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Full Length Research Paper

Farmers' perception and adaptation to climate change in Osun State, Nigeria

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African agriculture is negatively affected by climate change. Adaptation is identified as one of the options to reduce the negative impact of the change. This study identified the adaptation techniques employed by farmers and analyze factors that determine the adaptation techniques among farmers in the study area. Descriptive statistics and multinomial logit were used to analyze data obtained from a cross-sectional survey of 10 villages in two local government areas of Osun State. The analysis of perception of farmers to climate change revealed a high increase in temperature, and decrease in rainfall. The result showed that six adaptation methods were employed by the farmers. The result also showed that explanatory variables compared to the null model give better accuracy for no adaptation, early and late planting, and tree planting. Moreover, the analysis of factors affecting adaptation to climate change indicates that, access to loan and livestock ownership compared to the rest of explanatory variables has more significant impact on adaptation. It is recommended that policy makers should enlighten the farmers more on the danger of climate change to productivity of crops and livestock and provide necessary logistics to support various alternative course of action.

Key words: Climate change, adaptation methods, perception, multinomial logit.

INTRODUCTION

Agricultural production in Nigeria is weather dependent. Climate variability and change have a direct, often adverse influence on the quantity and quality of agricultural production in Nigeria (Sowunmi and Akintola, 2010). 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). Like other developing countries, the challenge of climate change and global warming is enormous in Nigeria due to widespread poverty.

CGIAR (2005) is of the opinion that in the tropics and sub tropics, some crops are near their maximum temperature tolerance, and where non-irrigation dominates, yields are likely to decrease with even small increase in atmospheric temperature. It was observed that overall agricultural productivity could decrease during the next century, leading to hunger and malnutrition in vulnerable area, especially in prone region of Africa. Though climate change is a threat to agricultural non-agricultural socioeconomic 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 practises will have to adapt to the change to ensure food security for human survival.

Adaptation is identified as one of the policy options to reduce the negative impact of climate change (Adger et al., 2003; Kurukulasuriya and Mendelsohn, 2006). 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 methods and factors influencing the choice of adaptation methods could enhance policy towards tackling the challenges climate change is imposing on Nigerian farmers. This is because agricultural sector in the Nigerian economy accounts for about 60-70% of the labour force and contributing 30-40% of the nation's gross domestic product (GDP) (Adejuwon, 2004).

Attempts have been made to study effect of climate change on agricultural productivity and farmers' adaptation in Nigeria's agriculture (Fakorede and Akinyemiju, 2003), but information on farmers' perception and

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factors influencing choice of adaptation methods by farmers in Nigeria has been limited. This study investigates the perception of farmers to climatic variable changes, adaptation methods adopted and factors influencing the choice of adaptation methods.

MATERIALS AND METHODS

Study area

The study was carried out in Osun state, Nigeria. The state is located in south-western Nigeria, and lies within latitude 7.0° and 9.0° N, and longitude 2.8° and 6.8° E. The state covers a total land area of approximately 8,602 km^2 and lies between 300 and 600 m above the sea level with a largely gentle and undulating landscape. The average rainfall ranges from 1125 mm in derived savannah to 1475 mm in the rain forest belt. The mean annual temperature ranges from 27.2°C in the month of June to 39.0°C in December. The soil types are varied but most contain a high proportion of clay and sand, and are mainly dominated by laterite.

The area is mainly agrarian. Food crops grown in the area include maize (*Zea mays*), yam (*Dioscorea* spp.), cassava (*Manihot esculenta*), cocoyam (*Colocasia* spp.), rice (*Oryza sativa*) and vegetable (*Amaranthus* spp.). The permanent crops include cocoa (*Theobroma cacao*), kolanut (*Cola nitida*) and oil palm (*Elaeis guinensis*). These crops are usually mixed or intercropped.

Data collection

The data used for this study were obtained from a cross sectional survey of farmers registered with the Osogbo Diocese's Rural Development Programme (RUDEP) in Osun state, Nigeria, which is partitioned into the Osogbo, Ila and Ijesha zones. The data was obtained from 2008/2009 cropping season. Data were collected using a pre-tested, well structured questionnaire on socio-economic characteristics of the respondents, perception on climatic variables, methods of adaptation, problems of adaptation and factors influencing adaptation techniques.

Sampling procedure and sample size

Multistage sampling technique was employed. Food crop farmers registered with RUDEP were purposively selected. Out of their food crop farmers, 100 of them were selected from 10 villages covering Ila and Odo-Otin local government areas of Osun state. The food crop farmers were chosen because the effect of climate change is likely to be more instantaneous on them.

Analytical techniques

Descriptive statistics

Descriptive statistics was used to describe socio-economic features of the respondents' perception about climate change, methods and problems of adaptation. Those used include mean, percentages and frequency counts.

