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Does Financial Inclusion Influence the Adoption of Climate Change Adaptation Strategies among Smallholder Farmers? Evidence from Oyo State, Nigeria

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ABSTRACT

The ability of smallholder farmers to adapt to climate change hinges on their financial resources. The main objective of this study was to investigate the influence of financial inclusion on the adoption of climate change adaptation strategies among smallholder farmers in Oyo State, Nigeria. Using a well-structured questionnaire, primary data were collected from 170 randomly selected respondents through a multistage sampling technique. Analysis of the data was conducted using descriptive statistics alongside the Multivariate Probit (MVP) model. The descriptive statistics unveiled that smallholder farmers employed a variety of adaptation measures to mitigate the detrimental impacts of climate change on their agricultural activities. Techniques such as soil and water conservation, cultivation of drought and heat-resistant crop varieties and mixed cropping emerged as the most utilised adaptation options in the study area. The results from the MVP model indicated that the socio-economic characteristics, including age, gender, marital status, education, household size, cultivated land area, farming experience, access to extension services, total income, of the smallholder farmers as well as financial inclusion indicators including credit accessibility, and bank account ownership have a significant influence on their decision to adopt any of the adaptation strategies. Based on these findings, the study recommends that farmers be educated about the importance of having a bank account and calls for the attention of relevant stakeholders to facilitate the availability and accessibility of credit to smallholder farmers to enhance their ability to adapt to the rapidly changing change.

INTRODUCTION

Over the years, research has underscored the detrimental effects of climate change in sub-Saharan Africa, particularly highlighting the heightened vulnerability of the agricultural sector compared to other economic domains (Parker *et al.*, 2019). Marie *et al.* (2020) emphasized the disproportionate impact on smallholder farmers, for whom agriculture is the primary livelihood. This disparity is especially pronounced in Nigeria, where agriculture heavily relies on rainfall due to limited irrigation infrastructure and technological resources. Despite its potential to alleviate poverty and ensure food security, agriculture in Nigeria faces significant challenges from climate change, necessitating the adoption of diverse adaptation measures by smallholder farmers (Nor *et al.*, 2022). However, implementing such strategies requires financial resources which are typically scarce in developing nations (Ojo & Baiyegunhi, 2020). Consequently, engaging farmers in adopting these measures proves challenging without adequate financial inclusion. Financial inclusion, encompassing easy access to affordable financial services such as bank account ownership, savings, credit access, insurance, and mobile money, amongst others, is a fundamental catalyst for economic development (Fungáčová & Weill, 2014).

Fowowe (2020) highlighted the significant financial exclusion experienced by the agricultural sector in Nigeria compared to other economic sectors, with nearly one-third of smallholder farmers lacking access to formal financial services. The impact of financial inclusion on smallholder agriculture is profound, as finance plays a crucial role in reducing poverty and inequality. Access to finance enhances agricultural productivity by enabling farmers to implement necessary adaptation measures, ultimately increasing income and reducing hunger and poverty among smallholder farmers (Fowowe, 2020). While previous research has extensively examined the effects of climate change on agricultural productivity and the necessary adaptation measures, this study takes a unique approach by focusing on how specific indicators of financial inclusion influence smallholder farmers' adaptation strategies to climate change in Oyo State. It aims to identify the various adaptation strategies adopted, financial services utilized, and the impact of financial inclusion indicators on the adoption of climate change adaptation strategies within the study area.

METHODOLOGY

The study was conducted in Oyo State, located in the southwest, Nigeria. The State was carved out from the Old Western region in 1976 and lies between latitude 8.0^0N and Longitude 3.0^0E. The State is bounded to the north by Kwara State, to the south by Ogun State, to the east by Osun State and to the west partly by Ogun State and the Republic of Benin. The State has a total landmass of 28,454 square kilometres and an estimated population of 7.8 million (National Bureau of Statistics, 2016). The State has an equatorial climate with dry and wet seasons and relatively high humidity. The dry season runs between November and April, while the wet season lasts from April to October. Oyo state is an agrarian state. Its climatic condition favours all-year-round cultivation of crops such as maize, yam, cassava, millet, rice, plantain, cocoa tree, palm tree and cashew.

