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Trends, Perceptions and Adaptation Options of Livestock Farmers to Climate Change in Imo State, Nigeria: A Multinomial Logit Model Approach

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Abstract
The study evaluated trends, perceptions and adaptation options of livestock farmers to climate change in Imo State, Nigeria. Multi-stage random sampling technique was used in selection of respondents. Sample size comprised sixty households livestock farmers. Well structured questionnaire was the main tool for data collection. Descriptive statistics, Smart-Art, trend analysis and multinomial logit model were used for data analysis. In order to forecast the future trends of climate change in the area and beyond, climatic record of 40 years (1972 and 2012) duration were obtained from Agro-meteorological Station, National Root Crops Research Institute (NRCRI) Umudike, Abia State, Nigeria. Mean age was 43.10years. Majority (78.33%) were males. Greater proportions (71.67%) were married with an average household size of six persons. Average farm income was ₦64,370.00 ($429.130). The study confirmed the evidence of climate change in the area. Farmers rightly perceived the direction of change as well. Thus, farmers have started responding to the change through the adoption of several local practices to thwart the negative impacts of the change. Unfortunately, farmers local adaptation options are inadequate to prevent them from devastation. However, if the trend continues, livestock production in the area may be adverse with time. 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 effective agricultural policies and programmes should focus on intensifying awareness on climate change. . Government at all levels and private's sector support fund is necessary to enhance farmers easy adaptation to climate change. Ultimately, in cooperating local knowledge into climate change, concerns should not be done at the expense of modern 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.
Keywords: Livestock farmers, Trends, Perceptions, Adaptation Options, Multinomial Logit Model, Barriers, Imo State

INTRODUCTION

The term climate change is used to describe a significant and sustained average adjustment in the geometric distribution of global environment over time (Onubuogu and Esiobu, 2014). Therefore, 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).Several studies asserted that Africa's agriculture is negatively affected by climate change (IPCC, 2010) and that adaptation is one of the policy options for reducing the negative impact of climate change (Kurukulasuriya and Mendelsohn, 2006). Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). 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 (WACDI, 2011). 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 ₦15 billion ($100 billion) and ₦69 trillion ($460 Billion) (IPCC, 2010 and BNRCC, 2011). Also greater proportion of livestock 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. Adaptation has the potential to significantly contribute to reductions in negative impacts from changes in climatic conditions as well as other changing socioeconomic

conditions (Kandlinkar and Risbey, 2000). 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. However, understanding perceptions and adaptation to climate change in rainforest and coastal communities of Nigeria where Imo State is situated has been the keen curiosity of several researchers (Gren, 2010; WACDI, 2011; Umoh *et al*., 2011; Nzeadibe *et al.,* 2012 and Onubuogu and Chukwu, 2014). However, only Onubuogu and Esiobu, (2014) have rigorously modeled climatic records of 40 years durations along with perceptions and adaptation options. Though, their study provided incisive insight on, their study did not consider households livestock farmers. This left a void in research. Thus, the study is worthy to be undertaken.

METHODOLOGY

The study was carried out in Imo State, Nigeria. Imo State is located in the eastern zone of Nigeria. The State lies between latitudes 5 45'N and 6 35'N of the equator and longitudes 6 35' E and 7 28' E of the Greenwich Meridian (Microsoft Corporation, 2009). It occupies the area between the lower River Niger and the upper and middle Imo River. It is bounded on the east by Abia State, on the west by the River Niger and Delta State; and on the north by Anambra State, while Rivers State lies to the south. Imo State covers an area of about 5,067.20 km^2, with a population of 3,934,899 (NPC, 2006 and NBS, 2007) and population density of about $725km^2$ (Ministry of Lands Owerri, 1992 and Microsoft Corporation, 2009). The State has three Agricultural zones (Orlu, Owerri, and Okigwe Agricultural Zones). These divisions are for administrative and extension services and not for any agro-ecological difference. It is also delineated into 27 local government areas (Imo ADP, 2004). The State has an average annual temperature of 28°c, an average annual relative humidity of 80%, average annual rainfall of 1800 to 2500mm and an altitude of about 100m above sea level (IOnubuogu and Esiobu, 2014). Ultimately, Imo State was selected because of proximity, cost, familiarity and predominates by livestock farmers. Multistage random sampling technique was used for the study. Firstly, the three agricultural zones of the State were selected. In each agricultural zone, two Local Government Areas (LGAs) were randomly selected. In each of the selected LGA, six communities were randomly selected. Ultimately, twelve farmers were randomly selected in each of the community to give a sample size of seventy-two livestock farmers for the 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 livestock production in the communities and this list was obtained from the community heads and Agricultural Development Programme (ADP) extension agents. Primary data were collected through the use of a set of well structured, validated and pre-tested 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;

