Journal of Agricultural and Crop Research
Vol. 2(8), pp. 152-159, August 2014
ISSN: 2384-731X
Research Paper

Arable crop farmers' adaptation to climate change in Abuja, Federal Capital Territory, Nigeria

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Accepted 23rd July, 2014

Abstract. The study examined the socioeconomic factors affecting crop farmers' adaptation to climate change in Abuja, F.C.T, Nigeria by describing the socio-economic characteristics of farmers in the study area, determining their perception of the climate change phenomenon, identifying the climate change adaptation measures adopted as well as examining the socio-economic factors influencing the choice of the adaptation measure used by the farmers. The study used primary data elicited from the farmers with the use of questionnaire. A total of one hundred and twenty crop farmers were selected randomly from the six area councils namely, Abaji, Abuja municipal, Bwari, Gwagwalada, Kuje and Kwali in the Federal Capital Territory (F.C.T.). Proportionate and random sampling techniques were used to select the respondents to ensure representativeness and to reduce bias. Data collected were analyzed using descriptive statistics and multinomial logit regression analysis. Results indicated that the average farm size was 1.5 ha, an indication that the study covered small scale family managed farm units. The average years of schooling, age of the farmers and years of experience were 7.1, 42 and 17 respectively, suggesting that the farmers have some basic literacy, were relatively youthful and energetic and have some experience in arable crop production. Over 90% of the respondents perceived long term change in temperature and rainfall pattern in the study area. The common adaptation options for climate change used by farmers were portfolio diversification (33.30%) while 20.83% of the farmers surveyed did not use any adaptation measure to mitigate climate change. Results of the multinomial logit model revealed that farmers' socioeconomic characteristics such as age, extension education and years of formal education significantly affected the probability of uptake of adaptation measures to counteract the negative effects of climate change. The study recommends increased formal and informal institutional support such as farm advisory services and education in promoting the use of adaptation options to reduce the negative effects of climate change. This is with a view to increasing farmers' ability to cope and the evolution of appropriate risk reduction production strategies in response to perceived climate change to improve their well-being.

Keywords: Climate change, adaptation, risk reduction, mitigate.

INTRODUCTION

Climate change adaptation is especially important in developing countries since these countries are predicted to bear the brunt of the effects of climate change. The goal of adaptation measures should be to increase the capacity of a system to survive external shocks or change. It has been ascertained that adaptation helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socioeconomic conditions, including climate variability, extreme weather conditions such as droughts and floods, and volatile short-term changes in local and large-scale markets (Kandlinkar and Risbey, 2000).

An understanding of farmer perceptions regarding long-term climatic changes, current adaptation measures and their determinants will be important to inform policy makers for future successful adaptation of the agricultural sector (Baethgen et al., 2003). This is important to provide information that can be used to formulate policies that enhance adaptation as a tool for managing a variety of risks associated with climate change in agriculture. Africa is generally acknowledged to be the continent most vulnerable to climate change. West Africa is one of the most vulnerable to the vagaries of the climate, as the scope of the impacts of climate variability over the last three or four decades has shown (IPCC, 2001). This is in 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; Royal Society, 2005; Adams et al., 1998). Accordingly, there is the need to gain as much information as possible, and learn the positions of rural farmers and their needs, their knowledge and perception of climate change, in order to offer adaptation practices that meet these needs.

