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Factors influencing the perception and choice of adaptation measures to climate change among farmers in Nigeria. Evidence from farm households in Southwest Nigeria

Abstract

There is widespread interest on the impacts of climate change on agriculture in Sub-Saharan Africa (SSA), and on the most effective investments to assist farmers strengthen factors influencing their choice of adaptation measures. This study uses the Heckman probit model to analyze the two-step process of adaptation measures to climate change, which initially assesses a farmer's perception that climate is changing and followed by an examination of the response to this perception in the form of adaptation. Simple purposive random sampling was used to select two states out of six states. Random sampling was used to select Ondo and Oyo States, while communities that are prone to climate change were purposively selected. The study administered questionnaire and held Focus Group Discussions to elicit information, where 350 valid responses were used for further analysis. The dependent variables are adaptations measures adopted by farmers, where the independent variables are those natural, socio-economic, institutional and physical factors influencing the choice of these measures. The analysis indicate that 53.4% of the investigated farmers have observed increasing temperature over the past 10 years whereas 58% have observed that they noticed decreasing rainfall over the past 10 years. Findings from the FGDs conform to secondary data gathered. This analysis show that 64.57% of farmers have adopted one or more of the major adaptation options identified through the research survey. Education of the head of household, livestock ownership and extension for crop and livestock production, availability of credit and temperature are factors influencing choice of adaptation.

Keywords: adaptation, perception, climate change, Southwest Nigeria.
JEL Classification: Q12, Q54.

Introduction

Studies have shown that economies of most Sub-Saharan Africa (SSA) countries are extremely dependent on agricultural production (Apata et al., 2011a; Alvaro et al., 2009; Burke et al., 2009; ANAP, 2006). These studies revealed that about 17% of GDP was derived from agriculture in SSA in the years of 2005-2008. Given the central role of agriculture and the unprecedented changes in climate anticipated by various studies over the next few decades in the region there is a need to examine possible ways and methods farmers in these areas cope with the vagaries of climate change. Climate change affects agriculture and agriculture also affects climate change. Agriculture affects climate change through the emission of greenhouse gases (GHG) from different farming practices (Edwards-Jones et al., 2009; Byravan & Chella, 2009). Climate change in the form of higher temperature, reduced rainfall and increased rainfall variability reduces crop yield and threatens food security in low-income and agriculture-based economies like Nigeria. Adverse climate change impacts are considered to be particularly strong in countries located in tropical Africa that depend on agriculture as their main source of livelihood (Apata et al., 2011, 2011b; Badigger, 2010; IAC, 2004; Dixon, Gulliver & Gibbon, 2001; IPCC, 2001).

It was evidenced that climate change will have a strong impact on Nigeria-particularly in the areas of agriculture; land use, energy, biodiversity, health and water resources. Nigeria, like all the countries of Sub-Saharan Africa, is highly vulnerable to the impacts of Climate Change (Apata, 2011, Obioha, 2008; IPCC, 2007; NEST, 2004). It was also, noted that Nigeria specifically ought to be concerned by climate change because of the country's high vulnerability due to its long (800km) coastline that is prone to sea-level rise and the risk of fierce storms (Apata et al., 2011b; Apata, 2006; Adejuwon, 2004; FGN, 1997). In addition, almost 2/3 of Nigeria's land cover is prone to drought and desertification (ANAP, 2005). Its water resources are under threat which will affect energy sources (like the Kainji and Shiroro dam). Moreover, due to rain-fed agriculture that are practiced by these farmers, and fishing activities from which 2/3 of the Nigerian population depend primarily on for food and livelihood are also under serious threat. Also, the high population pressures of 140 million people surviving on the physical environment through various activities within an area of 923,000 square kilometers calls for attention (Oluwatayo et al., 2008; IPCC, 2007; NEST, 2004).

