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Perception and Adaptation to Climate Change among Farmers in Selected Communities of Ekiti State, Nigeria

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Abstract: This study discusses the findings of the research that was carried out in Ikogosi Warm Spring Communities of Ekiti State among predominantly smallholder arable crop farmers on their knowledge of climate change and adaptation strategies. The study discovered that almost all the farmers interviewed perceived changes in climate. The result of factors influencing farmers' perception decisions using ordered logit regression analysis showed that gender, age and level of education were statistically significant in making decisions on the level of perception made by the farmers. Finally, multinomial logit regression model was employed to analyse the factors that are influencing farmers' choice of adaptation on climate change and variability. The results indicate that gender, age, farming experience, land tenure, farm size, access to extension services, access to loan, engage in non-farming activities, temperature and rainfall were the main factors influencing farmers' choice of adaptation to mitigate effect of climate change in the study area. It is therefore, concluded that government policies and investment strategies must focus on most of the factors highlighted above in order to rescue the poor crop farming households from the danger of climate change.

Key Words: Farmers, perception, adaptation, climate change, multinomial logit

1. Introduction

Agriculture, primarily small-scale, is one of the most important sectors of the Nigerian economy with South-west zone (Ekiti State inclusive) being one of the major food producing zones. Agriculture accounts for about 42% of Nigeria's Gross Domestic Product (GDP) and two-thirds of employment which is the highest among all the sectors. It accounts for over 70% of non-oil exports and, perhaps most important, provided over 80% of the food needs of the country. Not only that, about 70% of Nigerians live in rural area, and 90% of these engaged in agriculture. This implies that agriculture is a key sector that stands to affect majority of Nigerians positively (Okolo, 2004). Despite its high contribution to the overall economy, this sector has been seriously facing challenges of many factors of which climate-related disasters like drought and floods are the major ones. The challenge is composed of the likely impacts of climate change on ecosystem services, agricultural production, and livelihoods (Odada *et al*.,2008), as well as limited resilience and high vulnerability characterizing regions dominated by economic poverty, subsistence food production, and a low and highly variable natural production potential (Mertz *et al*., 2009). Nigeria's agricultural sector, just as in many developing countries in the subtropical region, is more vulnerable to climate change landless farmers, livestock keepers, people in poor health, those who are undernourished, people with low economic power, women and children including women headed households, those with low level of education, and those with low technological know-how are more exposed to the risk of climate change.

The indigenous farmers who are vital and active parts of many ecosystems may help to enhance the resilience of these ecosystems. Their livelihoods depend on natural resources that are directly affected by climate change, and they often inhabit economically and politically marginal areas in diverse, but fragile ecosystems. In addition, they interpret and react to climate change impacts in creative ways, drawing on traditional knowledge as well as new technologies to find solutions, which may help society at large to cope with the impending changes (Jan and Anja, 2007;

Ishaya and Abaje, 2008). Again, policy responses to climate change/variability have been mainly driven by debates among scientists, whilst the insights of poor people living on the frontline have been largely neglected (Mutekwa, 2009). Doss and Morris (2001) opined that the perspectives of the indigenous people, the way they think and behave in relation to climate change, as well as their values and aspirations have a significant role to play in addressing climate change.

Most of the studies carried out in the literatures (Deressa, 2008; Deressa *et al.*, 2009; Gbetibouo, 2009; Benedicta *et al.*, 2010 and so on) examined farmers' perceptions of climate change by asking them whether there is increased or decreased, changed or no changed on climate attributes such as temperatures, precipitation/rainfall and sunshine hours. This study observed that farmers' response to the above questions were based on present weather situation at the time of asking the question and farmers placed more weight on recent information than its efficiency as also reported by Gbetibouo, 2009. It has also been noticed that there is no rational farmer who does not know that climate is changing. The argument at this time should be the level of perceptions rather than whether farmers perceived or not perceived climate change. Deressa *et al.* (2011) also opined that in developing countries, the common approach to studying the perception of farmers to climate change is based on comparing farm survey or farm group discussion results with data records from meteorological stations.

The studies were informative in terms of understanding the level of perception of farmers and the possibility of validating farmers' claims of perceptions of change against meteorological data, but these approaches do not explicitly identify factors influencing perception of climate change. Adaptation to climate change has been observed as a two-step process; the first step requires the farmers to perceive a change in climate and the second step requires them to act through adaptation (Maddison, 2006; Deressa *et al.*, 2011) using Heckman probit selection model. Although informative in terms of understanding the factors influencing farmers' perception of and adaptation to climate change but failed to analyse factors influencing level of perception of climate change alone. Ishaya and Abaje (2008) reported that climate models paint the bigger picture of climate change and provide estimates for the likely consequences of different future scenarios of human development; they are not very good at providing information about changes at the local level. This study therefore adopted the method used by Ishaya and Abaje (2008) to examine farmers' perceptions of climate change by asking the farmers psychological and "enviro-behavioural" questions that portrait the symptoms of climate change in the region. The study was later modelled to examine socio-economic factors influencing the level of perception of climate change.

