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AN ASSESSMENT OF IMPACT AND ADAPTATION STRATEGIES TO CLIMATE CHANGE BY LOCAL INDIGENOUS FARMERS OF MICHIKA LOCAL GOVERNMENT AREA OF ADAMAWA STATE, NIGERIA

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Abstract

The aim of the study is to assess the impact and adaptation strategies to climate change by the local indigenous farmers in Michika Local government Area of Adamawa State, Nigeria. The data of this study were collected using a structured questionnaire survey to 369 local indigenous farmers from the 8 district of the study area. 21 years of rainfall and temperature data were also obtained from the Adamawa State Agricultural Development Programme, Michika. The data collected were analyzed using descriptive statistics in terms of tables, percentage, and trend analysis of rainfall and temperature. The rainfall and temperature trend for the study area showed an increasing trend. The respondents are aware of the impact of climate change, and as such, they mentioned loss of soil fertility (23%), low yields of crops (170%), ease spread of pest and disease (14%), and flood and erosion (13%). The local indigenous farmers employed adaptation strategies such as planting early maturing crops (26.2%), planting resistant crops to pest and drought (22.7%), mixed farming (23.3%), and the intensive use of fertilizer (17.8%). However, constraints towards adaptation according to the respondents includes the lack of adequate knowledge on how to cope with adaptation (16.2%), limited access to improve crop varieties (18.6%), high cost of fertilizers and other farm inputs (19.2%), and the lack of financial resources (17.8%). Chi-square was used to assess the association for the indigenous farmer's level of awareness of climate change and socio-economic variables (gender, age, education, qualification, and farming experience). Therefore, all the calculated values mentioned respectively is greater than the critical value (Table 5,6,7,8) at a significance level of 0.05.

In addition, we reject H_o and accept H_1. Hence, there is association between all the socio-economic variables and climate change in the study area.

Keywords: Assessment, impact, adaptation, strategies, climate-change, indigenous-farmers.

Introduction

Climate change has been defined as any change in climate over time, whether due to natural variability or as a result of human activities. However, it has also been the latest challenge to sustainable human development worldwide.

Food and Agriculture Organization (FAO) (2007) and Jianchu et al. (2007) reported that as climatic patterns changes, so also the spatial distribution of agro-ecological zones, and the habitats distribution patterns of plant diseases and pest which can have significant impacts on agriculture and food production changes.

FAO (2007) has predicted that in developing countries, 11% of the arable land would be affected by climate change, including a reduction in cereal production in sixty-five countries, and also 16% agricultural Gross Domestic Product (GDP). Thus, the increase in temperature has both negative and positive impact on agriculture. This is because IPCC (2007) has projected that food production has the potential to increase with an increase in local average temperature over a range of 1 to 3^{o}C. Nevertheless, above this, it was projected to decrease.

Africa is generally acknowledged to be the continent most vulnerable to climate change. West Africa is one of the most vulnerable to the vagaries of the climate, as shown by the scope of the impacts of climate variability over the last three or four decades. The recent food crises in Nigeria are reminders of the continuing vulnerability of the region on the impacts of climatic condition. Consequently, this is due to weak institutional capacity, limited engagement in environmental and adaption issues, and lack of validation of local knowledge (Adams et al., 1988). Accordingly, there is need to gain as much information as possible and learn the position of indigenous farmers and their needs. In addition, it is important to understand what they know about climate change in order to offer adaption practices that meet their needs.

In Nigeria, due to the changing nature of climate, some areas like the Niger Delta regions receive more than normal rainfall, while other areas in the Northern region receive almost no rainfall. As a result, growing season is changing, ecological zones are shifting, and rainfall is becoming more unpredictable and unreliable both in its timing and volume (Brett, 2009). Despite the devastating effects of climate change, some studies (Barr, 1985;

Hoover and Witala; in Rickson et al., 1985) asserted that farmers seem to misperceive either the existence or extent of climate change on their farmland. However, this is due to the insidious nature of their pervasiveness. Aune (1995), however concluded that over a long term, farmers experience with pervasive hazard of climate change has led to psychological adjustment on the condition and knowing its effect on their agricultural products. Hence, a significant farmer's response to climate change is usually based on their short-term assessment.