$$Pr(Y_i = j) = \frac{e^{\beta_j x_{ij}}}{1 + \sum_{m=0}^{6} e^{\beta_m x_{ij}}}, \quad j = 0,1,2,3,..,10 \quad \text{(Equation 1)}$$

$$Pj = Pr(Y_i = j) = \frac{e^{\beta_j x_{ij}}}{1 + \sum_{m=0}^{6} e^{\beta_m x_{ij}}}, \quad j = 0,1,2,3.10 \quad \text{(Equation 2)}$$

Where: Pr $(Y_i=j_i)$ is the probability of choosing either of the adaptation options set aside. The reference category or based category is on adaptation options as the reference or, *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 probability response is stated as follows; Where:

P = Response Probability (J =0,1,2,3,---10).
Y = Adaptation category; J = 1, 2 ….10;
1= Mixed farming,
2= Water immersion/Sprinkling,
3= Early stocking,
4=, Late stocking,
5= Supply of heat during cold weather,
6= Stock rotation,
7= Use of well acclimated breeds,
8= Diversification of livelihood,
9= Regular feed change/supply,,

10 = No adaptation

The implicit functional form of the explanatory variables for the regression model is

$Y = f(X_1,X_2,X_3,X_4,X_5,X_6,X_7,X_8,X_9+ei)$

Where Y = Adaptation category (J =0,1,2,3,---10)

X_1= Age (years)

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

X_3= Educational level (years)

X_4= Farming experience (years)

X_5= Access to climate information (access=1, otherwise=0)

X_6= Household size (number of persons)

X_7 = Farm income (₦)

X_8= Access to credit (access=1, otherwise=0)

X_9 = 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 Livestock Farmers

Table 1 reveals that majority (31.67%) of the farmers fell within the age bracket of less than 40 years.

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	47	78.33
Female	13	21.67
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**
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**

Average age = 43.10 years; Mean Educational level= 11.15 years; Average Farming Experience = 21.27 years; Mean household size= 6.0persons; Average Income = ₦64,370.00 ($429.130); Source: Field Survey Data, 2013

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 Onubuogu and Esiobu (2014) that majority of farmers within the age range of 41 to 50years 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 farmers 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 (78.33%) of the farmers were males while 21.67% 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 show that majority (65.00%) of the farmers had secondary 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 and Onubuogu and Chukwu, 2014). Exposure to high level of education is an added advantage in terms of climate change adaptation measures. This findings support Esiobu *et al.,* (2014b) 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, efficiency and how well informed they are to the innovations, technologies and awareness levels and adaptation to climate change (Onubuogu and Esiobu, 2014). **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 no doubt increases ease access to production variables such as land and labour which are traditionally owned and provided by husbands. Onubuogu and Esiobu (2014) reported that this could be as 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. The mean farming experience was 21.27 years. It is implies that farmers with high years of experience should be more efficient and their chances of adapting to climate change is 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 support the finding of Esiobu *et al.,* (2014a) that previous experience in agribusiness enable farmers to set realistic time and cost targets, allocate, combine, utilize resources efficiently, identify production and marketing risks. Result of household size is also seen in **Table** 1 and it indicated 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) and Onubuogu and Esiobu (2014) who 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 (and Esiobu *et al.,* 2014a and Esiobu *et al.,* 2014b). 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. Result in **Table** 1 also shows that larger percentage (78.33%) of the farmers received 1-2 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 (Chukwu, 2013 and Onubuogu and Chukwu, 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 have 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

(Onubuogu and Esiobu, 2014). Access to climate change information is also reported in **Table** 1 and it indicates that majority (86.67%) of the farmers have 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) and Nhemachena and Hassan (2007); Deressa *et al*., (2008); Gbetibouo (2009) and Ndambiri *et al.,* (2012), 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 of new technologies and take-up adaptation techniques to counteract the negative impact of climate change. Entries in **Table** 1 also shows that majority (48.33%) of the farmers area have an average monthly farm income between ₦41,000 to ₦60,000. The average farm income was ₦64,370.00 ($429.13). 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.

