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Full Length Research Paper

A study of socio-economic characteristics of farmers and their adaptation options to climate change

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The study evaluated the trends, perceptions and adaptation options of arable crop farmers to climate change in Imo State, Nigeria. Multi-stage random sampling technique was adopted in selection of respondents. The sample size comprised sixty farming households. The main tool for data collection was a set of structured questionnaire. Data collected were analyzed using descriptive statistical tools, trend analysis and multinomial logit regression model. In order to forecast the future trends of climate change in the area and beyond, climatic record of 40 years duration were obtained between 1972 and 2012 from Agro-meteorological Station, National Root Crops Research Institute (NRCRI) Umudike, Abia State, Nigeria. Findings revealed mean age to be 43.24 years. Majority (73.33%) were males. Greater proportions (71.67%) were married with an average household size of six persons. Average farm size was 0.97 ha. The study confirmed the evidence of climate change in the area, as result from trend analysis revealed a sustained decrease in number of rainy days and relative humidity while results on temperature level and sunshine duration showed an increasingly significant trend, respectively. If the trend continues, arable crop production (vegetables, maize, okra, roots and tubers) in the area may be adverse with time. Perceptions of farmers on climatic variables were all in line with the trends result. Thus, it is obvious that arable crop farmers in the area are noticing the change and its negative impact in the area and are responding to the change through the adoption of certain local practices to thwart its negative impacts. Estimated multinomial logit model showed that socio-economic characteristics of the farmers have a significant influence on their adaptation options to climate change. Farmers complained of inadequate information. It was therefore recommended that agricultural policies and programmes should focus on intensifying awareness on climate change as this would affect farmer's adaptation to climate change positively.

Keywords: Arable crop farmers, socio-economic characteristics, trends, perceptions, adaptation options, multinomial logit model, Imo State, Nigeria.

INTRODUCTION

The term climate change refers to an observed change in climate which is attributed directly or indirectly to human activities which alter the composition of the global atmosphere and which are in addition to natural variability observed over comparable time periods (IPCC, 2007; IPCC, 2010). Therefore, "Climate Change" describes a significant and sustained adjustment in the geometric distribution of global environment over time. There is increasing evidence that climate change will be one of

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the challenging issues for future development (Odada et al., 2008). The challenge is composed of the likely impacts of climate change on ecosystem services, agricultural production and livelihoods (Mertz et al., 2010). de Acquah and Onumah (2011) reported that climate change is expected to pose a serious threat on environment, agricultural production and food security of most developing countries including Nigeria. In particular, rural farmers, whose livelihoods depend on the use of natural resources and economics of scales, are likely to bear the brunt of adverse. Babatunde et al. (2011) also submitted that climate change is expected to with increased frequency and intensity of extreme weather conditions in rainforest region of Nigeria. The implications for the region are that the region would generally experience water than average climate, more extreme weather conditions, particularly erosions, windstorms which would be unfavourable for crop production in Imo State, Nigeria and perhaps beyond if the trends continues. Climate change and agriculture are interrelated processes, both of which take place on a global scale. Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, precipitation and glacial run-off (Kemausuor et al., 2012). The most significant trend in crop production in developing countries especially Nigeria is the rapid growth in demand for crop product driven by urbanization, population growth and income increases, this trends in demand will be for both increased quantity and quality particularly among rural and urban consumers who purchase crop products for consumption. However, several studies indicated that Nigeria agriculture is negatively affected by climate change (IPCC, 2007; IPCC, 2010; Nzeadibe et al., 2012). Thus, Perceptions, adaptation and mitigation remains the policy options for counteracting the negative impact of climate change over time. Recent estimates suggest that, in the absence of adaptation, climate change could result in a loss of between 2% and 11% of Nigeria's GDP by 2020, rising to between 6% and 30% by the year 2050 (BNRCC, 2011). This loss is equivalent to between N15 billion (US $ 100 billion) and N69 trillion (US $ 460 Billion) (IPCC, 2010; BNRCC, 2011). Also greater proportion of crop farmers in the area are conservative and remains unaware of the negative impact of climate change while other have developed the capacity to counteract the negative impact of climate change in the area but the speed and intensity at which the changes occur is outpacing their capacity to adapt. Currently, in Imo State, Nigeria, we do not know farmers socio-economic characteristic, farmers level of awareness to climate change, trend of climate change, farmers perceptions to climate change and farmers strategies to improving adaptation to climate change. Farmers barriers to improving adaptation to climate change in the area is also not known. Besides, the empirical evidences emerging from few studies (Walker, 2004; Ahmed, 2006; Munonye and Okoli, 2008; Nwajiuba et al., 2008; Gren, 2010; Onyeneke and Madukwe, 2010; Nzeadibe et al., 2012; Onubuogu and Chukwu, 2014) on effect, trends , adaptation, awareness and perceptions to climate change at the crop farmers household level yielded mixed results that are inconclusive and conflicting. Also, little or no study has rigorously modeled the trends of climate change along with crop farmers perceptions in Imo State, Nigeria. Empirical evidence remains largely scanty, isolated and devoid of in-depth analysis of trends, perceptions and adaptation options of arable crop farmers to climate change in Imo State, Nigeria, using logit multinomial model approach. This creates a deep vacuum in research, knowledge and literature. Thus, the study is still worthy of further research. To fill this dearth, the study identified socio-economic characteristics of the farmers; determined farmers perceptions on climatic variables; examined trends of climatic variables in Imo State, Nigeria; determined farmers adaptation options to climate change and identified farmers barriers to climate change in the study area.

RESEACRH METHODOLOGY

The study was carried out in Owerri Agricultural Zone of Imo State, Nigeria. The zone is located between Latitudes 4°45´ and 7°25´ north of the equator and Longitudes 6°5´ and 7°25´ east of the Meridian (Microsoft Corporation, 2009). Owerri Agricultural Zone is one of the three Agricultural Zones in Imo State. It is located at the southwestern part of Imo State. It is bounded on the East by Abia State, on the west by Anambra and Rivers State, on the North by Isu and Isiala Mbano Local Government Areas of Imo State and on the South by Abia and Rivers States (Imo ADP, 2004). It comprises eleven local Government Areas, namely: Aboh Mbaise, Ahiazu Mbaise, Ezinihitte Mbaise, Ikeduru, Mbaitoli, Ngor-okpuala, Ohaji/Egbema, Oguta, Owerri Municipal, Owerri North and Owerri West. It has a population of 1,663,361 (NPC, 2006 and NBS, 2008). There are two main seasons in the zone–dry and rainy seasons. The annual rainfall is between 1900mm and 2200mm while the mean annual temperature is between $20^{0}C$ with a relative humidity of about 75% annually (Imo ADP, 2004 and Microsoft Corporation 2009). The zone is richly endowed with fertile land suitable for growth of arable crops. Farmers in the zone are mainly smallholder farmers (Imo ADP, 2004). All these necessitated the choice of the zone as the study area. Multi-stage random sampling technique was adopted in selecting the respondents for the study. Seven out of the eleven Local Government Areas were randomly selected. The second stage of the selection involved the random selection of two communities from each of the seven LGAs making a total of fourteen communities. Another stage involved a random selection of two villages from each of the fourteen selected communities making a total of twentyeight (28) villages. Ultimately, a random selection of three arable crop farmers was done from each village making a total of eighty four respondents for study. However, the study found only sixty responses valid and was used for data analysis. These farmers were selected from the list of households who are into arable crop production in the communities and this list was collected from the community heads and Agricultural Development Programme (ADP) extension agents. Primary data were collected through the use of well structured questionnaire and it was supplemented with oral interview in situations where the respondents could neither read nor write. The primary data that were collected for the study include the socio-economic characteristics of the farmers, farmers perceptions, farmers adaptation options to climate change and barrier to climate change in the Descriptive statistics namely: frequency distribution, percentage and flow charts were used to realize the objectives. The formular of the Multinomial Logit Model (MNL) is given below:

$$Pr(Y_i = j) = \frac{e^{\beta_j x_{ij}}}{1 + \sum_{m=0}^{6} e^{\beta_m x_{ij}}}, \quad j = 0,1,2,3,\ldots,11 \quad \text{(Equation 1)}$$

$$P_j = Pr(Y_i = j) = \frac{e^{\beta_j x_{ij}}}{1 + \sum_{m=0}^{6} e^{\beta_m x_{ij}}}, \quad j = 0,1,2,3,\ldots,11 \quad \text{(Equation 2)}$$

Where:

$Pr(Y_i=j_i)$ is the probability of choosing either mixed farming, agroforestry, adjustment in planting dates, adjustment in harvesting dates, diversification of livelihood, use of irrigation, mulching, planting of trees, use of resistance crop varieties, intercropping with on adaptation options as the reference or based category,

J is the number of climate change adaptation options in the choice set,

X_i is a vector of the predictor (exogenous) socio-economic factors (variables)

β_j is a vector of the estimated parameters

The implicit functional form for the regression model is:

Where P = Response Probability (J =0,1,2,3,---11)

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Where P = Response Probability (J =0,1,2,3,---11)

Y = Adaptation category; J = 1, 2 ….11;

1= Mixed farming,

2= Agroforestry,

3= Adjustment in planting dates,

4= Adjustment in harvesting dates,

5= Diversification of livelihood, 6= Use of irrigation, 7= Mulching,

8= Planting of trees,

9= Use of resistance crop varieties, 10= Intercropping, 11 = No adaptation

The explanatory variables are as follows:

$Y = f(X_1,X_2,X_3,X_4,X_5,X_6,X_7,X_8,X_9,X_{10}+e_i)$

Where Y = Adaptation category (J =0,1,2,3,---11)

X_1= Age (years)

X_2= Gender (male=1, female=0)

X_3= Educational level (years)

X_4= Farming experience (years)

X_5=Farm size (hectare)

X_6= Household size (number of persons)

X_7= Access to credit (access=1, otherwise=0)

X_8= Access to climate information (access=1, otherwise=0)

X_9 = Monthly farm income (₦)

X_{10} = Access to extension agents (access=1, otherwise=0)

e_i= Error term

Regressors Model; Bq=β_1, β_2, β_3, β_4, β_5, β_6, β_7, β_8, β_9, β_{10}= Respective parameter estimates of the explanatory variable, while β_{0i} is the constant term.

RESULTS AND DISCUSSION

Socio-economic characteristics of arable crop farmers

Table 1 reveals that majority (31.67%) of the farmers fell within the age bracket of less than 40 years. It also showed that (28.33%) of the farmers fell within the age bracket of 51 to 60 years, 23.33% of the farmers fell within the age bracket of 61 years and above, while 16.67% fell within the age bracket of 51 to 60 years. The mean age was 43.24years. This implies that farming activities in the study area is dominated by young individual. The implication is that younger farmers are likely to adopt new innovation faster than the older ones. The finding is in agreement with Gbetibouo (2009) that majority of farmers within the age range of 41 to 50 years are still in there active age, more receptive to innovation and could withstand the stress and strain involved in agricultural production and ease adaptation to climate change. The young farmer’s involvement in agricultural production in the area is very encouraging. Government efforts should focus on how to sustain this result, improve ease awareness and adaptation to climate change through the young farmers in the area. Table 1 also reveals that majority (73.33%) of the farmers were males while 26.67% were females. This implies that males headed household constituted a greater proportion of those involved in agricultural production in the study area. The finding is in line with Nhemachena and Hassan (2007) who reported that males headed household constituted a greater proportion of those involved in agricultural production. The implication of males greater proportion may be that productivity is expected to be higher because males have tendency to be more labour efficient. Taking labour efficiency into concern, the finding confirmed the study Onubuogu et al. (2014) that three women are equivalent to two men. Entries in Table 1 also

Table 1. Socio-economic characteristics of farmers.

Age (years)	Frequency	Percentage (%)
Less than 40	19	31.67
41-50	10	16.67
51-60	17	28.33
61 and Above	14	23.33
Total	**60**	**100.00**
Gender		
Male	44	73.33
Female	16	26.67
Total	**60**	**100.0**
Educational level (Years)		
Non Formal	4	6.67
Primary	11	18.33
Secondary	39	65.00
Tertiary	6	10.00
Total	**60**	**100.0**
Marital status		
Married	43	71.67
Single	9	15.00
Widowed	8	13.33
Total	**60**	**100.0**
Farming experience (Years)		
Less than 20	38	63.33
21-30	9	15.00
31-40	5	8.33
41 and above	8	13.33
Total	**60**	**100.0**
Household size (Number of persons)		
1-5	26	43.33
6-10	34	56.67
Total	**60**	**100.0**
Extension contact (Number of Visit)		
1-2	47	78.33
3 and above	14	21.67
Total	**60**	**100.0**
Access to Credit		
Access	46	76.67
No access	14	23.33
Total	**60**	**100.0**
Access to climate change information		
Access	52	86.67
No access	8	13.33
Total	**60**	**100.0**

Table 1. Contd.

Average Income (Naira)		
Less than 20,000	5	8.33
21,000-40,000	9	15.00
41,000-60,000	32	53.33
61,000-80,000	12	20.00
Total	**60**	**100**
Farm size(Ha)		
Less than 1.0	41	68.33
1.0-1.5	19	31.67
Total	**60**	**100.0**

Average age = 42.24 years; Mean Educational level= 11.15 years; Average Farming Experience = 21.27 years; Mean household size= 6 persons; Average Income = ₦59,500.00; Average farm size = 0.97ha; Source: Field Survey Data, 2013.