As earlier mentioned, the growing problems of climate change are becoming more threatening to human sustainable development, i.e. changes in temperatures and rainfall pattern. Furthermore, increase in carbon dioxide (CO_2) level is expected to have an effect on agriculture, especially in tropical areas. Thus, such changes may lead to the reduction of land quality and low or poor agricultural yields. Oyekale (2009) asserted that the entire human conditions are likely to be affected by climate change due to decrease water availability especially in the arid regions. Blakie et al. (1994) described the vulnerability and adaption to climate change, and that the reason local indigenous farmers still suffer is due to their dependence on rain-fed agriculture and lack of capacity for diversity.

In response to climate change, different emergency survival strategies are gradually being use by the indigenous farmers to cope with the shocks and stresses of climate change either through mitigation strategies or adaption strategies.

Mitigation strategies are also known as preventive measures. Therefore, these are measures taken to deal with the causes of climate change. Some of the possible causes of climate change are natural factors that are outside the influence of man. Man can only deal with the man-made alteration of the chemistry of the atmosphere through the emission of greenhouse gases by various human activities.

Mitigation can also be described as steps taken to reduce the amounts of greenhouse gases being produced by the human society over a long period of time. Most of the mitigation measures will be in the energy sector through the use of cleaner technologies; forestry sector, through reforestation; and the agriculture sector, through improved fertilizer application, crop and livestock management.

Climate change mitigation involves reduction in the concentrations of greenhouse gases, either by reducing their sources or by increasing their sink. The United Nation defined mitigation in the context of climate change, as a human intervention that reduces the source or enhances the sinks of greenhouse gases. For example, the use of fossil fuel more efficiently for industrial processes or electricity generation was switched to renewable energy (solar energy or wind power), Others include improving the

insulation of building, and expanding forests and other "sinks" to remove greater amount of carbon dioxide from the atmosphere (Eke, 2011).

Adaptation to climate change requires that farmers or communities should first notice that the climate is changing, and then identify useful adaptation measures and implement them (Maddison, 2006). Furthermore, adaptation to climate change refers to any adjustment that occurs naturally within ecosystems or in human systems in response to climate change that either moderates harm or exploits beneficial opportunities in response to actual or expected climate related to environmental changes.

Therefore, it is in view of the above that the study was designed to assess the adaptation strategies used by the local indigenous farmers in Michika Local Government Area of Adamawa State, Nigeria. The specific objectives of the study were:

i. To analyse the trend of fluctuation in rainfall amount and temperature for the period of 21 years (1992-2012).
ii. To examine the impact of climate change on crop production in the study area.
iii. To identify the adaptation strategies employ by the local indigenous farmers.
iv. To examine constraints towards adaptation.
v. To examine the effects of socio-economic variables on farmers level of awareness of climate change (gender, age, educational qualification, and farming experience).

The Study Area

Michika Local Government Area is situated in the North Eastern corner of Adamawa State between latitude $10^{0}36^{1}$N-$10^{0}40^{1}$N and longitude $13^{0}21^{1}$E-$13^{0}35^{1}$E (Google Map Data, 2011). It shares common boundaries with Madagali Local Government Area to the North, Lassa (Borno State) to the West, Republic of Cameroun to the East, and to the South, Mubi North and Mubi South Local Government Area. It has a land area of about 142, 199km^{2}. Mcihika Local Government is divided into 8 districts, with 16 electoral wards and 1445 polling units, with a total population of 155,238 according to 2006 population census count. The study area has a tropical wet and dry type of climate, which is coded as a Koppen's classification.

Dry season last for a minimum of five months (November to March), while wet season spans from April to October. Thus, the mean annual rainfall in Michika ranges from 900-1050 mm (Adebayo, 2004). Generally, the planting of crops begins earlier in the mountainous area due to graphic factors. Also, agriculture is the mainstay or major occupation of about 80% of the inhabitants of Mcihika local government area. (Figure 1 and 2).