Primary data were collected from the sampled smallholder farming households through a multistage sampling technique. Based on the Agricultural Development Programme (ADP), the State is divided into four (4) zones comprising Ibadan/Ibarapa, Oyo, Ogbomosho, and Saki. In the first stage, we randomly selected two (2) ADP zones (Ibadan/Ibarapa and Oyo). The second stage involves random selection of 3 blocks in the Ibadan/Ibarapa zone and 2 blocks in the Oyo zone, considering the number of blocks in each zone. The third stage involves selecting one cell from the selected blocks to make a total of 5 cells. We randomly selected two (2) villages from each selected cell in the fourth stage. Finally, we used a systematic random sampling technique to select seventeen (17) agricultural households from each village to give a total of 170 smallholder farmers sampled for the study. However, due to incomplete information, which made two questionnaires unsuitable for analysis, 168 questionnaires were considered for the data analysis (a response rate of 98.8%).

The data was analysed by employing descriptive statistics and an econometric model, specifically the Multivariate Probit Model. All analyses were carried out utilizing STATA 17. Descriptive statistics, including frequency and percentage distribution tables, were utilised to describe and illustrate the various climate change adaptation strategies embraced by smallholder agricultural farmers in the study area.

Econometric Model Specification – Multivariate Probit Model (MVP)

The multivariate probit model is a binary regression framework employed to simultaneously estimate the relationship between a set of independent variables and multiple dependent variables, allowing for correlated error terms (Arun & Yeo, 2020; Milioti *et al.* 2015). It assumes that the error term follows a multivariate normal distribution with a mean of zero and unit variance (Lutomia *et al.*, 2019; Mulwa *et al.*, 2017). In the face of extreme weather events, farmers often adopt a combination of strategies to adapt or mitigate rather than relying on a single approach.

Thus, it becomes essential to utilize a model capable of analyzing the influence of independent variables on the array of strategy choices made by farmers. Hence, we employed the multivariate probit model to assess the impact of financial inclusion indicators on the selection of climate change adaptation strategies by smallholder agricultural households in Oyo State. This modelling approach has been widely applied in studies examining climate change adaptation strategies among farmers in various regions, including Malawi (Mulwa *et al*., 2017), Ethiopia (Tesfaye & Seifu, 2016) and Nepal (Arun & Yeo, 2020). The general specification of the multivariate probit model, as Greene (2012) outlined, is provided below.

$$y_m^* = x_m'\beta_m + \varepsilon_m, y_m = 1 \; if \; y_m^* > 0, 0 \; otherwise, m = 1, \ldots\ldots, M,$$
$$E[\varepsilon_m | x_1, \ldots., x_M] = 0$$
$$Var[\varepsilon_m | x_1, \ldots., x_M] = 1$$
$$Cov[\varepsilon_j \varepsilon_m | x_1, \ldots., x_M] = \rho_{jm}$$
$$(\varepsilon_1, \ldots., \varepsilon_M) \sim N_M[0, R]$$

Where x is a vector representing independent variables, β is a vector representing unknown regression coefficients, and ε_m is residual error. R is the variance-covariance matrix. The off-diagonal elements in the correlation matrix ρ_{jm} represent the unobserved correlation between the stochastic component of the jth and mth options (Arun & Yeo, 2020; Greene, 2012).

Dependent Variable

We used the self-reported and available-in-literature climate change adaptation strategies adopted by the household as the dependent variables. These adaptation strategies include crop rotation, organic manure, soil and water conservation techniques, mixed cropping, planting of pest and disease-resistant crop varieties, and planting of drought and heat-resistant crop varieties. We collected data on the choice of climate change adaptation strategies by asking the respondents a series of yes or no questions with respect to the adaptation strategies. We assigned a value of 1 if the household adopts a particular strategy and 0 if otherwise.

Independent Variables

Independent variables including household socioeconomic characteristics and financial inclusion indicators, were considered factors influencing the selection of climate change adaptation strategies (see Table 1).