Trend Analysis of Climatic Variables

Level of Temperature (1972 – 2012)

Table, 2 and **Figure, 1** reveals the trend analysis of record of the level of temperature between 1972-2012 in the study area which shows an increasing trend with the minimum (29.22^{o}C) and maximum (30.43^{o}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^{o}C and 1.52^{o}C, respectively.

Table 2: Trend Analysis of Temperature Record (1972-2012)

Temperature record	**Value (^{o}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

Hence 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 concluded to be a 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. The warming is real as well and would continue to increase over time increases in the area.

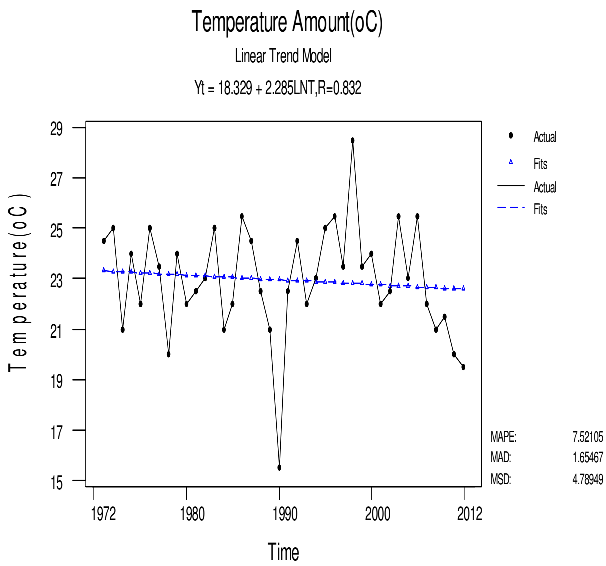

Figure 1: Trend Analysis of the Temperature Record for Imo State Rainforest Zone of Nigeria from 1972-2012; Source: Field Survey Data, 2013

The finding is in accordance with Babatunde *et al.,* (2011) and Onubuogu and Esiobu (2014) who reported that the evidence of variations in the climates of the coastal and rainforest regions of Nigeria of with Imo State in involved 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 livestock production. Thus, time is a major determinant of variation in temperature level. In other word, the impact is very clear as many livestock farmers over time in the area will continue to witness low yield/output in production due to the increased scorching temperature and heavy heat stress on livestock. Livestock production may be affected by dehydration.

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.

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

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.

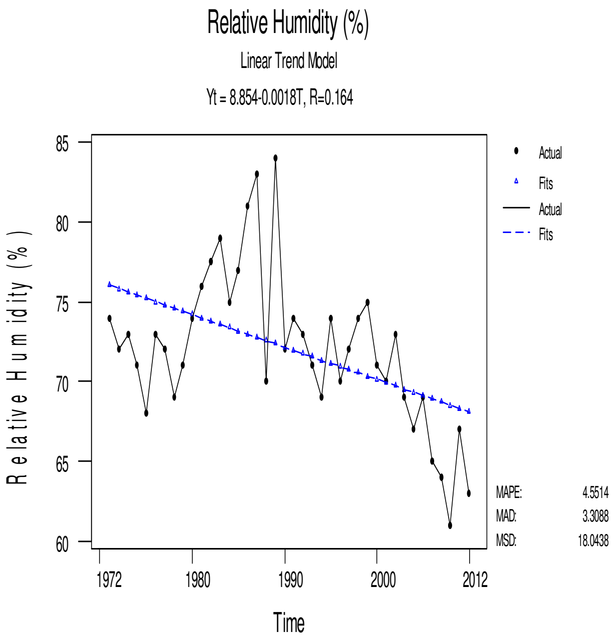

Figure 2: Trend Analysis of the Relative Humidity for Imo State Rainforest Zone of Nigeria from 1972-2012
Source: Field Survey Data, 2013

The result is in accordance Onubuogu and Esiobu (2014) who reported that the evidence of variations in the climates of the coastal and rainforest regions of Nigeria of with Imo State, Nigeria in involved is seen on steady decreases in surface relative humidity amount. The implication of the finding is that livestock farmers will experience too high or too low moisture in the atmosphere which will retard growth, cause reduction in egg laying brooding, parturition and affect feed consumption negatively.

Trend Analysis for Rainfall Amount (1972 – 2012)

Table 4 and **Figure, 3** shows 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 2864.60mm while the lowest value recorded in 1989 was 1430.20mm. The mean and standard deviation of the amount of rainfall in the area between 1972 and 2012 were 1868.684mm and 420.30mm respectively.