Some attempts have been made in recent past to examine farm level adaptation methods in a regional and sub-regional basis in sub-Saharan Africa (Nhemachena and Hassan 2007; Deressa, 2007; Nwajiuba et al., 2008; Deressa et al., 2008; Gbetibouo, 2009). However, no specific effort has been devoted to isolating the determinants of the adaptation methods to climate change embraced by farmers in this agro ecological zone. Climate change has negative impact on agricultural productivity through increase in temperature, low precipitation and other weather vagaries which restrict farmers to the production of certain crops and animals that can thrive well in such condition (Adger et al., 2003). A number of traditional and modern adaptation measures exist that can help farmers to mitigate these effects. These adaptation measures vary in complexity and cost depending on their socio-economic status. Farmers are likely to adopt them in order of simplicity and cost effectiveness. Although a number of researchers have analyzed the effect of climate change on agriculture especially in Asian countries, there is a dearth of studies related to Nigerian farmers and the socio economic factors which influences their choice adaptation measures. This study aims at filling this information gap by providing policy makers with basis for informed agriculture-friendly climate change intervention schemes and policies. A lack of such baseline information in the past has led to policy failures in various spheres where government attempted to transplant best practices in other countries to Nigeria without regards to local conditions. Farmers' production has been dwindling due to the effect of climate change and for farmers to cope with these effect, they must put some measures in place in order to tackle the problem posed by climate change. Empirical studies measuring the economic impacts of climate change on agriculture in Africa (Kurukulasuriya and Mendelsohn, 2006a; Seo and Mendelsohn, 2006a; Benhin, 2006) show that such negative impacts can be significantly reduced through adaptation.

The study will lead to an increased understanding of environmental, social and economic implications of climate induced risks. The study will identify which adaptation measures practiced by the arable crop farmers are effective for the purpose of standardization and dissemination through extension mechanisms to enhance adaptive capacity of other vulnerable communities to reduce their risks to climate-change. Practicing and prospective farmers will also be guided by the findings in their investment decisions. Also, the lessons learnt on indigenous adaptive experience and coping mechanisms will be published to promote replication and policy influence. The output of the study can also be used as baseline study for the future research in similar areas.

The objectives of this study are to describe the socio-economic characteristics of respondents in the study area, determine farmers' perception of the climate change phenomenon, identify the climate change adaptation measures adopted by crop farmers as well as examine the socio-economic factors influencing the choice of the adaptation measure used by the farmers.
The following hypothesis was tested for this study:

H_0: The estimated regression coefficients of explanatory variables across the six adaptation categories are not significantly different from zero.

Conceptual framework

The decision on whether or not to adopt a new technology is considered under the general framework of utility or profit maximization (Norris and Batie, 1987; Pryanishnikov and Katarina, 2003). It is assumed that economic agents, including farmers use adaptation methods only when perceived utility or net benefits from adopting such a measure is greater than doing without the technologies. The cardinal objective of every rational farmer is to maximize profit or utility. Although utility is not directly observed, the actions of farmers are observed in the choices they make. Suppose that Za and Zb represent a farmer's utility for two choices, which are denoted by Ya and Yb, respectively. The linear random utility model could then be specified as:

$$Y_a = \beta a X_i + \varepsilon a \quad (1)$$

$$Y_b = \beta b X_i + \varepsilon b \quad (2)$$

Where, Ya and Yb denote perceived utilities of adaptation methods a and b, respectively, Xi is the vector of exogenous variables that affect the perceived desirability of the method, βa and βb are parameter estimates of the exogenous variables, and εa and εb are disturbance terms assumed to be independently and randomly distributed (Greene, 2003). If a farmer decides to use option ‘a’, it follows that the perceived utility or net benefit from option ‘a’ is greater than the utility or net benefit from other options (say b) depicted as:

$$Y_i a(\beta a X_i + \varepsilon a) > Y_i b(\beta b X_i + \varepsilon b) \qquad (3)$$

The probability that a farmer will adopt option ‘a’ among the set of climate change adaptation options could then be defined as:

$$P\ (Z=1/X) = P(Y_i a > Y_i b) \qquad (4)$$

Substituting Equations 1 and 2 into 3:

$$P\ (\beta a X_i + \varepsilon a - \beta b X_i - \varepsilon b) > 0/X \qquad (5)$$