Table 1: List of Independent variables (N = 168)

Variables	Definition	Units	Mean	SD
Age	Age of household head	Years	41.80	4.82
Gender	Gender of Household head (Male = 1)	Dummy	0.58	0.49
Marital status	Marital status of household head (Married = 1)	Dummy	0.63	0.48
Education	Number of years of schooling of household head	Years	12.74	4.14
Household size	Number of household members	Count	4.31	1.58
Land cultivated	Total land area cultivated	Hectares	0.32	0.23
Farm experience	Total years of farming experience	Years	18.92	7.18
Extension visits	If households have access to extension service (Have access = 1)	Dummy	0.71	0.45
Total income	Total amount of money received by the household as income	Naira (₦)	92220.24	34518.84
Access to credit	access to credit by the household head (Have access =1)	Dummy	0.67	0.47
Own a bank account	Dummy for ownership of bank account (Owned =1)	Dummy	0.46	0.50

Save money in the bank	Dummy for saving money in the bank (Saved = 1)	Dummy	0.70	0.46

RESULTS and DISCUSSION

Adaptation Strategies to Climate Change Adopted by Smallholder Farmers.

This section reveals the various climate change adaptation strategies at the farm level adopted by the smallholder farmers during the previous cropping season in the study area. The results presented in Table 2 revealed that the smallholder farmers in the rural areas of Oyo state are implementing various adaptation measures to respond to and cushion the adverse effects of climate change and maintain or boost crop yields. More than half of the surveyed smallholder farmers practised each of the identified adaptation measures, indicating that they rely heavily on climate change adaptation strategies. The most common among the different strategies employed are the use of soil and water conservation techniques (82.14%), mixed cropping (72.02%), and planting of drought and heat-resistant crop varieties (72.02%). Other climate change adaptation strategies adopted include crop rotation (63.69%), organic manure (58.93%), and planting of pest and disease-resistant crop varieties (51.19%). This result partly aligns with the findings of earlier research conducted in Nigeria (Ogunnaike et al., 2021) and elsewhere (Marie *et al.*, 2020; Olabanji *et al.*, 2021) that climate change has spurred the adoption of different adaptation strategies, among which mulching, multiple cropping, improved seeds, adjusting the planting dates, growing of new crop varieties, crop diversification, planting drought-tolerant crop varieties were the most commonly adopted.

Table 22: Adaptation strategies to climate change adopted by smallholder farmers in the study area

Adaptation strategy	Response	Frequency	Percent
Crop rotation	No	61	36.31
	Yes	107	63.69
Organic manure	No	69	41.07
	Yes	99	58.93
Soil and water conservation techniques	No	30	17.86
	Yes	138	82.14
Mixed cropping	No	47	27.98
	Yes	121	72.02
Planting pest and diseases resistant crop varieties	No	82	48.81
	Yes	86	51.19
Planting drought and heat-resistant crop varieties	No	47	27.98
	Yes	121	72.02

Source: Field Survey, 2021

Effect of Financial Inclusion Indicators on Smallholder Farmers' Choice of Climate Change Adaptation Strategy

The Multivariate Probit (MVP) Model was utilised to analyse the factors that influenced the decision of the smallholder farmers in the study area to select the climate change adaptation option(s) they adopted to mitigate the negative effects of climate change. The results of the model parameter estimates are presented in Table 3. The Wald chi-square test statistic (Wald $\chi^2(72) = 178.83$) used to test the overall significance of the variables was significant at the 1% level ($Prob > \chi^2 = 0.0000$), indicating that all the regression coefficients in each equation are significantly different from zero. Thus, the chosen explanatory variables can be said to be relevant in explaining the model, and the model is of good fit. Additionally, the likelihood ratio test of the null hypothesis of the independence of the climate change adaptation strategies ($\rho_{ij} = 0$) is significant at 1%

($\chi^2(15) = 38.5883$; P > 0.0007). Consequently, the null hypothesis, that all of the ρ (Rho) values were jointly equal to 0, is rejected. This suggests that the model fits the data well and that the decisions made regarding the various adaptation strategies were interdependent. These findings support the use of the MVP model rather than the estimation of independent univariate probit models.

