Applied Tropical Agriculture

Adaptation Strategies to Climate Change by Farmers in Ekiti State, Nigeria

Ajayi, J.O.

Department of Agricultural and Resource Economics, Federal University of Technology, P.M.B 704 Akure, Nigeria.
josephomotosoajayi@yahoo.com

ABSTRACT

The threat to agriculture and food security, occasioned by climate change, has reached alarming stage. Farmers are constantly involved in adaptation strategies to ensure continuous production of crops and livestock. This study analysed adaptation strategies to climate change by farmers in Ekiti State, Nigeria. The study identified and described adaptation strategies used by the farmers and analysed the factors that determined them. Data were collected with aid of well-structured questionnaires and interview schedules administered on one hundred and twenty (120), randomly selected farmers in six (6) Local Government Areas of Ekiti State, Nigeria. The data were analysed using descriptive statistics and multinomial logit. The results revealed that six (6) major adaptation strategies were used by the farmers, with the independent variables of no adaptation, change in planting and harvest time, and planting cover crops and trees having better accuracy when compared to the null model. Furthermore, the result revealed that access to credit and ownership of livestock, as compared to the rest of independent variables had more significant impacts on adaptation while inadequate information remained the biggest constraint to adaptation to climate change. Based on the results, awareness and research into effective technology-based climate change adaptation strategies were recommended.

Key words: Adaptation strategies, climate change, Ekiti State, farmers, multinomial logit

INTRODUCTION

The climate has obvious and direct effects on agricultural production (ICTSD, 2010; Ajayi, 2014a). The effects of agriculture on Green House Gases (GHG) emissions are also large. Climate change is used to describe a change in the climate, measured in terms of its statistical properties, e.g. the global mean surface temperature (Baede, 2007). Thus, climate change is taken to mean the change in average weather condition of a place. Climate can change over a period of time ranging from months to thousands or millions of years. The classical time period is 30 years, as defined by the World Meteorological Organization (WMO, 2007). The change in the climate may be due to natural causes (e.g. changes in the sun's output), or due to human activities (e.g. change in the composition of the atmosphere (Albritton, 2001). Any human-induced change in climate will occur against the "background" of natural climatic variations (IPCC, 2007). The effects of the impacts of climate change may be physical, ecological, social or economic. Evidence of observed climate change includes the instrumental temperature record, rising sea levels, and decreased snow cover in the northern Hemisphere (IPCC, 2007).

In Nigeria, like in the rest of developing countries, agricultural production is weather-dependent (Sowunmi and Akintola, 2010). Climate variability and change have a direct, often adverse influence on the quantity and quality of agricultural production in Nigeria (Sowunmi and Akintola, 2010, Sofoluwe *et al*, 2011, Ajayi, 2014a). ICTSD (2010) further noted that, climate change exacerbates the already daunting challenges facing the agricultural sector, and this is particularly the case in developing countries. Innovations in agriculture have always been important and will be even more vital in the context of climate change. There is observed decline in crop yield and food crop production due to reduction in rainfall and relative humidity, and increase in temperature in Nigeria (Agbola and Ojeleye, 2007). Sofoluwe *et al*, (2011) observed that, the challenge of climate change and global warming is enormous in Nigeria due to widespread poverty, which is also true in many developing countries. Though climate change is a threat to agricultural, non-agricultural, and socio-economic development, agricultural and production activities are generally more vulnerable to climate change than other sectors (Ajetomobi and Abiodun, 2010). Thus in the long run, agriculture and agricultural practices will have to adapt to the changes in climate to ensure food security for human survival (Sofoluwe *et al*, 2011). Adaptation and mitigation potential is nowhere more pronounced than in developing countries where agricultural productivity remains low; poverty, vulnerability and food insecurity remain high; and the direct effects of climate change are expected to be especially harsh (ICTSD, 2010). Adaptation to climate change refers to adjustment in natural or human system in response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities (IPCC, 2001). The knowledge of adaptation strategies and factors determining their choice could enhance policy towards tackling the challenges climate change is imposing on Nigerian farmers (Sofoluwe *et al*, 2011). This study was conducted in response to the scare knowledge on adaptation strategies by farmers in Ekiti State and specifically to investigate farmers' primary adaptation strategies to climate change in Ekiti State and the constraints to climate change adaption strategies in Ekiti State.