It is no more a news that Africa's agriculture will be negatively affected by climate change most especially Sub-Saharan Africa in which Nigeria is inclusive. Farauta *et al.* (2011) opined that more than two thirds of Nigeria is thought to be prone to desertification and also confirmed that the desert, which now covers about 35 percent of Nigeria's land mass, is advancing at an estimated 0.6 km per annum, while deforestation is taking place at 3.5 percent per annum. The weather variability that has been experiencing in Nigeria for some years now has been a great challenge to rural farmers who depend solely on rain-fed agriculture. They manifest in a number of ways which include: occurrence of flood or drought on average in some regions, uneven distribution and unpredictable rainfall, longer hours of sunshine and drying up of streams/rivers that do flow round the year in some regions, late onset of monsoon with wind storms which do destroy farm assets and rises in sea level have characterized the climatic system of Nigeria most especially in Southwest region. Therefore, to tackle the impact and effect of climate change on agriculture, it has been considered important to take adaptation seriously. Bryant *et al.* (2000) reports that adaptation in agriculture is how perception of climate change is translated into agricultural decision-making process. Adaptation to climate change refers to 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, 2001). Failure to address the issue of climate change may lead to a situation where Nigeria and other West Africa countries incur agricultural losses of up to 4% of GDP due to climate change (Mendelsohn *et al.*, 2005). Parts of the country that experienced soil erosion and operate rain-fed agriculture could have declined in agricultural yield of up to 50% within 2000-2020 due to increasing impact of climate change (IPCC, 2007). Since agriculture (mainly food crop) is the mainstay of the people in the study area, it is therefore imperative to find out what farmers perceived about climate change and at the same time, the coping strategies they are employing to overcome the situation. This knowledge of farmers' perception and adopted adaptation measures will also go a long way in providing an alternative adaptation strategy that can be best employed to stabilize food production in the face of anticipated changes in climate in the study area. Again, in order to be continually relevant in arable crop enterprise in the region, it is high time a study of this nature was carried out to analyse perception and adaptation to climate change among arable crop farmers in Ikogosi Warm Spring communities of Ekiti State, Nigeria. The specific drive of this study is to ascertain the socio-economic characteristics of the respondents, analyse farmers' perceptions about climate change and factors influencing farmers' choice of adaptation measures in the study area. The knowledge from this study will also help in policy making that may have positive impact on the life of farming households who are directly affected by climate change.

2. Materials and Methods

2.1. Study Area

The study was carried out in Ikogosi Warm Spring Communities of Ekiti State, Nigeria and the areas of interest were: Ekiti West, Ado-Ekiti and Ekiti South West with the population of 179,892; 308,621 and 165,277 respectively (NPC, 2006).

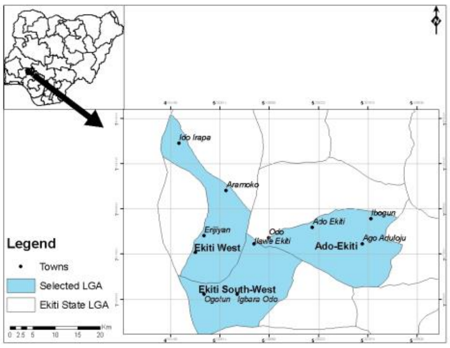

Figure 1: *Map of Ekiti State indicating the Ado-Ekiti, Ekiti West and Ekiti South-West locations*

The geographical coordinates are 70 35′ North and 40 59′ East (Ekiti West), 70 25′ North and 50 19′ East (Ekiti South West) and 70 40′ North and 50 15′ East (Ado-Ekiti) as shown in Figure 1. Notable among Nigeria tourist attractions is the Ikogosi tourist centre which is referred to as the haven of tourism in Nigeria. At Ikogosi, the warm and cold water oozing out from different sources from the earth crust flow separately to meet in a pool each retaining its thermal identity. The area enjoys lowland tropical rain forest climate type with distinct rainy season (April – October) and dry season (November – March). The temperature ranges between 21^0C and 28^0C with high humidity. The south westerly wind and the northeast winds blow in the rainy and dry (Harmattan) seasons respectively. The state is largely agrarian. Agriculture is the mainstay of the state economy. It employs over 75% of the state working population. Ekiti is greatly endowed with mineral deposits and it is known to be one of the largest producers of both cash and arable crops.

2.2. Data Collection and Sampling Technique

The population of this study was arable crop farmers in Ikogosi Warm Spring Communities of Ekiti State. Both primary and secondary data were used for this study. Well structured questionnaire was used to obtain pertinent information on socioeconomic characteristics of the farmers, perception of the farmers about climate change and perceived adaptation measures. This study was randomly administering 135 questionnai

the respondents. Generally, the area is kno one of the food producing States in Nigeria and it has been experiencing significant weather variabilities for some years, therefore, necessitate the full understanding of effects of coping strategies used in the study area. Multistage sampling technique was used for the random selection of respondents. Three local government areas (LGAs) were purposively selected which are: Ekiti west, Ekiti south west and Ado local government areas. Three communities were randomly selected from each LGA using simple random sampling technique. The communities are: Ikogosi, Erinjinyan, Aramoko (Ekiti West), Igbara-odo, Ilawe, Ogotun (Ekiti South West), Ago-aduloju, Odo, Erufun (Ado-Ekiti). Simple random sampling was used to select 15 households from each community and this making a total of 135 households from the three LGAs. In addition to this, only farmers aged 30 or more were selected for this survey. Secondary data were collected on climate attributes from a review of literature on climate change, particularly the Intergovernmental Panel on Climate Change (IPCC) reports. Descriptive statistics, likert rating scale which was later modelled to ordered logit regression and multinomial logit regression were used to achieve the objectives of this study.