show that majority (65.00%) of the farmers had secondary education, 18.33% had primary education, 10.00% had tertiary education, while 6.67% had non-formal education. The mean educational year was 11.15 years. Following the findings, farmers in the study area could be said to be literate enough. The results contrasts with general farm-level survey data which asserts and classify most Nigerian farmers as illiterates, which means having no formal or low (primary) educational status (Ekong, 2003). Exposure to high level of education is an added advantage in terms of climate change adaptation measures. This findings support Nhemachena and Hassan (2007) and Onubuogu et al. (2014) who noted that higher education was likely to enhance information access to the farmer for improved technology up take and higher farm productivity. They have also observed that education is likely to enhance the farmers' ability to receive, decipher and comprehend information relevant to making innovative decisions in their farms. Thus, higher level of education determines the quality of skills of farmers, their allocative abilities, and efficiency and how well informed they are to the innovations, technologies and awareness levels and adaptation to climate change. Table 1 also reveals that that majority (71.67%) of the farmers were married, 15.00% were single, while 13.33% were widowed. This implies that greater proportion of farmers in the area are married individuals which increases ease access to production variables such as land and labour which are traditionally owned and provided by husbands. Olorunfemi (2009) reported that this could be as a result of high labour requirement in agricultural production in which they use members of their family as labour force. Farming experience is also reported in Table 1 and it reveals that greater proportion (63.33%) of the farmers had less than 20 years of farming experience, 15.00% of the farmers had 21 to 30 years of farming experience, 13.33% of the farmers had 41 years of farming experience and above, while 8.33% of the farmers constitute those with 31 to 40 years of farming experience in the study area. The mean farming experience was 21.27 years. It implies that farmers with high years of experience should be more efficient and their chances of adapting to climate change are higher than farmers with little years of experience (Onubuogu et al., 2014). The findings support Deressa et al. (2008) that farmers with high years of farming experience would be more efficient, have better knowledge of farming conditions and climatic situation and are thus, expected to adapt effectively and efficient to climate change in the area. Also, this study support the finding of Esiobu et al. (2014) that previous experience in agribusiness enable farmers to set realistic time and cost targets, allocate, combine, utilize resources efficiently, identify production and marketing risks. The result of household size is also shown in Table 1 and illustrate that majority (56.67%) of the farmers had household size of 6 to 10 persons, while 43.33% had household size of 1 to 5 persons. The mean household size was 6 persons. This implies that farmers in the study area have a large household size. This findings support the result of Teklewold et al. (2006), Tizale (2007), Onubuogu et al. (2013) and Esiobu et al. (2014), they reported that large household size is a proxy to labour availability, ensure ease adaptation to climate change and reduce the cost of hired labour. A household comprises all persons who generally live under the same roof and eat from the same pot (FOS, 1985; Esiobu et al., 2014). Lipsey (1986) and Onubuogu et al. (2014) also describe a household as all people who live under one roof and who make or are subject to others making for them, joint financial decision. For the purpose of this study, a household comprises the head, the wife/wives, children and other dependents that live in the same house. Results in Table 1 also shows that larger percentage (78.33%) of the farmers received 1-2 extension visits per month while 23.33% received 3 and above of extension visits per month. The mean visit per month was 2.0 times. This implies that the farmers in the study area are poorly visited by extension agents to ascertain their farming problem and know where they need assistance (Onubuogu et al., 2013; Onubuogu et al., 2014). The implication of the finding is that extension contact which is a channel through which agricultural innovations and information are passed to farmers for improvement in their standard of living, production and productivity are missing. This could bring about low productivity due to lack of innovative information. Knowler and Bradshaw (2007) and Deressa et al. (2008) noted that adequate extension contact have a positive relationship with the adoption of agricultural technologies since extension agents transfer modern agricultural technologies to farmers to help them counteract the negative impact of climate change in their area. Table 1 also shows that majority (76.67%) of the farmers in the study area have access to credit while 23.33% have no access to credit. This implies that farmers in the study area have access to credit which enhances easy adaptation to climate change. Despite the various adaptation options, farmers could be aware of and willing to practice but inadequate fund to purchase the necessary inputs and other associated equipment are the significant barriers to adaptation to climate change. Access to climate change information is also reported in Table 1 and it indicates that majority (86.67%) of the farmers in the area have access to climate change information, while 13.33% have no access to climate change information. This implies that farmers in the study area have access to climate change information which enhances easy adaptation to climate change. A number of studies confirmed these results such as those by Adesina and Forson (1995), Maddison (2006), Nhemachena and Hassan (2007), Deressa et al. (2008), Gbetibouo (2009) and Ndambiri et al. (2012), they have separately noted that farmers access to information on climate change is likely to enhance their probability to perceive climate change, and hence adopt new technologies and take-up adaptation techniques to counteract the negative impact of climate change. Entries in Table 1 also show that majority (48.33%) of the farmers in the study area have an average monthly farm income between ₦41,000 to ₦60,000, 20.00% have an average monthly farm income between ₦61,000 to ₦80,000, 15.00% have an average monthly farm income of ₦21,000 to ₦40,000, 8.33.% have an average monthly farm income of below ₦20,000, while 3.37% have an average farm income of ₦81,000 and above. The mean monthly farm income was ₦59,500.00. Farmers with the higher monthly farm income will easily adapt to climate change than those of their counterpart who have poor farm monthly income. Onubuogu et al. (2013) and Onubuogu et al. (2014) noted that farmers incomes (whether on-farm or off-farm income) have a positive relationship with the adoption of agricultural technologies since the latter requires sufficient financial wellbeing to be undertaken. Ultimately, Table 1 also reveals that majority (53.33%) of the farmers in the study area had farm size of between 1.0-2.5 ha, 40.00% had a farm size less than 1.0 ha, while 6.67% had farm size of 2.6 ha and above. The mean farm size was 0.97 ha. This implies that the farmers in the study area are mainly smallholder farmers operating on less than or equal to 1.5 ha of farmland. This could be as a result of land tenure system predominant in the area or due to the increasing population. Large farm size increases agricultural productivity, improves farmers technical, allocative, resource use efficiency as well as easy adaptation to climate change (Deressa et al., 2008; Ndambiri et al., 2012; Onubuogu et al., 2013; Onubuogu et al., 2014).

Trend analysis of climatic variables

Level of temperature (1972 – 2012)

Table 2 and Figure 1 reveals the trend analysis of record

Table 2. Trend analysis of temperature record (1972-2012).

Temperature record	Value (°C)
Minimum temperature	29.22
Maximum temperature	30.43
Mean	28.95
Standard deviation	1.52
Trend(^{O}C/year)	2.285
Pearson correlation	0.0835***

Source: Computer Printout of MINITAB (2013); ***Significant correlation at 1% level of probability.

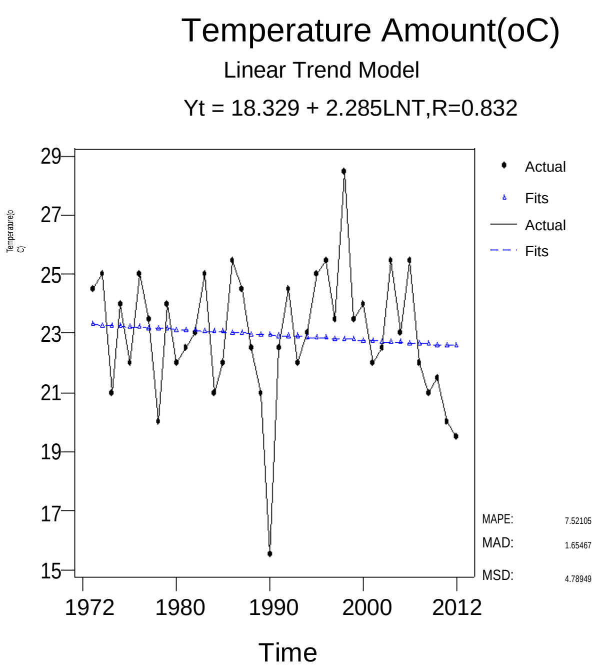

Figure 1. Trend analysis of the temperature record for Imo State Rainforest Zone of Nigeria from 1972-2012; Source: Field Survey Data, 2013.

of the level of temperature between 1972-2012 in the study area which shows an increasing trend with the minimum (29.22°C) and maximum (30.43°C) temperature recorded in 1990 and 1998, respectively. The mean and standard deviation of the level of temperature in the Imo State rainforest zone of Nigeria between 1972 and 2012 were 28.95 and 1.52°C, respectively.

