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FACTORS INFLUENCING ADAPTATION TO CLIMATE CHANGE AMONG SMALLHOLDER FARMING COMMUNITIES IN NIGERIA

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ABSTRACT

The determinants of adaptation strategies to climate change by farmers in sub-Saharan Africa have generated considerable development interest. From a policy perspective, it is important to document the experiences of farming communities in adapting to climate change, in order to determine suitable adaptation options for the future. The objective of this study was to analyse adaptation and coping strategies to climate change, and ascertain the factors influencing adaptation by farmers in Osun State, Nigeria. A multi-stage random sampling technique was used to select 180 households; while descriptive statistics and multinomial logit (MNL) were used to analyse the household data collected. The results show that the most widely used adaptation and coping strategies included diversifying household income sources, sharing planting materials and land in case of crisis, adjusting tasks within the households, listening to weather forecasts on radio, television and reading newspapers; and use of agro-chemical inputs and irrigation schemes. Factors influencing farmers' choice of adaptation methods included household size, access to credit and to extension agents, monthly farm income and access to climate change information. Consequently, to strengthen adaptive capacity of farmers to climate change, relevant agencies should liberalise access to credit, deepen scope of extension services and improve access to climate change information.

Key Words: Adoption, coping strategies, credit, radio

RÉSUMÉ

Les déterminants des stratégies d'adaptation aux changements climatiques par les paysans en Afrique sub-saharienne ont généré de considérable intérêt de développement. D'un point de vue perspectif politique, il est important de documenter les expériences des communautés paysannes dans l'adaptation au changement du climat en vue de déterminer les stratégies d'adaptations appropriées pour le futur. L'objectif de cette étude était d'analyser les stratégies d'adaptation et de survie face aux changements climatiques, et de déterminer les facteurs qui influencent l'adaptation des paysans dans l'Etat de Osun, Nigéria. Une technique d'échantillonnage aléatoire multi-étage a été utilisée pour sélectionner

180 ménages ; et des statistiques descriptives et le logit multinomial (MML) ont été utilisées pour analyser les données collectées auprès des ménages. Les résultats ont montré que les stratégies d'adaptation et de mitigation les plus utilisées comprennent la diversification des sources de revenus des ménages, le partage des matériels de plantation et des terres en cas de crises, ajustement des tâches à l'intérieur des ménages, être à l'écoute des informations sur le climat, sur les chaines de radio, télévision et en lisant les journaux ; et usage des intrants agro-chimiques et des systèmes d'irrigation. Les facteurs influençant le choix des méthodes d'adaptions par les paysans comprennent la taille du ménage, l'accès aux crédits et aux agents de vulgarisation, le revenu mensuel et l'accès à l'information sur les changements climatiques. En conséquence, pour renforcer la capacité adaptative des paysans aux changements climatiques, des agences importantes doivent libérer l'accès aux crédits, approfondir la portée des services de vulgarisation et améliorer l'accès à l'information sur les changements climatiques.

Mots Clés: Adoption, strategies de mitigation, credit, radio

INTRODUCTION

The concern about the impact of climate change on sub-Saharan African agriculture stems from its potential to undermine the local economy and livelihoods in farming communities heavily dependent on crop production for food and incomes. The seasonality of most agricultural activities and limited use of inputs in Africa, make it especially vulnerable to weather or climate-related challenges across the various stages of the production cycle (Odekunle, 2004; Adejuwon, 2006). Recent predictions suggest that extreme climatic conditions would intensify as a result of greenhouse emissions and associated global warming (IPCC, 2012). This manifests in climate-induced shocks such as floods, severe droughts and tropical storms which dampens yields, reduces incomes, worsens malnutrition and exacerbates food insecurity (Brown *et al.*, 2012).