Rearranging;

$$P(\beta a Xi - \beta b X_i + \varepsilon a - \varepsilon b) > 0/X \qquad (6)$$

$$P(X^* X_i + \varepsilon^*) > 0/X = f(\beta a^* X_i) \qquad (7)$$

Where P is the probability function, Yia, Yib and Xi are as defined above, $\varepsilon^* = \varepsilon a - \varepsilon b$ is a random error term, $\beta a^* = (\beta a - \beta b)$ is a vector of unknown parameter estimates that can be interpreted as the net influence of the vector of explanatory variables influencing adaptation, and $f(\beta a^* X_i)$ is a cumulative distribution function of ε^* evaluated at $\beta a^* X_{i.}$ The exact distribution of f depends on the distribution of the random disturbance term, ε^*. Depending on the assumed distribution that the random disturbance term follows, several qualitative choice models can be estimated (Greene, 2003).

METHODOLOGY

Study area

The Federal Capital Territory (FCT) is located in the epicenter of Nigeria. Specifically, the territory is located north of the confluence of the River Niger and Benue River. It is bordered by the states of Niger to the West and North, Kaduna to the northeast, Nasarawa to the east and south, and Kogi to the Southwest. It lies between latitudes 8°25′ and 9°20′ North of the equator and longitudes 6°45′ and 7°39′ East of Greenwich Meridian. The Federal Capital Territory has a landmass of approximately 7,315 km^2, of which the actual city occupies 275.3 sq km. It is situated within the Savannah region with moderate climatic conditions. The territory is currently made up of six Area Councils, namely: Gwagwalada, Abuja Municipal, Abaji, Kuje, Bwari and Kwali. It had a population of 1,408,239 persons according to 2006 population census but has grown to 2,245,000 in 2010 (Wikipedia, 2011). A typical year consists of wet (March to October), and dry (November to February) seasons. Maximum monthly rainfall averages about 342 mm which usually occur in August. Monthly maximum and minimum temperatures are around 44 and 16°C, respectively. The average humidity ranges from 30 to 85% and is highest in the rainy months and lowest in the dry season.

The vegetation in the study area including most parts of the FCT is dominated by herbaceous plants which are occasionally interspersed with shrubs. The soil characteristics in the study area is determined by the basement complex as well as sedimentary rocks which have a strong influence on the morphological characteristics of the local soils. The major crops grown in the area include maize (*Zea mays*) and sorghum (*Sorghum vulgare*), groundnuts (*Arachis hypogaea*), cassava (*Manihot utilsima*), and miscellaneous crops such as okra, pepper and garden egg.

Sampling technique and sample size

The study was carried out in the six area councils of the FCT. The locations were chosen randomly whereby, from each of the area councils, two farming communities were selected. The heads of households were chosen proportionate to the population of the arable crop farmers in each community. Proportionate selection was done to ensure representativeness and to reduce bias. Sampling frames for arable crop farmers for each of the communities were not readily available but were obtained by the researcher from the village heads through a reconnaissance survey. A total of one hundred and twenty respondents were sampled from the frames from which information were elicited.

Data collection

Data for the study were obtained with the questionnaire complemented with oral interviews. Personal visits to farms were made to interact with the farmers and in rare cases in their farmstead settlements. Trained Officers of the Agricultural Development Programme of the F.C.T. assisted the researcher in data collection. Data collection for this study commenced in July and ended in September 2012. Data were collected on the following: socio economic characteristics of farmers such as household size, gender of household head, age, level of education, access to credit, extension services, personal income and farm size in hectares. Others are perception of farmers on some climatic factors such as temperature and precipitation; adaptation measures adopted by farmers in the study area such as changing planting dates, portfolio diversification, soil conservation and changing tillage operations.

Data analysis

Data collected were analyzed using descriptive statistics and the multinomial logit regression model.

Specification of the multinomial logit regression model

This study adopted the models used by Onyeneke and madukwe (2010) and Budry et al. (2006) in an attempt to express the probability of a farmer being in a particular category. The farmers were categorized into six (6) categories based on the type of adaptation measures adopted. The adaptation measures include: (1) Portfolio diversification, (2) Changing planting dates (3) Changing tillage operations, (4) Planting trees, (5) Soil conservation, and (6) No adaptation/reference category.