Multinomial logit model

The multinomial logit was used to analyse factors that determine adaptation techniques. The multinomial logit model (MNLM) is used for analyzing unordered qualitative variables. It deals with truly nominal and mutually exclusive categories. Suppose a dependent variable (DV), y, has m categories that is y = 1, 2 …m with P_1, P_2…P_m as associated probabilities, such that $P_1+P_2+…+P_m = 1$. The usual thing is to designate one as the reference category. The probability of membership in other categories is then compared to the probability of membership in the reference category. Consequently, for a DV 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 DV and the independent variables (IVs). 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 is:

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

For m > 1

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

For K covariates, a total of (K+1)*(M-1) parameters will be estimated.

The odds and odds-ratios for a variable with M categories and baseline, M=1:

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

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

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

Specifically, the standard MNLM for model with m = 6 categories becomes:

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

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

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

The MNLM is built on the independence of irrelevant alternatives (IIAs) assumptions. The Hausman-McFadden is used for the tests of IIA. The procedure is to first estimate the full model with m outcomes. Then, a restricted model is estimated by eliminating one or more m. The test of the difference between the two, which is asymptotically distributed as chi-square with degrees of freedom 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 (Ojiako et al., 2009).

Empirical model

The empirical multinomial logit model for this study is specified as:

$$Y_i = f(X_1, X_2, ..., X_5)$$

Where y_i, the dependent variable is polychotomous and it is the method of adaptation chosen by the farmer; x_{is} are the explanatory variables. The dependent variable (y_i) is defined as 1 for no adaptation, 2 for soil conservation, 3 for planting of trees, 4 for planting different variety, 5 for early and late planting and 6 for irrigation. The independent variables are:

X_1 = household size
X_2 = off farm income
X_3= livestock ownership
X_4= gender
X_5 = access to loan

RESULTS AND DISCUSSION

Descriptive analysis of socio-economic demographics of respondents

Socio-economic characteristics of the respondents are presented in Table 1. Mean age of the respondents was 45.4. This indicates that the farmers were still in their active age bracket. Younger farmers have been found to be more knowledgeable about better practices and may be more willing to bear risk and adapt to better farming techniques because of their longer planning horizons. The older the farmers, the less likely they are to understand inherent benefits in a given innovation. But, a low level of post secondary education (15.5%) was generally observed for the farmers. Education may play important role in adopting a new system of farming. As farmers acquire more education, their ability to obtain, process, and use information improves. Education increases the ability of farmers to use their resources efficiently and the allocative effect of education enhances farmers' ability to obtain, analyze and interpret information. About 14.1% had no formal education as opposed to 38.0% who had primary education. However, there were more male (95.8%) engaging in farming activities in the study area. In short, the socio-economic characteristics indicated that the respondents are young, averagely educated and comprising more men.

Farmers' perception of climate change

The analysis of farmers' perceptions of climate change is contained in Table 2. As indicated in the table, most of the farmers (77.5%) in this study were aware of increase in temperature and decline in rainfall. Their perception on precipitation show that majority of them (42.3%) perceived a decline in the level of precipitation.

Adaptation of farmers to climate change

The adaptation methods employed by farmers are indicated in Table 3. Although majority of the farmers interviewed claimed that they had perceived at least one change in climatic attributes, some of the farmers (28.2%) did not respond by taking adaptation measures. Majority (66%) responded by employing late planting, planting trees, irrigation and soil conservation while a few (2.8%) opted for planting different varieties. This probably suggests lack of access to crop varieties in the study area or lack of information on availability of such technology. As indicated, late planting is the most commonly used method whereas planting different varieties is the least practised among the major adaptation methods identified in the study area. Greater use of late planting as an adaptation method could be associated with the convenience and no direct cost to the farmers, while the limited use of planting different varieties could possibly be attributed to inaccessibility, poor access to information and higher expense associated with the purchase. Those that had not adopted might have been constrained by problems discussed in the next section.

Problems of adaptation method

The analysis of barriers to adaptation to climate change in the study area indicates that there are five major constraints militating against adoption of adaptation methods. These are lack of information, lack of capital, shortage of labour, shortage of land and poor potential for irrigation (Table 4). Lack of information on appropriate adaptation options could be attributed to the dearth of research on climate change and adaptation options in the country. It could also be attributed to inefficient extension service in the country and this is the most important problem being faced by majority (33.8%) of the sampled farmers. Lack of capital is the next most reported problem (31.0%). Lack of money hinders farmers from getting the necessary resources and technologies that facilitate adapting to climate change. Given that the study area is not so rich in water resources, poor irrigation potential (18.3%), is most likely associated with the inability of farmers to have water source close to their farms. Rural farmers are generally poor and cannot afford to invest in irrigation technology to adapt to climate change or sustain their livelihood during harsh climatic conditions such as drought. Adaptation to climate change is costly (Mendelson, 2004), and the need for intensive labour use

Table 1. Socio-economic demographics of respondents in Osun State.

Item	Frequency	Percentage
Education level		
No formal schooling	10	14.1
Primary school	27	38.0
Secondary school	22	31.0
Post-secondary	11	15.5
Total	70	100
Age group		
21-29	9	12.7
30-38	10	14.1
39-47	21	29.6
48-56	19	26.8
57-65	9	12.7
66 and above	2	2.8
Grand total	70	98.6
Sex		
Female	68	95.8
Male	2	2.8
Total	70	98.6

Source: Field survey, 2009.

