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FACTORS INFLUENCING THE CHOICE OF ADAPTATIVE STRATEGIES BY RICE FARMERS IN KOGI STATE NIGERIA

Omede U. D.[1], Onu Y.[2] and Obaniyi, K. S[3]

1 Ph.D. Scholar Department of Agricultural Extension and Rural Development Landmark University Kwara State Nigeria and Principal Lecturer Department of Agricultural Education, Federal College of Education, Odugbo Benue State.
2 Department of Agricultural Economics and Extension, Prince Abubakar Audu University, Anyigba, Kogi State.
3 Senior Lecturer Department of Agricultural Extension and Rural Development Landmark University Kwara State Nigeria
Email: omede.ugbede@lmu.edu.ng

ABSTRACT

The specific objectives of the study were to: determine the socioeconomic factors influencing the choice of adaptative strategies by rice farmers in the study area and to estimate the profitability of rice farmers in the study area. Primary data were collected from a sample of 120 rice farmers selected through a multi-stage sampling technique. The multinomial logit regression analysis revealed that the choice of adaptation strategies was significantly influenced by several socioeconomic factors. Gender was a significant positive predictor for adopting strategies like introducing new crops ($\beta = 0.101, p<0.01$) and dry season farming ($\beta = 0.997, p<0.05$). Age and farming experience also positively influenced the adoption of a wide range of strategies; introducing flood-resistant varieties ($\beta = 0.005, p<0.05$), while farming experience was significant for adopting improved varieties ($\beta = 0.007, p<0.05$). Conversely, a larger household size acted as a constraint, negatively influencing the adoption of strategies like introducing new crops ($\beta = -0.027, p<0.01$) and planting cover crops ($\beta = -0.062, p<0.05$). The cost-return analysis showed that rice farming was a profitable venture, with a net profit of ₦299,000 per hectare and a Benefit-Cost Ratio of 3.47, indicating a ₦2.47 return on investment of ₦1 despite the costs associated with flood adaptation. To protect the profitability of rice farming and encourage investment in more effective adaptation measures, there is a need to improve farmers' access to affordable credit and insurance products.

Keywords: *adaptative strategies, socioeconomic factors, climate change*

INTRODUCTION

Climate change adaptative measures

Adaptation is an essential response action for minimizing the vulnerability of farmers to climate change. Many countries in the world have focused on strategic adaptation plans and actions to reduce the vulnerability of sectors, communities and regions (Egwu, 2014; Ikpe and Omede, 2025).

The climate change adaptation strategies employed by rice farmers to mitigate the effect of climate change include varying land size, sales of crops, and varying planting and harvesting dates; soil and water conservation techniques; and mulching. Other adaptation strategies include the rearing of improved livestock varieties, and mixed cropping, combined effects of climate change adaptation strategies and some socioeconomic characteristics such as age, gender, education, farming experience, access to credit, access to information, membership of farmers in agricultural based cooperative and location of rice farmers (Onyeneke, 2020; Vinaya et al., 2025).

Floods are a climatic risk that can result in significant yield losses for smallholder farmers. Decrease in rice yield is usually accompanied by an increase in flooded farm proportion. The expected rice yield for a 10% flooded rice land was 7.20 tons/ha throughout the year. Additionally, an increase in the proportion of flooded rice land from 10% to 20% resulted in a decrease of 1.19 tons/ha of rice yield. During the wet season, floods negatively impacted rice yield, irrespective of their severity. Conversely, flooding benefited rice production in the dry season following flooding. These findings offer policymakers insight into appropriate protection plans and adaptation strategies (Bunuo, *et al.*, 2024; Vinaya and Gadde, 2025).

Consequently, future climate events are expected to affect the yield of tropical crops, raising concerns regarding food insecurity, particularly in rural households (Palazzo *et al*., 2017). Furthermore, reductions in rice yields can be attributed to changes in atmospheric conditions. In 2018, the total rice yield loss in the Long Xuyen Quadrangle was estimated at 15,729 tons. This resulted in an economic loss amounting to approximately 1.47% of the total gross regional domestic product of the Long Xuyen Quadrangle in the Vietnam Mekong Delta (Bui and Nguyen 2024). Consequently, adapting farming systems to climate change will require a thorough understanding of its impacts on the livelihoods of agricultural households Devkota and Bhattarai 2018).

