Factors Influencing Cassava Farmers' Choices of Climate Adaptation Strategies in Rainforest Agro-Ecological Zone of Southwest, Nigeria

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Abstract— *Evidences from literature and past studies have revealed that climate change has influenced agricultural productivity leading to declining global food production. The study was to examine the effect of climate change adaptation strategies on cassava production in Southwest, Nigeria where rain forest agro-ecological zones (AEZ) was chosen for the study. The study used multi-stage sampling procedures, with the aid of well-structured questionnaire, to select 150 cassava producers. Data analysis was done using descriptive statistics and multinomial logit model. From the study, it was revealed that cassava farmers in the study area were relatively young, fairly educated, mostly married, well experienced, adequately aware of climate change, but operated on a small scale. Factors influencing the choice of these climate adaptation strategies were; sex, age, farm income, years spent in school, labour availability, amount of credit obtained intensity of temperature. It is therefore recommended that government should provide adequate extension services with knowledgeable and skilled extension agents who are equipped with climate useful information, thereby making the farmers aware about the available adaptation strategies to climate change and the benefits inherent in them; farmers, via extension agents, should be encouraged to use improved varieties of cassava as adaptation strategy in order to achieve increased output and multiple planting dates should be embraced by the cassava farmers.*

Keywords*— *Cassava farmers, climate adaptation strategies, multinomial logit.

I. INTRODUCTION

Climate change manifests itself through increasing variation in the weather, including temperature, precipitation, and wind. Scientific research confirmed climate change is occurring and expected to aggravate in coming decades (IPCC, 2014). Since 1950, the number of warm days and nights has increased, and it is projected that the length, frequency, and intensity of heat waves will increase on most of the land (Field *et al.,* 2012). As a result of climate change the pattern, timing and intensity of the precipitation has also altered. The number of heavy precipitation events has increased but with strong regional variations (Field *et al.,* 2012). Rise in temperature and changes in precipitation are changing water availability and other stresses for crops with effects on crop yield, income, and poverty.

Climate change poses threats to food security because of its impact on the agricultural system. Agricultural production in most Sub-Saharan African Countries (Nigeria inclusive) is dependent on weather. Climate change has a direct influence on the productivity of physical production factors such as soil's moisture and soil fertility and this affects farming output. Evidences from literature and past studies have revealed that the recent climate change has influenced agricultural productivity leading to declining global food production (Kurukulasuriya and Mendelsohn, 2006; (International Institute for Sustainable Development) (IISD), 2007; Lobell *et al.,* 2008). A negative and unfavourable climate change could engender adverse climatic conditions like drought, flooding that would result into food shortage and food insecurity like is being experienced in countries like Somalia, Sudan and other countries within the borders of the arid zones. Nigeria is not left out of this environmental quagmire. During the flooding in the southern part of the country in 2013, for example, several hundreds of thousands of farmland/crops were destroyed. Extreme and adverse environmental conditions can also trigger price increases and food import to augment local production. Extreme weather events can damage or destroy transport and distribution infrastructure and affect other non-agricultural parts of the food system adversely (Felix *et al.,* 2018).

It is then less difficult to believe that agricultural productivity under the prevailing climate change situation in most developing countries will be very low. Consequently, the low crop yield will lead to unavoidable shocks to the already fragile economies in African countries. Food prices are expected to rise, worsening the food insecurity and poor nutritional health conditions in the continent. The impact of climate change on food production, prices and food security depends on regional climate change, biological effects of increasing atmospheric carbon dioxide, changes in floods, droughts and other extreme events, existing agricultural systems, adaptive capacity, changes in population, economic growth and technological innovation (Pittock, 2005). A clear example is the drought and food crisis situation that has been ravaging the horn of Africa (particularly Somalia, Northern Kenya, Ethiopia, Djibouti and Eritrea) since the second quarter of 2011 which has claimed many human lives, led to the death of millions of animals and livestock and has predisposed millions of people to health and nutritional challenges (Solomon and Leslie, 2015).

Large-scale farmers are more likely to adapt to climate change because they have more capital and resources (Hassan and Nhemachena, 2008; Aymone, 2009). Productive resources such as capital, land and labor serve as important factors for coping with and adapting to climate change. The choice of the suitable adaptation measure depends on factor endowments (i.e. family size, land area and capital resources) at the disposal of farming households (Hassan and Nhemachena, 2008). The study focused on climate change adaptation strategies of cassava production where socio-economic variables and factors determining cassava farmers' choice of climate adaptation strategies were assessed for this study.

II. MATERIALS AND METHODS

2.1 Study Area

This research work was carried out in Southwest, Nigeria. The Southwest region is mainly a Yoruba speaking area, though there are different dialects within the same State. It consists of six States; Ekiti, Ondo, Osun, Oyo, Ogun and Lagos. The study area lies between longitudes $2^0\ 3^1$ and $6^0\ 00^1$ East of the Greenwich meridian and latitudes $6^0\ 2^1$ and $8^0\ 37^1$ North of the equator with a total land area of 77,818 km^2 and a population of 27,581,992 (NPC, 2006), with 2018 projected population estimate of 39,742,334 based on annual percentage population growth of 2.619% as reported by NPC, 2016.