Table 3: 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 insignificant correlation between the amount of rainfall and time in the study area. This finding is in line with Okorie *et al.* (2012) and Onubuogu and Esiobu (2014) who reported that rainfall volume in the rainforest and coastal regions of Nigeria Imo State included 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 and erosion and farmers would loss valuable assets from heavy down-pull 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 livestock production in the area may be adverse. Excess of rainfall leads to high moisture content of the environment and as a result of this, pests and diseases could be spread and invariably the high moisture provide a comfortable atmosphere for breeding of pests and disease parasite. This would be a severe threat to the nation's food security.

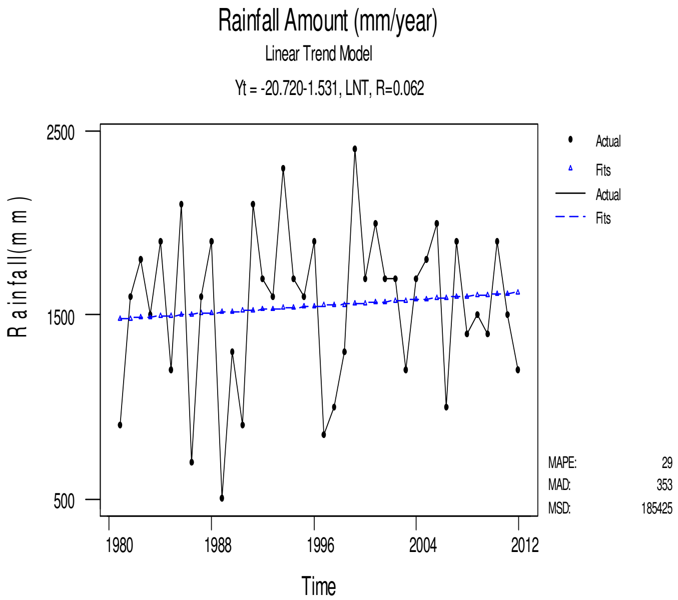

Figure 3: Trend Analysis of the Amount of Rainfall for Imo State Rainforest Zone of Nigeria from 1972-2012; Source: Field Survey Data, 2013

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 hours per year. The minimum and maximum value of sunshine duration obtained were 4.10 hours in 1984 and 5.80 hours in 2010 respectively. The mean and standard deviation of the sunshine duration in the study area between 1972 and 2012 were 4.42 hours and 0.72 hours 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 concluded to be a poor positive and insignificant correlation between the sunshine duration and time in the study area.

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

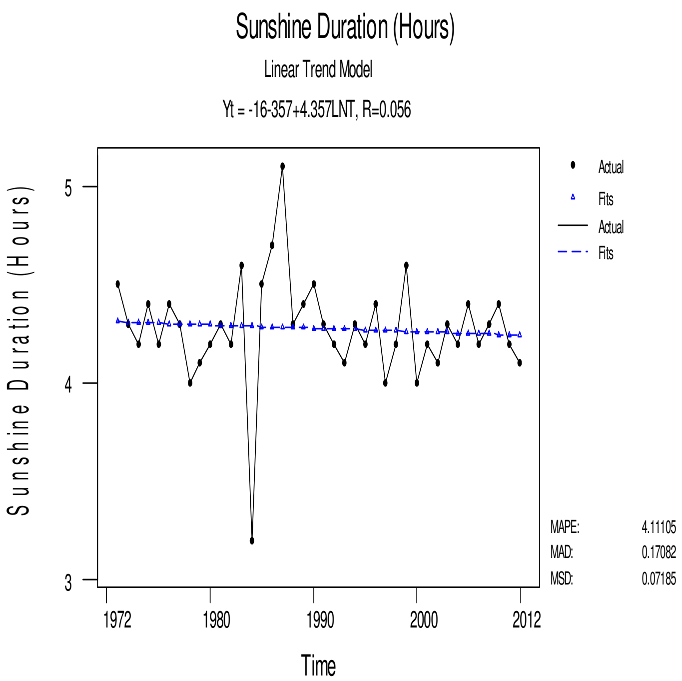

Figure 4: Trend Analysis of the Sunshine Duration for Imo State Rainforest Zone of Nigeria from 1972-2012; Source: Field Survey Data, 2013

This finding is in line with Olorunfemi, (2009); Onubuogu and Esiobu (2014) who 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. In other word, the impact is very clear as many livestock farmers over time in the area will continue to witness low yield/output in livestock production due to the increased scorching sunshine and heavy heat stress on livestock. Livestock production may also affected by dehydration, poor lactation and Increased in pests and diseases transmission by faster growth rates of pathogens in the environment as well as make livelihood of farmers unfavourable in the study area.