Adaptative strategies and their effects on rice yield

Adaptation is very important in managing risks posed by climate change to rice farming. The climate change adaptation strategies employed by rice farmers to mitigate the effect of climate change include varying land size, sales of crops, and varying planting and harvesting dates; soil and water conservation techniques; and mulching. Other adaptation strategies include the rearing of improved livestock varieties, and mixed cropping, combined effects of climate change adaptation strategies and some socioeconomic characteristics such as age, gender, education, farming experience, access to credit, access to information, membership of farmers in agricultural based cooperative and location of rice farmers

The importance of adaptation in climate change management cannot be overemphasized. The vulnerability of rice production to climate change has received attention from researchers. Terdoo and Feola (2016) observed rice production, especially in sub-Saharan Africa, is highly sensitive to climate change. Therefore, there is an urgent need to reduce the vulnerability of the rice sector to climate change. Adapting rice production to climate change is necessary to increase farmers' yields and food security. There are several local adaptation practices used by farmers in managing climate risks in different parts of the world. Some of the local adaptation practices include minimum tillage, drainage and bond, combined use of organic and inorganic fertilizer, crop diversification, improved rice varieties, use of nursery, use of pesticides, livelihood diversification and changing planting and harvesting dates Oselebe, *et al.,* (2016).

Several researchers have noted the importance of minimum tillage in controlling flood and erosion, enhancing soil fertility and climate resilience as well as conserving the environment (Verhulst *et al.,* 2014).

The combined use of organic and chemical fertilizer is also an important climate change adaptation strategy in agricultural production. Climate change depletes soil fertility through increased flooding, erosion, runoff and washing away of soil nutrients Brevik (2013) thereby adversely affecting soil pH, water holding capacity, bulk density and other soil properties. Correct use of organic and chemical fertilizers (in terms of getting the fertilizers from the right sources, using the right rate and applying the fertilizer at the right time and place) enhances soil fertility and increases yield thereby reducing farmers' vulnerability to climate change. Similarly, improved rice varieties have been used by many farmers in managing climate risks. Early maturing rice varieties, for instance, are better suited for managing delayed onset and early cessation of rain that now characterize agricultural production in many parts of Nigeria. The construction of local drainages and bunds for managing climate risks in agricultural systems has received considerable attention by researchers (Aryal, *et al.,* 2017).

Crop diversification reduces the impacts of climate change on farmers and contributes to their buffer capacity (Belay *et al.,* 2017). Crop diversification contributes to climate change adaptation in rice production because production and income risks are spread through planting different crops, which in turn leads to minimization of farmers' vulnerability.

Sustaining the rice grain yield under climate change conditions is a significant challenge at local, regional, and global level. So, adaptation strategies become imperative and are mandatory for reduction of the climate susceptibilities. The adversative impact of climate warming can be lessened by evolving of heat tolerance, demanding higher growing degree days cultivars and some modifications in current rice crop management practices and technologies. Adaptation strategies deliver the valuable information for the researchers, academia, as well as farming community for the mitigation of the adverse impact of climate warming. Floods are a climatic risk that can result in significant yield losses for smallholder farmers (Bunuo, *et al.,* 2024).

Nigerian government is struggling to promote agriculture production particularly rice production in the country in order to sustain local economy, employment and food security among its people. However, the adverse effects of climate change are on the increase.

It is against this background that the study is designed to provide answers to the socioeconomic factors influencing the choice of adaptative strategies by rice farmers in the study area.

OBJECTIVE

The broad objective of this study is to find out the socioeconomic factors influencing the choice of adaptative strategies by rice farmers, in Kogi State.

The specific objectives were :

(1) determine the socioeconomic factors influencing the choice of adaptative strategies by rice farmers in the study area and;

(2) estimate the profitability of rice farmers in the study area.