The study area (Southwest, Nigeria) is bounded in the East by Edo and Delta States, in the North by Kwara and Kogi States, in the West by Republic of Benin and in the South by the Gulf of Guinea. The climate of South west Nigeria is tropical in nature. The weather condition varies between two distinct seasons in Nigeria; the rainy season (March - October) and the dry season (November - February). The dry season is characterized by the harmattan dust; cold dry winds from the northern deserts blow into the southern region. The temperature ranges between 21^0C and 34^0C, while the annual rainfall ranges between 1500mm and 3000mm (Falade, 2016). There is high temperature during the dry season with heavy rainfall during the rainy season (November to March). The wet season is associated with Southwest monsoon wind from Atlantic Ocean while the dry season is associated with the Northeast trade wind from Sahara desert (Otitoju and Enete, 2014).

The vegetation in Southwest Nigeria is made up of fresh water swamp and mangrove forest, the lowland in the forest stretches inland to Ogun and parts of Ondo State while secondary forest is towards the Northern boundary where derived and southern savannah exist (Faleyimu *et al.*, 2009). There are good soils favorable to agricultural production in the study area. Occupations common among the people of Southwest Nigeria include: farming, hunting, fishing, produce buying, sports, butchering and meat selling, crafts and trading. Agriculture provides income and employment for about 75% of the populace and they produce both food and cash crops. The food crops in this area are; rice, yam, cassava, maize, cocoyam and cowpea while the cash crops are; cocoa, oil palm, kolanut, plantain, banana, cashew, citrus and timber (Sakiru, 2013).

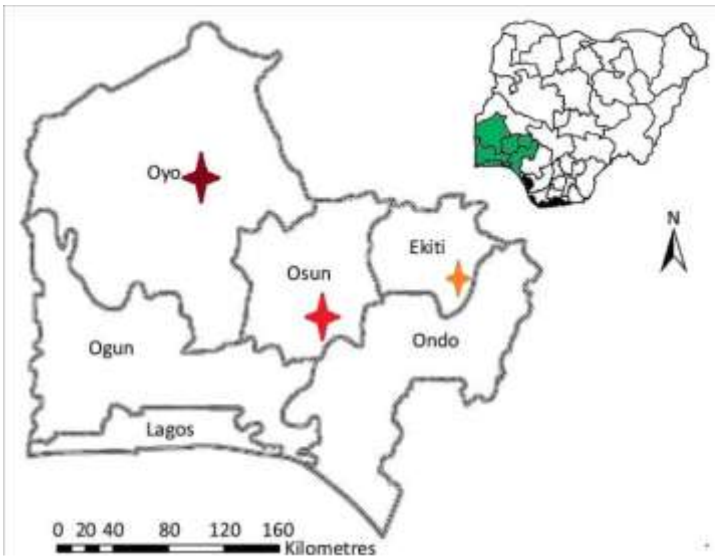

FIGURE 2: Map of Southwest, Nigeria showing the study area
Source: https://t2.gstatic.com/images

2.2 Sampling Procedure and Sample Size

A multi-stage sampling procedure was used in the selection of location and respondents for the study. At the first stage, three States; Ekiti, Osun and Oyo were randomly selected. The second stage involved purposive selection of one Local Government Area (LGA) of rainforest Agricultural Ecological Zones (AEZ) from each State based on the volume of cassava output. In Ekiti State, Emure LGA was selected because it is the highest cassava producing LGA in rain forest AEZ in the State (Ekiti State Ministry of Agriculture and Rural Development). Also, Atakunmosa East LGA was purposively selected as rain forest zones in Osun State based on their level of involvement in cassava production (Osun State Ministry of Agriculture and Food Security) while Ibarapa East LGA was chosen as rain forest AEZ in Oyo State based on their output level in cassava production in the State (Oyo State Ministry of Agriculture, Natural Resources and Rural Development). In totality, six (3) LGAs were chosen for the study. The third stage involved purposive selection of three communities from each LGA chosen based on their level of involvement in cassava production. In all, the study made use of eighteen (9) communities. Based on the population of the communities selected for this study, simple random sampling procedure was used to select between 15 to 20 respondents per community, indicating that equal number of respondents were not chosen from each community, but a total of 50 respondents per LGA remained consistent. In all, a total of 150 respondents were interviewed for the study.

2.3 Data Sources and Collection

Primary data were collected from 150 cassava farmers with the aid of a well-structured questionnaire, personal interview and Focus Group Discussion (FGD) sessions. The data comprised of socio-economic characteristics of the cassava farmers such as age, educational level, gender etc. and determinants of choice of adaptation strategies.

2.4 Method of Data Analysis

Descriptive statistical analysis was used to describe socio-economic variables of the respondents while multinomial logit model was used to determine cassava farmers' choice of climate adaptation strategies in the study area.

2.4.1 Multinomial Logit Model (MNL)

The determinants of cassava farmers' choices of adaptation strategies was analyzed using Multinomial Logit Model. Base on the finding of (Aenro *et al.,* 2015), the household decision of whether or not to undertake adaptation strategies for climate change is considered under the general framework of utility or profit maximization. For the purpose of this study, the six most commonly practiced climate change adaptation strategies were selected.

a. Use of improved varieties
b. Multiple planting dates
c. Increasing farm size
d. Mulching
e. Farm plots fragmentation
f. Crop diversification

Note: crop diversification was chosen as a reference point.

