Perception and Adaptation of Yam Based Farmers to Climate Change in Edo State, Nigeria

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ABSTRACT

This paper examines the perception and adaptation to climate change by yam based farmers in Edo State. The study employed primary data collected using structured questionnaire from the sampled yam based farmers in the study area. Data were analyzed using descriptive statistics and Multinomial Logit Model. Empirical results revealed that 67.20% of farmers perceived a decrease in precipitation while 43.20% ranked the effect of decrease in precipitation as not severe on yam production in the study area. The result also showed that 72% of the farmers utilized mulching as coping strategy for climate change effect on yam production while 13% of the farmers did not apply any adaptation method. The Multinomial Logit Model revealed that age and household size influenced (p<0.05) the probability of adopting yam varieties as coping strategy. Access to credit facilities and extension services are the determinants (p< 0.05) of adopting mulching as coping strategy. It is recommended that stakeholders in agriculture should intensify their efforts in sensitizing farmers more on the menace of climate change to yam production as well as the workable coping strategies through extension agents and radio.

Key words: Adaptation, perception, climate change, multinomial logit model and yam.

INTRODUCTION

Climate change is emerging as the most important environmental problem facing modern society. Increases in atmospheric stocks of Greenhouse Gases (GHG), including carbon dioxide (CO$_2$), methane (CH$_4$) and nitrous oxide (N$_2$O), due to human activities have been linked to global climate change (IPCC, 1990; 2007). According to IPCC (2007) report, it is virtually certain (more than 99% probability of occurrence) that most land areas will have warmer and fewer cold days and nights. It is also very likely that most areas (between 90 to 99% probability of occurrence) will have warmer temperature, more frequent heat waves and heavy precipitation events. More drought, tropical cyclone, and incidence of extreme high sea level are also likely.

Agriculture is vulnerable to climate change due to its dependence on natural weather patterns and climate cycles for its productivity. There is a growing literature focused on predicting and quantifying the impact of climate change on agricultural systems in many areas around the world. A few degrees of warming will generally increase temperate crop yields while in the tropics, yields of crops near their maximum temperature tolerance and dry land crops will decrease. A large decrease in rainfall would have even greater adverse effect on yields. In addition, degradation of soil and a decrease in water resources resulting from climate change are likely to have negative impacts on global agriculture (IPCC, 2001). However, with adaptation, crop yields will likely be less affected by climate change.

Quantifying the economic impact and assessing perception of climate change on agriculture is receiving increasing attention in literature. It was estimated that a
temperature increase of 2.5°C or more would cause a decline in crop yields and prompt food prices to increase due to growth in global food demand being faster than expansion of global food capacity (Parry et al., 1999). In the light of this, Kaiser and Drennen (1993) opined that climate change will not only have an effect on the productivity of agricultural products but will also have economic consequences on farm profitability, agricultural supply and demand, trade and price among others.

The capacity of Nigerian agricultural system to adapt to the changing weather shocks associated with climate change is not well known and also depends on varying perceptions. Developing a better understanding of this adaptation capacity provides the ground for wiser agricultural and environmental policies. For Nigeria, climate change poses great challenges to livelihoods and the development of the people. This is because, after petroleum and its product, the country depends on agriculture as a major engine for economic growth and development (Sofofewe et al., 2011). Like other developing countries, the challenge of climate change and global warming is enormous in Nigeria due to widespread poverty. Meeting the present and future need of the population in terms of food becomes a major challenge for every government. Nigeria is not an exception as it has been classified among countries where population exceeds the carrying capacity of its land resources when cultivated at low levels of technology (FAO, 1987). The population of Nigeria was put at 150 million based on 2006 population census figures; this figure is expected to increase to about 220 million by the year 2025 (Musa, 2000).

