshops, action programs, literacy programs, investment in education, grassroots mobilizations, publications, schools, and networking
III. Rural women should be adequately trained in schools and institutions.
IV. Develop research and innovations and reinforce information gathering that affect rural women
V. Employ women as extension officers to disseminate research findings and innovations torural women.
VI. Provide feeder roads for easy evacuation of produce from rural areas to market centers.

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