For climate change adaptation options, if a farmer decides to use option *j*, then it follows that the perceived utility or benefit from option *j* is greater than the utility from other options (say, *k*) depicted as:

$$U_{ij} = (\beta_j^{'} X_i + \varepsilon_j) > U_{ik} = (\beta_k^{'} X_i + \varepsilon_k), j \neq k \quad (1)$$

Where;

U_{Ij} and U_{ik} are the perceived utility by farmer i of adaptation options j and k respectively; i.e. Cassava output (kg)

X_i= Vector of explanatory variables which influence the choice of the adaptation option.

These are itemized below:

X_1 = Sex (Male =1, Female =0)

X_2 = Age (Years)

X_3 = Marital status (Married = 1, otherwise = 0)

X_4 = Educational level (Years of schooling)

X_5 = Livestock holding (Yes = 1, Otherwise =0)

X_6 = Farm income (₦)

X_7 = Farming experience (Years)

X_8 = Household size (number)

X_9 = Non-farm income (₦)

X_{10} = Frequency of extension contact (Number)

X_{11} = Access to climate change information (Yes = 1, Otherwise =0)

X_{12} = Amount of credit obtained (₦)

X_{13} = Farm size (Hectares)

X_{14} = Labour availability (Yes = 1, Otherwise =0)

X_{15} = Access to inputs (Yes = 1, Otherwise =0)

X_{16} = Fertility of the soil as perceived by the farmer (Fertile =1, otherwise= 0)

X_{17} = Temperature (Increased = 1, reduced =0)

X_{18} = Rainfall (Increased = 1, reduced =0)

X_{19} = Agro-ecological zones (Rain forest =1, guinea savanna = 0)

β_j and β_k = Parameters to be estimated,

ε_j and ε_k = Error terms.

III. RESULTS AND DISCUSSION

3.1 Socio-economic characteristics of the respondents

Table 1 revealed the distribution of cassava farmers in both AEZs based on their relevant socio-economic characteristics. The result showed that 78.67 and 21.30 percent of the respondents sampled in rain forest AEZ were found to be males and females respectively, 84.67 and 15.33 percent of the respondents from savannah were males and females respectively. This is in agreement with Otitoju and Enete (2014) who noted males are more involved in cassava production in Benue State. The result further reported 54 and 48 years as the mean age of cassava farmers in rain forest and savannah AEZs respectively, implying that cassava farmers in the study area were ageing. The cassava farmers in the study area were fairly educated as 41.7 and 26.7 percent of them acquired secondary education; this is expected to help the farmers in resource allocation in order to optimize productivity. The mean farm size cultivated in the entire study area as revealed by the pooled data was 1.6 hectares of land. This implies that these cassava farmers were still operating on small scale and this will have a tendency to reduce the production of cassava in the study areas. This is in consonance with Osanyinlusi and Adenegan (2018) who noted half of the farmers (50.0%) cultivated between 1-3 hectares of land for cassava production in Ekiti State. The finding revealed that the farmers had started farming when they were young. The mean years of farming experience was 10.6 years, which showed that the cassava farmers are experienced. This is expected to boost their production as they are familiar with the practices involved in cassava production and they would be able to mitigate against the loss or challenges they face as a result of climate change in the course of production, as it is often said ‘experience is the best teacher. From the result, it was clearly reported that majority (72%) of the rainforest cassava farmers indicated that they were aware of climate change while the remaining 28% said they were not. Likewise, majority (96.7%) of the savannah cassava farmers indicated that they were aware of climate change while the remaining 3.3% said they were not. The result further showed the mean value of income generated in rain forest and savannah AEZs as ₦273,814 and ₦215,650 respectively.

TABLE 1
DISTRIBUTION OF CASSAVA FARMERS BASED ON RELEVANT SOCIO-ECONOMIC CHARACTERISTICS

Socio-economic variables	frequency	percentage	frequency	percentage
Sex				
Female	32	21.3	23	15.33
Male	118	78.67	127	84.67
Age				
≤30	5	3.3	15	10
31-40	22	14.7	20	13.3
41-50	41	27.3	58	38.7
51-60	61	40.7	40	26.7
>60	21	14	17	11.3
Level of education				
No primary education	18	12	40	26.7
Primary education	63	42	72	48
Secondary education	42	28	30	20
Tertiary education	27	18	8	5.3
Farm size				
≤2.0	85	66.7	104	69.3
2.1-5.0	54	36	41	27.3
>5.0	11	7.3	5	3.4
Farming experience				
5-Jan	33	22	27	18
10-Jun	47	31.3	42	28
15-Nov	58	38.7	20	13.3
>15	12	8	61	40.7
Awareness of climate change				
Aware	108	72	145	96.7
Not aware	42	28	5	3.3
Cassava income				
≤100,000	17	11.3	30	20
101,000-200,000	29	19.3	38	25.3
201,000-300,000	46	30.7	40	26.7
301,000-400,000	32	21.4	27	18
401,000-500,000	17	11.3	11	7.3
>500,000	9	6	4	2.7

