integrity Research Journals

Journal of Agricultural Extension and Rural Economics
Volume 2(2), pages 26-33, April 2025
Article Number: 835C41D92
https://doi.org/10.31248/JAERE2025.016
https://integrityresjournals.org/journal/JAERE

Full Length Research

Effect of climate-smart agricultural practices adoption on livelihood strategies of rice farmers' along Bakalori Irrigation Valley of Zamfara State, Nigeria

Sulaiman Muhammad Gusau* and Yusuf Habibu

Department of Agricultural Education, Zamfara State College of Education, Maru, Nigeria.

*Corresponding author. Email: sulaimanmuhammadgusau@gmail.com

Copyright © 2025 Gusau and Habibu. This article remains permanently open access under the terms of the Creative Commons Attribution License 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Received 26th February 2025; Accepted 21st April 2025

ABSTRACT: Research on the adoption of climate-smart agriculture practices among rice farmers and their implications on the livelihood status of farmers in Zamfara State is very scant. This study, therefore, will bridge the existing gap in the literature by assessing the effect of climate-smart agricultural practice adoption on rice farmers' livelihood strategies in Zamfara State, Nigeria. Primary data were collected from a survey of 293 rice farmers across 12 selected Communities from three (3) Local Government Areas along the Bakalori irrigation valley of Zamfara State. The results show that the majority of the respondents were within 20-69 years of age and married with household sizes of between 1-27 persons. The finding of this study witnesses the existence of diverse livelihood activities in the study area. The result of the multinomial logit model indicates that among the hypothesized variables, education status, household size, size of farm holding, access to credit, and extension contact were the factors influencing livelihood strategies choice in the study area. The estimated multinomial logit model indicates a Pseudo R^2 of 0.71, which implies that all the explanatory variables included in the model were able to explain about 71% of the variability in the livelihood strategies choice of the respondents. The likelihood ratio represented by chi-square statistics indicated the overall model is highly significant ($p<0.00$), which implies the strong explanatory power of the model. This study therefore recommends that there is a need to train rice farmers across the state on climate-smart agricultural practice adoption. The training can be carried out by extension agents during their regular visits to respondents. However, there is a need for improving the extension agents-farmer contact by the state governments.

Keywords: Bakalori Irrigation Valley, climate-smart agricultural, rice farmers, Zamfara State.

INTRODUCTION

The agricultural sector in Nigeria and most developing countries offers the primary source of livelihood as well as employment for the majority of its populace and also contributes a very significant portion to Gross Domestic Product (GDP) (Olajide *et al*., 2012). The vulnerability of the Nigerian agricultural sector to climate change is of particular interest to policymakers because agriculture is a key sector of the economy accounting for between 60-70% of the labour force and contributing between 30-40% of the nation's GDP (Ajetomobi *et al*., 2011; FAO, 2020). Climate-smart ideas include activities that would ensure minimum tillage; utilization of organic agricultural practices rather than inorganic methods that would further deplete the soil in the long term; crop rotation and mulching to reduce evapotranspiration; composting with planting of legumes and cover crops which assist in moderating the long term effects of climate change by giving an enduring environmental strength to the soil (Ojoko *et al*., 2017; Olorunfemi *et al*., 2019).

Rice is one of the major food crops that is of considerable importance for food security, expenditure, and incomes of households. The demand for rice has been increasing at a faster rate in Nigeria than in other West African Countries (Dauda *et al*., 2015). Despite the increasing demand for rice, there is a lopsidedness in the level of rice production in Nigeria. However, drought, fluctua-

tion of the water table, flooding, salt stress, and extreme temperatures, due to climate change, are the major problems associated with rice production (Van Oort and Zwart, 2018). Farmers adopt a particular rice production system based on the topography, input, expected output and returns (Chidiebere-Mark *et al*., 2019). In Zamfara state, data related to the adoption of climate-smart agriculture practices among rice farmers is very scant. However, adopting climate-smart agricultural practices will require information from the farmers, since skills, experiences, other socio-economic factors, and the ability to adapt and cope with climate change depend on farmers' knowledge. This study is useful as it will provide baseline data on the effect of the adoption of climate-smart agricultural practices on rice farmers' livelihood along the Bakalori irrigation valley in Zamfara state. However, this research work fills the knowledge gap in the literature by assessing the effect of climate-smart agricultural practice adoption on rice farmers' livelihood strategies in Zamfara State, Nigeria.