The multinomial logit can be specified as:

$$\Pr(Y_i = j) = \frac{\exp(\beta_j X_i)}{\left[1 + \sum_{j=1}^{k} \exp(\beta_j X_i)\right]} \qquad (8)$$

Where y_i= observed outcome for the ith individual, Xi is a vector of the explanatory variables, βj are the unknown parameters to be estimated, j = adaptation measure (groups) and ∑ is the summation sign.

The probability of adapting each of the measures (P_{ij}) is given as:

$$P_{ij} = \frac{\exp(\gamma_j X_i)}{1 + \sum_{j=1}^{5} \exp(\gamma_j X_i)} \quad \text{for } j = 1, 2, 3...5 \qquad (9)$$

The probability of being in the reference group or Group 6 is given as:

$$P_{i6} = \frac{1}{1 + \sum_{j=1}^{5} \exp(\gamma_j X_i)} \qquad \text{for } j = 5 \qquad (10)$$

According to Rahji and Fakayode (2009), the coefficients of the reference group are normalized to zero. This is because, the probability for all the choices must sum up to unity. Following Green (2003), the odd ratio of equation of equation 6 and 7 gives the estimating equation as:

$$\ln \frac{(P_{ij})}{(P_{i0})} = \gamma_j X_i \qquad (11)$$

Equation 8 denotes the relative probability of each of the groups 1-5 to the probability reference group. Regression coefficients estimated for each choice therefore, reflects the effects of Xi's on the likelihood of the farmer choosing that alternative relative to the reference group. The multinomial logit regression model is specified explicitly as:

$$P_{ij} = \; = \beta_0 + \beta_1 EDU + \beta_2 GEN + \beta_3 AGE + \beta_4 HHSZ + \beta_5 INC + \beta_6 EXT + \beta_7 CRDT + \beta_8 FSZ + \beta_9 EXP \qquad (12)$$

where; $P_{ij} =$ Probability of adapting any of the i^{th} measures by j^{th} respondents; EDU = Level of education (in years), GEN = Gender (Dummy variable, male = 1, female = 0); HH = Household Size (No. of persons); INC = Total Income of farmer measured in (₦ naira); EXT = Extension (Dummy variable, Yes =1,No =0); CRDT = Access to Credit (Dummy variable, Yes = 1, No = 0); FSZ = Farm Size (ha); EXP = Years of farming Experience (years).

Marginal effects and quasi–elasticities

The marginal effects or partial derivatives ($\partial P_j/\partial X_i$) are obtained by differentiating Equations 6 and 7 with respect to the particular explanatory variable. The derivation techniques implicitly indicate that neither the sign nor the magnitude of the marginal effects need bear any relationship to the sign of the coefficients used in obtaining them (Greene, 1993). The partial derivatives were converted to quasi elasticities by using the formula:

$$\beta J_i = \overline{X}_i (\partial P_j/\partial X_i) \qquad (13)$$

where $\overline{X}_i$ is the mean value of X_i. The quasi-elasticity represents the percentage point change in P_j upon a one percent increase in X_i. These elasticities are superior to the coefficients and the partial derivatives by their ease of interpretation. However, like the derivatives they too may change sign as well as value when evaluated at different points (Basant, 1997).

RESULTS AND DISCUSSION

Socio economic characteristics of the respondents

The socioeconomic characteristics of respondents are summarized in Table 1. Results in Table 1 indicated that the average farm size was 1.5 ha, an indication that the study covered small scale family managed farm units. The average years of schooling, age of the farmers and years of experience were 7.1, 42 and 17 respectively, suggesting that the farmers have some basic literacy, were relatively youthful and energetic and have some experience in arable crop production. Education increases

Table 1. Summary of the descriptive statistics of the variables in the model.