Yam is one of the major staple food in Nigeria, its production has being experiencing decline over the past 40 years dropping from 27 million tonnes per annum in 1961 to 6.7 million tonnes per annum in 2001 (FAO, 1999). This decrease can however be attributed to a number of factors such as fungal diseases, plant viruses, declining soil fertility and stress caused by climate change (Adeniyi, 2012). This decline in average yield per hectare has been rather drastic dropping from 14.9% in 1986 to 1990 to 2.5% in 1999 (CBN, 2002). As a result of this decline in production coupled with its importance in daily food menu and as a source of income to Nigerians, Bill and Melinda Gates foundation recently released $12.2 million for the purpose of increasing yam production both in yield and net output by 40% in Ghana and Nigeria. The new yam project is called "Yam Improvement for Income and Food Security in West Africa" (YIIFSWA) (Adeniyi, 2012). The perception of farmers to climate change, however, affects the strategies to be adopted for yam production in order to achieve YIIFSWA objectives.

In furtherance, Edo state in the Southern Nigeria has also been hit hard by harsh climatic variability. The good climatic condition which once favoured a high level production of food crops has changed; the state now witnesses a steady decline in yam production, owing mainly to a fall in productivity as a result of unfavorable climatic condition (Odjugo, 2006). CBN (2004) revealed that as at 2003, yam production amounted to just one-fourth of that of the peak production year (1999 to 2000). The low productivity crisis being experienced now was first noticed in 2000/2001 cropping season, when the state's production hit an all-time low 50% reduction from that of the peak period. Production, as ever since, being experiencing some seasonal fluctuations and an overall decline still persists. In addition to the foregoing, yield and biomass production of yam and as a result of climate change are declining at an alarming rate. There is therefore a need for a study aimed at identifying adaptation strategies that can help to assuage the scourging effect of climate change on yam production.

The objective of the study is to determine the perception as well as, identify the adoption methods of yam based farmers in Edo state. The study is also aimed at determining the factors influencing the choice of adaptation method to climate change by the farmers in the study area. The outcome of this study will therefore go a long way to improve yam production which is a prerequisite for enhanced farmers’ welfare in Edo state and by extension serve a useful purpose in formulating national policies aimed at tackling the ruinous effect of climate change and resultanty enhancing farmers’ welfare in Edo state and Nigeria at large.

THEORETICAL FRAMEWORK

The analytical approaches that are commonly used in an adoption decision study involving choices representing the selection of one among a set of mutually exclusive alternatives are Binary Logit Model, Binary Probit Model, Multinomial Logit Model, Multinomial Probit Model and Nested Logit Model etc. In these models, the set of alternatives must be exhaustive (that is, choosing any other alternative) and finite (Hensher et al., 2001). Agricultural technology adoption models are based on farmers' utility or profit maximizing behaviors (Norris and Batie, 1997).

The assumption here is that farmers adopt a new technology only when the perceived utility or profit from using this new technology is significantly greater than the traditional or the old method. While utility is not directly observed, the actions of economic agents are observed through the choices they make. Probit and Logit Models are the most commonly used models in the analysis of agricultural technology adoption research. Binary Probit or Logit models are employed when the number of choices available is two (whether to adopt or not).

The extensions of these models, most often referred to as multivariate models are employed when the number of choices available is more than two. The most commonly cited multivariate choice models in unordered choices are Multinomial Logit (MNL) and Multinomial Probit (MNP) models. MNLM is widely used in adoption of decision
studies involving multiple choices and it is easier to compute than its alternative- the Multinomial Probit model (Hausman and Wise, 1998; Wu and Babcock, 1998). Multinomial Logit model has computational simplicity in calculating the choice probabilities that are expressible in analytical form (Tse, 1987). The main limitation of the model is the Independence of Irrelevant Alternatives (IIA) property, which states that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set (Hausman and McFadden, 1984; Hassan and Nhemachena, 2008). Multivariate choice models have advantages over their counterparts of binomial Logit and Probit models in two aspects (Wu and Babcock, 1998). First, they allowed exploring of both factors conditioning specific choices or combination of choices and second, they took care of self-selection and interactions between alternatives.

Methods employed to analyze the effect of climate change on agricultural production do not just cover the aspect how farmers makes the best choice to come to the best decision on the probability of choosing appropriate strategy to adopt after which perceived effect have been rationalized. There are other ways of looking at climate change not only in the area of adaptation to the effect on crop production; rather, we tend to look at the area of impact of climate change to agricultural production in general. Two main approaches used to measure the impacts of climate change on agriculture were estimated:

(a) Structural modeling of crop and farmer response, which combines crop agronomic response with economic/farmer management decisions and practices; and
(b) Spatial analogue models that measure observed spatial differences in agricultural production (Adams et al., 1998a; Schimmelpfennig et al., 1996). Other impact assessment methods used are the integrated impact assessment method and the agro-ecological zone method (Mendelsohn, 2000).