METHODOLOGY

Study Area

The study area is flood-prone area of Kogi State, Nigeria. Kogi is popularly called the *"Confluence State"* because of the confluence of river Niger and river Benue at its capital, Lokoja, which is the first administrative capital of modern-day Nigeria. The state is divided into three senatorial districts (Kogi East, Kogi Central and Kogi West) and structured into 21 local government areas Ponchang, *et al.,* 2017). It is situated between latitudes 6°33'N and 8°44'N and longitudes 3°22'E and 7°49'E with a total land area of 29,833 Sq. km and an estimated population of 4,473,500 (National Population Commission (NPC), 2016). About 172,000 farm families, 70% of who lives in the rural areas and are actively engaged in crop production and rearing of animals (Ibitoye 2021).

The state is characterized by a tropical climate with distinct dry season between November and March and a wet season between April and October. Majority of the population are predominantly farmers who are into both crops farming and animal rearing.

Kogi State has a total population of 4,473,500 which is made up of 1,691,737 males and 1,586,750 females, with an average of 172,000 farm families (NPC, 2016). The State is located between latitude $6^0$30'N, and $8^0$50N, and Longitude $5^0$51'E and 8^0.00'E Kogi State Economic Empowerment and Development Kogi State Economic Empowerment and Development (KOSEEDS) (2014). It shares common boundaries with Niger, and Nasarawa States and the Federal Capital Territory to the North and Benue State to the East. To the West, it is bounded by Kwara, Ekiti and Ondo States and to the South by Enugu, Anambra, and Edo States. With a total land mass of about 30,354.74 square kilometers. About 2 million hectares of her land is cultivable, but only 0.5 million hectare is currently under cultivation (KOSEEDS, 2014). It is well supplied with river valleys and swamp lands for dry season farming. Annual rain fall stands between 1016mm and 1524mm. it has a minimum temperature of 33.2^{o}C and average temperature of 22.8^{o}C, with an average humidity of 70% it has a land area of 154.3Km^2 (NPC, 2016).

The major occupation of the people is farming. A few people are in the civil service, trading and the crafts. The farmers practice several farming systems such as sole cropping, mixed cropping and mixed farming. There is strong land tenure system in the State. Land belongs to the community, clan and the family. Community and clan land are available for common projects in the community. Family land is used mainly for farming and such land is passed from father to son through inheritance. Important food and cash crops grown in the state are rice, cassava, yam, cocoyam, sweet potato, maize, sorghum, millet, cowpea, pigeon pea, bambara ground nuts, groundnuts, beniseed, melon, banana/ plantain and cotton. Fruits and leafy vegetables such as okro, pepper, fluted pumpkin and spinach are highly cultivated Tree crops grown in the state are cashew, cocoa, coffee, oil palm and citrus. Cattle, sheep, goats and poultry are the major animals reared.

Fish farming is coming up among the elite farmers. Fishermen carry out fishing activities on rivers Niger and Benue, their tributaries and other inland water bodies.

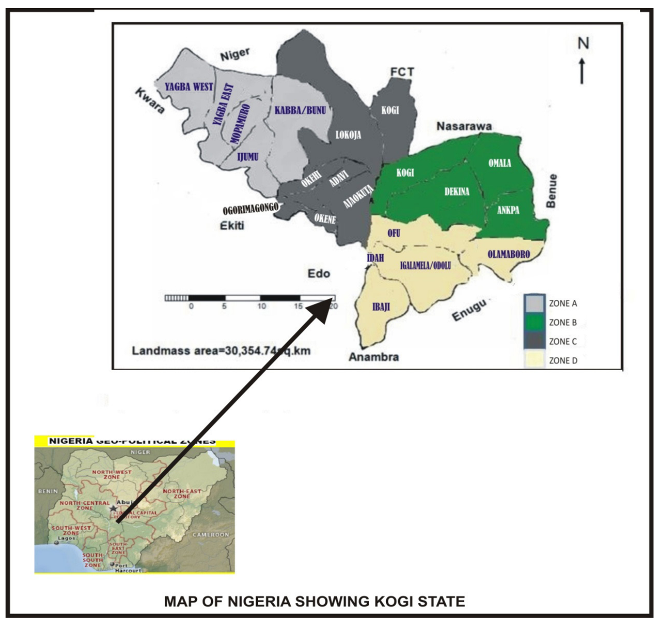

Fig. 2: map of nigeria showing kogi state

Source: KSU Geography Department GIS Lab

Population of the Study

The entire rice farmers in flood-prone farming communities in Kogi State Nigeria constitute the population of the study.