METHODOLOGY

The study area

The research was conducted in Zamfara State. Zamfara State is located in the northwest region of Nigeria. It covers a land area of 38,418 square kilometers. The State shares boundary with Sokoto State and republic of Niger to the North, Kebbi and Niger State to the west, Katsina to the east and Kaduna to the south. Zamfara State has two distinct seasons, the dry season (November-April) and the rainy season (May-October). The State lies between latitudes 10°21′N to 13° 5′N and longitude 6^0 20^1E (Zamfara State government (ZSG), 2022). The rain in Zamfara falls mostly in the spring, with relatively little rain in summer. In a year, the average rainfall is 1199 mm. The variation in annual rainfall is around 5.6°C (Zamfara State government (ZSG), 2022). It is estimated that over 3.5 million hectares of land are cultivated in Zamfara State, representing about 30 percent of the area. Agriculture remains unique in the economy of Zamfara State. It is estimated that agriculture, in its various forms, provides the means of livelihood to over 80 percent of the population of the area. Zamfara is blessed with a large area of arable and fertile land that supports the production of a variety of crops. The Bakalori irrigation scheme had brought well over 30,000 hectares of land under cultivation for the production of wheat, rice, tomatoes, sweet potatoes, and other food and cash crops.

Sampling procedure and sample size

The multi-stage sampling technique was employed in selecting sampled respondents for the study. The first stage involves a purposive selection of three (3) Local Government Areas (LGAs) along the Bakalori irrigation valley of Zamfara State. The second stage involved the purposive selection of four (4) major rice-producing communities from each of the three (3) Local Government Areas. Finally, the third stage involved the determination of requisite sample size from the list of rice farmers as obtained from Rice farmers Association of Nigeria (RIFAN Zamfara State Chapter) using Yamane sample size formula (Yamane, 1973), and then proportionate random sampling procedure was employed to select farmers from each community sample frame. The formula is stated as follows:

$n = N/1+N\ (e)^2$

Where: n = required sample size, N = number of rice farmers obtained from the list of registered rice farmers in each community; and e = permissible error (0.05).

Substituting the values of N and e into the equation above, we have:

$n = 1097/1+1097(0.05)^2$ $n = 1097/3.7425 = 293$

Respondents from each community were therefore selected randomly and proportionately using the expression below:

$x = (X/n)*N$ (Yamane, 1973).

Where: x = Sample size per community, X = Number of registered rice farmers per community, n = Total number of registered rice farmers in the three Local Government Areas, N = Required sample size for the study (from Taro Yamane's formula).

Therefore, a total of two hundred and ninety-three (293) rice farmers were selected across all selected Communities for the study. The selected Local Government Areas, Communities, and the number of sampled rice farmers from each Community are shown in Table 1.

Data analysis

Descriptive statistics such as frequency, percentage, and cluster analysis were used to describe the socioeconomic characteristics of rice farmers in the study area and identify the livelihood strategies engaged in by the rice farmers in the study area.

Cluster analysis: Cluster analysis has been widely used in numerous applications, including market research, pattern recognition, data analysis, and image processing. Clustering households into distinct livelihood strategy groups using sectoral income share through clustering

Table 1. Sampling frame and sample size.

LGA Selected	Communities selected	Communities sample frame	Communities sample size
Bakura	Yargeda	86	23
	Rini	92	25
	B/tudu	89	24
	Damri	86	23
Mafara	Makera	108	29
	Matusgi	91	24
	Danfako	101	27
	Mafara	93	25
Maradun	Maradun	96	25
	Kaya	92	25
	Janbako	81	22
	Gidan Kano	77	21
Total	**12**	**1097**	**293**

Source: Reconnaissance survey 2024.

analysis has become a dominant approach in livelihood studies (Soltani *et al*., 2012). Cluster analysis was therefore used to categorize rice farmers into distinct livelihood strategy activities, and each strategy was named based on the share of different activities.