2.3. Data Analytical Procedure

Descriptive statistics were used to analyze socioeconomic characteristics of the respondents with the aid of using percentages, mean, maximum and minimum values, tables and charts. The variables used here are: Age (years), Household Size, Household Head, Gender (male or female), Level of Education (years), Farming Experience (years), Farm Size (hectare), Access to Market (kilometre), Access to Agricultural Extension Services, Access to Credit or Loan and Land tenure.

Likert Scale was used to examine respondents' perception about climate change in the study area. Twenty perception questions on climate change were asked from respondents base on their level of agreement or decision making. A 5-point Likert Rating Scale (LRS) was employed. This was graded as Strongly Agree (SA) = 5, Agree (A) = 4, Undecided (U) = 3, Disagree (D) = 2, Strongly Disagree (SD) = 1.

The mean score of respondents base on the 5-point LRS was computed as

$$5+4+3+2+1=\frac{15}{5}=3.00$$

Using the interval scale of 0.50, the upper cut-off point was determined as 3.00 + 0.50 =3.50; the lower limit as 3.00 – 0.50=2.50.

On the basis of this, mean scores below 2.50 (i.e. MS < 2.50) was ranked Low Perception; those between 2.50 – 3.49 were considered as Moderate Perception while mean scores that were greater than or equal to 3.50 (i.e. MS ≥ 3.50) were considered to have High Perception.

Again, an ordered logit model was employed to estimate the influence of household socio-economic factors on the level of perception decisions made by the respondents. This was done because the dependent variable was of ordinal categorical nature derived through a LRS which required the respondents to indicate the extent to which they perceived changes on climatic conditions under the three categories as: High = 3, Moderate = 2 and Low = 1. The ordinal logit model is built around a latent regression in the same manner as the binomial probit model.

$$\text{Let } y^* = \beta' X + \varepsilon i$$

Where y* is the underlying latent variable that indexes the level of contributions of respondents to perception decision making, X is a vector of parameters to be estimated and ε is the error term. The latent variable exhibits itself in ordinal categories, which could be coded as 0,1,2,3,…,j. the response of category j is thus observed when the underlying continuous response falls in the jth interval as:

$$\begin{aligned} Y &= 0 \text{ if } y^* \leq 0 \\ &= 1 \text{ if } 0 > y^* \leq \delta 1 \\ &= 2 \text{ if } \delta 1 > y^* \leq \delta 2 \\ &= 3 \text{ if } \delta 2 > y^* \leq \delta 3 \\ &\;. \\ &\;. \\ &\;. \\ &\;. \\ &= j \text{ if } \delta j\text{-}1 \leq y^* \end{aligned}$$

which is form of consoring, with the δ's being unknown parameters to be estimated with β(Green, 2000 cited in Enete and Amusa, 2010).

Multinomial logit (MNL) was employed to analyze factors influencing farmers' choice of adaptation measures already adopted to mitigate climate change effects in the study area. The dependent variables are adaptation measures already adopted in the study area which were grouped to the followings: Crop Diversification, Different Planting Dates, Changing Use of Chemical, Soil Conservation, Mulching & Planting Trees, Other Adaptations, No Adaptation.

While explanatory variables for MNL were all variables under socioeconomic characteristics mentioned above plus climate attributes (Annual Mean Temperature (degree Celsius) and Annual Mean Rainfall (millimetre).

2.3.1. Describling MNL Model

The advantage of MNL is that it permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories (Madalla, 1983; Woolddridge, 2002 cited in Deressa *et al*., 2009). To compliment this, Koch (2007) emphasizes the usefulness of this model by describing the ease of interpreting estimates from this model.

Let Yi be a random variable representing the adaptation categories or options chosen by any farming household taking on the values {1,2,…J} for J, a positive integer, and

Let X represents a set of conditioning variables which were the household attributes like age, level of education, farm size and so on.

The question is how ceteris paribus changes in the elements of X affect the response probabilities P(Y = j/X), j = 1,2,…J

Since the probabilities must sum to unity, P(Y = j/X) is determined once we know the probabilities for j = 2,…J

Let X be a 1 x K vector with first element unity.

The MNL model has response probabilities:

P (Y = j/X) = exp (X βj)/ [1 + exp (X βh), j = 1,…J] ………….. (1)

Where βj is K x 1, j = 1…J.