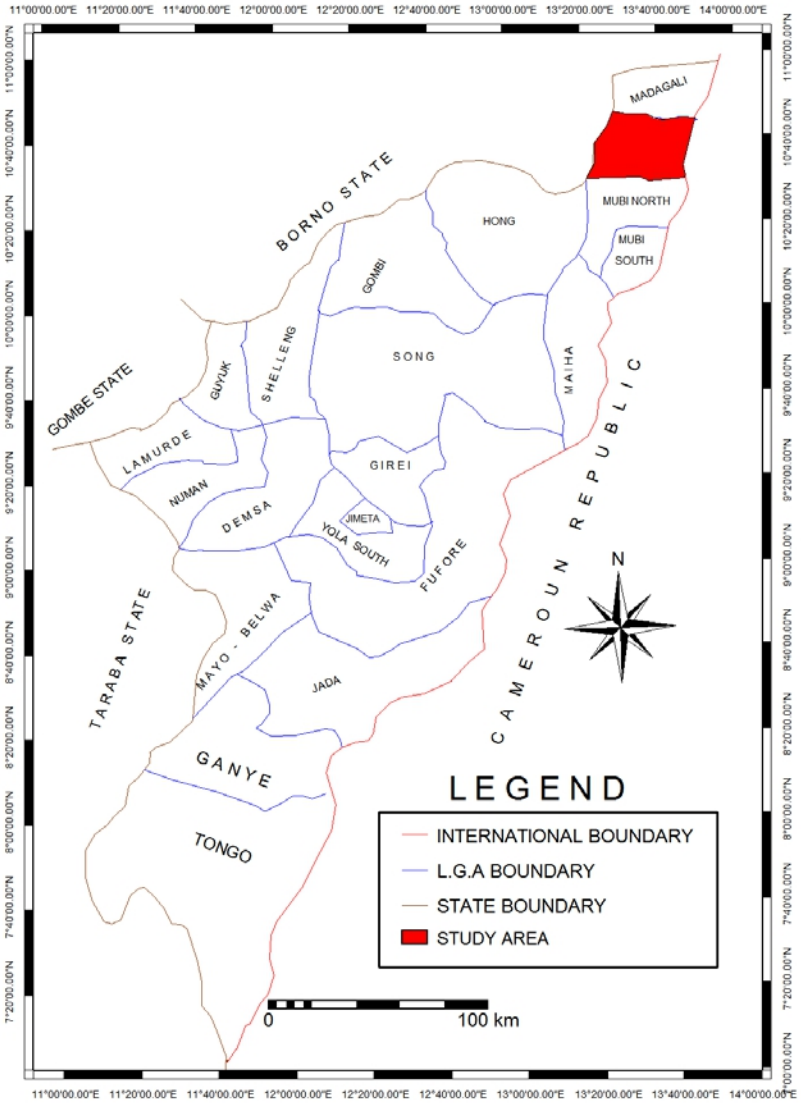

Fig.1: Adamawa State Showing the Study Area
(Source: Adamawa in Map, 1999)