Multinomial logistic Regression Model was used to determine the effect of climate-smart agricultural practices adoption on the choice of livelihood strategies engaged by rice farmers in the study area. The choice of this method is based on the fact that the dependent variable is a categorical variable which can take four (4) choices (0, 1, 2, and 3), a rational household is expected to choose among mutually exclusive strategies that could offer the maximum utility. Using the On-farm strategy alone as a base/reference category. The dependent variables for this study is the choice of livelihood strategies, which include category 1= On-farm strategy alone, 2= Combination of on-farm and off-farm strategy, 3= Combination of on-farm and non-farm strategy, and 4= Combination of on-farm, off-farm strategy and non-farm strategy. The multinomial logit regression model is specified as:

$$P(Y\ i\ =\ \mathrm{j}) = \frac{\mathrm{e}(\beta \mathrm{i}\ \mathrm{X}\ \mathrm{j})}{\Sigma \mathrm{Jj}=0\quad \mathrm{e}(\beta \mathrm{i}\ \mathrm{X}\ \mathrm{j})} \quad \mathrm{j}\ =\ 0$$

(Greene 2012).

Where: Y_i = represent four (4) unordered categories of livelihood strategy; Y_0 = On-farm strategy alone, Y_1 = Combination of on-farm and off-farm strategy Y_2 = Combination of on-farm and Non-farm strategy, Y_3 = Combination of on-farm, off-farm strategy and non-farm strategy Where Y_0 is the reference case of the livelihood strategies, P = is the probability of an economic activity, j = is the livelihood category, e = is the natural log, β = is coefficients associated with X_i independent variables.

Independent variables were:

X_1 = Age of the rice farmers (years), X_2 = Educational (years of schooling) X_3 = Household size (numbers), X_4 = Farming experience (years) X_5= Farm size (hactares), X_6= Access to credit (binary variable: yes =1, no = 0) X_7 = Extension contact (number of visit)

RESULTS AND DISCUSSION

Socio-economic characteristics of rice farmers

The socio-economic variables are presented in Table 2. Results reveal that the minimum age is 20 years and the maximum is 69 years, farmers that were within the age range of 20-29 covered 16 % , which is 47 of the total respondents in the study area, the result also reveal that the farmers that were within the age range of 30-39 years were 66 (23%) of the total respondents and 129 (44%) of the rice farmer were within the age range of 40-49, 32 (11%) of the rice farmers were within the age range of 50-59, and the remaining 6 % were within the age ranges of 60-69. Age is very important in agricultural production activities because it has a significant influence on the decision-making process of farmers with respect to livelihood strategies and other production-related decisions. The findings are in line with those of Ogbe *et al.* (2017), who revealed that the majority of the farmers in South-Eastern Nigeria were between the productive ages of 31 and 50. The result also showed that 94% of the household heads were married, while only 6% of the rice farmers were single. This implies that the majority of the rice farmers

Table 2. Distribution of respondents according to socio-economic characteristics.

Variable	Measurement	Frequency(n=293)	Percentage
Age	20-29	47	16
	30-39	66	23
	40-49	129	44
	50-59	32	11
	60-69	19	6
Marital status	Single	18	6
	Married	275	94
Education status	Informal education	39	13
	Quranic education	120	41
	Primary	78	27
	Secondary	56	19
Years of experience	11-19	86	29
	20-28	121	41
	29-37	55	19
	38-46	31	11
Household size	1-6	119	41
	7-13	141	48
	14-20	24	8
	21-27	5	2
	>27	4	1
Farm size	0-1	162	55
	2-3	86	29
	4-5	34	12
	6-7	11	4
Access to credit	Yes	118	40
	No	175	60
Source of credit	Commercial banks	17	6
	Micro-finance banks	32	11
	Bank of Agriculture	28	9
	Cooperatives	67	23
	Personal savings/friends	149	51
Extension contact	Yes	110	38
	No	183	62
Years of Membership	1-3	155	53
	4-6	65	22
	7-9	43	15
	10-12	30	10

Source: Field Survey 2025.

have more responsibilities, and therefore marital status is an important variable to be considered in establishing any programme aimed at changing the society, since family decisions are very essential in any activity to be embarked upon. According to Ogunremi *et al.* (2016), married people are responsible and will like to spend their profit on their family.