Note:

Unbiased and consistent parameter estimates of the MNL model in equation (1) require the assumption of independence of irrelevant alternatives (IIA) to hold which means that the probability of using a certain adaptation method by a given household needs to be independent from the probability of choosing another adaptation method (that is, Pj/Pk is independent of the remaining probabilities). The premise of the IIA assumption is the independent and homoscedastic disturbance terms of the basic model.

3. Results and Discussion

3.1. Socio-economic characteristics of the respondent

The results indicate that the mean age of the household is 48 years with a modal of 38 years showing that majority of the households (over 60%) are youth and therefore are still in their active working age. Sometimes, age of the head of household can be used to capture farming experience (Deressa *et al*., 2009) but this has not always been true since there is no specific age for the respondents to start farming. Therefore, one might be old and start farming late while another might be young and start farming at his/her early age. As shown in Table 2, over 60 percent of the respondents have over 20 years of farming experience while less than 40 percent has at most 20 years of farming experience. This indicated that majority of the respondents are matured and more experienced in farming, and assumed to have a better knowledge and information on changes in climatic conditions as reported by Nhemachena and Hassan, 2007. This was also connoted with what Oluwatayo, 2009 reported about resource use efficiency of maize farmers in Ekiti State.

Table 1: *Respondents' Distribution by Socio* **-** *economic Characteristics*

Household characteristics	**Frequency**	**Percentage of respondents**
Age (years)		
30 – 39	48	35.6
40 – 49	33	24.4
50 – 59	23	17.0
60 – 69	18	13.3
≥ 70	13	9.6
Farming Experience(years)		
≤ 10	7	5.2
11 – 20	42	31.1
21 – 30	34	25.2
31 – 40	23	17.0
≥ 41	29	21.5
Educational level		
No formal education	46	34.1
Primary education	31	23.0
Secondary education	39	28.9
Tertiary education	19	14.0
Gender		
Female	40	29.6
Male	95	70.4
Marital status		
Single	14	10.4
Married	101	74.8
Divorced	6	4.4
Widowed	14	10.4
Household size		
≤ 5	46	34.1
6 – 10	54	40.0
11 – 15	31	23.0
≥ 16	4	3.0
Farm size (ha)		
< 1.00	97	71.9
1.00 – 1.99	23	17.0
2.00 – 2.99	10	7.4
3.00 – 3.99	4	3.0
≥ 4.00	1	0.7
Income level (₦)		
≤ 100,000	62	45.9
100,001 – 500,000	61	45.2
500,001 – 1,000,000	11	8.1
≥ 1,000,001	1	0.7

1USD equivalent to ₦ 162 as at 2011.
Source: Field Survey, 2011.
No. of Observation: 135

Education is one of the factors influencing adoption decisions. Several studies have shown that improving education and disseminating knowledge is an important policy measure for stimulating local participation in various development and natural resource management initiatives (Bultena & Hoiberg, 1983; Anderson & Thampallai, 1990; Shields *et al*., 1993; Heinen, 1996; Traore *et al*., 1998; Higman *et al*., 1999; Anim, 1999; Lapar & Pandely, 1999; Glendinning *et al*., 2001; Dolisca *et al*., 2006; Anley *et al*., 2007; Tizale, 2007 as cited in Hassan and Nhemachena, 2008). The Table 2 also indicated that majority of the respondents (65.9%) have at least primary school education in which most of them were secondary school holders while less that 35 percent has no formal education.

It was unveiled that majority (70.4%) of the sampled respondents were male farmers while only about 30 percent were female. This signifies that male gender dominated farming sector in the study area. This has been in line with most of the studies in literature. The reason for this significant gap was the belief in the study area that a woman should not own a farm of her own when she still has a living husband. She is expected to work with her husband on his farm land. Nevertheless, widowed women who are single at the time engage in farming on their lands which are the one passed to them by their late husband so as to fend for their family (Oluwatayo *et al*., 2008).

Over two-third (74.8%) of them are married, 10.4 percent are single, 4.4 percent divorced and 10.3 percent widowed. It means that most of the respondents in the study area are married.

Household size between 6 and 10 formed the majority (40%) of the total number of the respondents. It was observed that over 65 percent of the respondents have at least household size of six. The average household size was eight (8) signifying that the size was fairly large enough to influence the adoption of a new technology significantly as well as assisting to reduce labour intensive and costs in the long run.

Studies on adoption of agricultural technologies indicate that farm size has both negative and positive effects on adoption, showing that the effect of farm size on technology adoption is inconclusive (Bradshaw, Dolan and Smith, 2004). Referring to the Table 2, respondents (88.9%) with less than two hectares of land were the majority in the study area while only five respondents (3.7%) have a farm size of at least three hectares. This implies that majority of the respondents are small scale farmers with average of 0.83 hectare of land.

Quite a large number of the respondents (91.1%) earns at most ₦500,000 from their arable crop produce. Sixty-two respondents which is about 46 percent earns less than equal to ₦100,000 annually. Twelve respondents (8.8%) earns greater than ₦ 500,000 annually. Wealth is believed to reflect past achievements of households and their ability to bear risks. Thus, households with higher income and greater assets are in better position to adopt new farming technologies. Couple this with their farm size above, one can still concur with the assumption that these people are not rich neither are they poor.