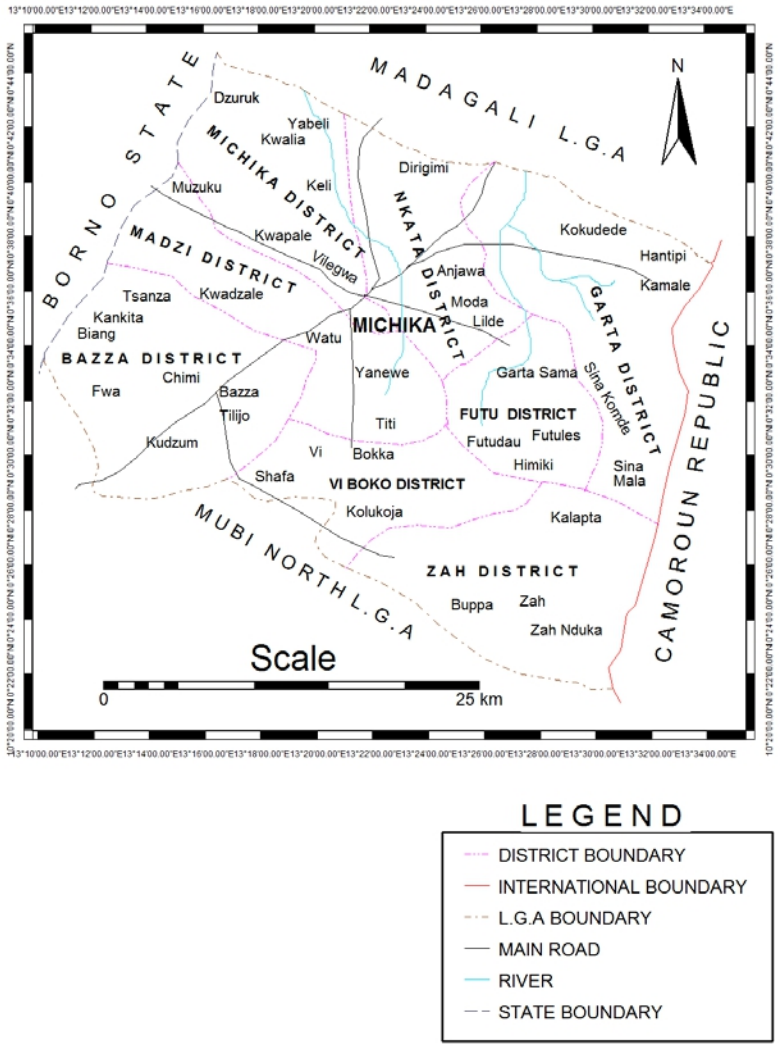

Fig.2: Map of Michika LGA showing the Districts
Source: Ministry of Land and Survey

Methodology

Data for this study was obtained through structural questionnaire survey of 369 farmers from all the eight districts of the study area. The questionnaire sort information on the impact of climate change on crop production in the study area, adaptation strategies employed by farmers

towards climate change, and constraints faced by the local indigenous farmers towards adaptation measures. Then, 21 years of rainfall and temperature data (1992-2012) from Adamawa State Agriculture Development Programme was analyzed.

In selecting the sample size, 10% of the villages in each district were purposively selected. Then, random sampling was used to select villages in which questionnaire was administered. This formed the sample size of 14 villages out of the 8 districts.

Due to disparity in population distribution in the selected villages and the need for adequate representation, Cochran (1997) proportional technique formula was used to determine the number of respondents in each selected villages. However, as indicated in table 1, data collected were summarized using descriptive statistics in terms of mean and percentage.

$$nh = \frac{Nh\ xn}{N}$$

Where nh= the number of the individual sample villages

Nh = the number of farmers in the individual villages

N = the total number of farmers in all the sample villages (22,488)

n = the number of questionnaire to be distributed among the sample villages (393)

Table 1. Number of Farm families in each sampled village with their size. The total number of questionnaire is = 393

S/N	District	Selected Villages	No. of Farmers in each Selected Villages (Nh)	Sample size (nh)
1	Michika	Tumbara Ngabili	1497	26
		Dzuruk Kwabapale	1113	19
			840	15
2	Madzi	Madzi	1704	29
3	Nkafa	Dlaka	2498	43
		Moda	1314	23
4	Bazza	Jigalambu	2342	41
		Tsukumu	1341	24
5	Vi-Boka	Tili	802	14
6	Zah	Buppa	2260	40
7	Futu	Himike	1450	25
		Debki	1091	20
8	Garta	Garta	2494	44
		Ghumchi	1744	30
	Total	**14**	**N=22,488**	**n=393**

Source: (AADP) Michika, 2006

While in objective V, chi-square was used to asses the association for the indigenous farmers level of awareness of climate change and socio-economic variables (gender, age, educational qualification, and farming experience)

$$X^2 = \sum \frac{(0-E)^2}{E}$$

Where:
$X^2 = Chi - Square$
$O = Observed\ value\ (Raw\ data\ from\ the\ Field\ Survey)$
$E = Expected\ value\ calculated\ from\ the\ observed\ value$.
The research hypothesis tested is stated as follows:
H_o: There is no association between the level of awareness of climate change and socio-economic variables (gender, age, qualification, and farming experience)
H_1: There is association between the level of awareness of climate change and socio-economic variable (gender, age, qualification, and farming experience)

Results and Discussion

a) Analysis of Trend of Annual Rainfall and Temperature for the Period of 21 years (1992-2012) in the Study Area.