Sub-saharan Africa suffers disproportionately from climate change due to its huge dependence on rain-fed agriculture and inadequate adaptive capacities for anticipating these events and attenuating their impacts (Nelson *et al.*, 2014; Adimassu and Kessler, 2016). According to IPCC 4thAfrican Assessment Report,75 to 250 million inhabitants of sub-Saharan Africa would face heightened water stress by 2020 and crop yields from rain-fed agriculture will decline by up to 50%, unless deliberate efforts are made to adapt to climate change (Boko *et. al.*, 2007). Indeed, evidence has shown that scorching temperature, erratic rainfall, incessant flooding and prolonged drought diminishes soil quality/ moisture and crop resilience, erodes productivity and hurts food production (IISD, 2007; Apata *et al.,* 2010; Ozor and Nnaji, 2011; Orebiyi *et al.,* 2014).

Clearly, adapting to climate change at the farm-level, by modifying current practices is a crucial coping strategy. The prevailing response strategies often draw on existing mechanisms such as altering farming systems or modifying farm technology and diversifying income sources (Taruvinga *et al.,* 2016). The array of adaptation techniques implemented in agriculture in sub-Saharan Africa to deal with the vicissitudes of climate includes intercropping or crop rotation, adoption of high yielding improved crop varieties resistant to climatic stress or more tolerant of parched conditions, varying of time of planting and diversifying into mixed crop livestock systems or off-farm occupations. Other strategies include use of soil and water conservation methods, irrigation schemes, ridges across slopes, no tillage and restoring soil fertility using agrochemicals or organic fortification; modulating the proportional use of capital and labour and planting of trees to protect the soil

(Bradshaw *et al*., 2004; Kurukulasuriya and Mendelsohn, 2006; Maddison, 2006; Nhemachena and Hassan, 2007, Obayelu *et al*., 2014, Olutegbe, 2016).

The choice of adaptation options is shaped by the socio-ecological context, infrastructure and institutional factors (Ravera *et al*., 2016). Specifically, adaptation is influenced among others by age, gender, household size, education, farm size, farming experience, farm income, access to credit and extension services, irrigation and distance to market and off-farm employment (Deressa *et al*., 2009; Oluwatusin, 2014; Taruvinga *et al*., 2016).

It is important to recognise and appreciate the adaptation responses of local communities to climate change, and the attendant challenges in order to proactively address them towards charting suitable adaptation paths for the future. This study provides empirical evidence on choice of adaptation strategies by farming households in Osun State, Nigeria. The study also improves on the corpus of research on this subject in sub-saharan African by harnessing perspectives on farmers' 'reactive coping strategies' to climate change (Ravera *et al*., 2016). Specifically, the objective of this study was to determine factors influencing adaptation strategies to climate change by farmers in Osun State in Nigeria.

MATERIALS AND METHODS

Study area. This study was executed in Osun State, which is an inland state located in the tropical rain forest zone of south-western Nigeria (latitude 7° 302 03 N and longitude 4° 302 03 E). The State's population is put at 3,423,535 by the 2006 National Population Census (Federal Republic of Nigeria, 2010). The economy of the state is agriculture-based, which is practiced at both subsistence and commercial levels.

Sampling procedure. A multi-stage sampling procedure was employed for this study. The first stage involved purposive selection of Osun State, which is located in Southwestern Nigeria with rainfall patterns that are conditioned by the position of the inter-tropical discontinuity movements (Ayanlade *et al*., 2017). Besides, there is a preponderance of farming activities in the State as a result of its location in the tropical rainforest ecological (and humid climate) zone of Nigeria. From the Agricultural Development Programme (ADP) zones in the State located at Ife/Ijesha, Iwo and Osogbo, Ife/Ijesha zone was purposively selected because of recent episodes of delayed rainy season and subsequent flooding from excessive downpour coupled with low soil fertility, which affected crop production in the zone. These climate factors constitute the greatest risk to rain-fed agriculture in this zone as crop failures are largely a consequence of heightened temperature or irregular rainfall and occasional dry spells or drought. Simple random sampling technique was used to select 20% of the 10 extension blocks in the zone. The selected extension blocks, Oriade and Obokun, have six cells each, 20% of which were selected. From the list of farming households in the selected cells, 20% farming households were randomly selected, making a sample size of 180, broken down into 100 and 80 for Oriade and Obokun, respectively.