Table 2. Perceptions of farmers to change in climatic variables.

Climatic variables	Perception	Percentage
Temperature	Increased	77.5
	Decreased	8.5
	Stayed the same	12.7
Rainfall	Increased	77.5
	Decreased	12.7
	Stayed the same	7.0
Precipitation	Increased	16.9
	Decreased	42.3
	Stayed the same	35.2

Source: Field survey, 2009.

may contribute to this cost. Thus, if farmers do not have sufficient family labour or the financial means to hire labour, they cannot adapt. However, the low attribution to labour (9.9%) as the barrier to adaptation could be due to the fact that many rural households engages in farming either for commercial or subsistence reasons. Shortage of land (5.6%) has been associated with high population pressure, which forces farmers to intensively cultivate a small plot of land and makes them unable to prevent

Table 3. Adaptation methods employed by farmers.

Adaptation method	Frequency	Percentage
Soil conservation	5	7.0
Planting of tree	10	14.1
No adaptation	20	28.2
Planting different variety	2	2.8
Early and late planting	26	36.6
Irrigation	6	8.5
Total	68	97.2

Source: Field survey, 2009.

Table 4. Problems of adaptation method.

Problem of adaptation	Frequency	Percentage
Shortage of labour	7	9.9
Lack of information	24	33.8
Lack of capital	22	31.0
Poor potential for irrigation	13	18.3
Shortage of land	4	5.6
Total	70	98.2

Field survey: 2008/2009.

further damage by using practises such as planting trees that compete for agricultural land. Because most rural farmers inherit land from ancestors, the low attribution of land as one of the main problems to adaptation is plausible.

Regression results

The results of the estimated equations are discussed in terms of the significance and signs of the parameters. The model (Table 5) shows that the set of significant explanatory variables varies across the groups in terms of the levels of significance and signs of regression coefficients. Livestock ownership is positively related (r = 16.74) to 'no adaptation decision taken by farmers'. Livestock ownership is a sign of wealth to farmers. The more the farmer possesses, the less likely his livelihood suffers, hence decision to maintain the status quo. But, it is negatively related (r = -15.23) to planting of trees, planting different varieties and late planting, although not significant in respect of planting different varieties relative to the reference group (Table 5).

Access to loan is positively related (r = 2.86) to all the adaptation methods identified but only significantly so in respect of planting of trees, late planting and the decision of the farmers not to adapt relative to the reference group. The result implies the important role of institutional support in promoting the use of adaptation methods to

Table 5. Parameter estimates of the multinomial logit climate change adaptation model.

Explanatory variable	Soil conservation		Planting trees		Planting variety		Early and late planting		No adaptation	
	Coefficient	P level	Coefficient	P level	Coefficient	P level	Coefficient	P level	Coefficient	P level
h/h size	0.281	0.190	-0.183	0.367	-0.267	0.310	0.023	0.885	-0.061	0.725
Off farm	-3.163	0.275	0.086***	0.000	5.507	0.396	1.187	0.515	6.005*	0.099
Livestock	0.501	1.000	-15.23***	0.000	-32.55	0.981	-16.11	.....	16.74***	0.00
Gender	0.375	0.971	-2.447	0.771	-0.885	0.949	1.650	0.820	-2.86	0.72
Access loan	1.078	0.519	4.247**	0.019	4.818*	0.068	2.241*	0.082	2.86**	0.05
Constant	-1.194	1.000	13.797	0.000	2.250	0.999	16.554	0.000	16.93	0.00
Diagnostics										
Base category	Irrigation									
LR Chi-Square	22.245									
Log likelihood	33.545									
Nagelkerke	0.285									

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

reduce the negative impact of climate change.

Off-farm income has a positive and significant impact on the likelihood of planting trees as an adaptation option. But it is negatively related (r = -3.163) to soil conservation option but not significantly so (p = 0.275).

Gender and household size have positive and negative impact respectively on decision to adapt any option but not significantly related to any of the adaptation options relative to the reference category.

The positive signs suggest an increase in the probability of sampled farmers in using any of the adaptation options relative to the reference group as the explanatory variables increase. The implication is that the probability of the farmers deciding on those adaptation options is greater than the probability of opting for the reference group. The negative and significant parameter means that the probability of opting for such options is lower relative to the probability of being in the reference group.

Conclusions

Farmers adapted to climate change by using different methods, of which the major ones are included in this study. Those who did not use any of the methods identified lack of information on adaptation methods and lack of capital as major constraints to adaptation. Of the estimated multinomial logit model, access to loan and livestock ownership had greater significant effect on the decisions of the farmers to adopt some of the methods such as early and late planting and planting of trees.

The analysis of the farmers' perceptions of climate change indicates that most of the farmers in the study area were aware that temperature is increasing and the level of rainfall is declining. The analyses of the constraints to adaptation and the factors that influence farmers' adaptation to climate change in the study area suggest a number of different policy options. These options include creating awareness of climate change and appropriate adaptation methods, facilitating the access to credit, encouragement of livestock ownership and creating opportunity for off farm employment and conducting research on the use of new crop varieties that are better suited to farmers' new climatic conditions.

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