Farmers Perception on Changes in Climatic Variables

Figure 5 reveals that majority (63.33%) of the farmers observed an increase in temperature level over 40 years. Farmers perceived that long-term temperature is increasing significantly. This implies that temperature level has significantly increased over 40 years in the study area. However, farmers perception on changes in climatic variables were in line with the result from trend analysis,

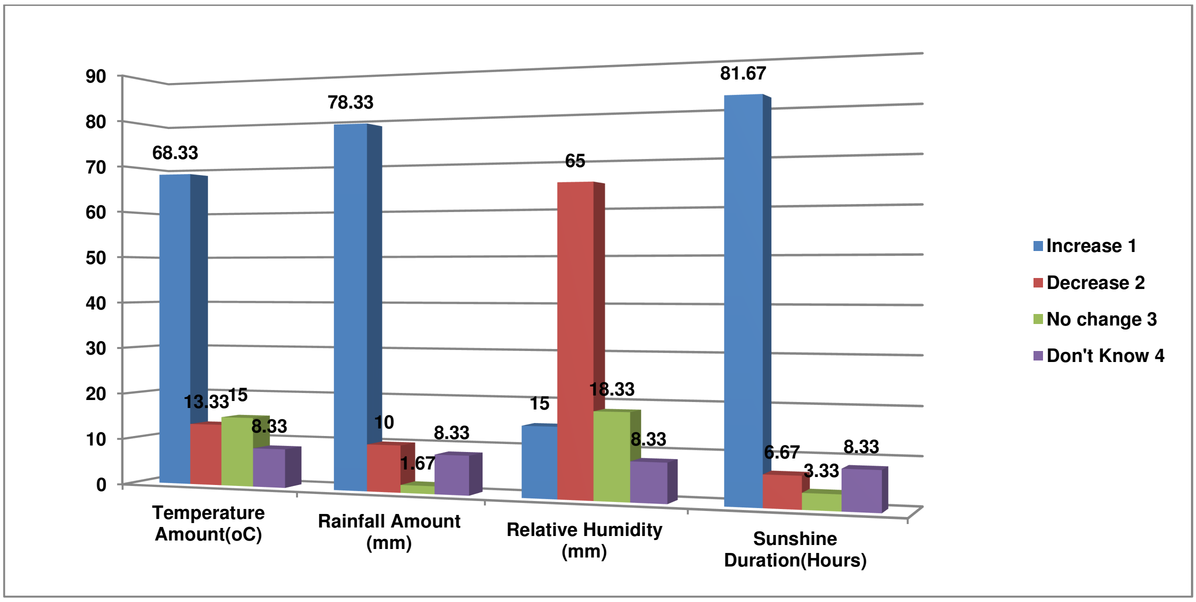

Figure 5; Bar Chart Distribution of Farmers Perceptions on Changes in Climatic Variables

it became clear that far
mers in the area rightly perceived the direction of changes in temperature level implying that they must have been responding to this changes. Entries in **Figure 5** 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 over 30 years in the study area. Thus, farmers perception on changes climatic variables was 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 over 40 years in the study area. Farmers perceptions on changes climatic variables was 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, **Figure 5** 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 in the study area. Farmers perceptions on changes climatic variables was 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.

Livestock Farmers Adaptation Options

From **Figure 6**, the adaptation options for this study were based on asking farmers about their perception on climate change and the actions they had taken to thwart its negative impacts. The adaptation options that farmers report may be profit driven, rather than climate change driven. Regardless of this dearth in knowledge, the researcher assumed that livestock farmers actions were climatic factor rather than profit driven, as identified by farmers themselves (Onubuogu and Esiobu, 2014). The adaptations options of the farmers includes; mixed farming, water immersion/sprinkling, early stocking, late stocking, supply of heat during cold weather, stock rotation, use of well acclimated breeds, diversification of livelihood, regular feed change/supply and mixed stocking. As identified by the farmers, mixed farming, early stocking, late stocking, water immersion/springing, diversification of livelihood and supply of heat during cold weather were the most commonly used adaptation options of the livestock farmers. Mixed stocking, regular feed change/supply and used of well acclimated breeds were least practiced adaptation options. Greater adoption of mixed farming, early stocking, late stocking, water immersion/springing, diversification of livelihood and supply of heat during cold weather as adaptation methods could be heavily associated with the lower expense, ease of access by farmers and pursuit of higher income through livelihood diversification, while the mixed stocking, regular feed change/supply and used of well acclimated breeds could be attributed to the need for more farm working capital and farm labour which are not easily available. Onubuogu and Esiobu (2014) reported that adaptation option is costly. Hence if farmers do not have sufficient family labour or the financial means to hired labour, they cannot adapt. The implication of the finding is that livestock 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.