METHODOLOGY

Description of the study area

The study was conducted in Ekiti State. Ekiti State is situated entirely within the tropics, with a total land area of about 5,887.890 km^2. The state has 16 Local Government Areas (LGAs), with the capital at Ado-Ekiti. It lies south of Kwara and Kogi State, East of Osun State and bounded by Ondo State in the East and in the South. Based on population census conducted by the National Population Commission, the population of Ekiti State has grown from 1,647,822 in 1991 to 1,750,000 in 1996 and 2,384,212 in 2006 (Ekiti State Government, 2013; NPC, 2007).

The State enjoys tropical climate with two distinct seasons: the rainy season (April-October) and the dry season (November- March) (Ekiti State Government, 2013). Ekiti State has a total annual rainfall of about 1400 mm with a low co-efficient variation of about 30% during the rainfall peak months, and with an average of about 112 rainy days per annum (Adebayo, 1993) Temperature ranges between 21°C and 28°C. Tropical rainforest exists in the south, while derived savannah occupies the northern peripheries of the state. The men are predominantly farmers while the women engage mainly in trading activities; for the educated indigenes who are employed in the formal sector, farming remains their secondary occupation (Oluwatayo, 2008). Ekiti State is important for this study since agriculture is the primary occupation of the citizens.

Sampling technique and data collection

A multistage sampling technique was used for this study. The first stage involved the purposive selection of six (6) Local Government Areas, which were purposively selected from the three senatorial districts (i.e. (two from each district) of Ekiti state. The following LGAs were selected: Ikere and Emure (Ekiti South Senatorial District); Ado and Ifelodun/Irepodun (Ekiti Central Senatorial District) and Ikole and Ido-Osi (Ekiti North Senatorial District). The second stage was the random sampling of ten (10) farmers from two (2) randomly selected villages in each LGA, thus resulting in total of one hundred and twenty (120) respondents for this study. Data were collected using a pre-tested, well-structured questionnaire on socio-economic characteristics of the respondents, adaptation strategies to climate change, constraints of adaptation and determinants of adaptation strategies.

Analytical techniques

Descriptive statistics (e.g. tables, pie chart, etc) was used to describe the socio-economic characteristics of the farmers, adaptation strategies to climate change and constraints of adaptation. Multinomial logit according to (Sofoluwe *et al*, 2011) was used to analyse the determinants of adaptation strategies to climate change. Mutinomial logit deals with truly nominal and mutually exclusive categories (Sofoluwe *et al*, 2011). Assuming that a dependent variable (Y) has m categories i.e. Y = 1, 2 …m with P_1, P_2…P_m as associated probabilities, such that $P_1+P_2+\ldots+P_m = 1$. The usual thing is to designate one of the variables as the reference categories. The probability of membership in other categories is then compared to the probability of membership in the reference category. Consequently, for a dependent variable (Y) with m categories, this requires the calculation of m-1 equations, one for each category relative to the reference category, to describe the relationship between the dependent (Y) and the independent variables. The choice of the reference category is arbitrary but should be theoretically motivated. The generalized form of probabilities for an outcome variable with m categories according to (Sofoluwe *et al*, 2011) was adapted for this study as follows (equations 1 – 8):

$$\Pr(Y_i = m \mid X_i) = p_{im} \frac{\exp(x_i' \beta_m)}{1 + \sum_{m=2}^{m} \exp(x_i' \beta_m)} \qquad \ldots\ldots (1)$$