3.2. Analysing Farmers' Perceptions of Climate Change and Variability

Here, twenty perception questions were asked from the respondents to know the level of their perceptions about climate change and weather variability.

The questions were structured to capture issues like causes, effect and the belief of the people about climate and weather variability. The results from likert rating scale were categorized into three levels of perception as shown in Figure 2 and Table 2 below.

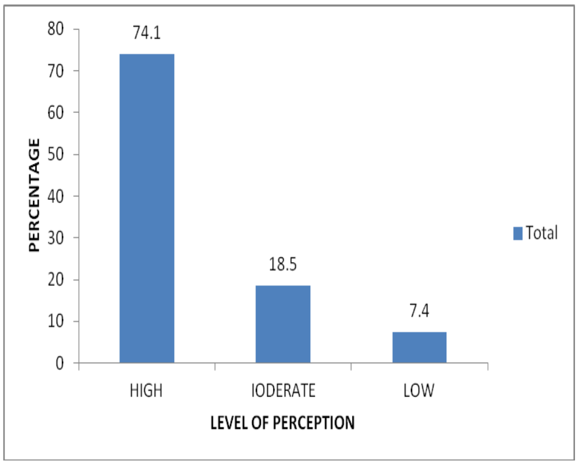

Figure 2: Level of perceptions of the respondents on climate change source: Computed from field survey, 2011

Figure 2 indicated that majority (74.1%) of the respondents perceived high that climate has changed in the past 20 years in the study area. 18.5 percent has a moderate perception while a small number (7.4%) has low perception that climate is changing.

Table 2: *Level of General Perception of Changes in Climate (%)*

Locations	Low	Moderate	High
Ekiti W	8.9	8.9	82.2
Ekiti SW	6.7	13.3	80.0
Ado LG	6.7	33.3	60.0
Total	7.4	18.5	74.1

Source: Field Survey, 2011

The trend was the same in all the three locations as shown in Table 2 with the exception of Ado LGA, where the least high perception (60%) and highest moderate perception (33.3%) that climate is changing, were noticed compare to Ekiti West (EkitiW) and Ekiti South West (EkiteSW) LGAs. The slight difference might be due to the urban nature of the area and less percentage of people were engaged in farming activities compare with other locations. And more than 60 percent of the respondents were non-indigene who might not know what have conspired over the years.

The outcomes from above were further subjected to analysis to confirm if the differences and/or similarities noticed are statistically significant. Table 3a revealed that the perceptions of the three locations that climate has changed or is changing, were weak but positively correlated meaning that there is a positive relationship among them. Nevertheless, the relationship between Ado LG & EkitiW and Ado LG & EkitiSW were further noticed to be very weak compare to EkitiW & EkitiSW.

Table 3a: *Paired Samples Correlations and t-tests among the Three Locations*

Locations	Correlation	t-tests
EkitiW & EkitiSW	0.241(0.111)	0.000(1.000)
EkitiW & Ado LG	0.024(0.878)	1.545(0.130)
EkitiSW & Ado LG	0.025(0.870)	1.593(0.118)

note: significant at $p < 0.05$

This also concurs with the fact that EkitiW and EkitiSW are more rural and agrarian compare with Ado LG. The results were analyzed further by running paired sample test among three locations based on their level of perception as shown in Table 3a. Considering the t-values and their level of significances, it was unveiled that their perceptions that climate is changing were not statistically significantly difference.

Table 3b: *ANOVA result comparing the samples means of the three locations*

Perception	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.200	2	0.600	1.623	0.201
Within Groups	48.800	132	0.370		
Total	50	134			

note: significant at $p < 0.05$
source: computed from field survey, 2011.

Table 3b showed the result of analysis of variance (ANOVA) which compares the means of the three locations altogether to further foster the level of significant based on their perception. Given P (0.201) > 0.05 significant level, further shows that the perception among the three locations are not statistically significantly difference. The results above can be justified because Ekiti has been known for their uniqueness and homogenousity in terms of culture, language, pattern of farming as well as vegetation.

As shown in the above section, a large number of farmers (over 90%) perceived that climate is changing. As suggested by Maddison (2006), this perception might be a case of prominence bias in questionnaires dealing with climate change or some respondents provided answers because they were indigenes of these areas. This study now went further by testing if the perceptions of the non-indigene farmers are statistically different from the indigene farmers in the study area. This was subjected to Kruskal-Wallis test (a nonparametric test). Given this result (Chi-square = 0.142; Asymp. Sig. = 0.931), it was indicated that the views between indigene farmers and non-indigene farmers are statistically not significantly difference.

3.3. Household Socio-Economic Factors Affecting the Contribution of the Respondents on Perception Decision

Table 4 presents the estimates of the parameters of ordered logit regression on factors influencing the level of perception decision made by the respondents. The overall goodness of fit as reflected by Prob > Chi2 (0.0025) was good. Threshold parameters D1 and D2 showed that the three categories in the response were indeed ordered.

