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Factors influencing farmers' choices of adaptation to climate change in Ekiti State, Nigeria

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Abstract: Climate change poses a great threat to human security through erratic rainfall patterns and decreasing crop yields, contributing to increased hunger. The perceptions of the indigenous people about climate change and their responses to climate change have significant roles to play in addressing climate change. Therefore a critical study on farmers' choices of adaptation is critical for ensuring food security and poverty alleviation. A multi-stage random sampling technique was used to select 156 households in Ekiti state while descriptive statistics and multinomial logit (MNL) were used to analyze the data obtained from the households. The results showed that the most widely used adaptation method by the farmers were soil and water conservation technique measures (67 percent). The multinomial logit analysis revealed that the factors explaining farmer's choices of climate change adaptation include age of the farmers, gender of the household head, years of education, years of farming experience, household size, farmers information on climate change, farmers access to credit, farm income, non-farm income, livestock ownership and extension contact.

Keywords: farmers' choices, climate change, adaptation methods and rural Nigeria

Introduction

Africa is generally acknowledged to be the continent most vulnerable to climate change and West Africa is one of the most vulnerable to the vagaries of the climate following the scope of the impacts of climate variability over the last three or four decades (IPCC, 2007). Recent food crises in sub-Saharan Africa are reminders of the continuing vulnerability of the region to the vicissitudes of climatic conditions. This is in a large measure due to weak institutional capacity, limited engagement in environmental and adaptation issues, and a lack of validation of local knowledge

(SPORE, 2008; BNRCC, 2008). Consequently, there is the need to gain as much information as possible, and learn the positions of rural farmers and their needs, about their knowledge of climate change, in order to offer adaptation practices that meet these needs.

Nigeria, like all the countries of Sub-Saharan Africa, is highly vulnerable to the impacts of climate change (IPCC, 2007; NEST, 2004). The country specifically ought to be concerned by climate change because of the country's high vulnerability due to its long (800 km) coastline that is prone to sea-level rise and the risk of fierce storms. Climate change also has a strong impact on Nigeria, particularly in the areas of agriculture; land use, energy, biodiversity, health and water resources. In addition, almost two-third of Nigeria's land cover is prone to drought and desertification and its water resources are under threat which will affect energy sources (like the Kainji and Shiroro dam). Moreover, rain-fed agricultural practices and fishing activities from which two-third of the Nigeria population depend primarily on for foods and livelihoods are also under serious threat besides the high population pressures of 140 million people surviving on the physical environment through various activities within an area of 923,000 square kilometers (IPCC, 2007; NEST 2004).

With the increasing concerns about climate change, several studies have considered its potential impacts on agriculture (Campbell, 1999; Adejuwon, 2006; Mozny *et al.*, 2009). With respect to crop production, the most important aspect of the climate of West Africa is its seasonal character, which sets the basis for the farming calendar in most parts. Given that agriculture in most parts of West Africa is largely non-mechanized, weather and climate assumes significance in every phase including the timing of cultivation, planting and harvesting operations, variety selection and transplanting (Odekunle, 2004; Adejuwon, 2006). Climate change can be exacerbated by human induced actions such as the widespread use of land, the broad scale deforestation, the major technological and socio economic shifts with reduced reliance on organic fuel and the accelerated uptake of fossil fuels (Millennium Ecosystem Assessment, 2005). Rural farmers, whose livelihoods depend on the use of natural resources, are likely to bear the brunt of adverse impacts of climate change (Gbetibouo, 2009).

Climate change poses a great threat to human security through erratic rainfall patterns and decreasing crop yields, contributing to increased hunger. Further, adverse climate change impacts on natural systems and resources, infrastructure and labour productivity may lead to reduced economic growth exacerbating poverty (UNDP, 2000) reference not listed. New studies confirm that Africa is one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity. Some adaptation to current climate variability is taking place; however, this may be insufficient for future changes in climate (IPCC, 2007). Given the climate dependent nature of agriculture and the importance of other external factors such as technological development and changes in demand for food, farmers generally have been used to adapting to changing conditions. It is frequently assumed that if climate change is gradual, it may be a small factor that goes unnoticed by most farmers as they adjust to other change. One of the policy options for reducing the negative impact of climate change is adaptation (Adger *et al.,* 2003; Kurukulasuriya and Mendelsohn, 2006). The perspectives of the indigenous people, the way they think and behave in relation to climate changes as well as their values and aspirations, have a significant role to play in addressing climate change (Doss and Morris, 2001). Nevertheless, indigenous and other traditional farmer are only rarely considered in academic policy and public discourses on climate change, despite the fact that they are greatly impacted by impending changes of climate (Berkes and Jolly, 2001).