For m > 1

$$\Pr(Y_i = 1 \mid X_i) = p_{i1} = \frac{1}{\sum_{m=2}^{M} \exp(X_i' \beta m)} \qquad \ldots\ldots (2)$$

(K+1)*(M-1)

$$\frac{P_{im}}{P_{i1}} = \frac{\eta_{im}}{\eta_{i1}} = \exp(X_i' \beta) \rightarrow \log \frac{P_{im}}{P_{i1}} = X_i' \beta_m \qquad \ldots\ldots (3)$$

$$\frac{\log(P_m \mid X_k = 1) \mid (P_1 \mid X_k = 1)}{(P_m \mid X_k = 1) \mid (P_1 \mid X_k = 0)} \qquad \ldots\ldots (4)$$

$$\frac{\log(P_m \mid X_k{}^0 = X_k{}^0 + 1)/(P_1 \mid X_k = X_k{}^0 + 1)}{(P_m \mid X_k = X_k{}^0)/(P_1 \mid X_k = X_k{}^0)} \qquad \ldots\ldots (5)$$

$$\Pr(Y_i = 1 \mid X_i) = p_{i1} = \frac{1}{1 + \exp(X_i' \beta_2) + \exp(X_i \beta_n)} = \frac{\eta_{i1}}{\eta_{i1} + \eta_{i2} + \eta_{i6}} \qquad \ldots\ldots (6)$$

$$\Pr(Y_i = 2 \mid X_i) = p_{i2} = \frac{\exp(X_i' \beta_m)}{1 + \exp(X_i' \beta_2) + \exp(X_i' \beta_n)} = \frac{\eta_{i2}}{\eta_{i1} + \eta_{i2} + \eta_{i6}} \qquad \ldots\ldots (7)$$

$$\Pr(Y_i = n \mid X_i) = p_{in} = \frac{\exp(X_i'\beta_n)}{1 + \exp(X_i'\beta_2) + \exp(X_i\beta_n)} = \frac{\eta_{i2}}{\eta_{i1} + \eta_{i2} + \eta_{i6}} \quad \ldots\ldots\ldots\ldots (8)$$

The multinomial logit model is built on the independence of irrelevant alternatives (IIAs) assumptions (Sofoluwe *et al*, 2011). The Hausman-McFadden is used for the tests of IIAs. The procedure is to first estimate the full model with m outcomes. Then, a restricted model is estimated by eliminating one or more m(s). The test of the difference between the two, which is asymptotically distributed as chi-square with degrees of freedom (Roco *et al*, 2014) equal to the rows in restricted model if IIA, is true. Significant $\chi 2$ values indicate violation of the assumption that the difference between the two models is not equal to zero (Sofoluwe *et al*, 2011).

Model specification

The model specification of the multinomial logit for the study is given thus:

$Y_i = f(X_1, X_2 \ldots\ldots X_5)$
X_1 = farm size
X_2 = non-farm income
X_3= livestock ownership
X_4= sex
X_5 = access to credit
Where Y_i= the dependent variable
X_1….. X_5= explanatory variables

Y_i is polychotomous and expresses the adaptation method to climate change by the farmers. X_1….. X_5 are the explanatory variables. The dependent variable (Y_i) is defined as 1 for no adaptation, 2 for mulching and soil conservation, 3 for planting of cover crops and trees, 4 for use of acclimated crop varieties, 5 for change in planting and harvest time while 6 is for irrigation following (Sofoluwe *et al*, 2011).