Sampling procedure and sampling size

A multistage sampling procedure was used for the study. Firstly, Ibaji, Idah and Kotokerfi Local Government

Areas (LGAs) of the state was purposively selected due to their involvement in rice production and their flood-prone nature. Secondly, 2 flood-prone communities were selected randomly from the selected LGAs to give a total of 6 communities in all. Thirdly, random selection of 2 farming settlements from each of the communities making a total of 12 farming settlements. Fourthly, 10 rice farmers were randomly selected from the list of registered farmers in each settlement, making a total sample size of 120 respondents.

Method of data collection

Primary data was used for this study. The data were collected using a well-structured questionnaire. The questionnaire was designed to capture information based on the stated objectives.

Method of data analysis

Objective i: (socioeconomic factors influencing the choice of adaptative strategies) was achieved using A multivariate probit (MVP) model

Objective ii: (profitability of rice farming in the area) was realized using gross margin analysis

Model Specification

A Multivariate Probit (MVP) Model

A multivariate probit (MVP) was used for the empirical analysis. The MVP approach models the effect of the set of regressors for each of the adaptation strategies simultaneously, while allowing free correlation among the unobserved factors (Bonou, 2024).

$$Y_j = 1\;{\rm if}\;{\rm \delta }X_i + {\rm \varepsilon } \gt 0$$

and

$$Y_j = 0\;{\rm if}\;{\rm \delta }X_i + {\rm \varepsilon } \le 0 \quad j = 1,\;2,\;\ldots ,\;9$$

where Y_j, adaptation strategies of the jth farmer; j, 1,2, … ,9 are the number of identified adaptation options.

X_i **is a vector of the independent variables; δ, parameter estimates of the independent variables and** ε, the error term following (Mulwa *et al.,* 2017).

Explicitly, the model is expressed as:

$$Ys = \alpha + \partial_1 X_1 + \partial_2 X_2 + \partial_3 X_3 + \partial_4 X_4 + \partial_5 X_5 + \partial_6 X_6 + \partial_7 X_7 + \partial_8 X_8 + e_i$$

Where

(Ys) = dependent variables (categories of adaptative strategies used by rice farmers to manage risks associated with climate change).

Y_1, minimum tillage (yes = 1, no = 0);

Y_2, drainage and bonds (yes = 1, no = 0);

Y_3, use of organic and inorganic fertilizer (yes = 1, no = 0);

Y_4, crop diversification (yes = 1, no = 0);

Y_5, improved rice varieties (yes = 1, no = 0);

Y_6, use of nursery (yes = 1, no = 0);

Y_7, use of pesticide (yes = 1, no = 0);

Y_8, livelihood diversification (yes = 1, no = 0);

Y_9, adjusting planting and harvesting dates (yes = 1, no = 0).

X_{is} are the independent variables and they include the socioeconomic variables

X_1 = age in years

X_2 = sex male or female

X_3 = family size (number of person)

X_4 = farm size (Ha)

X_5 = education (years)

X_6 = membership of association

X_7 = access to credit

X_8 = access to extension services

X9 = marital status

X10 = farming experience

∂1-8 = coefficients to be estimated.

e = error term.

Gross Margin Analysis

Gross margin is the difference between the gross farm income and the total variable cost.