Source: Computed from field survey data, 2018

3.2 Determinants of cassava farmers' choices of adaptation strategies to climate change

A multinomial logit MNL model was used to estimate the determinants of farmers' choices of adaptation practices to reduce the effect of climate change in rain forest AEZ in the study area. In this analysis, "crop diversification" was used as base category and the estimated coefficients compared with the base category. The likelihood ratio statistics indicated by the Chi-square test were found to be significant ($P < 0.01$) as indicated in Table 2, suggesting the model had a good fit. The use of the MNL model specification was found to be appropriate, and the model has been used previously by different studies to estimate the determinants of climate change adaptation options by farmers (Deressa *et al.,* 2009; Enete *et al.,* 2014 and

Negarsh, 2011, Abrham *et al.*, 2017).The problem of multicolinearity among the explanatory variables was tested using variance inflection factor and Contingency Coefficient for continuous and dummy explanatory variables, respectively. In both cases, no problem of multicolinearity was detected. Hence, the parameter estimates of the MNL model were used to provide the direction of the effect of the independent variables on the dependent (response) variable, whereas estimates represent neither the actual magnitude of change nor the probabilities (Table 2).

The result in Table 2 showed that being a male headed household, in rain forest AEZ, increased the likelihood of using improved varieties and increasing farm size as adaptation strategies at 5% and 1% significance levels compared to the base category. From the result, it was revealed that male-headed households had better opportunities to practice adaptation measures than the female-headed households. This finding is similar to a study by Deressa *et al.*, 2011 done in another part of Ethiopia that analyzed farmers' choices of climate change adaptation methods, which showed that male headed households could be more likely to have access to technologies and climate change information than female-headed households. As a result, they were in a better position to practice diverse adaptation strategies than the female-headed ones (Demetriades and Esplen, 2010).

The age of the household heads, in the rain forest AEZ, had positively influenced the decision to practice some of the adaptation strategies and negatively in the case of others. In this regard, age is positively related with the decision to use improved varieties, and it was statistically significant at 1%. Also, a positive relationship existed between age and multiple planting dates, indicating that as the farmers are ageing, they keep practicing multiple planting dates as adaptation strategy. This might be attributed to the experience and mastery they had had in cassava production in order to mitigate the climate change adversities. Contrarily, an inverse relationship existed among age, increasing farm size, mulching and farm plot fragmentation, implying that as the farmers got older, their farm size kept reducing, mulching of their cassava plots was reducing and farm plot fragmentation was becoming non-appealing. This might be caused by drudgery involved in all agronomic management practices in cassava production. Therefore, the strength to perform actively on the farm might not be there again bearing in mind the labour unavailability and rural-urban drift among the youths.

The coefficient of marital status was positively and significantly correlated to the probability of the households choosing the use of improved varieties at 1%. Also, the remaining four adaptation strategies were positively related to marital status, implying that households' heads who were married had higher tendency of adopting climate change adaptation strategies. This could be attributed to the fact that they had larger household size and dependents that they provide for their basic necessities i.e. feeding, clothing and education. Therefore, practicing different adaptation strategies to ensure food security was a task that needed to be done. The result conformed to the findings of Ajak *et al.,* 2018 who concluded that married and not aged households' heads were more knowledgeable about climate variability, suggesting that unmarried households' heads could have smaller household size which could mean less family labour for crop production practices and less engagement in adaptation strategy against climate change.

Years spent in school was found to be statistically significant (5%) and positively correlated with the use of improved varieties. This implies that being educated avails the farmers the access to improved varieties through information from radio, internet, television, Agricultural Development Projects (ADP) and interactions with friends. Also, multiple planting dates and mulching were positively correlated with the number of years spent in school while an inverse relationship existed between farm plots fragmentation as well as increasing farm size and years spent in school. Increasing the farm size does not always amount to increased output or income, but having a manageable size of farm does. Practicing farm plots fragmentation might not bring about efficiency in utilization of productive resources. This result agrees with the study of Kansiime, 2014 who observed that practicing farm plots fragmentation and increasing farm size is labour intensive and tedious, and this might be the reason why highly educated households would avoid using them than their less educated counterparts because education also broadens alternative income earning opportunities.

Livestock ownership positively influenced the cassava farmers' decision to practice the use of improved varieties because earnings or income from livestock enterprise(s) can be invested on improved varieties of cassava stem. Contrarily, all other adaptation practices (multiple planting dates, increasing farm size, mulching and farm plots fragmentation) had negative relationship with livestock ownership. This can be attributed to the fact that all the available adaptation practices are time consuming and tedious, and combining livestock rearing with practicing of those adaptation measures might appear difficult, bearing in mind that they had alternative source of income (livestock). This study conformed to the findings of Kurukulasuriya and Mendelsohn, 2008 who inferred that livestock ownership was found to be negatively correlated with multiple planting dates and other agronomic activities.

Use of improved varieties and increasing farm size were positive and statistically significant with farm income of households heads at 1 and 5% respectively. Also, multiple planting dates and mulching were positively related with farm income. Having huge output, which would translate to high income, would influence the farmers' decision to always plant improved varieties of cassava stem, and at the same time expand their farm size because there would be money to hire labour for agronomic activities. Contrarily, a negative interaction existed between farm income and farm plots fragmentation, implying that the higher the farm income, the lesser the practice of farm plot fragmentation as an adaptation strategy. The reason for this was that farmers with higher output preferred to acquire a large expanse of land in a particular location to ensure concentration and efficient allocation of resources rather than moving from one farm location to the other. This result is consistent with a study by Negarsh, 2011 which found that income had a positive relationship with changes in planting date and use of crop diversification.