RESULTS AND DISCUSSION

Socioeconomic characteristics of the farmers

The result of the socio-economic characteristic of the farmers (Table 1) shows that farmers older than 60 years had the highest percentage among other age groups. With a mean age of 62 years, it implies that, farmers in Ekiti State are aging and youth involvement in agriculture is low. This age distribution here is similar to that in (Ajayi, 2014b). This has implications for climate change adaptation strategies. The older the farmers, the less likely they are to understand innovative adaptation strategies since they may not be too willing to bear risks initially associated with better farming techniques. Farming in the state is male-dominant as represented by higher percentage of male to female farmers. This agrees with (Oluwatayo, 2008), who found that men in Ekiti State are predominantly farmers. The study further reveled that farmers in the study area were educated. Education increases the ability of farmers to use their resources efficiently and the allocative effect of education enhances farmers' ability to obtain, analyse and interpret information (Sofoluwe *et al*, 2011). The study further reveled that more than half (53%) of the farmers had farm size greater than 2 hectares and most (65%) have been into farming for more than 15 years (Table 1). Ownership of large farm size and long years of experience in farming are indications of the importance of farming to the socio-economies of the study area.

Table 1: Socioeconomic characteristics of the farmers

Variable	Frequency	Percentage (%)	Cumulative Percentage
Age (years)			
≤20	4	3.33	3.33
21-30	11	9.17	12.50
31-40	19	15.83	28.33
41-50	22	18.33	46.66
51-60	27	22.50	69.16
>60	37	30.84	100.00
Sex			
Male	72	60.00	60.00
Female	48	40.00	100.00
Educational Level			
No formal education	11	9.17	9.17
Primary School education	47	39.17	48.34
Junior secondary education	40	33.33	81.67
Senior secondary education	14	11.67	93.34
Tertiary education	8	6.66	100.00
Farm size (in hectares)			
<1	22	18.33	18.33
1.1-2	35	29.17	47.50
>2	63	52.50	100
Years of experience			
≤5	9	7.50	7.50
6-10	14	11.67	19.17
11-15	19	15.83	35.00
16-20	31	25.83	60.83
>20	47	39.17	100

Source: Field survey, 2013

Farmers' primary adaptive strategies

The farmers gave a list of many climate change adaptation strategies they had been using over the years. Figure 1, however shows the primary adaptation strategies the farmers use in the study area. This result shows that changing of planting and harvest time was the most widely adaptation strategy (34%) used by the farmers while the use of acclimated crop varieties was least adopted (8%) as climate change method of adaptation. Other adaptation methods used by farmers in Ekiti state include: mulching and soil conservation (12%), planting of cover crops and trees (18%) and irrigation system (10%). Some farmers (18%) still did not use any method of adaptation to climate change. This implies that farmers in the study area had developed different adaptation strategies to the effects of climate change.

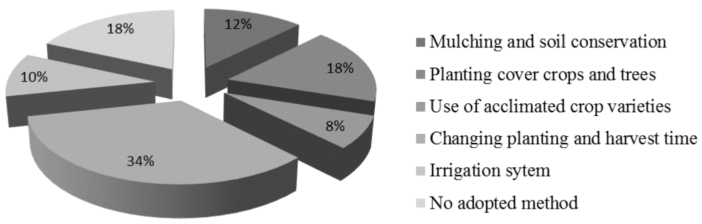

Figure 1: Dominant climate change adaptation strategies adopted by farmers in Ekiti state
Source: Field survey, 2013

Constraints to adaptation strategies of the farmers

The constraints to climate change adaptation strategies in Ekiti State included inadequate information, shortage of labour, inadequate capital, shortage of land, poor irrigation system and poor technical know-how of the farmers. Table 2 however indicated that inadequate information about climate change; poor technical know-how and inadequate capital were the three most notable constraints to climate change adaptation strategies in Ekiti State based on their rankings.