Data obtained from the Nigeria Meteorological Services (NMS, 2007) and extracts from CBN (2008) Statistical Bulletin indicated that the average minimum and maximum temperatures have been increasing by about 0.25°C and 0.15°C respectively over the past decade. In addition, rainfall has been characterized by a very high level of variability over the past 30 years (CBN, 2008). Although models predicting future precipitation from past studies provide conflicting results – reporting both increasing and decreasing precipitation – but there is agreement by these studies that temperatures will continue to increase in Nigeria over the coming years (Oluwatayo, 2011, Ayinde et al., 2010; Alvaro et al., 2009; Dabi et al., 2007). Moreover, studies show that the frequency and spatial coverage of drought have increased over the past few decades (Ayinde et al., 2010; Obioha, 2008; Dabi et al., 2007; Lautze et al., 2003); and this phenomenon is expected to continue in the future. From the foregoing it is evidenced that climate change is expected to influence crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems in Nigeria. However, the nature of these biophysical effects and the human responses to them are complex and uncertain.

Several studies have indicated farmers do perceive that climate is changing and have developed coping strategies to adapt or reduce the negative impacts of climate change on their farming operations (Deresaa & Rashid, 2010; Mertz et al., 2009; David et al., 2007). Some attempts have been made to analyze factors influencing the choice of adaptation measures to climate change and how farmers adapt to climate change in Africa (Apata, 2011; Hassan and Nhemachena, 2008; Deressa and Hassan, 2009; Admassie and Adenew, 2007; Deressa et al., 2009). The studies of Deressa and Hassan (2009) and Apata et al. (2011b) employed the Ricardian approach to estimate the monetary impact of climate change on agriculture. Even though the applied Ricardian approach includes adaptation, it does not explicitly address factors influencing the choice of adaptation and what adaptation methods they employ. Studies that have examined factors influencing the choice of adaptation measures to climate change and adaptation strategies in Africa, although informative, did not address the extent to which different socio-economic and environmental factors affect perceptions of climate change and adaptation (Akter & Bennet, 2009; Niggol & Mendelsohn, 2008 and Agrawala & Frankhauler, 2008). Others that have analyzed the factors affecting the choice of adaptation methods failed to explicitly explain how farmers perceive climate change and adapt to it (like Deressa et al. (2009) for Ethiopia and Apata et al. (2009) for Nigeria). This is the research gap that this study will like to address.

Furthermore, past studies have argued that adaptation to climate change is a two-step process, which initially requires the perception that climate is changing and then respond to changes through adaptation (Wang et al., 2009; Aggrawal, 2009). Fussel (2007) argues that emphasis should focus on adaptation because human activities have already influenced vagaries in climate fluctuation. This study has benefitted from the work of Maddison (2006) and Deressa et al. (2009) that addressed this two-step process of adaptation at the regional level for Africa. Their methodology helped to develop the model adapted for this study. Consequently, the objective of this study is to identify factors influencing the choice of adaptation measures to climate change and quantify the extent to which these identified factors influence perceptions and adaptation to climate change in Southwest Nigeria.

1. Conceptual framework

The conceptual framework of this study is that agricultural technology adoption, climate change adaptation methods and other related models involve decisions on whether to adopt or not. Previous studies have observed that agricultural technology adoption models are based on farmers' utility or profit maximizing behaviors (Norris and Batie, 1987; Pryanishnikov and Katarina, 2003). Probit and logit models are the most commonly used models in agricultural technology adoption research (Hausman & Wise, 1978; Wu and Babcock, 1998). Binary probit or logit models are employed when the number of choices available is two (whether to adopt or not). Extensions of these models, most often referred to as multivariate models are employed when the number of choices available is more than two. The most commonly cited multivariate choice models in unordered choices are multinomial logit (MNL) and multinomial probit (MNP) models. Multivariate choice models have advantages over their counterparts of binomial logit and probit models in two aspects (Wu and Babcock, 1998). First, they allow exploring both factors conditioning specific choices or combination of choices and second, they take care of self-selection and interactions between alternatives.