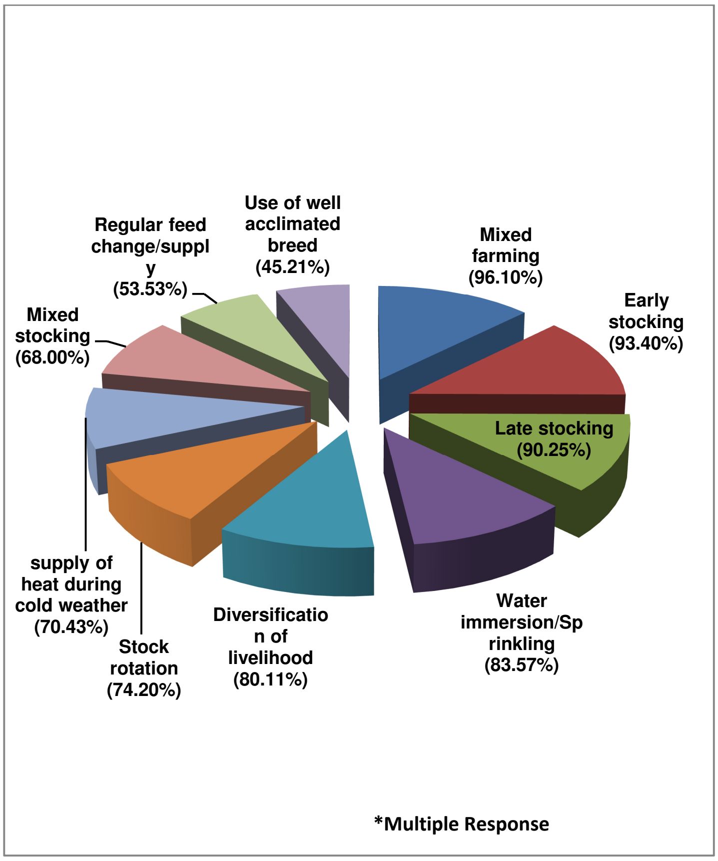

Figure 6: Livestock Farmers Adaptation Options; ***Field Survey Data, 2013***

Farmers Enterprise Type

Figure 7 reveals that majority (96.67%) of the livestock farmers are involved in poultry production. This implies that farmers have several livestock enterprise type. Diversification of livelihood is one of the options farmers used in adaptation to climate change as earlier found out in the study.

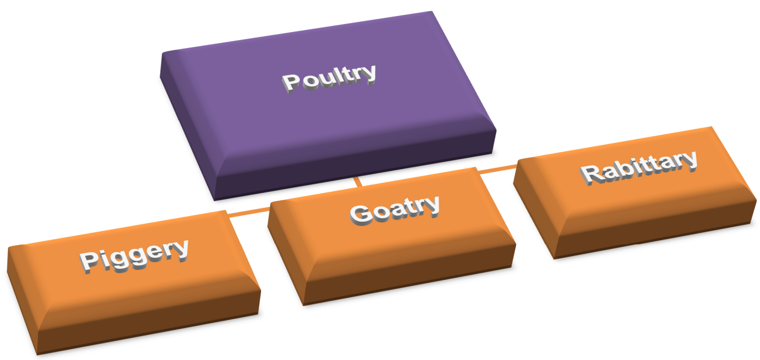

Figure 7: Smart-Art Distribution of Farmers Enterprise Type. ***Field Survey Data, 2013***

Livestock Farmers Socio-economic Characteristics and Adaptation Options

Table 6 shows the multinomial logit regression analysis of the influence of livestock farmers socioeconomic characteristics on their various adaptation option to climate change. The adaptation options set in the multinomial logit regression model included mixed farming, water immersion/sprinkling, early stocking, late stocking, supply of heat during cold weather, stock rotation, use of well acclimated breeds, diversification of livelihood, regular feed change/supply, mixed stocking 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_o) 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 5.879, with probability values ranging from 0.449 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 (1815.143) 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 livestock 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 livestock farmers 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. Farmer's age was positively related to the likelihood of choosing all the various adaptation options. Onubuogu and Esiobu (2014) 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 various adaption technologies.