Table 2: Constraints to adaptation strategies of the farmers *multiple responses exist
Source: Computed from field survey, 2013

Constraints*	Frequency	Percentage (%)	Rank
Inadequate information	93	77.50	1st
Shortage of labour	53	44.16	5th
Inadequate capital	81	67.50	3rd
Shortage of land	45	37.50	6th
Poor irrigation system	78	65.00	4th
Poor technical know-how	87	72.50	2nd

Determinants of climate change adaptation strategies in Ekiti State

Significance and signs of parameters are the commonest terms for explaining estimated multinomial logit equations of model. The results show that the significant explanatory variables vary across the groups in terms of the levels of significance and signs of regression coefficients (Table 3). Ownership of livestock as in (Tilahum and Bademo, 2014) is positively related (r = 13.43) to no adaptation). Since ownership of livestock is a measure of asset, it is therefore related to how wealthy the farmers are. The more livestock the farmer had, the less likely his livelihood suffered, hence decision to maintain the status quo. This ownership however is negatively related (r = -12.71) to planting of cover crops and trees, use of acclimated crop varieties and changing planting and harvesting time. This is however significant in respect of using acclimated crop varieties in relation to the reference group and consistent with (Daulagala *et al*, 2013). The result further shows that access to credit is positively related (r = 2.21) to all the adaptation strategies used by the farmers in the study area but only significant with respect to planting of cover crops and trees, changing planting and harvesting time and no adaption method in relation to the reference group. The result is an indication of the important role of institutional support in promoting the use of adaptation strategies to reducing the negative effects of climate change. Non-farm income has a positive and significant impact on the likelihood of planting cover crops and trees as an adaptation option. But it is negatively related (r = - 2.431) to mulching and soil conservation techniques but not significant (p = 0.263). The findings are in agreement with the findings of (Sofoluwe *et al.*, 2011).

Sex and farm size of the respondents have positive and negative impacts, respectively on choice to adapt any method but not significantly related to any of the adaptation strategies in relation to the reference category. The positive signs are indications of increase in the probability of sampled farmers to use any of the adaptation strategies in relation to the reference group as the independent variables increase. It therefore means that the probability of the farmers to adopt these adaptation strategies is greater than the probability of opting for the reference group. The negative and significant parameter implies that the probability of choosing such adaptation strategies is however lower relative to the probability of being in the reference group which is consistent with the views of Sofoluwe *et al.* (2011).

CONCLUSIONS

Many farmers in Ekiti State have been adapting to climate change by using different innovative techniques. The few farmers who have not been using adaptation strategies indicated inadequate information about the strategies as well as inadequate capital as main constraints to adaptation. Access to loan and livestock ownership had greater significant effect on the decisions of the farmers to adopt some of the adaptation strategies like changing planting and harvest time and planting of cover crops and trees. From the study, well-coordinated efforts aimed at creating awareness of climate change and appropriate adaptation strategies are required. Facilitating the access to credit, encouraging livestock ownership will create opportunities for non-farm business incomes. More researches need be carried out on the use of new acclimated crop varieties to be used by for farmers' for adaptation. This will forestall the increasing effects of climate change on agricultural production and raise incomes to farmers.

Table 3**:** Result of multinomial logit for determinants of climate change adaptation strategies in Ekiti State

Independent variables	Mulching and soil conservation		Planting covers crops and trees		Use of acclimated crop varieties		Changing planting and harvest time		No adaptation	
	Coefficient	P-level	Coefficient	P-level	Coefficient	P-level	Coefficient	P-level	Coefficient	P-level
Household size	0.212	0.180	-0.172	0.318	-0.203	-0.300	0.019	0.723	-0.059	0.703
Non-farm income	-2.431	0.263	0.091***	0.000	4.802	0.367	1.163	0.482	4.038*	0.088
Ownership of livestock	0.409	1.000	-12.71***	0.000	-29.31	0.899	-14.92	……	13.43***	0.000
Sex	0.302	0.873	-1.889	0.723	-0.773	0.873	1.648	0.723	-2.21	0.691
Access to credit	1.045	0.463	3.08**	0.012	3.26*	0.054	1.981*	0.061	2.21**	0.050
Constant	-1.178	1.000	11.493	0.000	2.015	0.981	15.786	0.000	15.942	0.000
Diagnostics	Irrigation system									
Base category	20.312									
LR chi square	31.072									
Nagelkerke	0.212									

***, **, *= significant at 1, 5 and 10% probability level respectively

Source: Computed from field survey, 2013

REFERENCES

Adebayo, W. O. (1993) Weather and Climate. In Ebisemiju, F.S. (ed) Ado-Ekiti Region. *A, Geographical Analysis and Master Plan.* Lagos: Alpha Prints, 11-14 pp.