Variables	Mean	Standard dev.	Minimum	Maximum
Education (years)	7.10	5.80	0.00	18.00
Age (years)	42.00	10.80	25.00	67.00
Household size (No.)	7.20	3.80	1.00	15.00
Farm size (ha)	1.50	0.66	0.10	2.50
Experience (years)	17.00	9.10	7.00	35.00

Source: Field Survey, 2012.

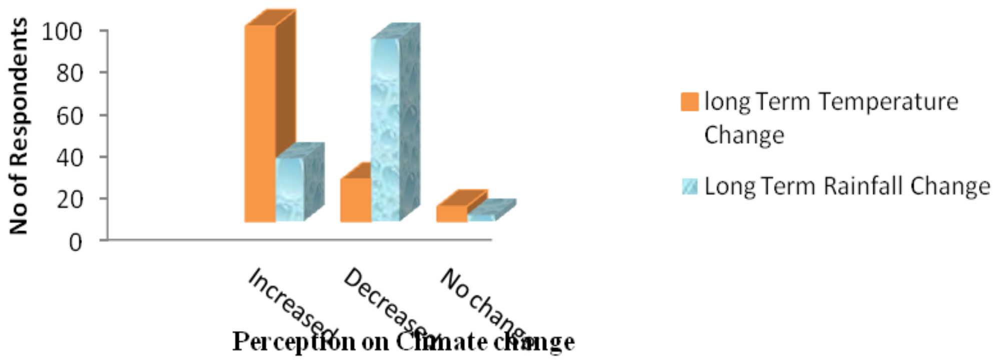

Figure 1. Respondents' perception of climate change parameters.

one's ability to receive, decode, and understand information relevant to making innovative decisions (Wozniak, 1984). Maddison (2006) and Nhemachena and Hassan (2008) also indicated that experience in farming increases the probability of uptake of adaptation measures to climate change. Results also indicated that majority of the households (83.33%) were headed by the males, suggesting that farming is considered as a male occupation in the study area. Tenge et al. (2004) affirmed that female-headed households may have negative effects on the adoption of soil and water conservation measures because, they have limited access to information, land and other resources due to traditional social barriers. Educated and experienced farmers are expected to be more informed about climate change and respond positively based on their knowledge. This corroborates the work of Maddison (2006) who found that educated and experienced farmers are expected to have more knowledge and information about climate change and agronomic practices that they can use in response to climate change phenomenon. Due to lack of education, a lot of traditional farming practices detrimental to the environment still persist and farmers find it difficult to modify.

The study also indicated that majority of the respondents (80.83%) have no access to extension services, this may serve as a barrier in adopting new farming practices which could help the farmers in adjusting to adverse effect of climate change, this corroborates the work of Yirga et al. (2007), who found that extension education on crop and livestock production and information on climate change enabled farmers to take decision. Various studies in developing countries including Ethiopia reported a strong positive relationship between access to information and the adoption behaviours of farmers. Moreover, Maddison (2006) and Nhemachena and Hassan (2007) showed that access to information through extension increase the chance of adapting to climate change.

Perception of respondents on climate change

Farmers in the study area perceived changes in some climatic factors of their environment and this had led to the action of majority adopting one adaptation measure or the other. The parametized factors were rainfall and temperature. Perceptions of farmers about climate change variables are presented in Figure 1. Changes in temperature globally have been attributed to climate change phenomenon. Depending on the agro ecology, the change could be in the trend of increasing, decreasing or unchanged respectively. Results in Figure 1 showed that 93 of the respondents perceived that the changes in temperature are long term with only 7 claiming to have noticed no change in temperature. Only about 20 respondents believed there was really a decreasing temperature trend. This corroborates the work by CEEPA (2006) who reported that many African studies indicate a large number of agriculturalists already perceiving that the climate has become hotter and the rains less predictable and shorter in duration. Result of

Table 2. Adaptation Measures adopted by the farmers.