Table 3: MVP Model Results of the Effect of Financial Inclusion Indicators on Smallholder Farmers Choice of Climate Change Adaptation Strategy

Variables	Crop rotation		Organic Manure		Soil and water conservation techniques		Mixed cropping		Planting pest and diseases resistant crop varieties		Planting drought and heat-resistant crop varieties	
	Coef.	Std. error	Coef.	Std. error	Coef.	Std. error	Coef.	Std. error	Coef.	Std. error	Coef.	Std. error
Age	0.0061	0.0252	**0.0717*****	0.0248	**0.0734****	0.0318	**-0.1015*****	0.0283	0.0150	0.0243	-0.0209	0.0270
Gender	-0.2224	0.3140	**-0.5224***	0.3086	-0.3598	0.3787	-0.0417	0.3323	0.1072	0.2876	**0.9950*****	0.3356
Marital status	0.2352	0.3674	-0.3079	0.3643	**-1.0176****	0.5166	**-0.8018****	0.3930	0.1131	0.3435	**-0.6939***	0.3866
Education	0.0424	0.0271	-0.0055	0.0287	-0.0166	0.0458	**0.0618***	0.0348	0.0172	0.0266	**0.1067*****	0.0289
household size	0.0780	0.0901	0.1029	0.0934	0.1425	0.1484	**0.2619****	0.1020	**0.1727***	0.0911	-0.0692	0.1024
Total land area cultivated	0.6383	0.5596	**-0.8763***	0.5189	-1.0089	0.6529	0.3957	0.5366	-0.1788	0.5677	0.1506	0.6298
Farming experience	-0.0108	0.0169	0.0020	0.0173	-0.0013	0.0239	0.0082	0.0173	-0.0025	0.0164	**0.0747*****	0.0205
Extension visits	**0.6196****	0.2554	-0.1687	0.2497	**1.2930*****	0.3219	-0.1194	0.2553	**0.5995****	0.2472	0.0468	0.2724
Total income	1.16e-06	3.84e-06	4.34e-06	3.80e-06	**2.01e-05 *****	7.19e-06	6.76e-06	4.50e-06	8.70e-07	3.66e-06	5.28e-06	4.70e-06
Access to credit	**0.6420*****	0.2402	**0.4885****	0.2335	**0.4872***	0.2944	**0.4750***	0.2492	-0.2887	0.2365	0.3013	0.2695
Ownership of bank account	-0.2941	0.2340	**0.4118***	0.2305	-0.2361	0.3381	**0.4469***	0.2411	0.1300	0.220 0	-0.1030	0.2558
Save money in the bank	0.0060	0.2330	0.2091	0.2304	0.2570	0.2963	0.1213	0.2373	-0.0267	0.2281	0.0439	0.2553
Intercept	-1.6203	1.0746	-3.3111	1.0981	-3.9810	1.4115	3.6997	1.2003	-1.9493	1.0384	-1.7609	1.1140
Rho2	**-0.2388***											
Rho3	**0.4241*****		**0.4856*****									
Rho4	-0.1603		-0.0866		**-0.4449*****							
Rho5	-0.1055		**0.2281***		-0.1350		-0.0640					
Rho6	-0.0702		-0.1897		0.0230		0.0730		-0.1269			
Predicted probability	0.6331		0.5862		0.8314		0.7160		0.5118		0.6331	
Joint probability (Success)	0.0964											
Joint probability (Failure)	0.0025											
Number of Observations	168											
Log Likelihood	-494.0247											
Wald $\chi^2(72)$	178.83											
Likelihood ratio test of $\rho(\text{Rho})_{ij} = 0$ i.e. (Rho 21 = Rho31 = Rho41 = Rho51 = Rho61 = Rho32 = Rho42 = Rho52 = Rho62 = Rho43 = Rho53 = Rho63 = Rho54 = Rho64 = Rho65 = 0), $\chi^2(15) = 38.5883$, Prob > $\chi^2 = 0.0007$												