Indigenous groups are not only enthusiastic bystanders of climate changes but are also actively trying adapting to the changing conditions. In some instances, farmers can draw on already existing mechanism for coping with short-term adverse climatic condition. Some of these responses may be traditionally included in their normal subsistence activities, while others may be acute responses, used only in case of critical weather conditions (Scott and Kettleborough, 2002). Adaptation to climate change is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). It also refers to all adjustments in behaviour or economic structure that reduce the vulnerability of society to changes in the climate system including its current variability and extreme events as well as longer-term climate change (Smit *et al.*, 2000).

The goal of adaptation is neither the prevention of all negative impacts from variable and changing climate, nor merely clean-up after each climatic disturbance or disaster. Rather, the goal of adaptation is long-term resilience, to create the conditions in which society and managed ecosystems are largely able to absorb the impacts from climate variability and change, such that any residual impacts beyond their coping capacity remains within (socially defined) acceptable limits of risks. Adaptation to climate change necessitates that farmers first notice that the climate has changed, and then identify useful adaptations and implement them (Maddison, 2006). Common adaptation methods in agriculture include the use of new crop varieties and livestock, species that are more suited to drier conditions, irrigation, crop diversification, mixed crop livestock farming systems, change of planting dates, diversification from farm to non-farm activities, increased use of soil and water conservation techniques, changed use of capital and labour, and trees planted for shade and shelter (Bradshaw *et al.*, 2004; Kurukulasuriya and Mendelsohn, 2006; Maddison, 2006; Nhemachena and Hassan, 2007).

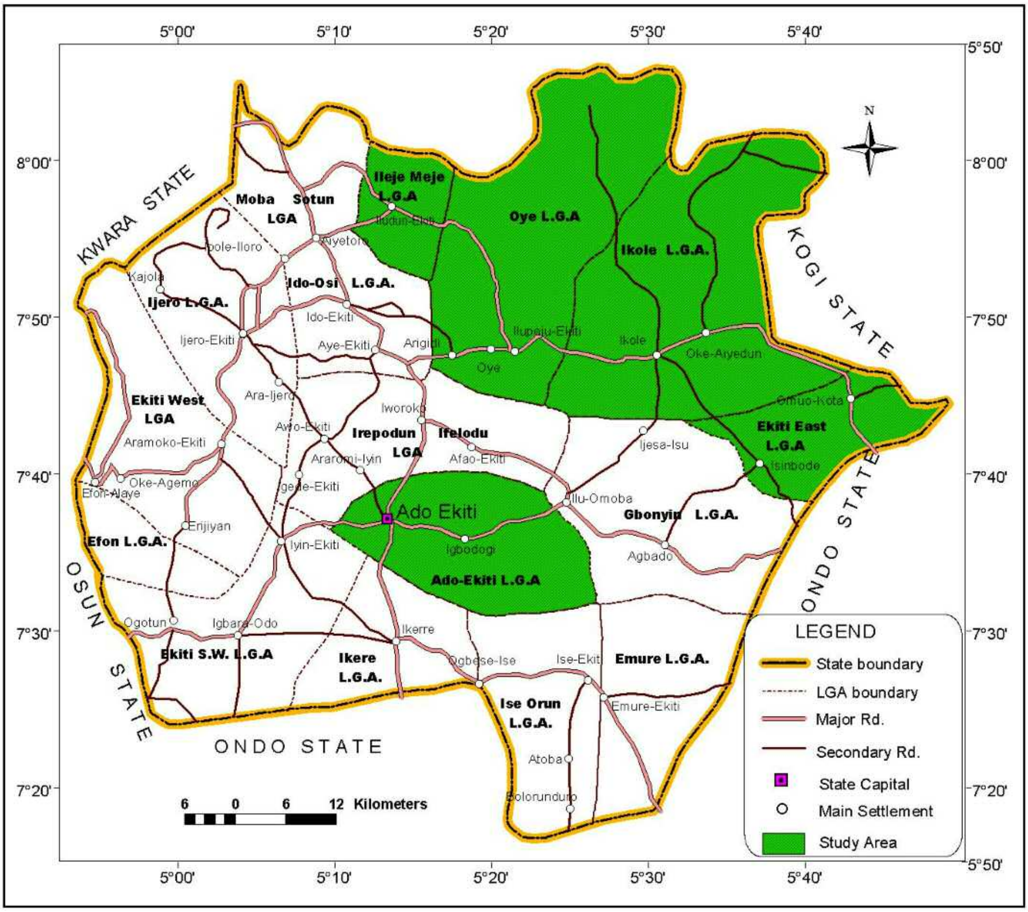
Previous studies on adaptation to climate change have identified its major determinants, including different household and farm characteristics, infrastructure, and institutional factors. The most commonly cited household characteristics include age, education, farming experience, marital status, gender of the head of household, and wealth. Farm characteristics include farm size and slopeand soil fertility; institutional factors include access to extension and credit while infrastructure includes poor potential for irrigation, distance to input and output markets (Norries and Batie, 1987; Asfaw and Admassie, 2004; Maddison, 2006;). Others include increased farm income, opportunities for off-farm employment, conducting research on use of new crop varieties and livestock species that are better suited to drier conditions, encouraging informal social networks, and investing in irrigation (Deressa *et al.*, 2008). Most of these factors can be linked to poverty. For instance, the lack of information on appropriate adaptation options could be attributed to the dearth of research on climate change and adaptation options. Lack of money may also hinder farmers from getting the necessary resources and technologies that could facilitate adaptation to climate change.