Furthermore, there is a little variability in the level of temperature all year round in the study area. The coefficient of Pearson product moment correlation between the level of temperature and time was 0.832, implying that there is a 83.20% relationship between the level of temperature and time in the study area. This could be attributed to the strong positive significant correlation between the level of temperature and time in the study area. Both time and the level of temperature in the study area are strongly correlated and as well moves in the same direction. As time increases, the level of temperature increases as well. As temperature increase, the warming is real as well and would continue to increase over time in the area. The finding is in accordance with Babatunde et al. (2011) who reported that the evidence of variations in the climates of the coastal and rainforest regions of Imo State, Nigeria is seen on steady increase in surface temperature level. The negative impact is that increased temperature will cause a poleward shift of the thermal limits to arable crop production. In other word, over time arable crop farmers in the area will continue to witness low yield/output in arable crop production due to the increased scorching temperature in the study area.

Trend analysis for relative humidity (1972 – 2012)

Table 3 and Figure 2 of the trend analysis of record on the relative humidity in the Imo State rainforest zone of Nigeria obtained from the Agro-meteorological Station, National Root Crops Research Institute (NRRI) Umudike, Abia State, Nigeria between 1972 and 2012 shows a decreasing trend over time with minimum (67.00%) and maximum (84.00%) value obtained in 1990 and 2010, respectively. The mean and standard deviation values of the relative humidity over the period were 81.50 and 3.65%, respectively. Hence, the relative humidity has a slight variability with the period of time. The finding from the trend coefficient (-0.0018%) showed a decreasing significant trend of relative humidity per year but however insignificant trend.

The coefficient of Pearson product moment correlation between the relative humidity and time was 0.164 implying that there is a 16.40% relationship between relative humidity and time. This could be concluded to be a positive but insignificant correlation between the relative humidity and time in the study area.

The result is in accordance with Olorunfemi (2009) who reported that the evidence of variations in the climates of the coastal and rainforest regions of Nigeria, Imo State, is seen on steady decreases in amount of surface relative humidity. The implication of the finding is that arable crop farmers will experience too high or too low level of transpiration which will retard arable crop growth in the study area.

Trend analysis for amount of rainfall (1972 – 2012)

Table 4 and Figure 3 show the trend analysis of record on the amount of rainfall in the study area between 1972 and 2012 which indicated a decreasing trend over time with the highest amount of rainfall recorded in 1997 and lowest in 1989. The value of the highest volume of the amount of rainfall which was recorded in 1997 was 2864.60 mm while the lowest value recorded in 1989 was 1430.20 mm. The mean and standard deviation of the amount of rainfall in the area between 1972 and 2012 were 1868.684 and 420.30 mm, respectively.

Table 3. Trend analysis of relative humidity record (1972-2012).

Relative humidity record	Value (%)
Minimum humidity	84.00
Maximum humidity	67.00
Mean	81.50
Standard deviation	460.30
Trend(%/year)	-0.0018
Pearson correlation	0.164*

Source: Computer Printout of MINITAB (2013); * Not Significant.

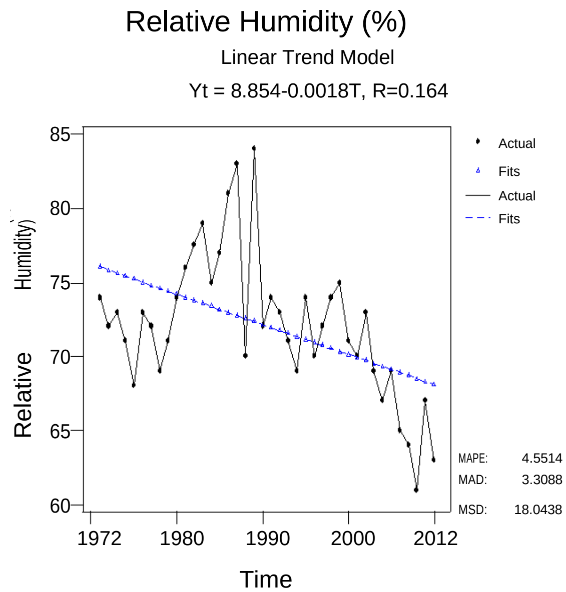

Figure 2. Trend Analysis of the relative humidity for Imo State Rainforest Zone of Nigeria from 1972-2012
Source: Field Survey Data, 2013.

Table 4. Trend analysis of rainfall amount record (1972-2012).

Rainfall amount record	Value (mm)
Minimum rainfall	2864.60
Maximum rainfall	1430.20
Mean	1868.84
Standard deviation	460.30
Trend(mm/year)	-1.531
Pearson correlation	0.062***

Source: Computer Printout of MINITAB (2013); ***Significant correlation at 1% level of probability.

The result implies that there is a huge variability in the amount of rainfall all year round. The coefficient of Pearson product moment correlation between the amount of rainfall and time was 0.062 implying that there is a 6.20% relationship between the amount of rainfall and time. This could be concluded to be a positive but

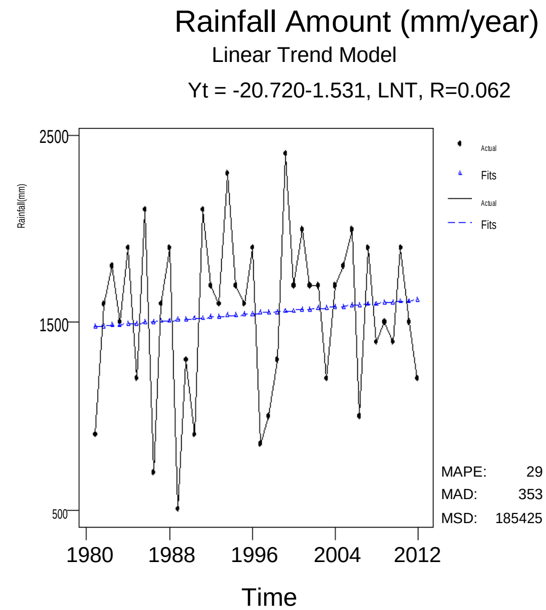

Figure 3. Trend analysis of the amount of rainfall for Imo State Rainforest Zone of Nigeria from 1972-2012.
Source: Field Survey Data, 2013.

insignificant correlation between the amount of rainfall and time in the study area. This finding is in line with Okorie et al. (2012) who reported that rainfall volume in the rainforest and coastal regions of Nigeria Imo State have been and will continue to experience increased trend all year round. The implication of the findings is that there could be significant increase in the incidence of flood in the study area. If the trend continues, the area would experience an increased volume of rainfalls with the poor number of rainy days hence arable crop production in the area may be adverse would be threaten food security all year round as well as farmers enterprise.