Adaptation measure	Frequency	Percentage
Portfolio diversification	40	33.30
Changing planting dates	18	15.00
Changing tillage operations	17	14.20
Tree planting	5	4.20
Soil and water conservation	15	12.50
No adaptation	25	20.80
Total	120	100.00

Source: Field Survey, 2012.

Table 3. Multinomial logit estimation results.

Variables	Portfolio diversification	Changing planting dates	Changing tillage operation	Tree planting	Soil and water conservation
Education	0.294 (3.09)***	0.194 (-1.3)	0.004 (-0.03)	0.076 (-0.72)	0.114 (-1.16)
Gender	0.759 (0.53)	0.713 (-0.42)	0.436 (-0.26)	1.001 (-0.62)	0.534 (-0.39)
Age	0.092 (1.89)*	0.089 (-1.13)	0.076 (-1.45)	0.053 (-1.02)	0.114 (2.35)**
Household size	0.106 (-0.86)	-0.112 (-0.54)	0.017 (-0.13)	0.059 (-0.46)	0.056 (-0.47)
Income	0.008 (1.24)	0.006 (-0.89)	0.01 (-1.6)	0.006 (-0.89)	0.007 (-1.12)
Extension	1.892 (-1.52)	0.001 (6.74)***	0.897 (-0.63)	1.956 (-1.55)	2.616 (2.15)**
Credit	0.02 (-1.57)	-0.669 (0.00)	0.018 (-1.26)	0.019 (-1.5)	0.015 (-1.14)
Farm size	-0.664 (-1.09)	0.375 (-0.39)	-0.197 (-0.28)	-0.111 (-0.17)	-0.422 (-0.70)
Experience	-0.064 (-1.37)	-0.063 (-0.67)	-0.052 (-0.92)	-0.019 (-0.38)	-0.012 (-0.26)
Cons	-5.68 (-2.00)**	6.964 (2.82)***	-4.379 (-1.36)	-4.369 (-1.43)	-6.133 (-2.17)**
.					
Numbers of observations = 119					
Log likelihood = -150.21616***					
LR Chi-square= 86.97***					
Pro> Chi-square = 0.0002					
Pseudo R^2 = 0.2245					

***; ** and * = Significant at the 0.01, 0.05 and 0.10 levels of probability respectively. Figures in parenthesis are calculated Z-values.

the survey also showed that 117 of the respondents across the study area perceived that there was long-term change in the quantity of rainfall while only 3 did not notice any change in the rainfall pattern. However, while 30 noticed increase in rainfall, 87 believed there was really a decreasing rainfall trend. This is also in consonance with CEEPA (2006) findings.

Climate change adaptation measures adopted by the farmers

There were six categorical dependent groups known as adaptation categories in this study. Results in Table 2 indicate the measures adopted by farmers to mitigate climate change. Results in Table 2 indicate that portfolio diversification is the most commonly used method as 33.3% of the farmers confirmed it. Fourteen point two percent practiced changing tillage operation, 15% practiced changing planting dates, 12.50% undertook soil and water conservation and planting of trees is the least practiced among the adaptation methods identified in the study area as reported by 4.20% of the farmers. The adoption of portfolio diversification as an adaptation method by many could be associated with the lower expense and the ease of access by the farmers. Moreover, 20.80% of the surveyed farmers reported not to have taken any adaptation method .This could be due to certain reasons associated with poverty and lack of information.

Factors influencing the choice of adaptation measures among respondents in the study area

The factors influencing the choice of adaptation measures were examined using the multinomial logit model. The results are presented in Table 3. The results

Table 4. Marginal effects and the quasi–elasticity estimates.