Figure 3 below shows the trend in the annual rainfall distribution by year in the study area.

As shown in figure 1 from 1992-2004, the total annual rainfall in the study area does not exceed 1,260mm. From 2005-2012, there was a substantial increase in the total annual rainfall, which is above the previous years mentioned. In addition, the highest peak of rainfall within the period under study (1992-2012) was in August 2007 (747mm).

Then, the years with the highest total annual rainfall were 2007 (1853.1mm), 2006 (1771mm), and 2012 (1670.8mm). Similarly, the years with the low total annual rainfall were 1992 (852mm), 1993 (908.5mm), and 1996 (999.5mm). Therefore, it could be concluded that as shown in Figure 3 the rainfall trend in the study area is increasing from 2005-2012.

Then, Figure 4 below shows the total mean maximum temperature of the study area (1992-2012). The highest mean maximum temperature of 39.2^{o}C and 37.8^{o}C was recorded in 1994 and 2012, respectively. Conclusively, the annual maximum temperature in figure 4 shows a slight increase in temperature.

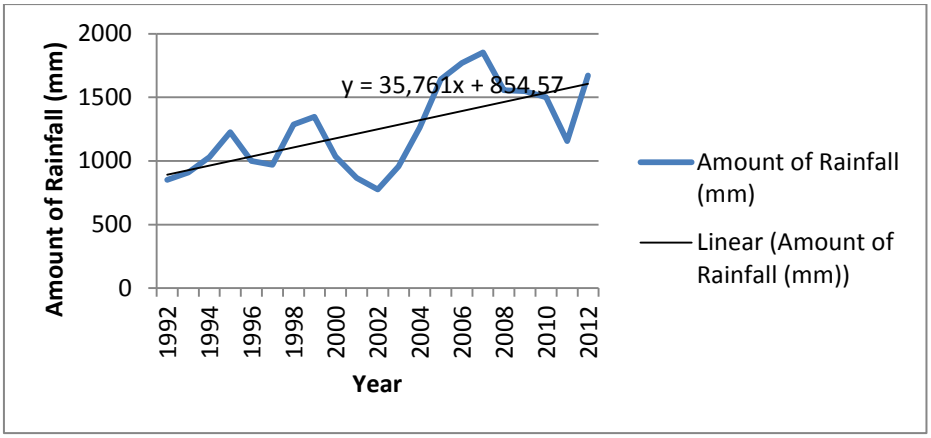

Figure 3. Trend in Total Annual Rainfall (mm) in Michika for 231 (1992-2012)