Trend analysis for sunshine duration (1972–2012)

Table 5 and Figure 4 reveals the trend analysis of record on the sunshine duration in the study area between 1972 and 2012 which shows a significant increasing trend with a coefficient of 4.357 h per year. The minimum and maximum value of sunshine duration obtained were 4.10 h in 1984 and 5.80 h in 2010, respectively. The mean and standard deviation of the sunshine duration in the study area between 1972 and 2012 were 4.42 and 0.72 h, respectively. Hence, there is a poor but significant variability between sunshine hours and time all year round in the study area. The coefficient of Pearson product moment correlation between sunshine duration and time was 0.056 implying that there is a 5.60% relationship between sunshine hours and time in the study area. This could be attributed to a poor positive and insignificant correlation between the sunshine duration and time in the study area. This finding is in line with Olorunfemi (2009) and Babatunde et al. (2011) who

Table 5. Trend analysis of sunshine duration (1972-2012).

Sunshine duration	Value (Hours)
Minimum duration	30.43
Maximum duration	29.22
Mean	28.95
Standard deviation	1.52
Trend (hrs/year)	4.357
Pearson correlation	0.056***

Source: Computer Printout of MINITAB (2013); ***Significant correlation at 1% level of probability.

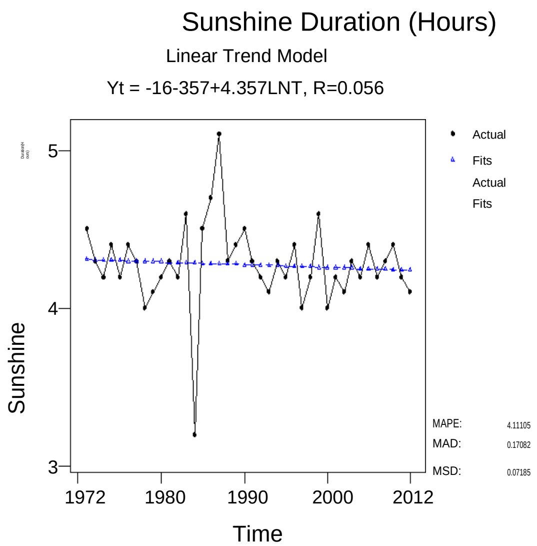

Figure 4. Trend analysis of the sunshine duration for Imo State Rainforest Zone of Nigeria from 1972-2012. Source: Field Survey Data, 2013.

reported that sunshine duration in the rainforest and coastal regions of Nigeria of which Imo State is included have been and will continue to experience increasing trend all year round. The negative impact would be that arable crop farmers will continue to witness low yield/output as high sunshine or too low sunshine in the area will negatively affect the production of some sun loving (tomatoes, peppers, cucumbers, eggplants) crops as well as make livelihood of farmers unfavourable in the study area.

Farmers' perception on changes in climatic variables

Table 6 reveals that majority (63.33%) of the farmers in the study area observed an increase in temperature level for over 40 years. This implies that temperature level has significantly increased for over 40 years in the study area. However, farmers perception on changes in climatic variables were in line with the result from trend analysis, it became clear that farmers in the area rightly perceived the direction of change in temperature level implying that

Table 6. Perceptions of arable crop farmers to climatic variables.

Perceptions	Frequency	Percentage (%)
Temperature amount(°C)		
Increase	38	63.33
Decrease	8	13.33
No change	9	15.00
Do not know	5	8.33
Total	**60**	**100.0**
Rainfall amount (mm)		
Increase	47	78.33
Decrease	6	10.00
No change	1	1.67
Do not know	5	8.33
Total	**60**	**100.0**
Relative humidity (mm)		
Increase	8	15.00
Decrease	39	65.00
No change	11	18.33
Do not know	5	8.33
Total	**60**	**100.0**
Sunshine duration(Hours)		
Increase	49	81.67
Decrease	4	6.67
No change	2	3.33
Do not know	5	8.33
Total	**60**	**100.0**

Source: Field Survey Data, 2013.

they must have been responding to this changes. Entries in Table 6 also reveal that greater proportion (78.33%) of the farmers observed an increase in rainfall amount over 40 years. The implication of the findings is that rainfall amount has significantly increased for over 30 years in the study area. Thus, farmers perception on changes climatic variables is in line with the result from trend analysis, it became clear that farmers in the area rightly perceived the direction of change in rainfall amount implying that they must have been responding to this changes. Result also indicted that larger percentage (65.00%) of the farmers in the study area observed that relative humidity has decreased over 40 years. This implies that relative humidity has significantly decreased for over 40 years in the study area. Farmers perceptions on changes climatic variables is in line with the result from trend analysis, it also became clear that farmers in the area rightly perceived the direction of change in relative humidity implying that they must have been responding to this changes.

Ultimately, Table 6 result reveals that majority (81.67%) of the farmers in the study area observed that sunshine duration has increased over 40 years; this implies that relative humidity has significantly increased over 40 years

Table 7. Crop farmers Adaptation Options.

Adaptation Options	Frequency	Percentage (%) **
Use of resistance crop varieties	57	95.00
Agroforestry	55	91.67
Adjustment in planting dates	51	85.00
Adjustment in harvesting dates	46	76.67
Diversification of livelihood	43	71.67
Mulching	38	63.33
Planting of trees	32	53.33
Mixed farming	30	50.00
Intercropping	20	33.33
No adaptation	8	13.33

**Multiple responses. Source: Field Survey Data, 2013.

in the study area. Farmers perceptions on changes climatic variables is in line with the result from trend analysis, it became clear that farmers in the area rightly perceived the direction of change in sunshine duration implying that they must have been responding to changes.

Crop farmers' adaptation options

The adaptation options for this study were based on asking farmers about their perception of climate change and the actions they had taken to thwart its negative impacts. The adaptation options that farmers identified may be profit driven, rather than climate change driven. Regardless of this dearth in knowledge, the researcher assumed that arable crop farmers actions were climatic factor driven, as identified by arable crop farmers themselves in the area.

Table 7 shows that majority (95.00%) of the farmers in the study area uses resistance crop varieties as their adaptation measures to climate change, 91.67% have agroforestry as their adaptation option to climate change, 85.00% of the farmers have adjustment in planting dates, 71.67% have diversification of livelihood, 63.33% have mulching, while 53.33% identified planting of trees as their adaptation measures to climate change in the area. Others 50.00, 33.33, and 13.33% of the farmers have mixed farming, intercropping and no adaptation, respectively. This implies that farmers in the study area are noticing the change in climatic variables and have adopted various adaptation options to counteract the negative impact of climate change in the area.