Parameter	Portfolio diversification	Changing planting date	Changing tillage operation	Tree planting	Soil and water conservation
Education	0.056 (0.400)	0.005 (0.036)	0.000 (0.001)	0.011 (0.078)	0.023 (0.165)
Age	0.018 (0.739)	0.002 (0.099)	0.003 (0.141)	0.008 (0.317)	0.023 (0.968)
Extension	0.362 (0.109)	0.064 (0.019)	0.039 (0.012)	0.281 (0.084)	0.531 (0.159)

Note: Marginal effects are above while partial elasticities are in parentheses. Source: Field Data Analysis, 2012.

in Table 3 showed that the likelihood ratio (χ^2) value was 86.97 and this was significant at 0.01 probability level. This test confirms that all the slope coefficients are significantly different from zero. The pseudo R^2 value of 0.2245 also confirmed that all the slope coefficients are not equal to zero. In other words, the explanatory variables are collectively significant in explaining the choice of climate change adaptation measure by crop farmers in the study area. Previous studies by Hill (1983) obtained pseudo-R^2 values of between 0.3226 and 0.3484 while Zepeda (1990) and Rahji and Fakayode (2009) reported pseudo R^2 values of 0.25 and 0.3145 respectively as representing a relatively good-fit for a multinomial logit regression model. Hence, the pseudo R^2 value of 0.2245 in this study is indicative of good fit and the correctness of the estimated model and therefore econometrically validated. Level of education, age and extension education were found to be significant at explaining the choice of adaptation measures by the respondents. The level of education of a farmer has the propensity to raise the technical competence of the farmer and enables him/her make very objective assessments to circumvent the vagaries associated with climate change. Results in Table 1 indicated that the mean age of respondents was 7 years. This underscores the need for increased literacy levels and extension education. In the face of climate change phenomenon which has come to stay, adaptation to survive by arable crop farmers seems to be the only sustainable option. The need for increased farm advisory services and sensitization by way of early warning signs has become necessary.

Marginal effects and quasi–elasticities

The computed marginal effects and quasi-elasticity estimates are presented in Table 4. The there variables significantly affecting the choice of adaptation measures across the categories are inelastic, that is, their computed values ranged from 0.001 for changing tillage operation to 0.968 for soil and water conservation which are less than 1. The probability of classifying the farmers into any particular group is not greatly affected by marginal changes in these variables as a one percent change in each of the variables in turn, led to a less than proportionate change in the probability of adopting the adaptation measures in the study area. For example, the computed marginal effect for education was 0.056 for portfolio diversification. This implies that if the level of education of the farmers increased by 1%, the probability of adopting the improved management techniques will increase by 0.056%.

The critical value of the chi-square at 0.01 probability level and 45 degrees of freedom was 25.9 which is less that the computed chi-square value of 86.97. The null hypothesis is therefore rejected and it is concluded that at least one of the regression coefficients in the model is not equal to zero.

CONCLUSION AND RECOMMENDATIONS

The three variables significantly affecting the farmer's choice of adaptation measures to climate change were extension education, years of formal education and age of farmers. Farmers adapted to climate change phenomenon by using different measures to mitigate the adverse consequences. The adaptation stemmed from their awareness of these techniques. It was established from this study that some socioeconomic characteristics of farmers significantly influenced their adaptation decisions which underscores the need for appropriate policy attention to enhance their productivity and livelihoods.

The following policy recommendations are made. There is the need for increased formal and informal institutional support such as farm advisory services and extension education to promote the use of adaptation options and indigenous knowledge systems to reduce the negative effects of climate change. This is with a view to increasing farmers' ability to cope and the evolution of appropriate risk reduction production strategies in response to perceived climate change to improve their well-being. The current stance of the Nigeria Emergency Management Agency (NEMA) in sensitizing farmers by giving early warning signs based on scientific data should be further encouraged. There is also the need for the evolution of emerging technologies and land management practices by the government that could greatly reduce agriculture's negative impacts on the environment and enhance its positive impacts. The importance of education in empowering the farmers and enhancing their capacity to choose appropriate climate change adaptation measures cannot be over emphasized. Increased literacy campaign among farmers will enhance the farmers' capacity to cope with climate change.

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