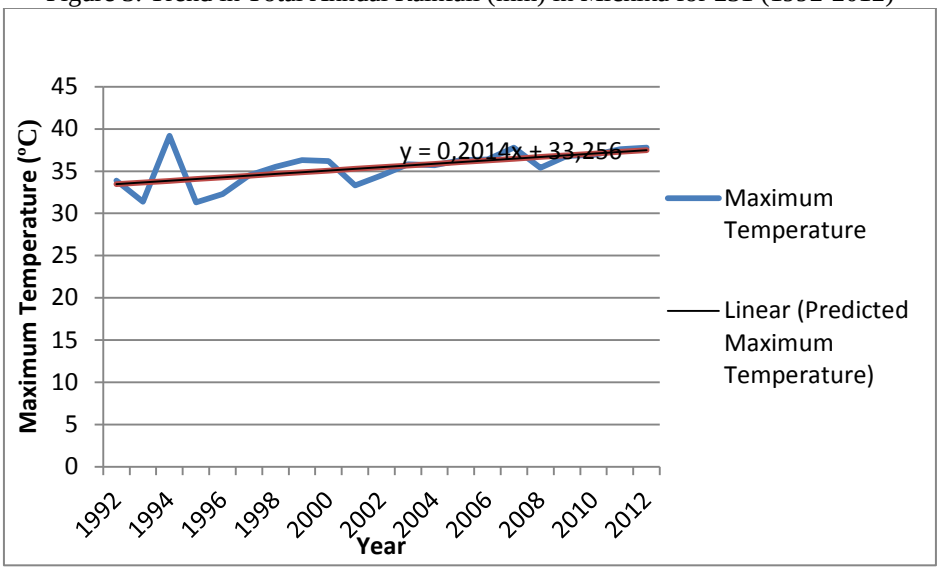

Figure 4. Trend of Maximum Temperature for Michika (1992-2012)

b) Impact of Climate Change on Crop Production

The response of the indigenous farmers in Table 2 reveals loss of soil fertility (23%) as the dominant impact. In addition, higher temperature (18%) can interfere with the ability of plants to get and use moisture. It also helps to accelerate evaporation from soil and to increase transpiration in plants. Thus, this leads to drastic reduction in crop yields. The respondents also mentioned low yields of crops (17%), ease spread of pest and diseases (14%), flood and erosion (13%) which might be due to increase in the nature of the rainfall in the study area as indicated in figure 3, drying of seeds after germination (10%), and stunted growth of crops (5%). The implication of this result is that climate change affect or impact on crop production negatively in the study area.

Table 2. Impact of Climate Change on Crop Production

S/N	Impact of Climate Change	Frequency	Percentage
1	Loss of soil fertility	86	23
2	High temperature	66	18
3	Low yields of crops	62	17
4	Ease spread of pest and diseases	53	14
5	Flood and erosion	46	13
6	Drying of seedling after germination	38	10
7	Stunted growing of crop	18	5
	Total	**369**	**100**

Source: Field Survey 2013

c) Indigenous Farmers Adaptation Strategies

The table 3 below presents adaptation strategies by the respondents. The strategies include planting of early maturing crops (26.2%), planting resistant crops to pest (22.7%), prayers to God and gods (6.5%), movement to new land (1.0%), mixed farming (23.3%), intensive use of fertilizer (17.8%), and changing of planting dates (2.1%). The result in this table revealed the best adaptation strategies employed by famers to combat climate change in the study area.

Table 3. Indigenous Farmers Adaptation Strategies

S/N	Adaptation	Frequency	Percentage
1	Planting early maturing crops	97	26.2
2	Planting resistant crops to pest and drought	84	22.7
3	Prayers to God and gods	24	6.5
4	Movement to new land	4	1.0
5	Mixed farming	86	23.3
6	Intensive use of fertilizer	66	17.8
7	Changing of planting dates	8	21.1
	Total	**369**	**100**

Source: Field Survey 2013

d) Constraints Facing Indigenous Farmers Towards Adaptation Strategies

Table 4 below presents constraints towards adaptation strategies. Consequently, 16.2% of the respondent lack adequate knowledge on how to cope with adaptation towards climate change, limited access to improve crop varieties (18.5%), difficulty towards adaptation due to lack of information on weather condition (3.2%), lack of good storage facilities for crops and water which are hindrance to adaptation (18.1%), high cost of fertilizer (19.2%), lack of financial resources (17.8%), and absence of government policy on adaptation measures (6.5%).

This finding is in agreement with Oyekale (2009), who reported that small scale farmers having low resources base, are more vulnerable and less able to cope with the consequences of climate changes. Such farmers also

lack access to credit, inadequate knowledge to cope with adaptation, or the capacity to develop technologies on their own.

Table 4. Indigenous Farmer Constraints Towards Adaptation Measures

S/N	Constraints	Frequency	Percentage
1	Lack of adequate knowledge on how to cope with adaptation	60	16.2
2	Limited access to improve crop varieties	69	18.6
3	Lack of access to weather information	12	3.2
4	No availabilities of good storage facilities for water and crop	67	18.1
5	High cost of fertilizer and other farm inputs	71	19.2
6	Lack of financial resources	66	17.8
7	Absence of government policy on adaptation measures	24	6.5
	Total	**369**	**100**

e) Effects of Socio-Economic Variables on Level of Awareness on Climate Change.