Arable crop farmers socio-economic characteristics and adaptation Options

Table 8 shows the multinomial logit regression analysis of the influence of arable crop farmers' socioeconomic characteristics on their various adaptation option to climate change. The adaptation options set in the multinomial logit regression model included the use of resistance crop varieties, use of improved breeds of livestock, adjustment in planting dates, adjustment in harvesting dates, diversification of livelihood, mulching, planting of trees, mixed farming, intercropping and no adaptation. The estimation of the multinomial logit regression model for the study was undertaken by normalizing one category, which is usually referred to as the "reference or base category". In the analysis, the last category (no adaptation) was the base category. The model was analyzed and tested for the reliability and validity of the independence of the irrelevant alternatives (IIA) assumption by using the Hausman test for IIA. The analysis accepted the null hypothesis (H_0) of independence of the farmers' adaptation options, suggesting that the multinomial logit regression model is appropriate to model climate change adaptation options of farmers in the study area, (Chi-square (X^2) ranged from 0.0001 to 5.861, with probability values ranging from 0.468 to 1.000 for the Hausman test). The total observations (sample size) were 60. The likelihood ratio statistics from multinomial logit regression model indicated that $\chi 2$ statistics (1872.516) are highly significant at 1% ($P<0.00001$) level of probability, hence suggesting that the model has a strong explanatory power. The variables of the multinomial logit regression model were in conformity with the signs of the *a priori* expectations. The significance of the likelihood ratio statistics revealed that the arable crop farmers' socio-economic characteristics have a significant influence on their adaptation options to climate change. The null hypothesis (H_0) of the study was therefore rejected; and the study therefore accepted that the arable crop farmer's socio-economic characteristics have a significant influence on their adaptation options to climate change in the area. Hence, the finding presents the marginal effects along with the levels of statistical significance.

Age (X_1): The age of the farmers had a significant relationship on various adaptations to climate change.

Table 8. Estimated multinomial logit analysis of the influence of arable crop farmers socio-economic characteristics on adaptation options to climate change in Imo State.

Variables	Mixed farming		Agroforestry		Adjustment in planting dates		Adjustment in harvesting dates		Diversification of livelihood		Mulching		Planting of trees		Use of resistance crop varieties		Intercropping	
	Coeff.	Wald	Coeff.	Wald	Coeff.	Wald	Coeff.	Wald	Coeff.	Wald	Coeff.	Wald	Coeff.	Wald	Coeff.	Wald	Coeff.	Wald
Age (X_1)	16.2^{XXX}	19.5	35.2^{XX}	10.5	9.5^{XXX}	19.4	12.3^{XXX}	23.2	17.5^{XXX}	18.1	28.4^{XXX}	17.4	16.3^{XXX}	22.1	7.1^{XXX}	18.1	1.2^{XXX}	20.5
Gender(X_2)	-18.1^{XXX}	15.3	-4.2^{XX}	6.6	-18.5^{XXX}	15.2	-14.5	1.1	-15.1^{XXX}	13.0	-15.2^{XXX}	11.1	-6.9^{XXX}	21.0	-9.0^{XXX}	22.1	-7.1^{XXX}	19.0
Edu (X_3)	38.1	1.2	3.1	0.5	23.0	1.2	42.1^{XXX}	15.2	19.1	0.1	17.0***	13.5	13.0	1.5	9.2	2.0	3.5	1.1
FExp (X_4)	12.2	1.5	21.3	1.2	19.0	0.2	35.2	0.5	35.0	1.2	6.1***	22.1	11.0	0.1	6.5 xxx	24.1	5.1	0.1
FMS (X_5)	18.3^{XX}	11.5	88.4^{XX}	8.5	$-12.^{XXX}$	18.3	-125.2^{XXX}	25.3	8.8^{XXX}	18.1	-8.1^{XXX}	26.4	-21.5^{XXX}	19.5	-54.0^{XX*}	27.3	-8.3^{XXX}	22.0
HHS(X_6)	14.1^{XXX}	19.4	35.2^{XX}	6.3	6.1^{XXX}	24.3	11.3^{XXX}	25.1	19.0^{XX}	9.3	26.9^{XXX}	16.5	19.0^{XXX}	13.0	15.3^{XXX}	20.1	6.5^{XXX}	24.0
ATC (X_7)	15.2^{XX}	8.5	28.0^{XXX}	9.5	15.9	0.5	35.3^{XXX}	156.5	18.0	1.2	14.0	3.5	13.1^{XX}	11.0	19.2^{XXX}	25.1	31.0^{XXX}	28.5
ACCI (X_8)	3.2	1.3	16.1^{XXX}	29.3	3.2	0.6	142.4	5.1	3.5	1.5	9.2	3.5	21.0	5.1	15.5^{XXX}	15.1	15.6	1.5
MFMI (X_9)	5.1 xxx	27.3	7.2^{XX}	8.2	8.3 xxx	3.1	56.5^{XXX}	35.0	14.0^{XXX}	2.5	26.3^{XXX}	3.5	9.5 xxx	2.5	5.1 xxx	2.5	6.1 xxx	1.1
AES(X_{10})	16.1^{XXX}	19.2	38.5^{XX}	9.6	6.3 xxx	24.2	12.7^{XXX}	23.2	15.5^{XXX}	25.1	25.1^{XXX}	19.5	11.2^{XXX}	26.5	6.5 xxx	19.5	3.1 xxx	21.0
Intercept	43.5	0.12	2.9	0.15	23.7	2.1	36.3^{XXX}	16.5	-32.2	0.1	35.0	0.5	-40.5	1.1	54.5	0.67	15.3	0.54

Reference / Base Category	**No Adaptation**
Likelihood Ratio Chi Square	**1872.516^{XXX}**
Pseudo R-Square (Cox and Snell; Nagelkerke; McFadden)	**(0.895; 0.842; 0.732)**

Hausman Test				
Least Chi Square Value	**Level of Significance**	**Robust Chi Square Value**	**Level of Significance**	**Total Observation**
0.0001	1.000	5.861	0.468	60

**Multiple responses.

Source: Computer Printout of STATA (2013); *Statistically Significant at 10%; **Statistically Significant at 5%; *** Statistically Significant at 1%, FEXP; Farming Experience, FMS; Farm Size, ACCI; Access to Climate Change Information, HHS; Household Size, MFMI; Monthly Farm Income, ATC; Access to Credit and AES; Access to Extension Services/Agent.

Age was positively significant across use of resistance crops varieties, agro-forestry, adjustment in planting dates, adjustment in harvesting dates, and diversification of livelihood, mulching, planting of trees, mixed farming and intercropping. The farmers' age was positively related to the likelihood of choosing all the various adaptation options. This relationship could be that the adaptation option has been obsolete with time itself. As time increases, the adaptation options becomes old, hence there is need for modern adaptation practices by the government to complement existing local adaptation measures used by the farmers in the area. Adesina and Forson (1995), Gbetibouo (2009) and Ndambiri et al. (2012) attest to these findings when they observed, in their respective studies, that there was a positive relationship between age of the household head and the adoption of improved agricultural technologies. They noted that older farmers' have more experience in farming and are better able to assess the attributes of a modern technology than younger farmers. Hence, older farmers' have a higher probability of adapting to climate change.