These models have also been employed in climate change studies because of conceptual similarities with agricultural technology adoption studies. For example, Nhemachena and Hassan (2007) employed the multivariate probit model to analyze factors influencing the choice of climate change adaptation options in Southern Africa. Kurukulasuriya and Mendelsohn (2006) employed the multinomial logit model to see if crop choice by farmers is climate sensitive. Similarly Seo and Mendelsohn (2006) used the multinomial logit model to analyze how livestock species choice is climate sensitive. Additionally Deressa et al. (2009) adopted the multinomial logit model to analyze factors that affect the choice of adaptation methods in the Nile basin of Ethiopia. These studies revealed that the decision processes of farmers to adopt a new technology require more than one step. In other words models with the two-step regressions are hence, employed to correct for the selection bias generated during the decision-making processes. For instance, William and Stan (2003) employed the Heckman two-step procedure to analyze the factors affecting the awareness and adoption of new agricultural technologies in the United States. In the William and Stan (2003) study, the first stage is the analysis of factors affecting the awareness of new agricultural technologies and the second stage is the adoption of the new technologies. Similarly, Yirga (2007) and Kaliba et al. (2000) employed Heckman's selection model to analyze the two-step processes of agricultural technology adoption and the intensity of agricultural input use. Deressa et al. (2009) employed the Heckman probit model to analyze the two-step process of adaptation to climate change, which initially assesses a farmer's perception that climate is changing, followed by an examination of the response to this perception in the form of adaptation. This study therefore use the conceptual constructs of the reviewed of past studies above to analyze the perception and factors influencing the choice of adaptation measures to climate change among farmers in Southwest Nigeria using Heckman's two-step regressions procedure.

2. Methodology

2.1. Description of the area of study. Southwest Nigeria is one of the six major political zones in Nigeria. This zone has six states in it. They are Lagos, Oyo, Ogun, Ondo, Osun and Ekiti States. This area is known for its arable food crop production (NPC, 2006). The local farmers are experiencing climate change even though they have not considered its deeper implications. This is evidenced in the late arrival of rain, the drying-up of stream and small rivers that usually flows year-round, the seasonal shifting of the "Mango rains" and of the fruiting period in the Southern part of Oyo State (Ogbomosho), and the gradual disappearance of flood-recession cropping in riverine areas of Ondo state are among the effects of climate disturbances in some communities of Southwestern Nigeria (BNRCC, 2008).

2.2. Data source and sampling procedure. The study used cross-sectional household survey data of 400 mixed crop and livestock farmers collected during the 2008-2009 production year in southwest of Nigeria. The study administered questionnaire and held Focus Group Discussions to elicit information. Both structured questionnaire and interviews were held with indigent and local government officials and all other stakeholders on climate change knowledge and adaptation. The study decomposes various measures of climate change adaptation. In addition, the study also uses Focus Group Discussions (FGDs) to find out the level of understanding of climate change from the farmers, also communities perception of the vagaries in weather conditions as well coping strategies adopted to survive'.

Simple purposive random sampling was used to select respondents used for this study. Random sampling was used to select Ondo and Oyo States out of six states in the Southwest zone, while communities that are prone to climate change were purposively selected (BNRCC, 2008; and Apata, 2006). The communities selected are, Ayetoro and Mahintedo in Ondo State and Fiditi and Ogbomosho in Oyo State respectively. One hundred farmers were randomly selected from each community identified above, making a total of 400 farming households interviewed, but only 360 data were useful for further analysis. Temperature and rainfall data were obtained from monthly/annually meteorological weather related data that were collected from the Nigerian Meteorological station/Unit and Central Bank of Nigeria (CBN) annual reports. In addition to collecting data on different socio-economic and environmental attributes, the survey also included information on farmers' perceptions of climate change and adaptation methods. Farmers were specifically asked to respond to questions on patterns of change in temperature and rainfall over the past 20 years. The study uses Heckman probit regression model to examine the characteristics that best explain variation in the measures of attitudes of the indigent perception and adaptation level to climate change and also factors that influences such decisions.