Table 4: *Result of ordered logit regression model*

Explanatory variables	Coefficient	P- value
Gender	1.294592***	0.009
Family size	-0.0534447	0.325
Age	0.0482796**	0.025
Level of education	0.5395975*	0.053
Farming experience	-0.0510896	0.273
Farm size	-0.03735008	0.872
Access to extension service	-0.7970237	0.131
D_1	2.401853	
D_2	4.066338	

Log likelihood = -87.159125; No of observation = 135; Chi2 = 22.08; Prob.>Chi2 = 0.0025; Pseudo R^2 = 0.1124; ***significant at 1%, **significant at 5%, *significant at 10%.
Source: Computed by the author

The gender of the respondents was positively and highly significantly related with their level of perception decisions. It means that male headed households were likely to perceive changes on climate than the female counterpart. The reason might be the large involvement of the male-headed households in farming activities since less than 40 percent of female-headed households were engaged in farm practices in the study area as observed in many studies such as Ishaya and Abaje, 2008; Oluwatayo *et al.,* 2008; Oluwatayo, 2009. Due to this, there is a probability that male-headed households may perceive changes in climate than the female counterpart.

Age of the household's head was also positively and significant related with the level of perception decision made by the respondents. It indicates that the older the respondent, the higher the probability of the respondent perceive changes on climatic conditions. This supported a priori expectation for the fact that one will expect older farmers to perceive changes in climate than the younger ones because they must have witnessed and exposed to significant variations in weather and climate over the years. The level of education was positive and important in explaining the level of perception decision made by the respondents. In other words, highly educated persons were likely to perceive that climate is changing than uneducated ones. The educated farmers have access to climate information through newspapers, mass media and internet which had broadened their knowledge on the implications of climate change unlike the illiterates who cannot read or write.

Again, from the perception questions, it was observed that more than 90 percent of the respondents at least agree that environment is changing due to human activities, almost all of them agreed that rain is coming late yearly and does not support crop production as before. They complained about the last and present seasons that they experienced crop failure most especially in maize and yam production due to late and short timing of the rainfall pattern. Over 80 percent amount this to excessive deforestation and said that this has led to food scarcity as well as food insecurity in the study area.

3.4. Factors Influencing Farmers' Choice of Adaptation Measures

The results of MNL model showed how factors of socio-economic characteristics influence farmers' choice of adaptation measures in the study area. The MNL failed to produce satisfactory results in terms of significance level of the parameters estimates when many adaptation options were first run. This was thus restructured by grouping closely related choices together in the same category. Planting different crops, Planting different varieties and practising crop diversification were grouped together as the same category, labelled "Crop Diversification", different planting dates and shorten length of growing period were grouped as the same category, labelled "Different

Planting Dates", move to different sites and changes amount of land were grouped as the same category, labelled "Soil Conservation" shading and shelter, planting trees and mulching were grouped together as the same category, labelled "Mulching & Planting Trees. Irrigation and use of insurance were discarded because none of them is adopting them. Prayers were not also used because it is not scientifically relevant and measurable. All the restructuring and grouping were made based on their closely related and can also be considered for the same purpose of risk-spreading.

Therefore, the choice set in the restructured MNL model included the following adaptation options: (a) Crop Diversification (b) Different Planting Dates (c) Changing Use of Chemical (d) Soil Conservation (e) Mulching & Planting Trees (f) Other Adaptations (such as use of insurance, farm to non-farm activities, migration, crop to livestock farming, irrigation, selling of farms) and (g) No Adaptation.

The MNL adaptation model with these restructuring choices was run and showed some significant levels of the parameters estimates. Table 5 showed the results of MNL Regression model. The likelihood ratio statistics as indicated by $\chi 2$ statistics (178.28) are highly significant ($P < 0.0001$), suggesting the model has a strong explanatory power.

In all cases, the estimated coefficients should be compared with the base category of no adaptation. Moreover, the MNL is run with and without many explanatory variables (endogenous and exogenous variables), as they were in many studies such as Deressa *et al*., 2009 and Gbetibouo, 2009 while some were later dropped because of their insignificant effect on the parameters of the estimates.

Therefore, Table 5 presents the MNL results along with the levels of statistical significance.

1. Gender. The results indicate that male-headed households adapt more readily to climate change. Gender significantly increases adaptation using crop diversification, different planting dates, changing use of chemical and mulching & planting trees in the study area. Soil conservation was not significant but positive which can also infer that gender has a positive relationship with soil conservation option. This result is in line with the argument that male-headed households are often considered to be more likely to get information about new technologies and take on risk than female-headed households (Asfaw and Admassie, 2004, Deressa, 2008 cited in Deressa *et al.*, 2009) but contrary to what Nhemachena and Hassan (2007) finds in their study carried out in Southern Africa region. This study follows the a prior argument that indicates that male-headed households are more likely to take up adaptation methods as they have more access to resources and information as it has been observed by Buyinza & Wambede, 2008; Deressa *et al.*, 2011.

2. Age. Age of the household head has a positive and significant impact on adaptation to climate change. The result revealed that as the farmer gets older, the probability of adopting adaptation to climate change using crop diversification, different planting dates and mulching & planting trees increases in the study area. The outcome of this study with respect to age was in line with studies reported by Deressa *et al*., 2009.