Unlike the structural modeling, spatial analogue approach uses cross-sectional evidence to make statistical (econometric) estimations of how changes in the climate would affect agricultural production across different climatic zones. In addition, the approach gives evidence of changes in farmer management practices and decisions in response to changing climatic conditions. Another advantage of the spatial analogue approach is that other factors that affect crop production such as soil type and quality are taken into account in statistical estimation (Adams et al., 1998a; Schimmelpfennig, 1996).

Two main spatial analogue methods were developed to account for adaptation in response to changes in climate: (a) the Ricardian approach (Mendelsohn et al., 1994); and (b) the Future Agricultural Resources Model (FARM) of Darwin et al. (1994, 1995). The basic underlying assumption for both methods that similar climates mean similar production practices allows the two approaches to implicitly capture changes in crop or livestock outputs, production inputs or management practices that farmers are likely to take in response to changing climatic and other conditions (Darwin, 1999). The FARM model combines a global computable general equilibrium (CGE) model with geographic information system (GIS). Estimates of the FARM model fully accounts for all responses by economic agents under global climate change including estimates of Ricardian rents. This model makes use of GIS to link climatically derived land classes with other inputs and agricultural outputs in a CGE economic model of the world.

One of the limitations of FARM is that the sensitivity of the Ricardian rents to changes in climate variables at grid levels is affected by the aggregation of climatic information into six land classes, which makes it difficult to downscale the analysis to country level. Another limitation is that the FARM fails to capture some seasonal variations in climatic variables such as temperature, precipitation and coldness (Darwin, 1999). The Ricardian cross-sectional approach measures the performance of farmers, households and firms across spatial scales with different climates. The technique draws heavily on the underlying observation by Ricardo that under competition, land values reflect the productivity of the land. The Ricardian approach regresses farmland values against various: climate, economic and other factors to estimate the economic impacts of climate change and other factors on farm performance (Mendelsohn and Dinar, 1999, 2003; Mendelsohn, 2000; Mendelsohn et al., 1996, 1994; Adams et al., 1998a) are empirically estimated as:

\[ R = \int P_{LE^{\delta t}} dt = \int [\sum P_i Q_i (X, F, Z, H, G) - \sum P_i X] e^{dt} dt \]

(1)

The Ricardian method assumes that each farmer will seek to maximize net farm revenues by choosing inputs (X) subject to climate, soils and economic factors. The resulting net revenue function observes the loci of maximum profits subject to a set of climate, soils and economic factors and the Ricardian model is a reduced form hedonic price model of the observed loci of profits. The standard Ricardian model relies on a quadratic formulation of climatic variables:

\[ R = \beta_0 + \beta_1 F + \beta_2 F^2 + \beta_3 Z + \beta_3 \log(H) + u \]

(2)

Despite this fact, methodological similarities could be traced between agricultural technology adoption, climate change adaptation methods and other related models involving decisions to whether to adopt or not a given course of action and the steps economic agents take in the process of action. Many studies have used this approach to evaluate the impact of the climate on crop production, for example, Reilly (1996), Rosenzweig and Iglesias (1994) and Rosenzweig and Parry (1994). Rao and Sinha (1994)
used this method to assess the impact of the climate change on wheat production in India. More recently, Kumar and Parikh (2001) evaluated the impact of climate modifications on rice and wheat using this method. This approach can assess the impact of low to very low factor variations; however, it overestimated the damage to crop yields due to climate change. Mendelsohn et al. (1994), call this bias as the 'dumb farmer scenario', in other words, it does not take into account farmers’ adaptations as a response to social, economic and environmental changes. Indeed, most of the studies using this model do not take into account farmers’ adaptations but simply assess one or several factors involved in crop yield.