Only the coefficient of use of improved varieties was found to be positively correlated and statistically significant at 10% with non-farm income. This is because having other sources of income might make improved varieties of cassava stem affordable to them. The result further revealed that all other four adaptation options (multiple planting dates, increasing farm size, mulching and farm plot fragmentation were inversely correlated with non-farm income. The reason for this was that they (cassava farmers) always found it difficult to sacrifice their time on practicing these adaptation options because most of them (adaptation practices) consume time, and the farmers needed to look for money from other sources asides farming in order to attend to their pressing needs. It was further revealed that increasing farm size was found to be positively correlated and statistically significant (10%) with labour availability, implying that labour availability was paramount in influencing the decision of the farmers to increase their farm size. In the same vein, the remaining four adaptation strategies were found to be positively correlated with labour availability, meaning that the more labour availability in the study area, the higher the cassava farmers practice these adaptation measures.

Farming experience had both positive and negative effects on some climate change adaptation strategies. It helped to stimulate response to the negative effects of climate change on agriculture. From the result, it was revealed that multiple planting dates was positively correlated and statistically significant at 1%. Also, farming experience was positively correlated with the use of improved varieties and mulching, indicating that more experienced farmers are assumed to have better knowledge about weather information and its implication on agricultural practices. On the other hand, increasing farm size and farm plots fragmentation were found to be negatively related with farming experience. This implies that the cassava farmers in the study area, based on their wealth of experience, concluded that increasing farm size and farm plots fragmentation did not necessarily amount to increased output, but concentrating the farm on a particular location, efficient allocation and intensification productive resources would bring about improved output. This result is consistent with the findings of Bazezew *et al.*, 2013 who observed that farmers chose adaptation practices based on their experience.

The coefficient of household size was positively correlated and statistically significant ($p < 0.05$) with increasing farm size, meaning that the larger the household size, the more the farm size cultivated for cassava production. This reason for this is that having larger household size would avail them family labour, thereby giving them the opportunity to increase their farm size. The result revealed further that the use of improved varieties, mulching and farm plots fragmentation were also positively related with household size, indicating that as the household size increases, the probability of practicing these adaptation options also increases. An inverse relationship existed between household size and the practice of multiple planting dates as adaptation strategy, meaning as the household size kept increasing, the probability of practicing multiple planting dates was diminishing. This could happen to household that is dominated by students. They were only available for farming activities during the weekends and holidays, and these are not enough times to assist the household heads in practicing multiple planting dates as an adaptation strategy. The result is in line with the findings of Kurukulasuriya and Mendelsohn, 2008 and Gbetibouo, 2009 who observed that larger family size and a larger number of productive household members increased agricultural production because it was associated with labor-intensive agricultural practices. Thus, household size has a significant association with some of the adaptation categories.

Farm size was positively correlated and statistically significant at 5% with the practice of increasing farm size, implying that household heads with larger farm size had a greater probability to increase their farm size. On the other hand, farm size was inversely related and statistically significant at 10% with farm plot fragmentation, indicating that the larger the farm size, the lesser the practice of farm plots fragmentation. This is because farmers with large farm size, concentrated on a particular location, can hardly think of having another farm elsewhere. The result further revealed that practicing of the use of improved varieties and mulching were inversely correlated with farm size while multiple planting dates co-moved with farm size.

All the coefficients of adaptation practices were negatively correlated with the amount of credit obtained, meaning that as the amount of credit obtained increased, the probability of practicing these adaptation measures reduced. This could be attributable to the fact that this credit, if truly obtained, was not spent on the purpose it was sourced for. Diverting this credit on payment of children's school fees and other pressing social needs had negative effect on practicing adaptation strategies. Access to climate information is an important variable that affects adaptation options. The results showed that as expected, access to climate information had impacted adaptation to climate change. Those (farmers) who had access to weather information had a higher probability of implementing climate change adaptation strategies such as use of improved varieties, multiple planting dates, increasing farm size, mulching and farm plots fragmentation which were all positively correlated with access to climate information. Access to climate information was statistically significant at 5% with the practice of multiple planting dates as an adaptation strategy. That is, cassava farmers who had better access to weather information (i.e., seasonal or mid-term forecasting) made better informed adaptation decision. This study is similar to the findings of Melka *et al.,* 2015.

Access to extension was positively and significantly (5%) related with the use of improved varieties, implying that the more the cassava farmers received the extension agents, the better the willingness to embrace improved varieties. It is the responsibility of extension agents to introduce these improved varieties to the farmers and made them realized the benefits inherent in adopting them. All the adaptation practices under this study, except farm plots fragmentation, had positive interaction with access to climate information, implying that access to extension services increases the probability of adopting different adaptation practices. Result of this study agrees with the findings of Abrham, 2017. Coefficients of increasing farm size and farm plots fragmentation were positive and statistically significant at 1% and 10% with access to inputs respectively. This indicated that the more the cassava farmers had access to inputs the higher the probability of practicing increasing farm size and farm plots fragmentation. Also, the result showed further that the use of improved varieties and multiple planting dates moved in the same direction with access to inputs while mulching was inversely correlated. It is evident from the result that seamless access to farm inputs stimulates practice of diverse adaptation strategies.