3. Education. Education also has a significant effect in adapting to climate change. A unit increase in the year of education of the farmer results in an increase in the probability of using adaptation such as different planting dates and use of chemicals as a measure to combat effects of climate change in the study area. The probable reason for this result could be due to the fact that education has exposed farmers to different adaptation measures and has allowed them to have a significant understanding of what climate change is and the likely things they can do to cushion its effects.

4. Farm Size. Farm size of the households surveyed has a positive and significant impact on crop diversification, different planting dates, changing use of chemical, soil conservation and mulching & planting trees. However, because farm size is always associated with greater wealth vis-a-vis more capital and resources, the larger the farmer's farm size, the more likely the probability of adapting to climatic change in the study area. Farm size has been a controversial issue in the literature. Several studies on adoption of agricultural technologies indicate that farm size has both negative and positive effects on adoption, showing that the effect of farm size on technology adoption is inclusive (Bradshaw *et al.*, 2004).

Therefore, this study supports the view of Daberkow and McBride, 2003 cited in Gbetibouo, 2009 which reported that given the uncertainty and the fixed transaction and information costs associated with innovation, there may be a critical lower limit on farm size that prevents smaller farms from adopting. As these costs increase, the critical size also increases. It follows that innovations with large fixed transaction and/or information costs are less likely to be adopted by smaller farms. But contrary to the findings of Deressa *et al.* (2011) in which they observed a negative relationship between adaptation and farm size.

Table 5: *Result of the multinomial logit model on climate change adaptation.*

Explanatory variables	Crop Diversification Coefficient (Std. Err.)	Different Planting Dates Coefficient (Std. Err.)	Changing use of Chemical Coefficient (Std. Err.)	Soil Conservation Coefficient (Std. Err.)	Mulching & Planting Trees Coefficient (Std. Err.)	Other adaptations Coefficient (Std. Err.)
Gender	**2.9962****	**2.137622***	**2.4651****	1.2647	**3.1132****	-22.6695
	(1.2848)	**(1.1167)**	**(0.9738)**	(0.8406)	**(1.2364)**	(37.7994)
Household size	-0.1786	-0.0606372	-0.1124	-0.0480	-0.1324	0.3597
	(0.1649)	(0.1026)	(0.0980)	(0.0867)	(0.1115)	(3.3686)
Age	**0.1691***	**0.1910906****	0.1196	0.0360	**0.2491*****	5.5897
	(0.0914)	**(0.0890)**	(0.0755)	(0.0727)	**(0.0843)**	(3.4220)
Education	0.4328	**0.3446*****	**0.8880****	0.0952	1.4408	32.0381
	(1.7316)	**(0.1162)**	**(0.4517)**	(0.9147)	(1.1833)	(38.4820)
Farming experience	-0.1234	-0.0972	-0.0474	0.0173	**0.1730****	**4.9120***
	(0.0967)	(0.0798)	(0.0703)	(0.0676)	**(0.0794)**	**(2.8769)**
Land tenure	11.6165	12.30643	-1.243021	-0.3101	-0.6084	**-165.9197***
	(311.2983)	(188.0102)	(0.9990)	(0.9564)	(1.1453)	**(94.6848)**
Farm size	**4.970192*****	**4.64486*****	**3.9060****	**2.7451***	**5.3243*****	39.4085
	(1.7845)	**(1.6835)**	**(1.6586)**	**(1.6256)**	**(1.6836)**	(72.1760)
Access to extension service	**0.1780341****	0.3467	**0.6491*****	0.0571	0.5163	46.6609
	(0.0848)	(1.1110)	**(0.0261)**	(0.9319)	(0.9502)	(49.1402)
Access to loan	**0.3164****	-0.7690	**0.1008****	**0.1032***	0.3063	**103.2487***
	(0.1352)	(0.9646)	**(0.0501)**	**(0.5810)**	(0.9502)	**(62.6012)**
Household income	-2.62E-06	-1.77E-06	2.33E-06	-1.83E-06	-2.84E-06	-0.0012
	(4.53E-06)	(3.85E-06)	(3.67E-06)	(3.57E-06)	(3.86E-06)	(0.0078)
Engage in non-farming activities	**0.7794****	**1.4345*****	**1.2518****	**1.2110***	0.4107	-15.5952
	(0.3193)	**(0.0936)**	**(0.6591)**	**(0.7340)**	(0.9282)	(19.7289)
Access to climate information	**311.3437*****	**188.0761*****	**2.8153****	1.5196	**4.3274****	248.1665
	(3.7115)	**(3.2061)**	**(1.4732)**	(3.3668)	**(2.2310)**	(5484.2530)
Temperature	0.6088	**1.0620*****	**0.9718***	0.6254	**0.9915***	**61.5611****
	(0.7788)	**(0.0586)**	**(0.5113)**	(0.4.656)	**(0.5844)**	**(31.4720)**
Rainfall	-0.0190	**1.465363***	-0.1591	0.3420	0.6058	**-42.3033***
	(0.8568)	**(0.8504)**	(0.5313)	(0.4948)	(0.7605)	**(24.5960)**
Constant	-18.7954	-25.1960	-3.3879	-3.6407	-9.0988	210.0384
Diagnostics						
Base category		No Adaptation				
Number of observations		135				
LR chi-square (91)		178.28***				
Log likelihood		-160.79297				
Pseudo- R^2		0.3567				

Note: ***' **' * significant at 1%, 5% and 10% respectively.