Data collection and analysis. Primary data were collected using a structured questionnaire, supplemented with in-depth oral interviews for non-lettered farmers. The questionnaire elicited information on household and farm characteristics, adaptation and coping strategies to climate change and factors influencing choice of adaptation methods. Significantly, the study considered adaptation or 'proactive strategies' as well as 'reactive coping mechanisms' in the aftermath of climate change. According to Ravera *et al*. (2016), 'proactive strategies' are actions taken to mitigate expected climate change; while 'reactive coping mechanisms' are actions meant to manage their impacts when they occur (Morton 2007; Ravera *et al*., 2011).

Descriptive and inferential analyses were subsequently performed on the data, the former involving construction of frequency distribution tables; and the latter entailing the estimation of a multinomial logit model.

The analytical anchor for farmers' choice of adaptation options is the utility or profit maximisation function (Yong, 2014). The presumption is that farmers would settle for adaptation strategy *j,* if they perceived the benefit as greater than that of other strategies (say, *k*):

$$U_{ij}\left(\beta'_{j}X_{i}+\varepsilon_{j}\right) > U_{ik}\left(\left(\beta'_{j}X_{i}+\varepsilon_{k}\right)k \neq j\right.$$
.... Equation 1

The farmer *i* derives utility U_{ij} and U_{ik} from adaptation options *j* and *k,* respectively; X_i is a vector of explanatory variables that determine choice of adaptation options; β_j and β_k are parameters to be estimated; and ε_j and ε_k are the error terms.

On the assumption that the farmer chooses options that produces, net benefits, and discards those that does not, the net benefit variable is defined as:

$Yij = 1$ if $Uij > 0$ and $Yij = 0$ if $Uij < 0$

The dependent variable is dichotomous and takes the value 1 when the farmer chooses an adaptation option and 0 otherwise.

The probability that farmer *i* will choose adaptation measure *j* among the set of adaptation measures is assumed to follow a logistic distribution:

$$P_{ij} = prob(Y = 1) = \frac{e^{x_i'\beta_i}}{1+\sum_{k=1}^{j} e^{x_i'\beta_i}}\ , \ ,j = 1,2,\dots \dots j$$
.... Equation 2

Where:

β is a vector of parameters, *x* denotes the set of explanatory variables that influence the choice of adaptation strategies, *j* denotes adaptation strategies.

The marginal effects of the explanatory variables are generated by differentiating Equation 2 with respect to each explanatory variable given as:

$$\frac{\partial P_j}{\partial x_k} = P_j\left(\beta_{jk} - \sum_{j=1}^{j-1} P_j\beta_{jk}\right) \text{,,,, Equation 3}$$

The multinomial logit model parameters were generated using maximum likelihood procedures.

RESULTS AND DISCUSSION

Table 1 presents the characteristics of the respondents of this study. The majority of them were male (83.7%); while only 16.3% were female. The respondents were spread across the various age categories, with 23.32% in the 31-40 age group and 28.3% in the 41-50 age group, indicating considerable presence of farmers in the active population category. With age, the farmer develops considerable farming experience and social links; and amasses financial means which enhance adoption of climate change adaptation strategies (Taruvinga *et al*., 2016). However, older farmers may be risk averse and fearful of embracing adaptation measures (Yong, 2014). Most (79.71%) of the respondents were married; 13.09% were single and 6.2% were widowed. A larger proportion (73.32%) of the respondents had household size of 6-10 persons, signifying the availability of labour within the households that could be channelled to farm work or for diversifying into non-farming activities (Mano and Nhemachena. 2006), but could also constrain farmers from expending resources on climate change adaptation strategies as they strive to cater for their large households' needs (Anyoha, *et. al*., 2013)