The level of education determines the level of opportunities

available to improve livelihood strategies, enhance food security, and reduce the level of poverty. As presented in Table 2, it revealed the majority of the rice farmers (41%) acquired Qur'anic education, while 13% have informal education, and 46 % have acquired Western education. This indicates that there is a low level of formal education among the rice farmers, and goes to show that Western education amongst rice farmers is not considered a priority. A relatively higher educational status will encourage acceptance of innovation which may raise farm productivity and income, thus improving the food security status of households (Muhammad *et al.,* 2015). Farming experience is expected to influence livelihood strategy choices because the experience acquired over time by older rice farmers can make them combine different livelihood activities, which in turn improve their income level and food security status. It was found from the result in Table 2; that 41 % had between 20-28 years of farming experience, 29 % had 11-19 years, and 19 % had 29-37 years of farming experience. Only 11% had farming experience greater than 40 years. This result showed that most of the rice farmers had long years of rice farming experience, implying that such farmers are likely to make decisions that would increase their output and income. Gbegeh (2013) reported that because of farmers' experience in farming and knowledge about the importance of improved agricultural production, farmers are capable of adopting new technologies.

Household size to a greater extent determines the level of rice productivity of the farmers, and also may enhance labour availability that can be used for different agricultural activities. Results in Table 2 revealed that the respondents had household sizes in the range of 1-6 members (41%), 7-13 members (48%) while about 10 % of the respondents had above 14 members. The results further showed that only about 1% had 28 members. This implies that household size in the study area was large and may be as a result of the polygamous nature of the household and the perception of the respondents that large family is a source of cheap labour, more people to cater for, and more hands to work on the farm and help with cattle herding. The findings is similar to those of Jamilu *et al.* (2014) who found an average family size of 11 persons in some areas of North-west Nigeria.

Table 2 also revealed that rice farmers that have the farm sizes of between >0-1 ha were 162(55%) of the total 293 rice farmers, 86(29%) out of the total rice farmers had farm that are within the sizes of 2-3ha, (12%) which was 34 of the total respondents have the farm size ranges of between 4-5 ha, the remaining 11(4%) of the rice farmers (respondents) had farm size of between 6-7ha. This shows that about 100% of the total rice farmers were smallholders who produced mainly for consumption. Membership of cooperatives influences the adoption of improved technologies, resulting in higher productivity and poverty alleviation (Amaza *et al*., 2009). The results showed that 53% had between 1-3 years of cooperative membership, about 22% had between 4-6 years of cooperative membership, 15% had between 7-9 years of membership, and 10% had between 10-12 years of membership. Agricultural Cooperative membership has effect on food security and farmers' livelihood. The result shows that only about 40% of the respondents had access to credit for use in rice farming. About 51% of the credits used in rice farming in the study area were from friends and personal savings. Those who accessed credit from Bank of Agriculture and Micro-finance banks were about 9% and 11% respectively, while cooperatives and commercial banks provided 23% and 6% of the credit used in rice farming, respectively. The result implies that only about 26% of the credit accessed by the 40% of the respondents who got access to credit for rice farming was provided by the banks. The low accessibility to credit from the commercial banks, micro-finance, and the Bank of Agriculture is a setback that affects the farmers' performance and productivity. According to Ojoko *et al*. (2017), access to credit is a vital tool that enables farmers to invest more in Climate-Smart Agricultural practices as a technology, which might be expensive to acquire. The results show 62% of rice farmers in the study area had no contact with the extension service. While 38% of the respondents have had extended contact. This could be attributed to the low extension agent-farmers ratio in the study area. The role of extension in agricultural productivity and even commercialization is enormous. According to Onyenobi *et al.* (2015), access to extension services is significant in agricultural production.

Livelihood strategies engaged by rice farmers in the study area

There are different methods of identifying livelihood strategies. This study employed cluster analysis to determine the livelihood strategies engaged in by rice farmers in the study area. The study categorized 10 sub-categories of livelihood activities into the following three (3) major categories: on-farm (cluster 1), off-farm (cluster 2), and non-farm strategy (cluster 3).

Table 3 summarizes the results of livelihood strategies engaged by rice farmers in the study area. Ten livelihood activities were identified. However, the research used the denomination where livelihood strategies were classified as "On–farm strategy" (cluster 1), Off Off-farm strategy" (cluster 2), and Non Non-farm strategy (cluster 3). The findings of this study witnessed the existence of diverse livelihood activities in the study area. The result showed that most of the respondents used a combination of the three classifications of livelihood strategies, but the most popular household livelihood strategy engaged in by rice farmers in the study area was rice production activities combined with crop production.