5. Access to Agricultural Extension Services. The result revealed that access to extension service was positively and significantly affects adaptation to climate change. The more the farmer has access to extension services, the more the chance of adopting adaptation measures such as crop diversification, different planting dates and use of chemicals. This study is in line with

various studies in developing countries that report a positive relationship between access to information and the adoption behaviour of farmers (Yirga, 2007), and that access to information through extension increases the likelihood of adapting to climate change (Maddison, 2006; Nhemachena and Hassan, 2007 and Deressa *et al*., 2009).

6. Access to Loan/Credit. Access to loan has a positive and significant impact on the likelihood of using adaptation measures such as crop diversification, different planting dates, use of chemicals and other adaptations. It means that having access to agricultural credit will likely increase the probability of using adaptation measures mentioned above in the course of changes in climatic conditions. In case of use of chemical, access to loan will allow farmers to purchase chemicals such as fertilizer, pesticide and herbicide as well as having financial capability to change amount of land and move to different site in order to reduce the negative impact of climate change.

7. Engage in Non-Farming Activities. In addition to farming activities, non-farming activities has significantly increased the use of crop diversification, different planting dates, changing use of chemicals and soil conservation. This study suggests that non-farming activities increase the probability of changing amount of land, use of agrochemicals, planting different crops and practising of shifting cultivation. Anyway, it has been reported that off-farm employment may present a constraint to adaptation because it competes for on-farm managerial time but this study, in line with Gbetibouo, 2009 suggests that expanding smallholder farmers' access to non-farming sources of income increases the probability that they will invest more in farming activities.

8. Access to climate information. Information on climate change had a significant effect on climate change. The more the farmers were informed about changing and its effects, the more the likelihood of using adaptation measures such as crop diversification, different planting dates, changing use of chemicals and mulching & planting of trees in the study area. Access to climate information will increase the level of perception vis-à-vis adoption of adaptation measures. This will also help the farmers in gathering momentum for the unforeseen climate change challenges.

9. Temperature. There is increased likelihood of adapting to climate change when there is a rise in annual mean temperature. The households are more likely to choose the following adaptation options in the course of rise in temperature in the study area: (i) different planting dates, (ii) changing use of chemical, (iii) mulching & planting trees and (iv) other adaptation options. Crop diversification and soil conservation also showed positive relationship with rise in temperature. The fact that adaptation to climate change increases with rising temperature is in line with the expectation that increasing temperature is damaging to African agriculture and farmers respond to this through the adoption of different adaptation methods (Kurukulasuriya and Mendelsohn, 2008 and Deressa, 2008).

10. Rainfall. A decrease in rainfall is likely to increase the probability of adapting to climate change. This result shows a significant impact between rainfall and adaption options such as different planting dates and other adaptations. Therefore, a delay in rainfall is likely to push farmers to delay their planting dates while an increase in rainfall may likely less the probability of adopting other adaptations' option. This result reconfirms that decreasing rainfall significantly increases the likelihood of using different planting date's option (Deressa *et al*., 2009).

4.0. Summary of Major Findings, Conclusion and Recommendations

The study discovered that almost all the farmers interviewed in all the three locations of Ikogosi Warm Spring communities perceived that climate is changing. The result of paired samples test and ANOVA test showed that there were no statistically significant differences among the three locations in terms of their perceptions to climate change. Furthermore, the result of factors influencing farmers' perception decisions using ordered logit regression analysis showed that gender, age and level of education were statistically significant in making decisions on the level of perception by the farmers. Finally, the results from MNL indicate that gender, age, farming experience, access to climate information, farm size, access to extension services, access to loan, engage in non-farming activities, temperature and rainfall are the major factors that statistically significantly influence farmers' choice of adaptation to mitigate effect of climate change in the study area.

The issue of climate change has gone beyond government effort alone. Everybody is a stakeholder in this struggle. Based on the findings of this study, it therefore suggests a number of different policy options that can sustain arable crop production through adaptation in the study area. These options include:

- more female-headed households must be involved in any climate change programme in the study area in order to increase their level of perceiving and adapting to climate change;
- government policy on climate change should focus more on illiterate farmers who are still agile and aggressive in farm enterprise;
- government should make farm credit/loan more available and accessible through the funding agencies so as to assist farmers in coping with the cost of adaptations;
- extension agents must be empowered and revitalized in order to intensify the level of awareness of climate change to the farmers;
- more programmes that deal with awareness of climate change must be encouraged among rural farmers who depend solely on rain-fed agriculture. By doing this, it will educate farmers on the implications of climate change, significant of conservation of the natural environment as well as achieving Millennium Development Goals (MDGs);
- government should make it a priority to make the environment conducive for non-farming activities as an alternative source of income for the farmers in investing in farm business.

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