TABLE 1. Household and farm characteristics of the respondents

Variable	Category	Percentage
Sex	Male	83.7
	Female	16.3
Age (years)	21-30	18.21
	31-40	23.32
	41-50	28.3
	51-60	17.85
	Above 60	12.32
Marital status	Single	13.09
	Married	79.71
	Widowed	7.2
Household size	1-5	18.32
	6-10	73.32
	11-15	8.36
Education	No formal	59.19
	Primary	19.36
	Secondary	18.81
	Tertiary	2.64
Farming experience	1-10	28.66
	11-20	46.64
	21-30	12.38
	Above 30	12.32
Farm size (ha)	1-5	73.49
	5.01-9	23.32
	Above 9	3.19
Access to extension serv.	Access	34
	No access	66
Access to credit	Access	13.32
	No access	86.68
Average monthly income	<N20,000(US$ 65.36)	30.42
	N20,000(US$ 65.36) –N50,000(US$163.40)	42.62
	N50,000(US$163.40) –100,000 (US$326.80)	16.54
	>N100,000 (US$326.80)	10.42

A majority of the respondents were underprivileged in term of education, with majority (59.2%) having no formal education. Formal education imparts farmers with intellectual capabilities for rationally appraising the benefits and costs of the various adaptation strategies (Allison *et al.* (2009). A great proportion (46.6%) of them had considerable (11-20 years) farming experience; while 28.7% had 1-10 years, experience. Considerable farming experience enhances farmers' understanding of climate patterns, exposes them to a menu of adaptation strategies and improves their capacity to combine and modify strategies across the adaptation portfolio (Nhemachena and Hassan, 2007). Most (73.

5%) of the respondents managed farm sizes ranging from 1 to 5 hectares, indicating a preponderance of smallholder farmers. Large farm sizes provide farmers with space to execute more adaptation strategies. Majority (66%) of the respondents had no access to extension services/agents; while 86.7% had no access to credit. Contact with extension agents may facilitate farmers' awareness and anticipation of climate change tides and the available adaptation options for dealing with them (Hassan and Nhemachena, 2008); while credit access empowers farmers to implement a suite of adaptation strategies. About 43% earned average monthly income of N20, 000 (US$ 65.36) to N50,000 (US$163.40); while 16.5% earn N50, 000 (US$163.40) –100,000 (US$326.80). Higher incomes and greater assets enable the adoption of climate change adaptation strategies (Semenza *et al.,* 2008)

Table 2 presents climate change adaptation and coping strategies utilised by the farmers in Osun State in Nigeria. The most widely used adaptation strategies included diversifying household income sources ($\bar{x}$ = 3.93), listening to weather forecasts on radio, TV and newspapers ($\bar{x}$ = 3.66), use of agro-chemical inputs and irrigation schemes ($\bar{x}$ = 3.54) and renting of land and outmigration to earn additional income ($\bar{x}$ = 3.11). Diversification of household income mitigates the impact of climate change-induced crop failures on the household, but erodes the time and effort expended on the farm including that devoted to implementing adaptation measures. By assiduously following weather forecasts, the farmers can reasonably predict climate changes and adapt more effectively. Irrigation

TABLE 2. Climate change adaptation strategies used by respondents in Osun State, Nigeria

S/N	Adaptation strategies	Mean	Standard deviation
1	Diversifying household income sources	3.93	1.26
2	Intercropping and crop rotation	3.84	1.31
3	Listening to weather forecasts on radio, TV and newspapers	3.66	1.42
4	Use of agrochemical inputs and irrigation schemes	3.54	1.46
5	Renting of land and outmigration to earn additional income	3.11	1.39
6	Changing planting location	2.78	1.65
7	Introduction of high yield improved varieties	2.56	1.5
8	Forecasting climatic events using natural elements (such as wings of ants, birds, moon)	2.27	1.35
9	Implementing soil and water conservation strategies	2.27	1.46
10	Planting short cycle crop species	2.26	1.43
11	Maintaining soil fertility through organic supplementation	2.24	1.46
S/N	Reactive coping strategies		
1	Sharing planting materials and land in case of crisis	3.88	1.54
2	Adjusting tasks within households	3.76	1.26
3	Modifying food habits to cope with food crisis	3.45	1.47
4	Adopting traditional crop varieties with nutritional properties	3.13	1.52
5	Taking common decisions on land use and management	2.91	1.48
6	Seed and subsidized food exchange in case of crisis	2.29	1.42
7	Orienting food preparation to achieve self sufficiency	2.16	1.34