RESEARCH METHODOLOGY

Study area
The study was carried out in Edo State. The state lies roughly between longitude 06° 04E and 06° 43' E and latitude 05° 44' N and 07° 34' N. Edo is geographically located in central southern Nigeria which is bounded in the North and East by Kogi State, in the south by Delta State and in the west by Ondo State. The Northern part of Edo State shares the same savannah conditions with Northern Nigeria. The South, Central and part of the North also share the rain forest conditions with the rest of Southern Nigeria. Edo State has a tropical climate characterized by two distinct seasons: the wet and dry seasons. The wet season occurs between April and October with a break in August, and an average rainfall ranging from 150 cm (59") in the extreme north of the State to 250 cm (98") in the south. The dry season lasts from November to April with a cold harmattan spell between December and January. There are eighteen local government areas in Edo state. Edo state is known for the cultivation of maize, groundnut, guinea corn, soybeans, cassava, yam, vegetables, fruits, oil palm, cocoa, rubber, pharmaceutical herbs and ornamental trees etc.

Data
The study utilized primary data. The primary data was obtained from respondents in the study area through the use of structured questionnaire range of data sources was used to produce this study. The study considered 270 yam farmers based in the study area. The information collected encompasses socio-economic characteristics such as age, sex, marital status, household size, farming experience and years of formal education as well as perception on climatic variables and methods of adaptation to climate change. A multistage (three stage) sampling procedure was employed to sample yam farmers from the three agro-ecological zones (the north, south and the central). In the first stage of sampling, Edo north and Edo central were randomly selected from the three agro-ecological zones. From the selected zones, ten local government areas known for yam production were purposively selected from a total of 18 local government areas in the state (second stage sampling). In each local government, a village was randomly selected based on the reasonably high number of yam based farmers in the state representing the third stage of sampling. The last stage involved a random selection of 27 farmers from the chosen villages and this gives a total of 270 farmers. However, of the 270 questionnaires distributed on the field, 20 responses were not sufficient, appropriate and suitable for analysis because of incomplete information as well as ambiguity during data coding. Therefore 250 responses were used for this research.

Method of analysis
The descriptive statistics and multinomial logit analysis were used to analyze the data. Descriptive statistics was used to analyze the socio-economic characteristics of respondents and also to profile the various adaptation strategies employed by yam based farmers to mitigate the adverse effect of climate change in the study area. Multinomial Logit Model (MNL) was used to determine the factors influencing yam farmers’ choice of adaptation strategy to climate change. Let $A_i$ be a random variable representing the adaptation measure chosen by the farmer. We assumed that each farmer faces a set of discrete, mutually exclusive choices of adaptation measures. These measures are assumed to depend on a number of climate attributes, socio-economic characteristics and other factors $X$. The MNL model for adaptation choice specifies the following relationship between the probabilities of choosing option $A_i$ and the set of explanatory variables $X$ (Greene, 2003) given as:

$$
\text{Prob} \left( A_i = j \right) = \frac{e^{\beta_j x_1}}{\sum_{k=0}^{j} e^{\beta_k x_1}} \quad j = 0, 1 \ldots J
$$

(3)

Where $\beta_i$ is a vector of coefficients on each of the independent variables $X$. Equation (3) can be normalized to remove indeterminacy in the model by assuming that $\beta_0 = 0$ and the probabilities can be estimated as:

$$
\text{Prob}(A_i = j | x_i) = \frac{e^{\beta_j x_1}}{1 + \sum_{k=0}^{j} e^{\beta_k x_1}} ; j = 0, 1 \ldots J, \beta_0 = 0
$$

(4)

Estimating Equation (4) yields the J log-odds ratios
Table 1: Definition of variables used in empirical analysis.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
<th>Measure</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE</td>
<td>Gender</td>
<td>1 = male; 0 = female</td>
<td>±</td>
</tr>
<tr>
<td>AG</td>
<td>Age</td>
<td>Years</td>
<td>±</td>
</tr>
<tr>
<td>AC</td>
<td>Credit</td>
<td>Naira</td>
<td>±</td>
</tr>
<tr>
<td>NE</td>
<td>Years of education</td>
<td>Years</td>
<td>+</td>
</tr>
<tr>
<td>FE</td>
<td>Farming experience</td>
<td>Years</td>
<td>+</td>
</tr>
<tr>
<td>HS</td>
<td>Household size</td>
<td>Individuals</td>
<td>+</td>
</tr>
<tr>
<td>CA</td>
<td>Awareness of climate change</td>
<td>Awareness=1; Not aware = 0</td>
<td>±</td>
</tr>
<tr>
<td>PP</td>
<td>Perception of precipitation change</td>
<td>Perceived = 1; Do not perceive = 0</td>
<td>±</td>
</tr>
<tr>
<td>AE</td>
<td>Access to extension services</td>
<td>Yes = 1, No = 0</td>
<td>±</td>
</tr>
<tr>
<td>PW</td>
<td>Perception of wind intensity change</td>
<td>Perceived = 1; Do not perceive = 0</td>
<td>±</td>
</tr>
</tbody>
</table>