Therefore; GM = GFI – TVC ---------------------------------3.2

Where

GM = Gross margin

GFI = Gross farm income

TVC = Total variable cost

3.7 Measurement of variable

Variable	Units
Age	(Years)
Sex	(Male & Female)
Marital Status	(Married, Single, Widow, Divorced, Widower)
Level of Education	(years spent schooling)
Household Size	(Numbers)
Experience	(Years)
Labour	(man-days)
Output valued	(Kg)
Income	(Naira)
Credit used	(Naira)

Analytical framework

A multivariate probit (MVP) was used for the empirical analysis. The MVP approach mode ls the effect of the set of regressors for each of the adaptation strategies simultaneously, while allowing free correlation among the unobserved factors (Lin *et al.,* 2005). The source of correlation may be complementary, which denotes a positive correlation and substitutability indicating a negative correlation between different adaptations strategies used in the model (Belderbos et al.*,* 2004).

A multivariate probit (MVP) will be used for the empirical analysis. The MVP approach models the effect of the set of regressors for each of the adaptation strategies simultaneously, while allowing free correlation among the unobserved factors (Bunuo, et al.*,* 2024).

$$Y_j = 1\;{\rm if}\;\delta X_i + \varepsilon \gt 0$$

and

$$Y_j = 0\;{\rm if}\;\delta X_i + \varepsilon \le 0 \quad j = 1,\;2,\;\ldots,\;9$$

where Y_j, adaptation strategies of the *j*th farmer; *j*, 1,2, … ,9 are the number of identified adaptation options.

X_i **is a vector of the independent variables; δ, parameter estimates of the independent variables and** ε, the error term following (Mulwa, 2017).

RESULTS AND DISCUSSION

Socioeconomic factors influencing the choice of adaptation strategies by rice farmers

The decision by rice farmers to adopt specific adaptation strategies is influenced by a combination of socioeconomic factors, as shown by the multinomial logit regression results in Table 1. The analysis showed how individual and household characteristics shape their capacity and willingness to respond to flood risks.

The results in Table1 showed that gender significantly influenced the adoption of several adaptation strategies. Specifically, it was a positive determinant for introducing new crops ($\beta = 0.101$, $p<0.01$), using improved crop varieties ($\beta = 0.095$, $p<0.05$), increasing animal production ($\beta = 0.114$, $p<0.05$), applying inorganic fertilizer ($\beta = 0.122$, $p<0.05$), practicing crop rotation ($\beta = 0.007$, $p<0.05$), inter-cropping ($\beta = 0.224$, $p<0.05$), and dry season farming ($\beta = 0.997$, $p<0.05$). This suggests that male farmers were more likely than their female counterparts to adopt these particular strategies. This could be due to men having better access to information, credit, and other resources needed to implement these changes. These findings are consistent with [20], who reported that gender was a significant predictor of adaptation among fish farmers in Uganda, where male farmers had greater capacity to make changes. In contrast, Hoque, (2023) found that women in Bangladesh often developed their own unique and effective strategies, suggesting that while men may dominate in adopting certain formal strategies, women's contributions should not be overlooked.

The results in Table 1 showed that a farmer's age was also a key factor. Age significantly influenced the choice of introducing new crops ($\beta = 0.007$, $p<0.1$), planting cover crops ($\beta = 0.007$, $p<0.05$), using improved varieties ($\beta = 0.009$, $p<0.05$), increasing animal production ($\beta = 0.005$, $p<0.05$), applying inorganic fertilizer ($\beta = 0.010$, $p<0.05$), introducing flood-resistant varieties ($\beta = 0.005$, $p<0.05$), changing planting dates ($\beta = 0.005$, $p<0.05$), and natural regeneration ($\beta = 0.008$, $p<0.05$). The positive coefficients indicate that older farmers were more likely to adopt these strategies. This may be because age often correlates with accumulated experience and a deeper understanding of local environmental patterns, enabling more strategic decision-making. This supports the findings of a study on farmers in Bihar, India by Yadav and Ghosh (2023), which found that experience, closely linked to age, was crucial for the effective implementation of adaptation mechanisms. However, this contrasts with the study's earlier demographic finding of a youthful farming population, suggesting that while the workforce is young, it may be the more experienced older farmers who are leading the adoption of a wider range of resilience-building practices.