3. Empirical model and variables

3.1. Empirical model. Adaptation to climate change is a two-stage process involving perception and adaptation stages. The first stage is whether the respondent perceive that there is climate change or not, and the second stage is whether the respondent adapt to climate change depending on the first stage that he/she has perceived climate change. Because the second stage of adaptation is a sub-sample of the first stage, it is likely that our second stage sub-sample is non-random and different from those who did not perceive climate change creating sample selection bias. This study, therefore, used the well known maximum likelihood Heckman's two-step procedure (Heckman, 1976) to correct for this selectivity bias. Heckman's sample selection model assumes that there exists an underlying relationship which consists of. The latent equation is given by:

$yj^* = j\beta + \mu_1 j.$ (1)

Such that we observe only the binary outcome given by the probit model as:

$yj^{\ probit} = (yj^* > 0).$ (2)

The dependent variable is observed only if the observation *j* is presented in the selection equation:

$yj^{\ select} = (Zj\delta + \mu_2 j > 0),$

$\mu_1 \sim N(0, 1),$

$\mu_2 \sim N(0, 1)\ corr\ (\mu_1, \mu_2) = \rho,$ (3)

where, *x* is a *k*-vector of explanatory variables which include different factors hypothesized to affect adaptation and *z* is an *m* vector of explanatory variables which include different factors hypothesized to affect perception; u_1 and u_2 are error terms. The first stage of the Heckman's sample selection model is the perceptions of changes in climate and this is the selection model (equation (3)). The second stage, which is the outcome model (equation (1)), is whether the farmer adapts to climate change, depending on the first stage that she/he perceives a change in climate.

Literature revealed that the use of standard probit model techniques on equation (1) may produce biased results. To address this biased results Heckman probit model are mostly used. Thus, the Heckman probit provides consistent, asymptotically efficient estimates for all parameters in such models (Van de Ven and Van Praag, 1981). Hence, the Heckman probit selection model was used to analyze the perception and adaptation to climate change by farming households in the South-western part of Nigeria.

3.2. Dependent and explanatory variables for the selection and outcome equations. The dependent variable for the outcome equation is whether a farmer has adapted or not to climate change. The key concern of this issue is to discuss the factors influencing the choice of adaptation measures if the farmers have adapted. This means that the dependent variables are the adaptations measures adopted by farmers such as intercropping, mulching, zero tillage, ridges, etc. The independent variables are those natural, socio-economic, institutional and physical factors influencing the choice of these measures. The explanatory variables are chosen based on previous studies, climate change adaptation literature and data availability. These variables include: education of the head of the household, household size, gender of the head of the household, non-farm income, livestock ownership, extension for crop and livestock production, access to credit, farm size, distance to input and output markets, temperature rainfall and precipitation. A detailed description of the theoretical relationships between these variables and adaptation to climate change is included in Apata et al. (2009), Deressa et al. (2009), Hassan and Nhemachena (2007), Nhemachena (2009) and Apata et al. (2011b). Tables 1 and 2 provide a description of the model variables for the Heckman probit selection model.

Table 1. Description of model variables for the selection equation of the Heckman probit selection model

Dependent variable		
Description	Farmers that have perceived change (%)	Farmers that haven't perceived change (%)
Perception of climate change (takes the value of one if adapted and zero otherwise)	89	11
Independent variables		
Description	Mean	Standard deviation
Size of household (continuous)	5.8	1.7
Gender (takes the value of 1 if male and 0 otherwise)	0.72	0.32
Education of household head in years (continuous)	2.3	1.8
Farm income in Nigerian currency (continuous)	13,500	7500
Non-farm income in Nigerian currency (continuous)	19,720.00	8,650.00
Ratio of number of consumers to number of labors in the farm household	2.5	1.8
Access to credit (takes the value of 1 if access and 0 otherwise)	0.43	0.61
Farming experience in years (continuous)	7.3	4.6
Age of household head in years (continuous)	51	21
Access to information on climate (takes the value of 1 if access and 0 otherwise)	0.65	0.38
Farmer-to-farmer extension (takes the value of 1 if access and 0 otherwise)	0.82	0.25
Knowledge on local agro-ecology (takes the value of 1 if knowledgeable and 0 otherwise)	0.62	0.37
Access to adaptation measures (takes the value of 1 if access and 0 otherwise)	0.45	0.52