schemes may be expensive for individual farmers to undertake and often require intervention of local, State or national authorities; while agrochemicals have dangerous side effects on crop outputs and human health if wrongly applied. The renting out of land denies the farmer of potential output from the cultivation of arable land; while outmigration to earn addition income results in man hour losses on the farm. The most widely used 'reactive coping strategies' were sharing planting materials and land in case of crisis ($\bar{x}$ = 3.88), adjusting task within the households ($\bar{x}$ = 3.74) and modifying food habits to cope with food crisis ($\bar{x}$ = 3. 45). Traditional communal systems facilitate pooling of resources among farmers, sharing of tasks among households, and altering of food preferences in response to adverse climate change effects The least used adaptation strategies included planting short cycle crop species ($\bar{x}$ = 2.26) and maintaining soil fertility through organic supplementation ($\bar{x}$ = 2.24); while orienting food preparation to achieve self-sufficiency ($\bar{x}$ = 2.16) was the least reactive coping strategy. Exposure and access to short cycle crop species among farmers in the communities was limited; while burning of crop residues and post-harvest grazing of farmlands by livestock to restore organic soil fertility were rare practices among the farmers due to easy accessibility of chemical fertilisers.

The interplay of sociocultural practices (e.g. resource sharing and pooling, social networking and knowledge exchanges); ecosystem-based strategies (e.g. intercropping and organic fertility augmentation); and technological strategies (e.g. use of agrochemical and irrigation systems) helps to improve wealth creation and foster overall development.

Table 3 presents results of the multinomial logit regression of determinants of the choice of climate change adaptation strategies by the respondents. For ease of analysis, the adaptation methods investigated were limited to diversification of income sources, use of improved resistant crop varieties, agroforestry (simultaneous cultivation of food crops and forests), tree planting (afforestation), mixed farming and intercropping. The likelihood ratio of the model χ^2 = 294.77 was significant (P<0.0001), indicating strong explanatory power and implying that the socioeconomic and other characteristics of the farmers had significant influence on their climate change adaptation options. In general, the variables had their intuitive signs. The determinants were also ranked based on the magnitude of the significant coefficients and average rank across the adaptation strategies were determined.

The age of the farmer-household head had a positive and significant relationship with likelihood of choosing the various adaptation strategies (Table 3) This suggests that as farmers age, they apply the accompanying wisdom and sagacity in evaluating existing adaptation options, implying that older farmers had a higher probability of adapting to climate change. Deressa *et al.* (2009) and Davis and Ali (2014) also found positive associations between age of household heads and their adoption of climate change adaptation strategies in the Nile Basin of Ethiopia and rural Bangladesh, respectively. Similarly, Ozor *et al.* (2012) found positive relationship between age and adaptation methods in southern Nigeria. By contrast, Obayelu *et al*. (2014) reported a negative relationship between age and a range of adaptation strategies, meaning that older farmers are less adaptive to climate change. One intuitive explanation for this finding is that aged farmers are laidback or deeply entrenched in old practices and, therefore, apathetic to change.