\[
\ln \left( \frac{P_j}{P_k} \right) = x_j^i \left( \beta_j - \beta_k \right) = x_j^i \beta_j, f \ k = 0
\]

(5)

The dependent variable is therefore the log of one alternative relative to the base alternative. The multinomial Logit Model coefficients are difficult to interpret and associating the \(\beta_i\) with the \(j^\text{th}\) outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived as (Greene, 2003):

\[
\delta_j = \frac{\delta P_j}{\delta x_i} = P_j \left[ \beta_j - \sum_k P_k \beta_k \right] = P_j (\beta_j - \beta)
\]

(6)

The marginal effects measure the expected change in probability of a particular strategy being made in respect to a unit change in an explanatory variable (Long, 1997; Greene, 2000). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients. The empirical Multinomial Logit Model for this study is specified as:

\[Y = f \ (GE, AG, AC, NE, FE, HS, CA, PP, AE, PW)\]

Where \(Y\) is the dependent variable is polychotomous and it is the method of adaptation to climate change chosen by the farmer; Gender (GE), Age (AG), Access to credit (AC), Number of years of education (NE), Farming experience (FE), Household size (HS), Climate change awareness (CA), Perception of precipitation (PP), Access to extension (AE) and Perception of Wind Intensity (PW) are the explanatory variables (Table 1). The dependent variable (\(Y\)) is defined as:

1. for yam varieties,
2. for crop rotation,
3. for mulching,
4. for deep planting,
5. for no adaptation used as the base category.

The choice of the explanatory variables was dictated by theoretical behavior hypothesis, empirical literature and data availability. Socio-economic factors such as age, farming experience, gender and household size were documented in several literatures (Adejuwon, 2004; Sofoluwe et al., 2011; Patt and Gwata, 2002; Anim, 1999) as a pivotal factor that affects farmer’s choice of adaptation strategy. These literatures went further to validate that age, farming experience and marital status have a negative influence on the decision of selecting an adoption strategy.

RESULTS AND DISCUSSION

The study revealed that 87.6% of the households were headed by males (Figure 1) while 12.45% were headed by females. Also, 45.2% of the head of households were above 50 years. The percentage of household heads within the age bracket of 31 to 40 years was 18.8% (Table 2). The average household size in the study area was 7.7. Specifically, the result showed that 59.2% of the respondents had household size ranging from 5 to 10 while 20.4% of the respondents had household sizes ranging from 1 to 4 and above 10 respectively. The average year of formal education attended by respondents was 8.0 years. The result (Table 2) showed that 34.8% of the respondents had 1 to 4 years of formal education while 19.5% had no formal education.

Figure 2 presents the distribution of farmers’ perceptions on climatic change based on the three identified climatic variables (air temperature, rainfall and wind intensity). As indicated in the figure, 78% of the farmers in study area are aware of the continuous increase in air temperature while 67% of farmers perceived a steady decline in precipitation over the years. The farmers’ perceptions on wind intensity showed that 57.2 and 22.4% of the respondents observed an increase and decrease in wind intensity respectively. These results agree with the reports of Sofoluwe et al. (2011); Maddison (2006);
Figure 1: Gender Distribution of Head of Households. Source: Computed from field survey data (2012).