Different effects of rainfall on the practice of adaptation strategies were revealed in the result. Multiple planting dates and increasing farm size were positively and statistically significant at 5% with rainfall, implying that, with increased rainfall, cassava farmers in the study area were encouraged to expand their farm size and practiced multiple planting dates. From the result, it was evident that increased rainfall prevented the farmers from embracing the use of improved varieties, mulching and farm plots fragmentation. This is because, with increased rainfall, there was no need for improved varieties like drought resistant and early maturing varieties. Also, mulching of the cassava plots is not necessary since required volume of rainfall is guaranteed.

Likewise rainfall, mixed effects of temperature on practice of adaptation strategies were made known in the result. Practicing the use of improved varieties, multiple planting dates and mulching were statistically significant at 5%, 10% and 5% respectively. While positive relationship existed between increased temperature and the use of improved varieties and mulching, multiple planting dates, increasing farm size and farm plots fragmentation moved in negative direction with temperature. This implies that with increased temperature, farmers were ready to embrace improved varieties of cassava stems, which could withstand the adversity of climate change, as their adaptation strategy. Also, mulching was widely used among the cassava farmers as adaptation strategy to mitigate the harsh effect of extremely high temperature on the cassava production while increased temperature adversely affected the practice of multiple planting dates, increasing farm size and farm plots fragmentation.

The result further showed an inverse, but statistically significant (5%), relationship between soil fertility and increasing farm size, implying that as the fertility of the soil increases, the cassava farmers reduced their farm size or maintained the normal farm size being cultivated. The reason for this is that increasing their farm size beyond what they could manage would bring about efforts in futility since a manageable farm size would still achieve maximum output. In the same vein, the use of improve varieties and farm plots fragmentation were found to be negatively correlated with soil fertility, implying that the more the soil was reported to be fertile, the lesser the practice of the use of improved varieties and farm plots fragmentation, as adaptation options, would be embraced. This is because the farmers believed that any variety of cassava, either local or foreign species, would flourish on fertile soil. On the other hand, multiple planting dates and mulching were positively correlated with soil fertility, implying that improved soil fertility encouraged the practice of multiple planting dates and mulching as adaptation strategies.

TABLE 2
PARAMETER ESTIMATES OF THE MULTINOMIAL LOGIT MODEL FOR CLIMATE CHANGE ADAPTATION DECISIONS

Explanatory variables	Use of improved varieties	Multiple planting dates	Increasing farm size	Mulching	Farm plot frag.
	Coefficients	**Coefficients**	**Coefficients**	**Coefficients**	**Coefficients**
Sex	0.047*** (0.001)	0.067 (0.114)	0.1156** (0.043)	0.314 (0.134)	0.413 (0.971)
Age	0.051** (0.021)	0.411 (0.162)	-0.332** (0.041)	-0.213 (0.174)	-0.376 (0.142)
Marital status	0.226** (0.031)	0.417 (0.231)	0.412* (0.072)	0.521 (0.443)	0.094* (0.081)
Years spent in school	0.071*** (0.003)	0.068 (0.731)	-0.095 (0.535)	0.629 (0.174)	-0.051 (0.412)
Livestock holding	0.992 (0.423)	-0.777 (0.427)	-0.006478	-0.500 (0.606)	-0.211 (0.843)
Farm income	0.163*** (0.000)	0.216 (0.604)	0.475** (0.041)	0.175 (0.410)	-0.236 (0.450)
Non-farm income	0.078* (0.091)	-0.416 (0.722)	-0.021** (0.022)	-0.812 (0.762)	-0.612 (0.139)
Labour availability	0.241 (0.691)	0.086 (0.316)	0.029** (0.039)	0.062 (0.385)	0.541 (0189)
Farming experience	0.056 (0.140)	0.035 (0.014)	-0.612 (0.261)	0.041*** (0.644)	-0.497 (0.358)
Household size	0.118 (0.155)	-0.019 (0.211)	0.014* (0.090)	0.063 (0.494)	0.161 (0.477)
Farm size	-0.367 (0.171)	0.028 (0.159)	0.607** (0.040)	-0.660 (0.170)	-0.659** (0.017)
Amount of credit obtained	0.061*** (0.001)	-0.375 (0.181)	0.061** (0.042)	-0.891 (0.146)	-0.344 (0.103)
Access to climate info.	0.270 (0.148)	0.581** (0.042)	0.445 (0.699)	0.415** (0.031)	-0.132 (0.878))
Extent of extension contact	0.333** (0.011)	0.032 (0.713)	0.058 (0.304)	0.481** (0.045)	-0.611 (0.312)
Access to inputs	0.206 (0.201)	0.230 (0.509)	0.192*** (0.000)	-0.431 (0.619)	0.621* (0.067)
Rainfall	-0.176 (0.113)	0.144 (0.533)	0.213** (0.047)	-0.096*** (0.001)	-0.073 (0.619)
Temperature	0.028** (0.000)	-0.625 (0.429)	0.849 (0.772)	0.313*** (0.002)	-0.703 (0.307)
Soil fertility	-0.553 (0.481)	0.260 (0.443)	-0.319** (0.031)	-0.190 (0.316)	-0.446 (0.503)
Base category: Crop diversification					
Number of observation	150				
Log likelihood	690.815				
Prob> Chi^2	0				
Pseudo R-square	0.237				
LR Chi^2	171.451				