The dependent variable for the selection equation is whether a farmer has perceived climate change or not. The explanatory variables for the selection equation include different socio-demographic and environmental factors based on a literature review of factors affecting the awareness of farmers to climate change or risk perceptions as discussed in the previous section. It is hypothesized that the age and education of the head of the household, information on climate, farmer-to-farmer extension, and ratio of number of consumers to number of labors in a farm household, farm and non-farm incomes, and agro-ecological settings are variables influencing the awareness of farmers to climate change.

Table 2. Description of model variables for the outcome of the Heckman probit selection model

Dependent variable		
Description	Farmers that have adapted to change (%)	Farmers that haven't adapted to change (%)
Adaptation to climate change (takes the value of one if adapted and zero otherwise)	62	38
Independent variables		
Description	Mean	Standard deviation
Size of household (continuous)	5.8	1.7
Gender (takes the value of 1 if male and 0 otherwise)	0.72	0.32
Education of household head in years (continuous)	2.7	2.5
Farm size in acres (continuous)	5.0	3.2
Non-farm income in Nigerian naira (continuous)	23,000.00	12,500.00
Ratio of number of consumers to number of labors in the farm household	2.5	1.8
Access to credit (takes the value of 1 if access and 0 otherwise)	0.43	0.61
Farming experience in years (continuous)	7.3	4.6
Age of household head in years (continuous)	49	17
Livestock ownership (takes the value of 1 if owned and 0 otherwise)	0.35	0.61
Access to extension work (takes the value of 1 if access and 0 otherwise)	0.65	0.38
Distance to output market in kilometers (continuous)	3.3	2.7
Temperature in degree centigrade (continuous: annual average during the survey period)	17.5	6.6
Annual rainfall (continuous: annual average during the survey period)	85.00	49.8

The age of the head of the household represents experience in farming. Studies indicated that experienced farmers have a higher probability of perceiving climate change as they are exposed to past and present climatic conditions over the longer perspective of their life span (Maddison, 2006; Ishaya and Abaje, 2008, Deressa et al., 2009). Thus, we hypothesize that older and more experienced farmers have a higher likelihood of perceiving climate change. Education of the head of household, as discussed with the case of factors affecting adaptation in the outcome equation, is also hypothesized to positively affect awareness of climate change. Access to information on climate change through extension agents or other sources creates awareness and favorable condition for adoption of farming practices that are suitable under climate change (Maddison, 2006). Thus, it is hypothesized that farmers' contact with extension agents or any other sources, which might provide information on climate change, increase awareness of climate change. Higher income positively affects public perception of climate change (Semenza et al., 2008). By the same attestation, it is hypothesized that higher farm and non-farm incomes positively influence farmers' perception of climate change. In technology adoption studies, social capital plays a significant role (Isham, 2002) in information exchange, and hence, it is hypothesized that social capital is associated with the perception of climate change.

4. Results and discussion

Table 3 presents the results of farmers' perception of long-term temperature, rainfall and precipitation changes during Focus Group Discussions (FGDs). The analysis indicated that 53.4% of the investigated farmers observed increasing temperature over the past 10 years whereas 58% have observed that they noticed decreasing rainfall over the past 10 years. This result was from information gathered from the FGDs. FGDs were used to evaluate data gathered from secondary sources. For instance, FGDs revealed that majority of farmers perceived increasing temperatures over the past 10 years, this is in line with the information retrieved from Nigeria Meteorological Services. Likewise, farmers' perceptions of decreasing rainfall could be accredited to noticeable changes in their environment like drying of rivers (that usually flows all year round), delayed rainfall, drought. These observations by the people correspond with reports from weather stations that revealed high level of variability of rainfall distribution over the past 50 years (CBN, 2008).