Table 1: socioeconomic factors influencing the choice of adaptation strategies by rice farmers in the study area

variables	AD_1	AD_2	AD_3	AD_4	AD_5	AD_6	AD_7	AD_8	AD_9	AD_{10}	AD_{11}	AD_{12}	AD_{13}	AD_{14}	AD_{15}
Gender	0.101^{***} (0.037)	0.289 (0.053)	-0.08 (0.053)	0.035 (0.064)	0.084 (0.052)	0.095** (0.036)	0.114** (0.044)	0.122** (0.045)	0.198 (0.050)	0.007** (0.054)	0.224** (0.052)	0.997** (0.044)	0.324 (0.048)	0.114 (0.047)	0.061 (0.049)
Age	0.007^{*} (0.003)	0.007** (0.003)	0.006 (0.004)	0.005 (0.005)	0.009** (0.004)	0.005** (0.003)	0.005 (0.004)	0.010** (0.004)	-0.003 (0.004)	0.001 (0.004)	0.001 (0.004)	0.003 (0.004)	0.005** (0.004)	0.005** (0.004)	0.008** (0.004)
Marital Status	-0.005 (0.042)	0.045 (0.060)	0.113 (0.061)	0.127 (0.073)	0.072 (0.060)	0.079** (0.042)	0.059 (0.050)	0.104** (0.052)	0.195 (0.058)	0.169 (0.061)	0.194 (0.060)	0.047 (0.051)	0.067 (0.055)	0.048 (0.055)	0.011 (0.056)
Household Size	-0.027^{***} (0.007)	-0.062** (0.011)	-0.004 (0.011)	0.015 (0.013)	-0.045* (0.010)	-0.023* (0.007)	-0.026* (0.009)	-0.015 (0.009)	-0.009 (0.010)	-0.037 (0.011)	-0.008 (0.010)	-0.042 (0.009)	-0.029 (0.010)	-0.037 (0.010)	-0.039 (0.010)
Education	-0.036^{***} (0.005)	0.016* (0.007)	0.010* (0.007)	-0.007* (0.008)	-0.007* (0.007)	0.015** (0.005)	-0.006 (0.006)	0.0133* (0.006)	0.010** (0.007)	-0.036 (0.007)	0.022 (0.007)	-0.000* (0.005)	0.022* (0.006)	-0.0.11 (0.006)	0.006* (0.006)
Farming Experience	0.016^{***} (0.003)	0.004** (0.004)	0.007** (0.004)	0.010* (0.005)	-0.002* (0.004)	0.007** (0.003)	0.005 (0.004)	-0.010* (0.004)	0.004** (0.004)	-0.002 (0.004)	-0.014 (0.004)	0.013* (0.004)	-0.010* (0.004)	-0.002* (0.004)	-0.002 (0.004)
Secondary Occupation	0.022 (0.142)	-0.034 (0.203)	-0.301 (0.203)	0.398 (0.245)	-0.151 0.201	0.004** (0.140)	-0.029 (0.167)	-0.123** (0.174)	-0.216 (0.194)	0.818** (0.206)	-0,334 (0.201)	0.008 (0.171)	-0.041 (0.184)	-0.047 (0.184)	-0.037 (0.187)
Farm size	-0.024^{**} (0.009)	-0.002^{**} (0.013)	0.004^{***} (0.013)	0.020** (0.016)	-0.010^{*} (0.013)	-0.068* (0.009)	-0.040* (0.011)	-0.054* (0.011)	0.004** (0.013)	-0.038 (0.014)	0.022 (0.013)	-0.018* (0.011)	-0.026* (0.012)	-0.026* (0.012)	-0.054 (0.012)
Extension Access	0.061 (0.063)	-0.045 (0.090)	-0.024 (0.091)	-0.107 (0.109)	-0.142 (0.090)	0.082 (0.062)	0.093 (0.074)	0.143** (0.077)	-0.168* (0.086)	-0.211* (0.918)	0.148 (0.090)	-0.098 (0.076)	0.021* (0.082)	-0.134 (0.082)	-0.162* (0.083)
Memb. Of Associaton	-0.003 (0.089)	-0.420 (0.128)	-0.098 (0.128)	0.525 (0.154)	-0.371* (0.126)	-0.370* (0.876)	-0.353* (0.105)	-0.125** (0.109)	-0.289 (0.122)	0.335** (0.130)	-0.300* (0.126)	-0.421 (0.107)	-0.490 (0.116)	-0.256 (0.116)	-0.282 (0.117)
Farm Land Acquisition	1.061^{***} (0.172)	0.953 (0.247)	0.803 (0.248)	-0.676 (0.298)	1.458 (0.245)	1.016 (0.170)	1.191 (0.203)	0.705 (0.212)	1.259 (0.236)	0.490 (0.251)	0.565 (0.245)	1.278 (0.208)	0.998 (0.224)	1.463 (0.224)	1.352 (0.227)