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

Source: Field Survey, 2021

The model results suggested that there was a positive and significant interdependence between household decisions to adopt the use of crop rotation and soil and water conservation techniques, the use of organic manure and soil and water conservation techniques, as well as the use of organic manure and planting of pest and disease resistant crop varieties, demonstrating complementarity among these adaptation strategies. The results further suggested that there was a negative and significant interdependence between household decisions to adopt the use of crop rotation and organic manure as well as the usage of soil and water conservation techniques and mixed cropping, demonstrating that these adaptation strategies can substitute for each other. Furthermore, the result of the MVP model shows that the probability of households adopting the use of crop rotation, organic manure, soil and water conservation techniques, mixed cropping, and planning of pest and disease, as well as heat and drought-resistant adaptation strategies, were 63.31%, 58.62%, 83.14%, 71.6%, 51.18% and 63.31%, respectively. The joint probabilities of success or failure of adoption of the six adaptation measures suggest that smallholder farm households are more likely to jointly adopt the six adaptation strategies. The likelihood of the smallholder farm households using all the adaptation strategies was 9.64%, while the joint probability of failure to adopt all the adaptation strategies was only 0.25%.

All the hypothesised variables fitted into the MVP model significantly influence the likelihood of adopting at least one of the adaptation strategies except for "save money in the bank", which does not significantly affect the likelihood of choosing any of the identified adaptation strategies to climate change. Thus, the choice of measures for adapting to climate change in the study area is influenced by both socioeconomic characteristics and financial inclusion indicators. The age of the household head positively influences the choices of "organic manure" and "soil and water conservation techniques" but has a negative relationship with the adoption of "mixed cropping" as a measure for adapting to climate change. This implies that older farmers are more likely to adopt "organic manure" and "soil and water conservation techniques" adaptation strategies, and the younger farmers, in contrast, are more likely to choose "mixed cropping" as a climate change adaptation strategy in the study area. This finding agrees with the results of Nhemachena, Hassan, and Chakwizira (2014), that age positively influences the increased usage of water conservation techniques as well as that of Ojo and Baiyegunhi (2020), who obtained a negative relationship between the age of the household head and the decision to choose mixed cropping adaptation strategy. The adoption of organic manure by older farm households could be associated with its application safety as against using chemical fertilizers with a higher health risk. On the contrary, Ogunnaike et al. (2021) found that age has a significant and positive effect on the probability of not taking up any strategy to mitigate climate change.

The gender of the household head influenced the smallholder farmers' choice likelihood of “organic manure” and "drought and heat resistant crop varieties" adaptation strategies, with the effect being negative and positive, respectively. This implies that male-headed households have a higher probability of adopting drought and heat-resistant crop varieties to mitigate against the detrimental effects of climate change, while their female counterparts will more likely choose organic manure as an adaptation measure to climate change. This result corroborates the findings of a previous study conducted in the Ogbomoso Agricultural Zone of Oyo state (Ajao & Ogunniyi, 2011), which indicates that male-headed households are more likely to adopt drought-tolerant crop varieties to cope with the changing climate. Marital status has a significant and negative effect on the smallholder farmers' probability of adopting “soil and water conservation techniques”, mixed cropping and "planting drought and heat resistant crop varieties" adaptation strategies to climate change in the study area. This result implies that the probability of taking up these climate change adaptation strategies is lower among married smallholder farmers household heads than their unmarried counterparts, which contradicts Ogunnaike et al. (2021) findings of increased likelihood of adopting new crop variety and other coping strategies among the married smallholder farmers in some selected states in Nigeria.

The coefficient of education had a significant and positive effect on the probability of adopting climate change adaptation strategies of mixed cropping and planting drought and heat-resistant crop varieties in the study area. This implies that better-educated households are more likely to utilise these measures to respond to climate change. It is believed that households with a higher level of education can easily access, interpret, understand, and analyze information about climate change's consequences on productivity and the benefit of adopting measures to reduce its impact relative to the illiterate/less educated farm households (Sani et al., 2016). Evidence from previous studies (Arun & Yeo, 2020; Sani et al., 2016) has equally indicated a positive relationship between the education level of the household head and the adoption of adaptation strategies to climate change.

Household size had a significant and positive influence on the probability of taking up “mixed cropping” and “planting pest and diseases resistant crop varieties” as adaptation strategies to climate change. It can be deduced from this result that the larger the family, the greater the likelihood of the smallholder farmers implementing these adaptation measures to offset the harmful effects of climate change. This finding could be linked to the fact that households with a larger family size can provide surplus family labour (Gautam & Andersen, 2016) who can participate actively in agricultural activities and facilitate the adoption of climate change adaptation measures (Uddin *et al*., 2014), which are usually tasking. Similar studies (Ogunnaike et al., 2021; Ojo & Baiyegunhi, 2020) have also obtained a positive relationship between household size and the likelihood of adopting climate change adaptation strategies.