To approach the issue appropriately, the local communities' understanding of climate change must be taken into account. Accounting for these adaptations and adjustments is necessary in order to estimate climate change adaptation responses. The study therefore provides answers to the following research questions such as: How do farmers perceive climatic change? What are the different adaptation methods adopted by local farmers? And what factors influence farmers' choices of adaptation methods.

Methodology

Ekiti state is situated entirely within the tropics. It is located between longitudes 4051 and 50451 East of the Greenwich meridian and latitudes 70151 and 8051 North of the equator. Ekiti state enjoys tropical climate with two distinct seasons. These are the rainy season (April - October) and the dry season (November - March). Temperature ranges between 21˚C and 28°C with high humidity of over seventy-five percent. Tropical forests exist in the south, while the guinea savannah occupies the northern peripheries. The state is endowed with water sources including major rivers like Ero, Osun, Ose, Ogbese, Oni etc. The state is also dotted with rugged hills, among which are Ikere Ekiti Hills in the southern part, Efon,-Alaaye Hills in the western boundary and Ado Hills in the central part.

A multi-stage random sampling procedure was used in selecting the households surveyed in the study area. At the first stage, five Local Government Areas (LGAs) were randomly selected, these are Ikole Local Government Area, Ekiti East Local Government Area, Oye Local Government Area, Ado Local Government Area and Ilejemeje Local Government Area. The second stage involved the random selection of eight wards proportional to population size while the third stage was the random



selection of villages proportionate to the size of each ward. The final stage was the random selection of 156 households proportionate to the size of the selected villages. Table 1 presents the distribution of households surveyed by LGAs and Wards.

Table 1 - Distribution of Households surveyed by Ward and LGAs

Local Government Council	Ward(s) Selected	Villages Selected	Number of Households
Ikole	2	6	59
Ekiti-East	1	3	20
Oye	3	5	39
Ado	1	3	19
Ilejemeje	1	3	19

Descriptive statistics were used to assess the perception of farmers on climate change and the different adaptation methods adopted by them while the multinomial logit (MNL) was used to analyse the determinants of farmers’ choices of adaptation methods. The MNL allows the analysis of decisions across more than two classes, allowing the determination of choice probabilities for different categories (Wooldridge, 2002).