Sex had a negative and significant relationship with the likelihood of choosing adaptation to climate change strategies (Table 3). Specifically, female farmers had higher probability of making adaptation choices than

TABLE 3. Multinomial Logit regression showing determinants of climate change adaptation strategies used by farmers in Osun State, Nigeria

	Diversification of livelihood			Use of disease resistant crop varieties			Agroforestry			Mixed farming			Intercropping			Planting of trees		
	Coefficient	Rank	Wald	Coefficient	Rank	Wald	Coefficient	Rank	Wald	Coefficient	Rank	Wald	Coefficient	Rank	Wald	Coefficient	Rank	Wald
Age	19.5***	5	20.1	7.9***	7	20.1	39.2**	4	11.7	18.0***	4	1.7	1.3***	5	22.8	18.1***	2	24.6
Sex	-17.5***	6	15.0	-10.4***	8	25.6	-4.9**	8	7.6	-20.9***	9	17.7	-8.2***	7	22.0	-8.0***	8	24.3
Education	21.7***	2	19.1	10.5***	4	12.3	3.5**	9	6.7	43.3***	1	14.4	4.0***	6	17.2	14.8***	6	16.7
Farming experience	39.5***	-	21.4	7.3***	8	27.2	24.0***	6	18.4	13.8***	7	21.7	5.8***	4	19.8	12.4***	7	16.4
Farm size	10.1***	5	20.8	-62.2***	9	31.4	101.7**	1	9.8	21.1**	3	13.2	-9.6***	8	25.3	-24.7***	9	22.4
Household size	21.3**	3	10.4	17.1***	2	22.5	39.4**	3	7.1	15.8***	6	21.7	7.3***	3	29.1	21.3***	1	14.6
Access to credit	21.1	-	1.4	22.5***	1	29.4	32.8***	5	11.1	17.8**	5	9.9	36.3***	1	33.3	15.3**	4	12.9
Access to climate change information	3.9	-	1.7	17.1***	2	16.6	17.7***	7	32.2	3.5	-	1.4	17.2	-	1.7	23.1	-	2.6
Monthly farm income	24.3***	1	4.3	8.9***	5	4.3	12.5**	8	14.3	8.9***	8	47.4	10.6***	2	1.9	16.5***	3	14.3
Access to extension agents	20.9***	4	33.9	8.8***	6	26.3	52.0**	2	13.0	21.7***	2	25.9	4.2***	5	28.4	15.1***	5	35.8
intercept	-38.6		0.1	65.4		0.8	0.2		28.4	52.2		0.1	18.4		0.6	-48.4		1.3

LR $\chi^2(8) = 294.77$; Prob > $chi^2 = 0.001$; Pseudo $R^2 = 0.650$; Log likelihood = -19.844; *** = significant at 1%; ** = significant at 5%, * = significant at 10%

The Wald test is used in relation to logistic regression models to test the null hypothesis that a set of parameters is equal to zero in order to determine the significance of predictor variables. It is computed by dividing the value of the coefficients by their standard errors male farmers. This result is consistent with those of Nhemachena and Hassan (2007), who investigated farmers' adaptation to climate change in Southern Africa, and Ndambiri (2008) who looked at impact of small scale irrigation technologies on crop production in Niger State, Nigeria. Again, the negative relationship contradicts Obayelu *et al.* (2014), who found a positive relationship on the sex variable suggesting that males were more inclined to climate change adaptation strategies. Similarly, Oyekale and Oladele (2012) opined that men had higher probability of diversifying their crops and income sources to cope with climate change compared to women.

The years of education had a positive and significant relationship with the probability of adopting the right adaptation strategies (Table 3), a result that is robust to all the strategies. This finding is intuitive as education and learning equip farmers with basic intelligence to appraise the various options and make informed innovation choices. Maddison (2006) and Tasie and Ojimba (2016) corroborate this finding for the Maritime, Plateau and Savannah Regions of Togo and Emohua Local Government Area of Rivers State, Nigeria, respectively.

Farming experience had a positive and significant relationship with the probability of adopting climate change adaptation measures (Table 3). Years of experience in farming exposed farmers to knowledge of adaptation options. Experienced farmers are likely to be savvy enough to reduce losses through the use of adaptation strategies (Onubuogu and Esiobu, 2014). Maddison (2006) and Ayanlade *et al.* (2017) found significant connections between farming experience and farmers adaptation strategies. In contrast, Olutegbe and Fadairo (2016) found no such significant relationship, suggesting that farmers adoption of adaptation methods is determined by prevailing realities or exigencies rather than years of farming experience.