Table 2: Socio-economic characteristics of sampled farmers.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Characteristic</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sex of household head</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>219</td>
<td>87.60</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>31</td>
<td>12.43</td>
</tr>
<tr>
<td>2</td>
<td>Age (year) of Household Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less than 30</td>
<td>26</td>
<td>10.40</td>
</tr>
<tr>
<td></td>
<td>31 - 40</td>
<td>47</td>
<td>18.80</td>
</tr>
<tr>
<td></td>
<td>41 - 50</td>
<td>64</td>
<td>25.60</td>
</tr>
<tr>
<td></td>
<td>Above 50</td>
<td>115</td>
<td>45.20</td>
</tr>
<tr>
<td></td>
<td>Average: 48.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard deviation: 13.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Year of formal education</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>49</td>
<td>19.50</td>
</tr>
<tr>
<td></td>
<td>1 - 6</td>
<td>87</td>
<td>34.80</td>
</tr>
<tr>
<td></td>
<td>7 - 12</td>
<td>80</td>
<td>32.00</td>
</tr>
<tr>
<td></td>
<td>Above 12</td>
<td>34</td>
<td>16.83</td>
</tr>
<tr>
<td></td>
<td>Average: 8.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard deviation: 5.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Household size</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Less than or equal 4</td>
<td>55</td>
<td>20.40</td>
</tr>
<tr>
<td></td>
<td>5 - 10</td>
<td>140</td>
<td>59.20</td>
</tr>
<tr>
<td></td>
<td>Above 10</td>
<td>55</td>
<td>20.40</td>
</tr>
<tr>
<td></td>
<td>Average: 7.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard Deviation: 4.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Computed from field survey (2012).

Based on the perceptions expressed by the farmers, air temperature, rainfall and wind intensity are important climatic variables in crop production. Table 3 shows the effects of these farmers’ perceptions on yam production. The severity of the effect that corresponds to the change in a given climatic variable is ranked by the sampled farmers...
Figure 2: Distribution of Farmers’ Perception on Climatic Change. Source: Computed from field survey (2012).

Table 3: Farmers’ perceptions on the effect of climatic change on yam production.

<table>
<thead>
<tr>
<th>Climatic variables</th>
<th>Effects</th>
<th>Percentages (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temperature</td>
<td>Very severe</td>
<td>28.80</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>44.00</td>
</tr>
<tr>
<td></td>
<td>Not severe</td>
<td>31.20</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Very severe</td>
<td>32.40</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>24.40</td>
</tr>
<tr>
<td></td>
<td>Not severe</td>
<td>43.20</td>
</tr>
<tr>
<td>Wind intensity</td>
<td>Very severe</td>
<td>18.00</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>35.60</td>
</tr>
<tr>
<td></td>
<td>Not severe</td>
<td>46.40</td>
</tr>
</tbody>
</table>

Source: Computed from field survey (2012).

Table 3 shows that majority of the farmers ranked the effect of the change in both precipitation and wind change as not severe (43.2 and 46.4% respectively) while air temperature was ranked as severe (44.0%) on yam production. This is an indication that the effects of rainfall and wind intensity were not very pronounced. Many factors might have contributed to these perceptions, among which are the adoptions or non adoption of coping strategy as well as, the type of coping strategy being used where adoption is taking place. Table 4 shows the adaptation methods or strategies employed by the sampled farmers. The table shows that majority of the farmers perceived at least one change in climatic attributes. However, about 0.136 (proportion) of the sampled farmers did not adopt any adaptation measure to mitigate the negative effect of climate change. This may be attributed to lack of awareness on the part of the concerned farmers to different coping strategies or the unwillingness to change because they perceived that each change comes with its own challenges and as such farmers tend to rationalize input.

Table 4 reveals that most farmers adopted mulching (0.724) as the adaption method to the negative effect of climatic change on yam production. The table also shows that 0.65 and 0.40 proportions of the respondents (farmers) adopted deep planting and yam varieties as coping strategies respectively. Crop rotation was the least employed strategy (0.396). Majority of the farmers (0.724) adopted mulching strategy to combat the negative effect of
climate change on yam production. The large proportion of adopters of mulching as coping strategy may be attributed to the convenience of the method which attracts no direct cost (including overhead cost) to the farmers. The small proportion of farmers employing the use of different yam varieties as coping strategy (0.404) may be due to lack of access to these yam varieties in the study area, the cost implication and lack of information on availability of such technology. Hence, substantial proportion of respondents (farmers) opted for deep planting strategy (0.652).