The result showed that all (100%) of the respondents engaged in rice production, 97.1% combined rice and

Table 3. Livelihoods activities engaged in by the rice farmers in the study area.

Livelihood strategy	Frequency	Percentage
On-farm strategy		
Rice production	293	100
Rice production /crop production	284	97.1
Rice production/Livestock production	245	83.6
Off-farm strategy		
Sale of rice or crops product	201	68.6
Rice processing	212	72.3
Crop processing	83	28.3
Non- farm strategy		
Trading	121	41.2
Artisanship/craftwork	74	25.2
Government job	142	48.4
Non-farm labour work	163	55.6

Source: Field Survey, 2025 *Multiple responses recorded.

other crop production as an economic activity, followed by rice production and livestock production, 83.6%. The most widely used off-farm strategies are rice processing (72.3%) and sales of rice or crop products (68.6%). The result further indicates that non-farm strategies were also engaged frequently. However, 41.2% of the respondents were engaged in trading, 25.2% were engaged in artisanship and government jobs 48.4%. The finding contradicts that of Paudel Khatiwada *et al.* (2017), who reported non-farm activities as the dominant livelihood strategy in Nepal. This may be due to the proximity of their study site to marketplaces, as indicated by their result.

Effect of climate-smart agricultural practices adoption on the choice of livelihood strategies engaged in by rice farmers in the study area

The estimated multinomial logit model indicates a Pseudo R^2 of 0.71, which implies that all the explanatory variables included in the model were able to explain about 71% of the variability in the livelihood strategies choice of the respondents. The likelihood ratio represented by chi-square statistics indicated the overall model is highly significant ($p<0.00$), which implies the strong explanatory power of the model. The result of the multinomial logit model indicates that among the hypothesized variables, education status, household size, size of farm holding, access to credit, and access to extension services were the factors influencing livelihood strategies choice in the study area (Table 4). The model result used the on-farm strategy alone as the base/reference case, and only variables that are statistically significant were interpreted. The result showed that education had a positive and significant influence on the rice farmers' decision on the choice of the livelihood strategy at a $p<0.05$ probability level of significance. The positive coefficient indicates that educated farmers were more likely to engage in the combination of on-farm, off-farm, and non-farm activities. This finding contrasts with the findings of Abera *et al.* (2021), who revealed that education had a negative influence on the decision of the households' participation in agriculture plus non-farm, agriculture plus off-farm, and agriculture plus non-farm plus off-farm livelihood strategies in Ethiopia. The household size had a positive and significant effect on the choice of livelihood strategy at ($p<0.05$) and ($p<0.10$) significance level, respectively, relative to the base category, which was on-farm strategy alone. The positive association between household size and livelihood strategy choice is possibly due to the relation between household size and family labour. The result of this study is in line with the findings of Abera *et al.* (2021), who opined that the likelihood of households to diversify into agriculture + non-farm, agriculture + off-farm, and combination of agriculture + non-farm + off-farm livelihood strategies increases with the increase of household size. The model result reveals that farm size had a positive and significant influence on the decision of rice farmers' participation in on-farm, non-farm, and off-farm livelihood strategies at $p<0.01$ significance levels. The positive coefficient implies that the probability of engagement in a livelihood diversification strategy increases as farm size increases. The coefficient of access to credit by the rice farmers was found to be negative and significant at $p<0.01$ and $p<0.10$. This showed that the lower the farmers' ability to source formal and informal institutional credit, the more the likelihood of being engage in a livelihood diversification strategy. According to Ojoko *et al*. (2017), access to credit is a vital tool that enables farmers to invest more in Climate-Smart Agricultural

Table 4. Estimated multinomial logit model for the choice of livelihood strategies engaged by rice farmers in Bakalori irrigation area.