Gender (X_2): Gender had a negative relationship across all the farmers adaptation measures to climate change in the area. 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 Onubuogu and Esiobu (2014) 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 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 various adaptation options. 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 Onubuogu and Esiobu (2014) have all 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 all the adaptation options. 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) 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 climate variability across livestock and off farm activities than less experienced farmers.

Access to climate information (X_5): 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 various adaption options. 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 stock a particular reed of livestock. A number of studies confirm these results such as those by Maddison (2006) and Onubuogu and Esiobu (2014) 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 of new technologies and take-up adaptation techniques.

Household size (X_6): 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 all the adaptation measures to climate change in the area. The probable reason for this relationship is that large household size which is normally associated with a higher labour endowment 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 and Ndambiri *et al.* (2012); Onubuogu *et al.,* (2014) and Onubuogu and Esiobu (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.

Farm income (X_7): Farm income had a positive and significant coefficient with the likelihood of choosing all adaptation options. This is because farmers with higher 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 that by Franzel (1999); Knowler and Bradshaw (2007) and Onubuogu and Esiobu (2014) who 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_8): Access to credit had a positive and significant coefficient with the likelihood of choosing all the adaptation option. Inadequate fund is one of the main constraints to adjustment to climate change (Deressa *et al*., 2008 and Onubuogu and Esiobu, 2014).

Access to extension services/agents(X_9): The coefficients of access to extension services had a significant and positive relationship with the likelihood of choosing all the adaptation measures. 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 that by Franzel (1999); Thornton *et al.* (2007); Deressa *et al.* (2008) Knowler and Bradshaw (2007) and Ndambiri *et al.*(2012) and Onubuogu and Esiobu (2014) who 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 8 show that greater proportion (96.67%) of the livestock farmers complained of inadequate information. 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 livestock farmers in the area who would not accept extension services. 85.00% identified 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 (Onubuogu and Esiobu, 2014). 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% complained of high cost of labour and poor extension contacts respectively, which could be attributed to non-availability 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 livestock farmers as well as 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 maybe beyond.

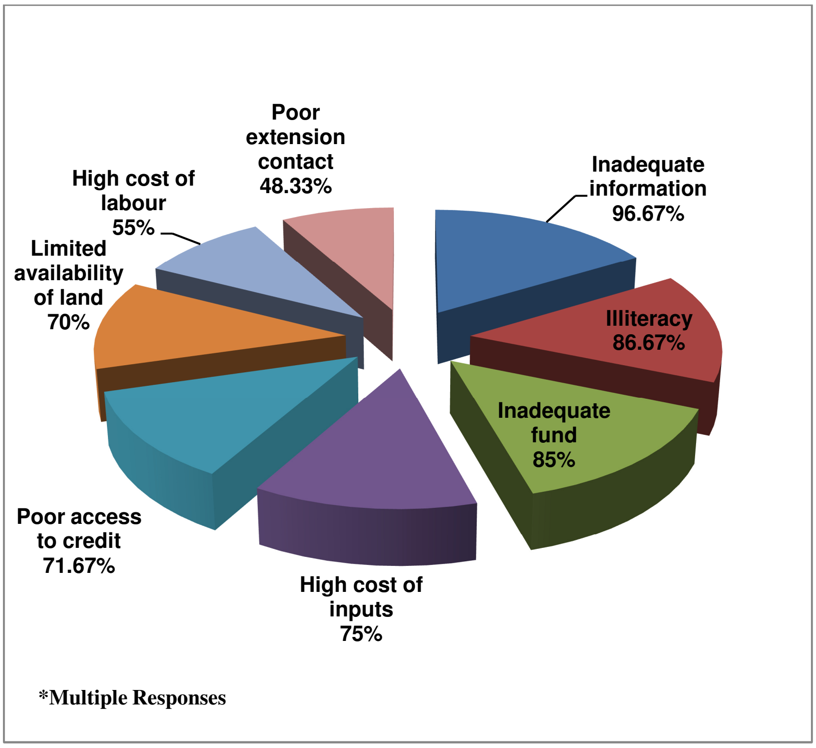

Figure 8: Pie Chart Distribution of Livestock Farmers Barrier to Climate Change Adaptation

Table 6: Estimated Multinomial Logit Analysis of the Influence of Livestock Farmers Adaptation Options to Climate Change in Imo State