This study modeled climate change adaptation behavior of farmers using discrete dependent variables with multiple choices. Any adaptation option could fall under the general framework of utility and profit maximization (Gbetibouo, 2009). A rational farmer then seeks to maximize his profit over a specified time horizon, and must choose among a set of J adaptation options. The ith farmer would choose to use jth adaptation option if it has a greater perceived net benefit than the utility from other adaptation options (say, k) depicted as:

$$U_{ij}(\beta_j X_i + \varepsilon_j) > U_{ik}(\beta_k X_i + \varepsilon_k), k \neq j \qquad 1$$

Uij are the perceived utility by farmer i of adaptation options j and k, respectively; Xi is a vector of explanatory variables that influence the choice of the adaptation options; ’j and ’k are parameters to be estimated…; and j and c are the error terms.

More specifically, the assumption requires that the probability P, of using a certain adaptation method by a given farmer needs to be independent from the probability of choosing another adaptation method (that is, P_{ij}/P_{ik} is independent of the remaining probabilities). The basis of the assumption is the independent and homoscedastic disturbance terms of the basic model in equation (1). Implicitly, the multinomial logit model is expressed as:

$$P(y = j / x) = \exp(x\beta_j) / \left[1 + \sum_{k=1}^{J} (\exp x\beta_j) + \varepsilon, j = 1, ..., J \right] \qquad 2$$

For this study, the adaptation options or response probabilities were grouped into six. These are use of improved varieties, soil and water conservation technology, mixed farming, diversification to non-farm activities, adjustment of planting period and reduction in farm inputs. Unbiased and consistent parameter estimates of the MNL model in the equation requires the assumption of independence of irrelevant alternatives to hold. The explanatory variables for this study include: X1 = Gender (Dummy, 1= male, 0 if otherwise); X2 = Years of Education (Years); X3 = Age of Household head (Years); X4 = Household Size; X5 = Farm Income (Naira); X6 = Non-farm Income (Naira); X7 = Livestock Ownership (1 = Owns livestock, 0 if otherwise); X8 = Information on Climate Change (1 = Yes; 0 if otherwise); X9 = Number of times of contact with Extension agent (days per year); X10 = Access to credit (1 = Yes; 0 if otherwise); X11 = Years of farming experience (years).

Results and discussion

Results in Table 2 revealed that most of the farmers (89.7 percent) perceived the change in temperature to be irregular while very few perceived no change in temperature at all. Results also showed that a large percentage of the farmers (76.3 percent) had never had any extension contact (Table 3) suggesting that majority of these farmers might not be adequately informed about improved adaptation methods to climate change. Further, the distribution of the farmers by their years of farming experience (Table 4) showed that the highest proportion (40.4 percent) of the farmers had between 11 and 15 years of farming experience followed by farmers with over 15years (32.1 percent) of farming experience.

This suggests that a higher proportion of the farmers who had more than ten years of farming experience were likely to understand the effect of climate change and might be willing to adopt adaptive measures against climate change.

Table 2 - Distribution of Farmers by Perception of Temperature

Perception of climate	Frequency	Percentage
Stable	13	8.3
Low Temperature	1	0.6
Irregular	140	89.7
No Change	2	1.3
Total	156	100.0

Table 3 - Distribution of Farmers by Contact with Extension Agents

Contact with Extension agents	Frequency	Percentage
No contact	119	76.3
Had contact	37	23.7
Total	156	100.0

Table 4 - Distribution of Farmers by Years of Farming Experience

Years of Farming Experience	Frequency	Percentage
1 – 5	8	5.1
6 – 10	35	22.4
11 – 15	63	40.4
>15	50	32.1
Total	156	100.0

Table 5 - Distributions of Farmers by Adaptation Methods

ADAPTATION METHOD	FREQUENCY	PERCENTAGE
Water & soil conservation	67	42.9
Use of improved varieties	12	7.7
Mixed farming	16	10.3
Diversification to non-farm activities	13	8.3
Adjustment of planting period	32	20.5
Reduction in farm inputs	16	10.3
TOTAL	156	100.0

The distribution of farmers by their choices of adaptation methods presented in Table 5 revealed that a larger proportion (42.9 percent) of the farmers preferred soil and water conservation adaptation methods to climate change; followed by adjustment of planting period by 20.5 percent of the respondents. However, mixed farming (7.7 percent) and diversification to non-farm activities (8.3 percent) were the least preferred adaptation measures by the farmers. The soil and water conservation measures mainly adopted by the farmers shown in Table 6 include mulching (64.1 percent), while the least adopted conservation measures were sole planting of legumes (1.3 percent) and a combination of planting of legumes and mulching (1.3 percent).