Source: Computed from Field Survey Data, 2018
, **, *** stand for level of significance at 10%, 5%, and 1%, respectively.
Note: Figures in parentheses are p-values, frag. = fragmentation

3.3 Marginal Effects of Choice of Climate Change Adaptation Strategies Used among Cassava Farming Households

Table 3 revealed the marginal effects on the choice of climate change adaptation strategies among cassava farmers in rain forest AEZ in southwest, Nigeria. From the result, it was shown that as the age of the household head increased by a year, the probability of the households practicing the use of improved varieties increased by 12.7% and those practicing multiple planting increased by 7.5%. Contrarily, a unit increase in age of the household head resulted in 3.5%, 4.9% and 8.3% decrease in the probability to practice increasing farm size, mulching and farm plot fragmentation as climate change adaptation strategies respectively. The result further revealed that a unit increase in number of married households' heads increased the probability of practicing the use of improved varieties by 4.2%, multiple planting dates by 1.6%, increasing farm size by 2.1%, mulching by 1.2% and farm plot fragmentation by 5.1%. The result conformed to the findings of Ajak *et al.*, 2018 who concluded that married and not aged households' heads were more knowledgeable about climate variability, suggesting that unmarried households' heads could have smaller household size which could mean less family labour for crop production practices and less engagement in adaptation strategy against climate change.

Regarding the years spent in school, a unit increase in number of years spent in acquiring education would lead to 13.9%, 7.4%, 1.6% increase in the probability of choosing and using improved varieties of cassava stem, multiple planting dates and mulching respectively. This is because educated farmers are expected to adopt new technologies based on their awareness of the potential benefits from the proposed climate change adaptation measures. Contrarily, it brought about decrease in the probability of increasing farm size and farm plots fragmentation by 1.2% and 6.4% respectively. Owning livestock would lead to 2.1% increase in the probability of choosing and using improved varieties of cassava stem as adaptation strategy. On the other way round, a unit increase in the number of households' heads rearing livestock would bring about 4.3%, 8.8%, 2.9% and 16.8% decrease in the probability of practicing multiple planting dates, increasing farm size , mulching and farm plots fragmentation respectively. This study conformed to the findings of Kurukulasuriya and Mendelsohn, 2008 who inferred that livestock ownership was found to be negatively correlated with multiple planting dates and other agronomic activities.

From the result, it was revealed that a unit increase in household farm income increased the likelihood to practice the use of improved varieties, multiple planting dates, increasing farm size and mulching by 16.3%, 2.2%, 4.7% and 1.7% respectively. This result is consistent with a study by Negash, 2011 which found that income had a positive relationship with changes in planting date and use of crop diversification. Also, a unit increase in non-farm income would increase the likelihood to practice the use of improved varieties by 7.8% while it would reduce the likelihood to practice multiple planting dates by 4.2%, increasing farm size (2.1%), mulching (8.1%) and farm plots fragmentation by 6.1%.The result further showed that a unit increase in labour availability would increase the likelihood to practice the use of improved varieties, multiple planting dates, increasing farm size, mulching and farm plots fragmentation by 6.1%, 9.7%, 12.8%, 2.7% and 12.7% respectively. From the result, it was evident that labour availability (hired and family labour) was very essential in using adaptation practices. On the same vein, a unit increase in farming experience would increase the probability to practice the use of improved varieties by 13.4%, multiple planting by 5.6%, and mulching by 2.2% while it would reduce the likelihood to practice increasing farm size by 6.2% and farm plots fragmentation by 0.6%. This result is consistent with the findings of Bazezew *et al.*, 2013 who observed that farmers chose adaptation practices based on their experience.

The result showed that a unit increase in household size increased the likelihood to practice the use of improved varieties by 1.3%, multiple planting dates by 9.1%, mulching by 1.9% and farm plots fragmentation by 1.8% and reduced the likelihood of practicing multiple planting dates by 4.5%. The result is in line with the findings of Kurukulasuriya and Mendelsohn, 2008 and Gbetibouo, 2009 who observed that larger family size and a larger number of productive household members increased agricultural production because it was associated with labor-intensive agricultural practices. Thus, household size has a significant association with some of the adaptation categories. Regarding the farm size, the result of marginal effects revealed that a unit increase in farm size reduced the likelihood to practice the use of improved varieties by 2.4%, mulching by 0.7% and farm plots fragmentation by 15.8% while it increased the practice of multiple planting dates by 2.9% and increasing farm size by 6.2%. As it was further revealed from the result of marginal effect, a unit increase in the amount of credit obtained reduced the probability of practicing the use of improved varieties by 3.2%, multiple planting dates by 1.6%, increasing farm size by 2.1%, mulching by 1.1% and farm plots fragmentation by 8.7%. Being well informed about weather variability increased the likelihood of practicing the use of improved varieties by 5.5%, multiple planting dates by 9.6%, increasing farm size by 1.9%, mulching by 6.8% and farm plots fragmentation by 8.3%. This study is similar to the findings of Melka *et al.*, 2015.