Gender (X_2): Gender had a negative relationship across all the farmers' adaptation measures to climate change in the area. Gender was negatively significant across use of resistance crops varieties, agro-forestry, adjustment in planting dates, adjustment in harvesting dates, and diversification of livelihood, mulching, planting of trees, mixed farming and intercropping. Female farmers were more likely to take up adaptation options than male farmers. The possible reason for this observation is that agricultural production in rural areas is gradually been taken-up by women while the male migrate to the city for white collar job. Nhemachena and Hassan (2007) and Ndambiri et al. (2012) came up with the same finding which was attributed to the fact that in most rural smallholder farming communities, much of the agricultural work is done by women because men are more often based in towns. Since women do much of the agricultural work, they are more likely to adapt based on available information on climatic conditions and other factors such as markets and food needs of the households. It is therefore recommended that investment effort should focus on women groups in the areas as this could increase women taking-up of more adaptation options to climate change in the area.

Educational level (X_3): Educational level coefficient had a positive and significant relationship across all adaptation options to climate change. A unit increase in the year of education of farmers increases the probability of choosing use of resistance crops varieties, agro-forestry, adjustment in planting dates, adjustment in harvesting dates, and diversification of livelihood, mulching, planting of trees, mixed farming and intercropping. The probable reason for the positive relationship is due to the fact that educated farmers have more knowledge of climate change and are already aware of various techniques and management practices that could be employed to combat the negative impact of climate change in the area. These findings are confirmed by studies undertaken by Norris and Batie (1987), Igoden et al. (1990) and Ndambiri et al. (2012) who have noted that higher education was likely to enhance information access to the farmer for improved technology up take and higher farm productivity. They have also observed that education is likely to enhance the farmers' ability to receive, decipher and comprehend information relevant to making innovative decisions in their farms.

Farming experience (X_4): Farming experience had a positive relationship with all the adaptation options to climate change. The result showed that experienced farming households have an increase likelihood of choosing use of resistance crops varieties, agro-forestry, adjustment in planting dates, adjustment in harvesting dates, diversification of livelihood, mulching, planting of trees, mixed crop farming and intercropping as an adaptation options to climate change. Experience has taught most of the farmers on the various farm management practices and techniques that could be used in the face of anticipated climate change in the area. The findings are similar to those arrived at by Nhemachena and Hassan (2007), Deressa et al. (2008) and Ndambiri et al. (2012) that farming experience enhances the probability of uptake of various adaptations as experienced farmers have better knowledge and information on changes in climatic conditions and livestock management practices. Since the experienced farmers have high skills in farming techniques and management, they may be able to spread risk when faced with climate variability across livestock and off farm activities than less experienced farmers.

Farm size(X5): Farm size had a negative significant relationship with the probability of choosing adjustment in planting dates, adjustment in harvesting dates, mulching, planting of trees, mixed farming and intercropping as farmer's adaptation measure to climate change in the area. Positive relationship exists in all other farmers various adaptation measures to climate change in the area. The negative relationship between farmers adaptation measure and farm size is contrary to the study carried out by Nhemachena and Hassan (2007), Gbetibouo (2009) and Ndambiri et al. (2012) but in line with Deressa et al. (2008) who reported that the probable reason could be due to the fact that climate change adaptation measures is plot- specific. This means that it is not the size of the farm but the specific characteristics of the farm that dictates the need for a specific adaptation measures to climate change. Also, increase in farm size increases the tendency of farmers' easy adaptation to climate change (Fatuase and Ajibefun, 2013).

Access to climate information (X_6): Access to climate change information had a positive significant relationship with using all adaptation options to climate change. It implies that access to climate information has increased the probability of choosing use of resistance crops varieties, use of agro-forestry, adjustment in planting dates, adjustment in harvesting dates, diversification of livelihood, mulching, planting of trees, mixed crop farming and intercropping. Information on climate variables like temperature amount, relative humidity, rainfall amount and sunshine duration has really helped farmers in the area on the time to plant particular variety of crops and stock a particular variety of crop for the farming seasons. A number of studies confirm these results such as one by Maddison (2006), who have separately noted that farmers' access to information on climate change is likely to enhance their probability to perceive climate change, and hence adopt new technologies and take-up adaptation techniques.

Household size (X_7): For all the farmers various adaptation measures to climate change in the area. Household size had a positive and significant coefficient with them. Large household size increases the likelihood of choosing use of resistance crops varieties, agro-forestry, adjustment in planting dates, adjustment in harvesting dates, diversification of livelihood, mulching, planting of trees, mixed farming and intercropping as farmer's adaptation measures to climate change in the area. The probable reason for this relationship is due to the large household size which is normally associated with a higher labour endowment and this would enable a household to accomplish various farm production tasks especially at the peak of the farming seasons. As Teklewold et al., (2006), Tizale, (2007), Ndambiri et al. (2012), Onubuogu et al. (2013) and Onubuogu et al. (2014) note, household size is a proxy to labor availability. Therefore, larger households are likely to have a lower probability to adopt new agricultural practices since households with large household size are likely to divert labour force to off-farm activities in an attempt to earn more income to ease the consumption pressure imposed by a large family size.

Monthly farm income (X_8): The monthly farm income had a positive and significant coefficient with the likelihood of choosing use of resistance crops varieties, agro-forestry, adjustment in planting dates, adjustment in harvesting dates, diversification of livelihood, mulching, planting of trees, mixed farming and intercropping as farmer's adaptation measure to climate change. This is because farmers' with higher monthly farm income are poor in experiencing climatic risk, have access to information, and adapt easily to climate change at a lower discount rate, than farmers with less-income as adaptation options is expensive to be implemented (Knowler and Bradshaw, 2007). This observation is similar to those by Franzel (1999), Knowler and Bradshaw (2007), Deressa et al. (2008) and Ndambiri et al. (2012), they noted that farmers' incomes (whether on-farm or off-farm income) have a positive relationship with the adoption of agricultural technologies since the latter requires sufficient financial wellbeing to be undertaken. Nonetheless, off-farm income generating activities may sometimes present a constraint to adoption of agricultural technology because they compete with on-farm activities. Thus, off-farm income is sometimes less likely to influence on-farm adaptation by farmers.

Access to credit(X_9): Access to credit had a positive and significant coefficient with the likelihood of choosing use of resistance crops varieties, agro-forestry, adjustment in planting dates, adjustment in harvesting dates, diversification of livelihood, mulching, planting of trees, mixed farming and intercropping as farmers adaptation measures to climate change in the area. Inadequate fund is one of the main constraints to adjustment to climate change (Deressa et al., 2008; Ndambiri et al., 2012). Despite the various adaptation options farmers' could be aware of and willing to practice, inadequate fund to purchase the necessary inputs and other associated equipment is one of the significant barriers to adaptation to climate change (Franzel, 1999; Knowler and Bradshaw, 2007; Thornton et al., 2007; Deressa et al., 2008; Ndambiri et al., 2012).

Access to extension services/agents(X_{10}): The coefficients of access to extension services had a significant and positive relationship with the likelihood of choosing use of resistance crops varieties, agroforestry, adjustment in planting dates, adjustment in harvesting dates, diversification of livelihood, mulching, planting of trees, mixed farming and intercropping as farmers adaptation measures to climate change in the area. This implies that farmers who have access to extension agents are more likely to be aware of climatic conditions as well as the knowledge of various management practices that they could employ to adapt effectively, efficiently and steadily to change in the climatic conditions in the area. This observation is similar to those by Franzel (1999), Thornton et al. (2007), Deressa et al. (2008), Knowler and Bradshaw (2007) and Ndambiri et al. (2012) and they noted that adequate extension contact have a positive relationship with the adoption of agricultural technologies since extension agents transfers modern agricultural technologies to farmers to help counteract the negative impact of climate change.