Source: field survey (2025)

NOTE: AD1 = Introduced new crops. AD2 = Planting cover crops. AD3 = Construction of drainages. AD4 = Income Diversification. AD6= Use improved crop varieties. AD7 = Introduce and increase animal production. AD8 = Application of inorganic fertilizer. AD9 = use of organic manure. AD10 = Crop rotation. AD11 = Practice inter-cropping. AD12 = Dry season farming. AD13 = introduction of flood-resistant variety. AD14 = Changing planting and harvesting dates. AD15 = Natural regeneration.

Figures in parentheses are standard errors. ***, **, and * = sig. @ 1%, 5%, and 10% respectively.

The results in Table 1 showed that household size had a significant negative influence on the choice to introduce new crops (β = -0.027, p<0.01), plant cover crops (β = -0.062, p<0.05), use improved varieties (β = -0.045, p<0.1), increase animal production (β = -0.023, p<0.1), and apply inorganic fertilizer (β = -0.026, p<0.1). This suggests that farmers with larger households were less likely to adopt these strategies. While larger households provide more labor, they also face greater consumption pressures, which may limit their ability to invest in new, potentially risky, adaptation measures. This aligns with research by Alamgir *et al.,* (2023), who found that larger households in flood-prone areas of Bangladesh often struggled with poverty and food insecurity, constraining their capacity to invest in adaptation. Similarly, a study in Vietnam by Dinh (2023) showed that while household labor was an asset, the economic burden of a large family could be a significant barrier to adopting capital-intensive strategies.

The results in Table 1 showed that farming experience significantly influenced the choice of adopting the introduction of new crops (β = 0.016, p<0.01), planting cover crops (β = 0.004, p<0.05), construction of drainages (β = 0.007, p<0.05), income diversification (β = 0.010, p<0.1), using improved crop varieties (β = 0.007, p<0.05), and the use of organic manure (β = 0.004, p<0.05), among others. The predominantly positive coefficients suggest that farmers with more years of experience were more likely to adopt a wider array of strategies. This is logical, as experience provides a practical understanding of what works in their specific context. This finding is strongly supported by Nayak (2022), who reviewed farmers' preparedness in Eastern India and concluded that experience was a critical factor in the adoption of flood-resilient rice varieties. The negative relationship with a few strategies, such as the application of inorganic fertilizer (β = -0.010, p<0.1), might indicate that more experienced farmers prefer traditional or organic methods over chemical inputs, a preference also observed in some farming communities by (Baishakhy *et al.,* 2023).

The results in Table 1 showed that farm size had a significant positive influence on specific adaptation choices. It positively influenced the adoption of constructing drainages (β = 0.004, p<0.01) and income diversification (β = 0.020, p<0.05). This relationship suggests that farmers with larger landholdings have a greater asset base, which may empower them to invest in structural mitigation measures like drainages and provide the capital to pursue non-farm income opportunities. This is consistent with Jimoh, *et al.,* (2023), who advocated for a multidimensional approach to flood mitigation in Nigeria, recognizing that different farmers have capacities for different types of strategies. The findings also resonate with those of Dash *et al.,* (2024), who noted that coping strategies in Odisha were highly dependent on farmers' asset holdings, where those with more resources could undertake more capital-intensive adaptations.