Variable	Household Livelihood Strategies								
	On-farm plus off-farm			On-farm plus non-farm			On-farm, off-farm and non-farm		
	Coefficient	Std. err	Z-value	Coefficient	Std. err.	Z-value	Coefficient	Std.err.	Z-value
Age	0.112	0.089	1.25	0.140	0.091	1.53	0.611	0.910	0.67
Education level	1.041	0.480	**2.17****	1.331	0.540	**2.46****	1.380	0.700	**1.97****
Household size	0.125	0.051	**2.45****	0.074	0.031	**2.38****	0.070	0.040	**1.75***
Farming experience	0.264	0.301	0.87	0.215	0.200	1.08	0.215	0.205	1.05
Farm size	1.754	0.529	**3.31*****	1.147	0.921	1.24	1.040	0.88	1.18
Access to credit	-1.358	0.724	**-1.87***	-1.621	0.591	**-2.74*****	-1.594	0.610	**-2.61*****
Extension contact	1.031	0.569	**1.81***	1.215	0.589	**2.06****	1.256	0.597	**2.10****
Constant	21.236	7.141	**2.97*****	9.873	6.511	1.51	20.312	7.47	**2.71*****
Chi-square	0.000								
Log likelihood	-176.193								
Pseudo R^2	0.711								

Source: Field Survey, 2025 *** = Significant at 1%, ** = Significant at 5% *indicates significant at 10% probability level, respectively.

practices as a technology, which might be expensive to acquire. Extension contact was found to be positive and significantly influenced the rice farmers' choices of the livelihood strategy at $p<0.05$ and $p<0.10$ levels of significance. This implies that the engagement of rice farmers in diverse livelihood strategies increases as the farmers get access to extension services. This finding is consistent with the findings of Eneyew and Bekele (2012), which indicates that the frequency of extension contact was positively related to livelihood diversification.

Conclusion and Recommendations

The research was carried out to assess the effect of climate-smart agricultural practice adoption on rice farmers' livelihood strategies along the Bakalori irrigation valley in Zamfara State, Nigeria. Based on the findings of the study, it was concluded that most of the respondents used a combination of the three classifications of livelihood strategies, but the most popular livelihood strategy engaged in by rice farmers in the study area was rice production activities combined with crop production. The result of the multinomial logit model indicates that among the hypothesized variables, education status, household size, size of farm holding, access to credit, and extension contact were the major factors influencing livelihood strategies choice in the study area. The study therefore recommends that there is a need to train rice farmers across the state on climate-smart agricultural practice adoption. The training can be carried out by extension agents during their regular visits to respondents. It is expected that the training will build the capacity of rice farmers and assist in fighting the threat climate change poses to their livelihood activities, and would in turn motivate farmers to practice climate-smart agricultural practices. However, there is a need for improving the extension agents-farmer contact by the State Governments.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ACKNOWLEDGEMENTS

The authors sincerely appreciate the Tertiary Education Trust Fund (TETFUND) for providing the funds utilised for the study under the Institution-Based Research (IBR) Grant programme.

REFERENCES

Abera, A., Yirgu, T., & Uncha, A. (2021). Determinants of rural livelihood diversification strategies among Chewaka resettlers' communities of southwestern Ethiopia. *Agriculture & Food Security*, *10*, 30.

Ajetomobi, J., Abiodun, A., & Hassan, R. (2011). Impacts of climate change on rice agriculture in Nigeria. *Tropical and subtropical agroecosystems*, *14*(2), 613-622.

Amaza, P. S., Umeh, J. C., Helsen, J., & Adejobi, A. O. (2006). Determinants and measurements of food insecurity in Nigeria: some empirical policy guide. Contributed Poster prepared presented at the International Association of Agricultural Economists Conference, Gold Coast, Australia August 12-18, 2006

Chidiebere-Mark, N., Ohajianya, D., Obasi, P., & Onyeagocha, S. (2019). Profitability of rice production in different production systems in Ebonyi State, Nigeria. *De Gruyter Open Agriculture*, 4, 237-246.

Dauda, S. N., Tiamiyu, S. A. Tyabo, I. S., & Yusuf, L. T. (2015). Assessments of Profitability of Low Land Rice Production in Katcha Local Government Area of Niger State. *IOSR Journal*

of Agriculture and Veterinary Science, 8(4), 22-26.

Eneyew, A., & Bekele, W. (2012). Determinants of Livelihood Strategies in Wolaita, Southern Ethiopia. *Agricultural Research and Reviews, 1*(5),153-161.