Those farmers who asserted to have observed changes in climate over the past 10 years were afterwards asked how they have responded to the situation. The results of this analysis were presented in Table 4. Table 4 presented the farmers who claimed to have observed climate change and level of response. This analysis show that 226 farmers have adopted one or more of the major adaptation options identified through the research survey, such as planting trees, mixed farming, mixed cropping, soil conservation, use of different crop varieties, changing planting dates and irrigation (Table 4). This analysis revealed that mixed cropping (57.4%) is the most adaptation options used, follow by planting early or late (44.6%) due to variability in climate (Table 4). The survey analysis also showed that 35.4% of the farmers noticed climate change but failed to adapt to it. Respondents listed series of difficulty to adaptation, among which are lack of information on adaptation methods, no access to effective adaptation methods, lack of money or access to credit facilities, shortage of labor, shortage of land and poor capability for irrigation.

Table 3. Farmers' perception of long-term temperature, rainfall and precipitation changes (N = 350)

Climatic variables	Farmer's response (%)
Temperature increase	187 (53.4)
Temperature decrease	83 (23.7)
No change in temperature	42 (12.0)
Rainfall increase	30 (0.9)
Rainfall decrease	203 (58.0)
No change in rainfall	15 (0.4)
Precipitation increase	148 (42.3)
Precipitation decrease	113 (32.3)
No change in precipitation	35 (10.0)

Table 4. Adaptation options adapted by respondents from the areas of study

S/N	Adaptation options	Farmer's response (%)
	Yes to adaptation	226 (57.6)
1	Planting of trees	48 (13.7)
2	Mixed farming	104 (29.7)
3	Mixed cropping	201 (57.4)
4	Soil conservation	73 (20.9)
5	Intercropping	45 (12.9)
6	Mulching	80 (22.9)
7	Zero tillage	103 (29.4)
8	Making ridges	135 (38.6)
9	Irrigation	15 (04.3)
10	Early or late planting operations	156 (44.6)
11	No adaptation	124 (35.4)

4.1. Results and discussions of the Heckman probit regression model. In the running of the Heckman probit model, the model was first run and tested for its appropriateness over the standard probit model. The outcome of this operation revealed the presence of a sample selection problem (that is dependence of the error terms on the outcome and selection models) hence, justifying the use of the Heckman probit model with rho significantly different from zero (Wald = 10.84, with $P = 0.001$). Moreover, the likelihood function of the Heckman probit model was significant (Wald = 72.17, with $P < 0.0001$) showing a strong explanatory power of the model. Moreover, results show that most of the explanatory variables and their marginal values are statistically significant at 10% or less and the signs on most variables are as expected, except for a few as explained below (Table 5). The calculated marginal effects measure the expected changes in the probability of both perception of climate change and adaptation with respect to a unit change in an independent variable.

The results from the selection model indicated that age of the head of the household, farm income, information on climate change, farmer-to-farmer extension, ratio of number of consumers to number of labors in the farm household and agro-ecological settings are factors affecting the perception of climate change. However, findings revealed that most of the explanatory variables affected the probability of adaptation as expected, except farm size. Variables that positively and significantly influence adaptation to climate change include education of the head of the household, household size, gender of the head of the household being male, livestock ownership, extension for crop and livestock production, availability of credit, and temperature. On the other hand, farm size and annual average precipitation are negatively related.

The implications of this result is that higher likelihood of perceiving climate change with increasing age of the head of the household is associated with experience which lets farmers observe changes over time and compare such changes with current climatic conditions. Information on climate change through extension or other public sources, farmer-to-farmer extension and ratio of number of consumers to number of labors in the farm household increase the likelihood of climate change perception as they play an important role in the availability and flow of information.