Table 6 - Distribution of Farmers by Soil Conservation Measures Adopted

SOIL AND WATER CONSERVATION MEASURES	FREQUENCY	PERCENTAGE
Planting of cover crops	1	6.0
Planting legumes	2	1.3
Mulching	100	64.1
Planting canopy trees	4	2.6
Planting of over crops/mulching	11	7.1
Planting of legumes /mulching	5	3.2
Planting of legumes /canopy trees	2	1.3
Mulching/canopy trees	31	19.9
TOTAL	156	100.0

Determinants of farmers' choices of adaptation methods to climate change

Table 7 presents the determinants of farmers' choices of adaptation methods to climate change. The multinomial logit regression model was significant at one percent level indicating that all the independent variables jointly influenced the dependent variables. The gender of the household heads had a positive influence on the likelihood of diversifying to non-farm activities ($p<0.01$) and adjustment of planting period ($p<0.01$) implying that a male farmer had higher probability of diversifying to non-farm activities and adjusting their planting period relative to adopting soil and water conservation method. The male farmers were also more likely to adapt to climate change by adjusting their planting period than using soil and water conservation method. This is consistent with the findings of Tenge De Graffe and Heller (2004) in which being a female head of household had negative effects on the adoption of soil and water conservation measures, because women have limited access to information, land and other resources due to traditional social barriers.

The age of the farmers was negatively related to diversification to non-farm activities ($p <0.10$), use of improved varieties ($p <0.01$) mixed farming ($p <0.01$) and adjustment of planting period ($p <0.10$). Thus, increase in age of the farmers decreased the use of improved varieties, mixed farming, diversification to non-farm activities and adjustment of planting period relative to soil and water conservation techniques as adaptation measures to climate change In other words, farmers are more likely to use soil and water conservation technique than the use of improved varieties, mixed farming, diversification to non-farm activities and adjustment of planting period with increase in age. The years of farming experience of the farmers had a negative influence on diversification to non-farm activities ($p <0.05$) revealing that as farmers advance in years of farming experience, the adoption of soil and water conservation techniques is preferred to diversification to non-farm activities as an adaptation method to climate change. This is contrary to the findings of Kebede et al., (1990) which posited that a positive relationship exists between the number of years of experience in agriculture and the adoption of improved agricultural technologies in Ethiopia.

Evidence from various sources indicate that there is a positive relationship between the education level of the household head and adaptation to climate change (Maddison, 2006). This implies that farmers with higher levels of education are more likely to adapt better to climate change. The years of formal education of the farmers was positively related to both diversification to non-farm activities ($p <0.05$) and adjustment of planting period ($p <0.05$) relative to soil and water conservation adaptation techniques. The implication of this is that increasing the farmers' years of formal education would increase their likelihood of diversifying to non-farm activities and adjustment of planting period relative to the likelihood of using soil and water conservation measures.

Household size had a negative relationship with diversification to non-farm activities ($p <0.10$) and adjustment of planting periods ($p <0.05$). Thus, large family sizes could increase the use of cheap soil and water conservation measures and

Table 7 - Determinants of farmers' choices of adaptation methods to climate change (Multinomial Logit Model)