Agbola T. and Ojeleye D. (2007). Climate Change and Food Production in Ibadan, Nigeria. Afr. Crop Sci. Confer. Proc., 8: 1423-1433.

Ajayi J. O (2014a). Awareness of Climate Change and Implications for Attaining the Millennium Development Goals (MDGs) in Niger Delta Region of Nigeria, *Agris on-line Papers in Economics and Informatics*,4(1): 3-11.

Ajayi J. O (2014b). Comparative Economic Study of Mixed and Sole Cropping Systems in Nigeria, *Agris on-line Papers in Economics and Informatics*, 4(4): 15-23.

Ajetomobi J and Abiodun A (2010). Climate change impacts on cowpea production in Nigeria. Afr. J. Food Agric. Nutr. Dev., 1(3): 1-14.

Albritton, D. (2001). What Drives Changes in Climate: Technical Summary. New York: Cambridge University Press.

Baede, A. P. M (2007). *The Physical Science Basis. Contribution of working Group to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* New York: Cambridge University Press.

Daulagala, C, J Weerahewa, B Marambe, G Pushpakumara, P Silva, R Punyawardena, S Premalal, G Miah, J Roy, and S Jana (2013). Socio-Economic Characteristics of Farmers Influencing Adaptation to Climate Change: Empirical Results from Selected Home Gardens in South Asia with Emphasis on Commercial Orientation, *Sri Lanka Journal of Advanced Social Studies*, ISSN: 2012-9149

ICTSD, 2010. "Technologies for Climate Change and Intellectual Property: Issues for Small Developing Countries." International Centre for Trade and Sustainable Development, October.

Ekiti State Government official Website (2013): www.ekitistate.gov.ng. *Retrieved 16th August, 2013*

IPCC, Intergovernmental Panel on Climate Change (2007a). Projected Climate Change and its Impact; Retrieved from http://www.ipcc.ch/

IPCC, Intergovernmental Panel on Climate Change (2007b). Summary of Policy Makers. Retrieved from http://www.ipcc.ch/

IPCC, Intergovernmental Panel on Climate Change (2001). Climate Change: the scientific basis. http://www.ipcc.ch/

National Population Commission (NPC) (2007). *Population Census.* Abuja: NPC

Oluwatayo I.B, (2008). Explaining inequality and welfare status of households in rural Nigeria. Retrieved from *www.hg.org/climatechange.htm* (2011).*www.econexus.org*

Roco, Lisandro, Alejandra Engler, Boris Bravo- Ureta, and Roberto Jara-Rojas (2014). Farm level adaptation decisions to face climatic change and variability: *Evidence from Central Chile", Environmental Science and Policy*, ISSN 1462-9011

Sofoluwe, N.A, Tijani A.A and Baruwa O.I (2011): Farmers' Perception and Adaptation to Climate Change in Osun State, Nigeria: *African Journal of Agricultural Research*, 6(20): 4789-4794

Sowunmi, F.A., and Akintola, J.O. (2010). Effect of Climate Variability on Maize Production in Nigeria. Res. J. Environ. Earth Sci., 2(1): 19-30

Tilahun, U, and A Bedemo (2014). Farmers' Perception and Adaptation to Climate Change: Heckman's Two Stage Sample Selection Model, *Ethiopian Journal of Environmental Studies and Management*, ISSN: 1998-0507

United Nations (UN) (2010). Panel on Climate Change/Conference Report. The way forward. *www.springerlinkverlagi.com/content/climatechange*.