Barriers to climate change

Figure 5 shows that greater proportion (96.67%) of the arable crop farmers in the study area complained of inadequate information as constraint to climate change adaptation options. This could be attributed to dearth in research on climate change as well as poor information dissemination on the part of the government information agencies, thus, information is lacking in this area. 86.67% complained of Illiteracy. This could be attributed to conservativeness of the arable crop farmers in the area who would not accept extension services as well as poor education background of the farmers as early reported in the study. 85.00% indentified inadequate fund. This could be attributed to high cost of adaptation options. Inadequate fund hinders farmers from getting the necessary resources and technologies which assist to adapt successfully to climate change. Deressa et al. (2008) reported that adaptation options are costly. Hence if farmers do not have sufficient family labour or the financial means to hired labour, they cannot adapt. 75.00% complained of high cost of input. Adaptation options to climate change requires substantial amount of funds to purchase the needed equipment to enhance easy adaptation to climate change. 71.67% identified poor access to credit. This could be attributed to poor formal and informal credit sources in the area as well as their various astronomical security charges before lending to farmers in the area. 70.00% of complained of limited availability of land. This could be attributed to land tenure system which is prevalent in the area as well as the increasing population. Also, high population pressures force farmers to intensively farm over a small plot of land and make them unable to conserve from further damages by practices such as planting tress which competes agricultural land. Others 55.00 and 48.33% of the farmers in the study area complained of high cost of labour and poor extension contacts respectively, which could be attributed to non-availability

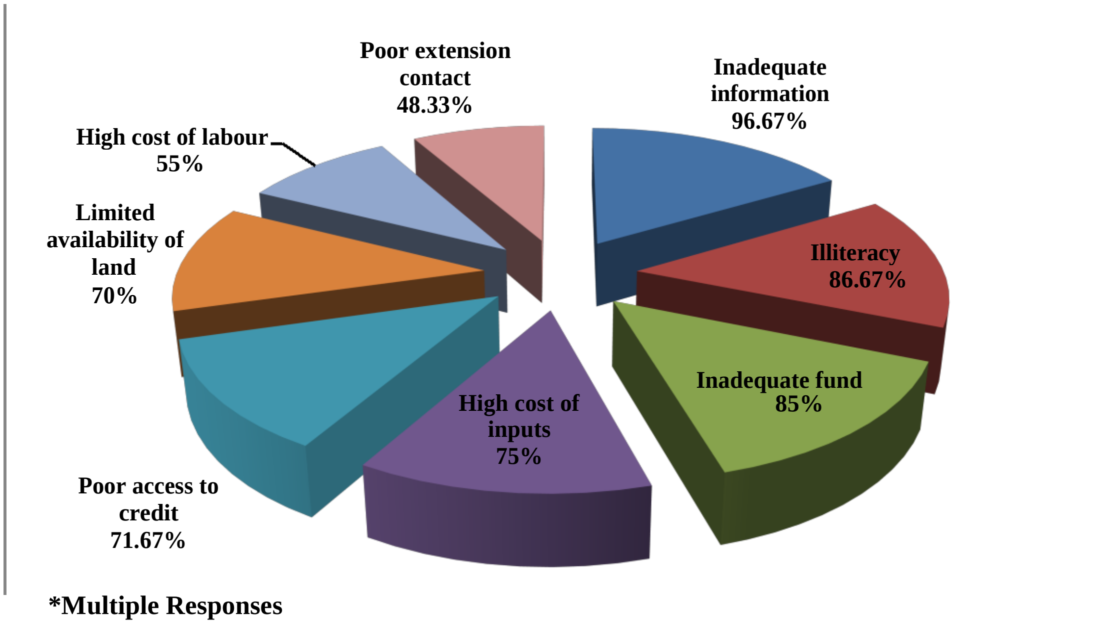

Figure 5. Pie chart distribution of arable crop farmers barrier to climate change adaptation.

of family labour as early identified in the study and also attributed to poor encouragement of extension staff by the government. Ultimately, there is no doubt that these barriers are responsible for poor adaptation to climate change by the arable crop farmers as well as poor resource use efficiency and poor output recorded in the area. Fighting these problems will be vital in promoting not just local adaptation option but global modern adaptation practices/options to climate change in the area and beyond.

Conclusion

Conclusively, the study confirmed the evidence of climate change in the area as result from trend analysis revealed a sustained decrease in number of rainy days and relative humidity between 1972 and 2012, while results on temperature level and sunshine duration from 1972-2012 showed an increasingly significant trends, respectively. This implies that increasing number of rainfall in decreasing number of rainy days will lead increase floods areas and erosion. The direction of temperature in the area is on the increase and has significant positive relationship with time. If the trend continues, arable crop production (vegetables, maize, okra, roots and tubers) in the area may be unfavourable with time. Arable crop farmers in the area rightly perceived the direction of changes in climatic variables implying that they have been responding to climate change. Farmers adapt in various ways to climate change. Most of the farmers in the area have taken steps to adjust their farming activities. The widespread adaptation options used by the arable crop farmers in the area are mixed farming. The main barrier to climate change adaptation were lack of information on appropriate adaptation option which could be attributed to dearth in research on climate change as well as poor information dissemination on the part of extension agents in the study area. The study also looked at the determinants of arable crop farmers use of various adaptation option to climate change using a multinomial logit model. The model permits the analysis of decisions across dichotomous categories, allowing the determination of choice probabilities for different categories. Multinomial logit results confirmed that access to credit, extension services, farming experience, education, access to credit, access to climate change information and farm size were some of the significant determinants of farm-level adaptation options.

RECOMMENDATIONS

The following recommendations were made based on the major research observations and findings of the study:

1. Effective agricultural policies and programmes should focus on how to intensify awareness on climate change. Investment strategies should also focus on expansion of farmers' farmland and improvement of their education as this would affect their adaptation to climate change positively.
2. The government must also design policy in such a way that farmers should have access to affordable credit as well as subsidized agricultural inputs in order to increase their ability and flexibility to change production strategies in response to the forecasted climatic conditions.
3. The government or interested organization should endeavor to build weather stations in all local government

areas in Nigeria to reduce the incidence of poor climate record keeping and to provide mid-term forecast of weather and other climatic variables.

4. Effective agricultural policies and programmes should focus on adult education of the farmers' as this would affect their resilience to climate change positively.

5. Future policy could also focus on creating awareness of climate change and facilitating the development and adoption of adaptation strategies. The intensive awareness on climate change will be best achieved in the study area through extension agents, mass media, town/village cry, agricultural show, symposium and the likes.

6. Effort should also focus on integrated development programmes to provide education, vocational skills and trainings to the farmers' as this would affect their resilience to climate change positively.

7. Ultimately, incorporating local knowledge into climate change concerns should not be done at the expense of modern/western scientific knowledge. Local knowledge should complement rather than compete with global modern practices in counteracting the negative impact of climate change in the area and beyond.

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