In conformity with Uddin *et al*. (2014), the total land area cultivated had a negative and significant influence on the likelihood of adoption of "organic manure" as a climate change adaptation measure, which implies that farmers that cultivate a larger farm size are less likely to adopt this adaptation strategy to climate change. This could be attributed to the fact that the adoption of climate change adaptation measures is tasking and capital-intensive. Thus, large farms will require greater levels of investment to implement adaptive strategies to climate change compared to small farms (Uddin et al., 2014). This can be further supported by the findings of Acquah (2011) that a negative relationship exists between farm size and willingness to pay for climate change mitigation policy.

The probability of adopting "planting drought and heat-resistant crop varieties" was influenced by the coefficient of farm experience, with the relationship being positive. This implies that an increase in the years of experience in farming increases the probability of farmers responding to climate change through the usage of this adaptation strategy. This is in contrast with the study of Ojo and Baiyegunhi (2020), who found that more experienced farmers in southwest Nigeria are less likely to choose varying planting and harvesting dates as a climate change adaptation strategy. Extension visits have a significant and positive effect on the likelihood of adopting crop rotation, soil and water conservation techniques and planting of pest and diseases resistant crop varieties as climate change adaptation measures in the study area. This positive relationship is expected as farmers who have regular extension visits tend to have access to firsthand information on adaptation strategies to climate change effects that are locally appropriate. This result is in tandem with the findings of Ojo and Baiyegunhi (2020), who found a positive relationship between access to extension services and the adoption of planting of improved crop varieties. In line with the results obtained by Ogunnaike *et al.* (2021), total income has a significant and positive effect on the probability of choosing soil and water conservation techniques as a strategy to mitigate climate change effect.

Access to credit had a positive and significant influence on the likelihood of adopting crop rotation, organic manure, soil and water conservation techniques and mixed cropping as climate change adaptation strategies in the study area. Adoption of climate change adaptation strategies is capital intensive and thus requires borrowed capital to complement their capital. Access to credit provides farmers the luxury of adopting different types of methods to mitigate the effect of climate shocks on their farms to enhance their productivity as well. Previous studies have equally reported a positive association between credit access and the adoption of climate change adaptation strategies (Arun & Yeo, 2020; Ojo & Baiyegunhi, 2020). Ownership of bank accounts had a significant positive effect on the likelihood of adopting organic manure and mixed cropping as adaptation strategies to mitigate climate change. The ownership of a bank account is a critical factor that determines access to and usage of many other financial services. Thus, farmers who own a bank account are expected to have a higher likelihood of having access to credit and other financial benefits, which will increase their likelihood of adopting climate change adaptation strategies, which are usually capital intensive, to raise productivity and incomes.

CONCLUSION

Using a multivariate probit (MVP) model, the study investigated the influence of socioeconomic characteristics of smallholder arable crop farmers and financial inclusion metrics on the adoption of climate change adaptation strategies in Oyo state, Nigeria. The rejection of the null hypothesis of no interdependence among the various adaption measures justified the adoption of the MVP model for the investigation. The strategies most frequently adopted by the smallholder farmers in the study area to adapt to the changing climate are soil and water conservation techniques, mixed cropping and planting of drought and heat-resistant crop varieties. The study found that age, gender, marital status, education, household size, total land area cultivated, farming experience, extension visits, total income, access to credit and ownership of a bank account had significant and mixed effects on the likelihood of adopting various climate change adaptation strategies in the study area. The result calls for the attention of relevant stakeholders to facilitate the availability and accessibility of credit to smallholder farmers. This will ensure that they have the financial capacity to adopt appropriate adaptation measures needed to cushion the adverse effects of climate change on their farms. Farmers should be educated on the significance of owning a bank account. Additionally, the government, decision-makers, and financial institutions should collaborate to develop and move small-holder farmers to a more suitable financial inclusion service.

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