Explanatory variables	Mixed farming		Water immersion/sprinkling		Early stocking		Late stocking		Supply of heat during cold weather		Stock rotation		Use of well acclimated breeds		Diversification of livelihood		Regular feed change/supply	
	Coeff. Wald		Coeff.	Wald	Coeff. Wald		Coeff. Wald		Coeff. Wald		Coeff. Wald		Coeff. Wald		Coeff. Wald		Coeff. Wald	
Age (X_1)	14.1^{xxx}	19.5	31.3^{xx}	9.2	6.9^{xxx}	18.7	10.1^{xxx}	21.6	13.1^{xxx}	18.5	28.5^{xxx}	15.1	11.1^{xxx}	23.2	6.7^{xxx}	17.1	1.4^{xxx}	17.0
Gender(X_2)	-16.3^{xxx}	12.4	-2.3^{xx}	5.1	-15.3^{xxx}	12.2	-12.1	0.2	-13.9^{xxx}	11.2	-16.7^{xxx}	-13.5	-5.6^{xxx}	23.0	-8.2^{xxx}	21.4	-9.2^{xxx}	17.8
Edu (X_3)	37.2	1.0	3.1	0.1	23.1	1.2	31.3^{xxx}	13.0	18.2	0.2	15.0***	11.1	12.3	1.7	7.2	2.2	2.7	1.0
FExp (X_4)	10.8	0.2	20.1	0.2	18.2	0.2	30.1	0.2	36.2	1.5	4.1***	20.3	10.0	0.2	5.5^{xxx}	25.2	4.2	0.2
ACCI (X_5)	12.4^{xxx}	18.3	31.1^{xx}	6.1	5.1^{xxx}	22.1	9.2^{xxx}	22.0	18.1^{xx}	8.5	22.1^{xxx}	13.7	16.1^{xxx}	11.1	12.3^{xxx}	9.1	5.3^{xxx}	22.5
HHS(X_6)	15.2^{xx}	6.2	23.0^{xxx}	7.3	13.0	0.2	32.0^{xxx}	150.0	16.2	0.2	11.1	2.5	15.1^{xx}	8.1	17.4^{xxx}	21.0	27.3^{xxx}	25.2
FmI (X_7)	3.5	1.5	15.2^{xxx}	25.1	2.1	0.5	145.0	2.1	2.5	0.5	8.7	2.8	19.4	3.2	14.3^{xxx}	12.0	11.3	1.9
ATC (X_8)	4.1^{xxx}	25.8	5.1^{xx}	4.0	6.3^{xxx}	2.5	67.1^{xxx}	34.0	11.9^{xxx}	2.6	27.5^{xxx}	3.3	7.1^{xxx}	2.1	4.2^{xxx}	2.1	4.1^{xxx}	1.0
AES(X_9)	15.1^{xxx}	17.1	38.1^{xx}	7.1	5.3^{xxx}	22.0	11.5^{xxx}	21.4	13.6^{xxx}	19.0	20.1^{xxx}	17.8	9.0^{xxx}	23.1	5.0^{xxx}	17.0	2.5^{xxx}	19.5
Intercept	41.1	0.10	2.5	0.10	25.8	2.1	32.1^{xxx}	15.0	-28.1	2.1	37.1	0.3	-39.5	0.10	35.1	0.30	8.3	0.20

Reference / Base Category	**No Adaptation Options**
Likelihood Ratio Chi Square	**1815.143^{xxx}**
Pseudo R-Square (Cox and Snell; Nagelkerke; McFadden)	**(0.812; 0.822; 0.685)**

Hausman Test

Least Chi Square Value	**Level of Significance**	**Robust Chi Square Value**	**Level of Significance Total Observations**
0.0001	1.000	5.879	0.449 60

Source: Computer Printout of STATA (2013); *Statistically Significant at 10%; **Statistically Significant at 5%; * Statistically Significant at 1%, FExp; Farming Experience, ACCI; Access to Climate Change Information, HHS; Household Size, MFmI; Monthly Farm Income, ATC; Access to Credit and AES;**

Access to Extension Services/Agent

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, livestock production in the area may be unfavourable with time. Livestock 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 livestock farmers in the area are mixed farming and water immersion/sprinkling 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 livestock 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;** Effective agricultural policies and programmes should focus on how to intensify awareness on climate change, access to credit, vocational skills and building of weather stations in all LGAs to reduce the incidence of poor climate record keeping and to provide mid-term forecast of weather and other climatic variables. 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.. Local knowledge should complement rather than compete with global modern practices in counteracting the negative impact of the change.

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