**Estimated Multinomial Logit Model**

The study estimated Multinomial Logit Model to determine the factors influencing yam farmers' choice of adaptation to climate change in Edo state. The software package used was STATA, version 10. Table 5 shows the coefficients and the standard error in parenthesis of the various factors that affect the choice of the adoption of strategies by farmers. The MNL model has a likelihood function of the model was found to be 57.96 and pseudo r^2 equal to 0.652. In addition, the likelihood function of the model was found to be -331.53 and statistically significant at (p<0.05). This indicated that the data has a good fit to the model. The category "no adaptation strategies" was taken as the basis for comparison. The results of the estimated equations are discussed in terms of the significance and signs of the parameters.

Table 5 shows the marginal impact of changes in the independent variables and the elasticities of probability of adopting an adaptation strategy to mitigate climate change. Specifically, the table shows that for the adoption of yam varieties strategy, for every unit increase in the age of farmer, probability of adopting the use of yam varieties as coping strategy will reduce by 0.5% (p<0.10). This finding may not be unconnected to the fact that older farmers are averse to the new technology. Also, for every unit increase in the number of household size, the probability of adopting the use of yam varieties as coping strategy increases by 2.0% (p<0.05) (This implies an elastic response of 1.13 when evaluated at the mean values of the independent variables). The need to ensure food security of the household may compel the head of household to always look for a way to tackle the negative effect of climatic change on yam production through the use of yam varieties. The larger the household the higher the probability of adopting new technology.

Furthermore, in the adoption of crop rotation strategy, the result showed that for every unit increase in the age of the farmer, the probability of adopting crop rotation strategy by farmers increase by 0.8% (p<0.05) (This implies an elastic response of 1.36 when evaluated at the mean values of the independent variables). Crop rotation has been an age-long technique used by farmers to prevent sharp decline in their production as the demand for non-agricultural activities increases. The old farmers are used to the technique, even before the effect of climatic change on crop production became pronounced. Its adoption may
be due to its convenience and low or no cost. Also, for every unit increase in household size, the probability of adopting crop rotation strategy decreases by 2.6% (p<0.05). This finding may be because the head of large household did not see the strategy as one that will give the desired result like the use of yam varieties (This implies an inelastic response of -0.72 when evaluated at the mean values of the independent variables). The probability of adopting crop rotation strategy also increases by 16.2% for every unit increase in the number of farmers that have access to extension (p<0.05) (This implies an elastic response of 0.22 when evaluated at the mean values of the independent variables).

For the adoption of mulching strategy, the probability of adopting mulching strategy to mitigate the negative effect of climatic change increases and decreases by 16.2 and 20.7% for every unit increases in the number of farmers having access to credit and extension services respectively. The farmers with access to credit may prefer strategy like mulching that does not attract any cost in order to put the credit at their disposal into other uses. For the number of farmers having access to credit, the result implies an elastic response of 0.19 while that of farmers having access to extension services implies an inelastic response of -0.19 when evaluated at the mean values of the independent variables.

**Conclusion and Recommendations**

This paper examines the perception and adaptation of yam based farmers to climate change in Edo state, Nigeria. It is noted from the empirical results that most of the farmers in the study area were aware that temperature and wind intensity are on the increase while the level of precipitation is on the decline. Adaptation to the changes in these three key variables (air temperature, wind intensity and rainfall) in crop production is important for farmers to achieve their farming objectives of food and livelihood security. Among the various methods used by farmers to mitigate the negative effect of climatic change, mulching strategy has the highest proportions of adopters. The findings revealed that age and household size influenced the choice of yam varieties as the coping strategy while accesses to credit and extension services were the determinant of mulching as adaptation to climatic change. Unlike the use of yam varieties and mulching as coping strategies; age of farmer, household size and access to extension services are the determinants of crop rotation as strategy to reduce the negative effect of climatic change on yam production in the study area.

More awareness still needs to be created through the extension agents and broadcast media (radio) for farmers to understand the negative effect of climatic change and various coping strategies available. The need for farmers to consider the effectiveness rather than easy availability of coping strategy is very imperative not only to ensure food security but also to enhance the livelihood of the households in the study area.

**REFERENCES**


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