Farm size had a negative and significant association with the probability of opting for intercropping, planting of trees and use of disease resistant varieties as adaptation measures to climate change, but exhibits positive relationship with other strategies (Table 3). Indeed, intercropping is often practiced on small parcels of land to support aggregate yield per unit of input. Planting of trees and disease resistant varieties can also be implemented on small farms, while large farms are generally conducive to mixed farming, agroforestry and diversified livelihoods. Deressa *et al*. (2008) and Olutegbe (2016) affirmed the negative relationship between farm size and adaptation measures; while Oluwatusin (2014) negated it. This mixed result is because implementation of climate change adaptation measures was plot specific, implying that the peculiar features of the farm site, such as soil quality and extent of degradation rather than its size, influenced adaptation choices.

Access to climate information was positively and significantly related with probability of using any of the adaptation options (Table 3) Indeed, access to information on climate change heightens farmers' awareness of the phenomenon and raises the likelihood that they would adapt (Groom, 2012). This finding is corroborated by Maddison (2006) and Asante *et al.* (2012), who concluded that such information reinforces perceptions about climate change and triggers the adoption of new technologies or adaptation strategies to deal with it.

Household size had a positive and significant relationship with the probability of using any of the adaptation techniques (Table 3). There is implicit correlation between large household size and availability of own-labour for use on the farm. This labour could be deployed to accomplish additional tasks associated with implementing adaptation strategies such as tree planting, mixed and inter-cropping. Anyoha (2013) and Taruvinga *et al*. (2016) validated the significance of household size to the choice of climate change strategies through more labour availability. Access to climate change information has positive and significant

TABLE 4. Ranking of determinants of climate change adaptation strategies used by farmers in Osun State, Nigeria

Variable	Average rank	Position
Age	5.3	6th
Sex	6.3	9th
Education	5.7	8th
Farming experience	5.6	7th
Farm size	6.3	9th
Household size	2.8	1st
Access to credit	2.8	1st
Access to climate change information	4.5	4th
Monthly farm income	4.5	4th
Access to extension agents	4.0	3rd

association with adaptation methods such as diversification of livelihood and use of disease resistant crop varieties.

Monthly farm income related positively and significantly with the likelihood of choosing the various adaptation strategies (Table 3). Farmers who earned more income from their farming activities presumably had more resources in the form of backup savings to invest on adaptation infrastructure. This result is reinforced by Ayanlade *et al.* (2017) and Zizinga *et al.* (2017).

Access to credit was also positively related to the probability of adopting the range of adaptation approaches (Table 3). The existence of reliable credit lines that farmers could activate had empowering effect on the probability of choosing climate change adaptation methods. As adaptation invariably involves committing financial resources to purchase of seeds or trees or to installing some technology; inadequate funds constrains even the consideration of options, except where there are available and accessible credit windows (Gbetibouo, 2009; Taruvinga *et al.*, 2016).

Access to extension services had significant positive relationship with the likelihood of making particular adaptation choices (Table 4). The hands-on knowledge exchanges with extension agents including those exposing the dangers of climate change and the merits of alternative adaptation paths, underpins the choices made by the farmers (Leeuwis and Hall, 2013; Phillipo, 2015).

The ranking of significant determinants of adaptation strategies by size of coefficient shows that access to credit and household size ranked joint 1st and access to extension agents ranked 3rd. Access to climate change information and monthly farm income ranked joint 4th, while age of household head and farming experience ranked 6th and 7th, respectively.

CONCLUSION

The factors influencing farmers' choice of adaptation methods among selected farming communities in Osun State of Nigeria includes household size, access to credit, access to extension agents, monthly farm income and access to climate change information. Consequently, to strengthen adaptive capacity of farmers to climate change, relevant agencies should liberalise access to credit, deepen scope of extension services and improve access to climate change information.

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