Finally, the results in Table 1 showed that marital status was a significant positive factor in the decision to use improved crop varieties (β = 0.079, p<0.05) and apply inorganic fertilizer (β = 0.104, p<0.05). This indicates that married farmers were more likely to invest in these modern inputs. This could be because married households may benefit from pooled resources, shared labor, and greater stability, which can support the financial outlay required for purchasing improved seeds and fertilizers. This finding is supported by Adadu *et al.,* (2024), who linked marital status to household stability and collaborative decision-making in agricultural communities in Benue State, Nigeria. Furthermore, the study by Qazlbash *et al.,* (2021) in Pakistan also found that household structure and stability were important determinants of a farming family's ability to adopt specific climate change adaptation measures, reinforcing the idea that a stable family unit can better manage the risks associated with investing in new technologies.

Cost and return in rice farming in flood prone areas

The economic viability of rice farming in the flood-prone study area was assessed through a cost and return analysis, with the results presented in Table 4.5. The analysis showed that for each hectare of rice cultivated, farmers incurred a Total Variable Cost (TVC) of ₦121,000. Despite these costs, which include an average of ₦15,000 for adaptation strategies, the enterprise proved to be profitable. Farmers generated a Total Revenue (TR) of ₦420,000 per hectare, resulting in a Net Profit of ₦299,000. This profitability is further underscored by a strong Benefit-Cost Ratio (BCR) of 3.47, which indicates that for every naira invested, farmers gained ₦2.47 in return. The Return on Investment (ROI) was also high at 247.1%. These findings highlight the potential for profitable rice farming in the region, even with the added costs of flood adaptation. However, the profitability is highly sensitive to the financial losses that floods can cause. For instance, Ajibade *et al.,* (2024) found in their study of flood losses among rice farmers in Benue State, Nigeria, that severe flooding could wipe out expected profits, turning a potentially viable enterprise into a significant financial loss. This underscores the critical importance of effective adaptation strategies not just for sustainability, but for the fundamental economic survival of these farming households.

Table 2 : Average costs, returns, and profitability for rice production (per hectare)

Cost/Return Item	Value (₦)
Seed	12,000
Empty bags	2,000
Labour	35,000
Fertilizer	22,000
Herbicide	8,000
Pesticide	4,000
Processing cost	15,000
Loading & Off-loading	4,000
Levies	1,000
Transportation	3,000
Cost of adaptive strategies	15,000
Total Variable Cost (TVC)	121,000
Revenue (main product)	375,000
Revenue (offal/by-product)	45,000
Total Revenue (TR)	420,000
Gross Margin (TR - TVC)	299,000
Net Profit (TR - TVC)	299,000
Benefit-Cost Ratio (BCR)	3.47
Return on Investment (ROI)	247.1%

Source: Field survey (2025)

CONCLUSION

The multinomial logit regression analysis revealed that the choice of adaptation strategies was significantly influenced by several socioeconomic factors. Gender was a significant positive predictor for adopting strategies like introducing new crops ($\beta = 0.101$, $p<0.01$) and dry season farming ($\beta = 0.997$, $p<0.05$). Age and farming experience also positively influenced the adoption of a wide range of strategies; for instance, age was a significant factor in adopting improved varieties ($\beta = 0.009$, $p<0.05$) and introducing flood-resistant varieties ($\beta = 0.005$, $p<0.05$), while farming experience was significant for adopting improved varieties ($\beta = 0.007$, $p<0.05$). Conversely, a larger household size acted as a constraint, negatively influencing the adoption of strategies like introducing new crops ($\beta = -0.027$, $p<0.01$) and planting cover crops ($\beta = -0.062$, $p<0.05$). The cost-return analysis showed that rice farming in the area was a profitable venture, with a net profit of ₦299,000 per hectare and a Benefit-Cost Ratio (BCR) of 3.47, indicating a ₦2.47 return on investment of ₦1 despite the costs associated with flood adaptation.

RECOMMENDATIONS

To protect the profitability of rice farming and encourage investment in more effective adaptation measures, there is a need to improve farmers' access to affordable credit and insurance products. This would provide the capital needed for upfront investments and create a financial safety net to help farmers recover more quickly from flood-related losses.

CONFLICT OF INTEREST

This is to declare that there is "No conflict of interest" among researcher.

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