TABLE 3
MARGINAL EFFECTS FROM (MNL) DETERMINANTS OF CHOICE OF CLIMATE CHANGE ADAPTATION STRATEGIES USED AMONG CASSAVA FARMING HOUSEHOLDS

Explanatory variables	Use of improved varieties	Multiple planting dates	Increasing farm size	Mulching	Farm plot frag.
	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients
Sex	0.086*** (0.000)	0.097 (0.167)	0.061* (0.074)	-0.011 (0.815)	0.066 (0.782)
Age	0.127*** (0.005)	0.075 (0.145)	-0.00322	-0.049 (0.270)	-0.083 (0.314)
Marital status	0.042* (0.062)	0.016 (0.268)	0.021 (0.233)	0.012 (0.566)	0.051 (0.310)
Years spent in school	0.139** (0.038)	0.170 (0.189)	-0.015 (0.667)	0.021 (0.245)	-0.012 (0.250)
Livestock holding	0.054 (0.437)	-0.098 (0.277)	-0.008832	-0.067 (0.513)	-0.275 (0.367)
Farm income	0.324** (0.034)	0.145 (0.176)	0.165** (0.042)	0.010 (0.315)	0.062 (0.386)
Non- farm income	0.015 (0.357)	-0.423 (0.233)	-0.125 (0.334)	-0.114 (0.081)	-0.012848
Labour availability	0.185** (0.035)	0.087 (0.555)	0.157* (0.096)	0.054 (0.873)	0.145 (0.534)
Farming experience	0.198 (0.400)	0.156*** (0.029)	-0.069 (0.314)	0.056(0.498)	-0.156 (0.675)
Household size	0.124 (0.451)	-0.045 (0.464)	0.133** (0.041)	0.068 (0.377)	0.098 (0.438)
Farm size	-0.235 (0.387)	0.140 (0.256)	0.099** (0.014)	-0.080 (0.721)	-0.04482
Amount of credit obtained	-0.216 (0.222)	-0.239 (0.165)	-0.007546	-0.033 (0.615)	-0.186 (0.342)
Access to climate info.	0.189 (0.225)	0.198** (0.022)	0.076 (0.156)	0.071 (0.815)	0.098 (0.316)
Extent of extension contact	0.356** (0.032)	0.098 (0.166)	0.113 (0.867)	0.027 (0.309)	-0.010 (0.400)
Access to farm inputs	0.247 (0.233)	0.134 (0.161)	0.146** (0.044)	-0.009 (0.254)	0.091* (0.074)
Rainfall	-0.011 (0.266)	0.067** (0.050)	0.136** (0.045)	-0.145 (0.587)	-0.247 (0.417)
Temperature	0.089 ** (0.038)	-0.00702	-0.097 (0.186)	0.197** (0.039)	-0.093 (0.653)
Soil fertility	-0.031 (0.609)	0.051 (0.344)	0.068** (0.019)	-0.048 (0.289)	-0.312 (0.672)

Source: Computed from Field Survey Data, 2018
****, **, *** stand for level of significance at 10%, 5%, and 1%, respectively.***
Note: Figures in parentheses are p-values, frag. = fragmentation

Having access to extension packages increased the likelihood of practicing the use of improved varieties by 32%, multiple planting dates by 24%, increasing farm size by 1.5%, mulching by 12% and farm plots fragmentation by 8.3%. Also, the result showed that a unit increase in access to inputs increased the likelihood of practicing the use of improved varieties by 3.6%, multiple planting dates by 2.4%, increasing farm size by 9.1% and farm plots fragmentation by 7.5% while it reduced adoption of mulching by 0.4%. It is evident from the result that seamless access to farm inputs stimulates practice of diverse adaptation strategies. The result further revealed that a unit increase in the volume of rainfall would increase the probability of multiple planting dates by 6.8% and increasing farm size by 9.7%. Contrarily, a unit increase in rainfall decreased the practice to use improved varieties by 3.3%, mulching by 13.6% and farm plots fragmentation by 22.9%. Unlike rainfall, a unit increase in temperature brought about increase in probability of practicing the use of improved varieties of cassava stems and mulching by 6.6% and 17.2% respectively. The result showed further that a unit increase in temperature reduced the likelihood of practicing multiple planting dates by 8.8%, increasing farm size by 6.1% and farm plots fragmentation by 6.7%. From the result, it was made clear that a unit increase in soil fertility resulted in likelihood to practice multiple planting dates by 4.9% and increasing farm size by 4.1%. The result further revealed that a unit increase in soil fertility reduced the probability of practicing the use of improved varieties by 2.1%, mulching by 0.8% and farm plots fragmentation by 2.4%.

IV. CONCLUSION AND RECOMMENDATIONS

Mixed effects of socio-economic and climatic variables were observed on choice of adaptation practices in the study area. It was concluded that sex, age, marital status, years spent in school, farm income, amount of credit received and temperature greatly influenced the decision of cassava farmers to choose adaptation strategies in rain forest AEZ. It is therefore recommended that government should provide adequate extension services with knowledgeable and skilled extension agents who are equipped with climate useful information, thereby making the farmers aware about the available adaptation strategies to climate change and the benefits inherent in them; farmers, via extension agents, should be encouraged to use improved varieties of cassava as adaptation strategy in order to achieve increased output and multiple planting dates should be embraced by the cassava farmers.

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