Variables	Use of improved varieties	Mixed farming	Diversification to non- farm activities	Adjustment of planting period	Reduction in farm inputs
Age	-25.600 (-10.16)***	-24.93(-7.10)***	-7.184 (-1.90)*	-30.164(-3.38)***	-1.489 (-0.71)
Gender	0.292 (0.28)	1.033 (1.16)	4.778 (3.20)***	4.63 (2.48)***	1.416 (1.04)
Years of education	0.407 (0.38)	-1.476 (-0.96)	3.232 (2.02)**	3.633 (2.03)**	-1.274 (-0.99)
Years of experience	-1.66 (-1.52)	-0.770 (-1.17)	-2.213 (-2.43)**	-1.135 (-1.32)	-0.675 (-0.74)
Number of household	0.362 (0.30)	-0.800 (-0.54)	-5.044 (-1.95)*	-1.633 (-2.54)**	0.215 (0.14)
Information on climate change	3.564 (2.16)**	1.668 (0.79)	4.935 (2.32)**	4.070 (2.09)**	2.430 (1.13)
Access to credit	1.671 (-1.13)	3.346 (1.34)	-8.599 (-1.87)*	-3.933 (-2.16)**	0.484 (0.28)
Farm income	-0.000 (-0.95)	8.850 (0.36)	(0.65)	-0.000 (-1.81)*	(0.82)
Non-farm income	(1.35)	(1.82)*	(0.74)	(0.70)	(0.72)
Livestock farming	1.819 (1.33)	0.814 (0.53)	-8.120 (-1.72)*	-1.047(-0.12)	1.774 (1.13)
Contact with extension agent	0.241 (0.20)	-0.532 (-0.39)	4.132 (1.17)	0.154 (5.36)***	-3.720 (-1.56)
Constant	24.692	22.045	0.525 (0.13)	20.466	-3.586 (-0.85)

Base category: soil and water conservation technique
LR chi^2 (55) = 101.01 Prob > chi^2 = 0.0002
Log likelihood = -52.472079 Pseudo R^2 = 0.4904

The values in parentheses are the z values:
* *Significance at 10 percent level*
** *Significance at 5 percent level*
*** *Significance at 1 percent level*

reduction in farmers' diversification to non-farm activities and adjustment of planting period. This is consistent with the findings of Apata *et al.*, (2008) that household size had a negative influence on adaptation to climate change among arable food crop farmers in South Western Nigeria. The study further showed that farmers that had more information on climate change, increased their use of improved varieties ($p<0.05$), diversified to non-farm activities ($p <0.05$) and adjusted their planting period ($p <0.05$) relative to the use of soil and water conservation measures. This is consistent with existing studies that access to information through extension services increases the likelihood of adapting to climate change (Maddison, 2006; Nhemachena and Hassan, 2007). Also, increased extension contact with extension agent increased the likelihood of adjustment to planting period and decreased the probability of the use of soil and water conservation measures.

Shiferaw and Holden (1998) stressed that wealth is believed to reflect past achievement of households and their ability to bear risks. Thus, households with higher income and greater assets are in a better position to adopt new farming technologies. Results showed that increase in farm income improved the use of water and soil conservation measures ($p <0.10$) while non-farm income increased the likelihood of mixed farming ($p<0.10$). Also, increase in number of livestock increased the farmers' preferences for the use of soil and water conservation measures but decreased their likelihood of diversification to non-farm activities ($p<0.10$). Farmers access to credit was positively related to diversification to non-farm activities ($p <0.10$) and adjustment of planting periods ($p <0.05$) respectively. Thus, access to credit negatively influenced diversification to non-farm activities and adjustment of planting period relative to their use of soil and water conservation measures. This is consistent with the findings of Caviglia-Harris (2000) that access to credit is an important variable which commonly has a positive effect on adaptation behaviour.

Conclusions and recommendation

This study showed that increase in farmers' access to credit decreases their diversification to non-farm activities, and improves their probability of using soil and water conservation measures. Thus, adequate access to credit in a form of loans should be provided for farmers by Government to enable them to overcome the major barrier of adaptation to climate change. Farmers with extension contact, preferred to adjust their planting period and reduced their likelihood of using of soil and water conservation measures. Thus, non-formal educational programmes should be encouraged, through extension services manned by competent and qualified extension agents to enlighten and sensitize farmers about the impact of climate change on agriculture, and also to train local farmers on how to efficiently utilize farm inputs like farm chemicals, the excessive use of which may aggravate effect of climate change on agricultural production.

Further, increase in farmers' non-farm income increased their probability of engaging in mixed farming and reduced their likelihood of adopting any of the soil and water conservation measures. Consequently, opportunities should be given to the farmers in realizing non-farm income, which will serve as an alternative source of income to them when there is a shock due to climate change.

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