This section analyses the effects of socio-economic characteristic (gender, age, educational qualification, and faming experience) on their level of awareness using chi-square statistical test.

The research hypothesis tested is stated as follows:

H_o: There is no association between the level of awareness of climate change and socio economic variable (gender, age, qualification, and farming experience)

H_1: There is association between the level of awareness of climate change and socio-economic variables (gender, age, qualification, and farming experience)

i. Gender and Level of Awareness of Climate Change

As shown in table 5, the gender distribution of the respondent in the study area reveals male to be 118 (32%) and female to be 521 (68%). However, both genders have significance level of awareness towards climate change. The chi-square result for the test of the research hypothesis is as shown in the table 5.

Since calculated value is 18.76, it is greater than the critical value (5.99) at significance level 0.05. Hence, we reject H_o and accept H_1.

Therefore, we conclude that there is an association between level of awareness of climate change and gender.

Table 5. Gender and Level of Awareness of Climate Change

Gender	Not Aware	Slightly Aware	Strongly Aware	Total	Chi-Square Value	DF	Critical value
Male	43	46	29	118	18.76	2	5.99
Female	56	75	120	251			
Total	99	121	149	369			

Source: Field Survey 2013

i. Age and Level of Awareness of Climate Change

Age alone can influence human being to be more aware of his living environment Thus, older people especially, acquire more experience within their environment as indicated in table 6. Furthermore, the entire age category were acquainted with their living environment but at various degrees.

Then, Chi-Square was used to ascertain age and level of awareness of climate change. This shown that the calculated value (16.12) is greater than the critical value (9.49) at significant level of 0.05. Hence, we reject H_o and accept H_1.

Therefore, we conclude that there is an association between age and level awareness of climate change.

Table 6. Age and Level of Awareness of Climate Change

Age	Not Aware	Slightly Aware	Strongly Aware	Total	Chi-Square Value	D F	Critical Value
30-40years	28	19	9	56	61.12	2	9.49
41-50years	38	63	39	140			
51 years and above	33	39	101	173			
Total	99	121	149	369			

Source: Field Survey 2013

i. Educational Qualification and Level of Awareness of Climate Change

As indicated in table 7 both those with formal and no formal education were aware that their immediate environment is changing. Then, chi-square analysis was used to ascertain whether there is an association between educational qualification and level of awareness of climate change.

In table 7, the chi-square results indicated that the calculated value (33.36) is greater than the critical value (12.59) at significance level of 0.05. Hence, we reject H_o and accept H_1.

Therefore, we conclude that there is an association between level of awareness of climate change and educational qualification.

Table 7. Educational Qualification and Level of Awareness of Climate Change

Age	Not Aware	Slightly Aware	Strongly Aware	Total	Chi-Square Value	DF	Critical Value
No. Formal Education	24	46	84	154	33.36	3	12.59
Primary School	36	28	38	102			
Secondary School	33	36	20	89			
Tertiary Institution	6	11	7	24			
Total	99	121	149	369			

Source: Field Survey 2013

i. Farming Experience and Level of Awareness of climate change

The experience acquire especially through farming determine how farmers respond to changes in farming techniques. As indicated in table 8, all the respondents have reasonable years of farming experience to ascertain their environments. The chi-square test was used to determine farming experience and level of awareness of climate change.

The result in table 8 indicated that the calculated value 56.52 is greater than the critical value (4.49) at a significant level of 0.05. Hence, we reject H_o and accept H_1.

Therefore, we conclude that there is an association between farming experience and level of awareness of climate change.