Moreover, increasing household size increases the likelihood of adaptation. This finding is in line with the argument, which assumes that a large family size is normally associated with a higher labor endowment, which would enable a household to accomplish various agricultural tasks, especially during peak seasons (Croppenstedt et al., 2003). The fact that adaptation to climate change increases with increasing temperature agrees with the expectation that increasing temperature is damaging to African agriculture and farmers respond to this through the adoptionof different adaptation methods (Kurukulasuriya and Mendelsohn, 2006; Deressa et al., 2009 and Apata et al., 2011).

Independent variables that have demonstrated negative relationship to adaptation such as farm size could be attributed to the fact that adaptation is plot-specific as documented by Deressa et al. (2009). In other words it is not the size of the farm, but the specific characteristics of the farm that dictate the need for a specific adaptation method to climate change. Thus future research, which accounts for farm characteristics, could reveal more information about factors dictating adaptation to climate change at the farm versus the plot level. Moreover, the probable reason for the negative relationship between average annual precipitation and adaptation could be due to the fact that increasing precipitation does relax the constraints imposed by increasing temperature on crop growth. In addition, factors identified as affecting the perception of an adaptation to climate change in the study areas are directly related to the development of institutions and infrastructure.

Table 5. Results of the Heckman probit selection model

Explanatory variables	Selection model				Adaptation model			
	Regression		Marginal values		Regression		Marginal values	
	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
Size of household (HH)	0.053	0.029	0.017	0.038	0.025	0.291	0.005	0.275
Gender	0.473	0.012	0.154	0.010	0.026	0.011	0.003	0.002
Education of household head	0.064	0.019	0.021	0.018	0.057	0.023	0.034	0.013
Farm size	-0.139	0.013	-0.052	0.018				
Non-farm income	0.000258	0.125	0.000315	0.103	0.000128	0.139	0.00047	0.014
Ratio of number of consumer to number of labor in the farm (HH)	0.012	0.041	0.002	0.0028	0.075	0.072	0.005	0.014
Access to credit	1.015	0.072	0.005	0.014	1.032	0.002	0.039	0.052
Farming experience	0.019	0.0215	0.041	0.193	0.025	0.013	0.0038	0.005
Age of the household head	0.115	0.002	0.041	0.193	0.025	0.013	0.038	0.052
Livestock ownership					1.013	0.005	0.304	0.001
Access to extension					1.015	0.013	0.083	0.022
Access to information on climate	1.039	0.008	0.438	0.033				
Farmer-to-farmer extension	0.372	0.014	0.015	0.009				
Knowledge on local agro-ecology	1.082	0.000	0.038	0.004				
Access to adaptation measures	1.011	0.000	0.349	0.001				
Distance to output market					-0.053	0.315	-0.016	0.013
Temperature					0.078	0.000	0.055	0.022
Annual rainfall					-0.018	0.000	-0.003	0.000
Constant	-3.064	0.0000			-0.216	0.004		
Total observation	350							
Censored	164							
Uncensored	186							
Wald Chi square (zero slopes)	73.28 *P* =0.0001							
Wald Chi square (independent equations)	12.63 *P* = 0,001							

Conclusions

Due to low outputs from farms, farmers seem to be abandoning mono-cropping for mixed and mixed crop-livestock systems while considering risky, mono-cropping practicing under dry land. Farming experience and access to education were found to promote adaptation. This implies that education to improve awareness of potential benefits of adaptation is an important policy measure.

Focus Group Discussions revealed lack of effective access to information on climate change. Thus, there is need for effective and reliable access to information on changing climate to dissuade farmers mind from spiritual angle. In addition, empowerment (credit or grant facilities) is crucial in enhancing farmers' awareness. This is vital for adaptation decision making and planning. Combining access to extension and credit ensures that farmers have the information for decision making and the means to take up relevant adaptation measures.

Consequently future policy should focus on awareness creation on climate change through different sources, such as mass media and extension. Also, facilitating the availability of credit especially for adaptation technologies could improve level of adaptation measures. Moreover, encouraging informal social networks and importing adaptive technologies from other countries with similar socio-economic and environmental settings could enhance the adaptive capacity of Nigerian farmers.

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