FAO (2020). Nigeria at a glance 2020. Retrieved 1st September 2024 from www.fao.org/docrep

Gbeger, B. D., & Akubuilo, C. J. C, (2013). Socio-economic Determinant of adoption of Yam minisett by farmers in Rivers State, Nigeria. *Journal of Agricultural Research, 2*(1), 33-38.

Greene, H. W (2012). *Econometric Analysis*: Seventh Edition. Prentice Hall. New York.

Jamilu, A. A., Haruna, S. K., Abdullahi, A. Y., & Baba, D. (2014). Effects of youth participation in guava production on poverty alleviation in two selected areas of Kaduna State. Conference Proceedings of 19th Annual National Conference of the Agricultural Extension Society of Nigeria held at the Federal University of Agriculture, Owerri, Imo State, 27th – 30th April, 2014. Pp. 110-118.

Muhammad, M. B., Umar, A. U., Haliru, I., & Zuaka, A. I. (2015). Factors affecting food security of small scale farmers in Kaduna state, Nigeria. *Proceedings of the 49th annual conference of the Agricultural Society of Nigeria, Delta 2015. Theme: The Nigerian Agriculture beyond oil. November 9th-13th, 2015.*

Ogbe, A. O., Dipeolu, A. O., Obayelu, A. E., Porbeni, J. B. O., Edewor, S. E., Ogbe, O. C., Tolorunju, E. T., & Oladeji, S. O. (2017). Technology gap and technical efficiency of rice production ecologies in South Eastern Nigeria. *Conference Proceedings of the 18th Annual National Conference of the Association of Agricultural Economists Held at Federal University of Agriculture, Abeokuta, Nigeria 16-19th 0ctober,2017.*

Ogunremi, S. O., Ogunremi, J. B., & Dubugo, O. C. (2016). Tanks fish culture and information sources among fish farmers in Obio/Akpor Local Government Area, Rivers state, Nigeria. *Proceedings of 50th annual conference of the Agricultural Society of Nigeria, Abia 2016. Theme: Economic Diversification: Agriculture Roadmap. October 3rd- 7th, 2016.*

Ojoko, E. A., Akinwunmi, J. A., Yusuf, S. A., & Oni, O. A. (2017). Factors influencing the level of use of climate-smart agricultural practices (CSAPs) in Sokoto state, Nigeria. *Journal of Agricultural Sciences, Belgrade*, *62*(3), 315-327.

Olajide, O. T., Akinlabi, B. H., & Tijani, A. A. (2012). Agriculture resource and economic growth in Nigeria. *European scientific journal*, *8*(22), 103-115.

Olorunfemi, T. O., Olorunfemi, O. D., & Oladele, O. I. (2020). Determinants of the involvement of extension agents in disseminating climate smart agricultural initiatives: Implication for scaling up. *Journal of the Saudi Society of Agricultural Sciences*, *19*(4), 285-292.

Onyenobi, V. O., Ewuziem, J. E. Okoye, B. C., Mazza, M., & Ogbonna, M. C. (2015). Determinants of Yam (*Diiscorea Rotundata*) commercialization by smallholder farmers in Imo State, Nigeria. *Proceedings of the 49th annual conference of the Agricultural Society of Nigeria, Delta 2015. Theme: The Nigerian Agriculture beyond oil.* November 9th-13th, 2015.

Paudel Khatiwada, S., Deng, W., Paudel, B., Khatiwada, J. R., Zhang, J., & Su, Y. (2017). Household livelihood strategies and implication for poverty reduction in rural areas of central Nepal. *Sustainability*, *9*(4), 612.

Soltani, A., Angelsen, A., Eid, T., Naieni, M. S. N., & Shamekhi, T. (2012). Poverty, sustainability, and household livelihood strategies in Zagros, Iran. *Ecological Economics*, *79*, 60-70.

Van Oort, P. A., & Zwart, S. J. (2018). Impacts of climate change on rice production in Africa and causes of simulated yield changes. *Global Change Biology*, *24*(3), 1029-1045.

Yamane, T. (1973). Statistics: An Introductory Analysis. 3rd Edition, Harper and Row, New York.

Zamfara State Government (ZSG) (2022). Zamfara State Government Official Diary, Ministry of Information, Gusau, Nigeria.