Table 8. Farming Experience and Level of Awareness of Climate Change

Farming Experience	**Not Aware**	**Slightly Aware**	**Strongly Aware**	**Total**	**Chi-Square Value**	**DF**	**Critical Value**
10-29 years	62	46	34	142	56.52	2	4.49
21-30 years	11	32	52	95			
31 years and above	26	43	63	132			
Total	99	121	149	369			

Source: Field Survey 2013

Conclusion and Recommendations

It is established from this study that the respondents were aware of climate change and its impact on food crop production as shown in table 2. However, the local indigenous farmers are able to develop adaptation strategies in a way that enables them to cope with the erratic impact of climate change on food production. These strategies include planting early maturing crops, planting resistant crops to pest and drought, mixed farming, and intensive use of fertilizer. These strategies are seen as the best by the local famers in the study area, due to increment in crop yield of productivity. However, according to the respondent, the major constraints are lack of adequate knowledge on how to cope with adaptation, limited access to improve crop varieties, lack of access to weather information, and lack of financial resources.

Consequently, based on the finding of this study, the following recommendations were suggested:

i. Government should improve knowledge and skills of extension service personnel about climate change and adaptive management strategies. Also, increasing extension farmers' ratio and making extension services more accessible to farmers, might be the key components of a successful adaptation programme.

ii. The development of supplementary irrigation system, i.e. farming practice that would supply water to crops during growing stage, especially during short period of drought

iii. Weather observation stations should be established and personnel should be trained on observation and manipulation of data. In addition, information should be made available to local farmers.

iv. Establishment of rural service centre to provide technical advice and information on viable agriculture water management options and other services to farmers.

v. Micro credit/revolving grants should be made available to farmers.

vi. Provision of improved crop varieties to the local indigenous farmers.

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Appendix i

Total Annual Rainfall of Michika Local Government Area, Adamawa State (1992-2012)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	Average	SD
1992	0	0	0	30	48	114	140	310	112	98	0	0	852 0	121.7	91.6
1993	0	0	0	35	62	96.5	210	223	178	104	0	0	908.5 0	129.8	73.9
1994	0	0	0	23	53	172	185	330.5	210	56	0	0	1029.5	147.1	109.7
1995	0	0	0	30	112	155.5	220	401.5	186.5	120	0	0	1225.5	175.1	116.8
1996	0	0	0	19	82	115	192.5	250	203	138	0	0	999.5	142.8	79.0
1997	0	0	0	22.5	61	93.5	140	297	230	125	0	0	969	138.4	95.9
1998	0	0	0	20.5	149	101.5	330.5	395.5	189	101	0	0	1287	183.9	134.1
1999	0	0	0	0	92.4	98.7	345.7	384.3	239.5	186.5	0	0	1347.1	192.4	140.5
2000	0	0	0	22.4	98.2	185.5	218.6	367.7	111.8	31.4	0	0	1035.6	147.9	121.0
2001	0	0	0	37.3	23.5	196.1	199.6	193.2	196.2	20	0	0	865.9	123.7	90.7
2002	0	0	0	36.5	53.2	86.7	162.9	145.2	246.2	45.1	0	0	775.8	110.8	77.4
2003	0	0	0	26.5	54.2	103.5	253.9	228.9	183.5	91.9	15.1	0	957.5	119.7	91.8
2004	0	0	0	30.3	99.6	176	186.7	314	313	141	0	0	1260.6	180.1	105.0
2005	0	0	0	33.3	77	248	468.5	412	240	162.5	0	0	1641.3	234.5	161.7
2006	0	0	0	17	110	256.5	377	493	381	136.5	0	0	1771	253.0	172.8
2007	0	0	0	44.5	49.6	308.5	349	747.5	295	59	0	0	1853.1	264.7	251.7
2008	0	0	0	24.5	131	202.5	387	428	261	121	0	0	1555	222.1	146.7
2009	0	0	0	14.6	148	190	257.5	523	243	171	0	0	1547.1	221.0	155.1
2010	0	0	0	0	146	149	256.5	448	352.5	147.5	0	0	1499.5	214.2	149.9
2011	0	0	0	0	247	112	245	430.5	121	0	0	0	1155.5	165.1	154.3
2012	0	0	0	40.3	149	196	260	620.5	245	160 J	0	0	1670	238.7	183.3

Source: (AADP) Michika, 2012 Adamawa State, Nigeria