Farmers' Perceptions of Climate Change and Adaptation Strategies in Northern Nigeria: An Empirical Assessment

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Abstract

This research paper looked at farmer's perception of causes, constraints and strategies towards effective climate change adaptation in northern Nigeria. Data were collected from 500 respondents using both qualitative and quantitative approaches through multistage random sampling technique. Simple descriptive statistics such as percentage and mean scores were used in data analysis. The results of the study showed that the respondents were informed of the incidence of climate change as regards uncertainties in terms of higher temperatures, delay in the onset of rains, erratic rainfall pattern; extremities of weather events such as desertification, heavy rainfall, drought; and increased farming problems such as loss of soil fertility; reduction in farm yields and high rate of disease incidence. The extent of climate change on farms were revealed by changes in uncertainties of onset of farming season, including the delay in onset of rainfall, less rainfall, higher temperature; extremities of weather events such as high sun intensity, loss of forest resources, heavy winds; and increase in farming problems, in particular, reduction in crop yields and loss of soil fertility. Respondents perceived the causes of climate change as bush burning, continuous cropping, deforestation and excess chemical use on farms. Adaptive strategies used included multiple cropping, intensive manure application, and use of wetland/fadama, use of resistant varieties, processing to minimize post harvest loss, and reforestation. Constraints to adaptation included: lack of financial resources, lack of access to weather forecasts, and limited access to improved crop varieties.

List of Acronyms

IPCC	International Panel on Climate Change
UNFCCC	United Nations Framework Committee on Climate Change
GHGs	Green House Gases
CFC	Chlorofluorocarbons
GDP	Gross Domestic Products
USDA	United States Department of Agriculture

1. Introduction

1.1 Problem Statement

Climate change has been defined by the Intergovernmental Panel on Climate Change (IPCC) as statistically significant variations that persist for an extended period, typically decades or longer. It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. Climate change manifests in a number of ways. They include: changes in average climatic conditions – some regions may become drier or wetter on average; changes in climate variability – rainfall events may become more erratic in some regions; changes in the frequency and magnitude of extreme weather events and changes in sea levels.

Climate change is a process of global warming, in part attributable to the greenhouse gases generated by human activity. These greenhouse gases are generated from the burning of fossil fuels such as coal, oil and gas. These fuels contain carbon and carbon dioxide is one of the gases which contribute to global warming.

Climate change impacts are felt on agricultural production, health, biodiversity, social and economic conditions, and affect people and the environment in general. It is predicted to worsen the incidence of drought and desertification and millions of people will become refugees as a result. The impacts of climate change are being felt by both developed and developing countries, and in Nigeria for example, more than two thirds of the country is thought to be prone to desertification. Mohammad (2009) reports that desert, which now covers about 35 percent of Nigeria's land mass, is advancing at an estimated 0.6 km per annum, while deforestation is taking place at 3.5 percent per annum. The desert

belt has moved from Kebbi, Kano, Maiduguri to new Bussa, Kaduna, Jos, Sheleng while Savannah now interface between desert and forest along Oyo, Osun, Kogi and Benue states. Moreover, the Sudano-Sahelian region of Nigeria has suffered a decrease in rainfall in the range of 3-4 percent per decade since the beginning of the nineteenth century. The concern with climate change is heightened given its linkage to the agricultural sector and poverty. In particular, it is anticipated that adverse impacts on the agricultural sector will exacerbate the incidence of rural poverty. Impacts on poverty are likely to be especially severe in Nigeria where the agricultural sector is an important source of livelihood for a majority of the rural population. Our agriculture is rain fed. Our food production system will be adversely affected by the variability in timing and amount of rainfall, frequent outbreaks of crop pests and diseases and heat stress.

Although Nigeria has made some efforts to adapt and mitigate climate change risks, the efforts are still rudimentary especially when compared with the impending catastrophe. Hence, the pertinent questions that guided this research work are: what are the perceived causes of climate change in northern Nigeria; what are the constraints being faced by farmers in adapting to the effects of the changing climate; and what adaptive strategies are been used in the study area to ameliorate the impacts of climate change on farming activities.

1.2 Objectives of the Study

The overall objective of this research paper is to ascertain farmer's perception of causes, constraints and strategies towards effective climate change adaptation in northern Nigeria. Specifically, the study sought to:

1. examine the nature of climate change impact in northern Nigeria;
2. identify the perceived causes of climate change in the area;
3. identify and describe the indigenous adaptation practices used by farmers in the area; and;
4. identify the problems farmers face due to the effects of climate change.

1.3 Justification of the Study

There is an urgent need for advocacy on climate change in order to enlighten people on the dynamics of climate change; this cannot be done effectively without any evidence. Research on climate change will therefore promote evidence-based advocacy. It is these facts that this work wants to provide.

With appropriate adaptation practices in place, the vulnerability to climate change will be minimized. Although the issue of climate change and agriculture is not a recent development, there has been little or no efforts aimed at scientifically documenting the existing situation among agrarian communities in northern Nigerian as regards the various indigenous innovative technologies and adaptation measures to combat the negative effects of climate change. The need for such baseline information, especially as it concerns designing appropriate strategies for mitigating climate change effect on agriculture, cannot be overemphasized.

This work will therefore go a long way to provide vital information on what the rural communities are doing to adapt their agricultural production properly in order to avoid losses, since their livelihood depend on agriculture. Again, due to the complex interactions between climatic, environmental, economic, political, institutional, social and technological processes, the findings of this study will be relevant to the agrarian rural poor, the researchers, NGOs, policy makers, the government and international organizations for information and policy.

2. Literature Review

2.1 The Concept of Climate Change

United Nations Framework Convention on Climate Change (UNFCCC) (1992) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer); climate change may be due to natural internal processes or external forces, or due to persistent anthropogenic changes in the composition of the atmosphere or in land use.

According to De Chavez and Tauli-Corpus (2008) global warming is the average increase of the earth's surface temperature and oceans as compared to previous centuries. This is a result of the continuous trapping of heat within the earth's atmosphere due to increased quantity of greenhouse gases. Global warming is one of the key aspects of climate change. Global warming can lead to the rise in the sea levels, oceans warm and glaciers melt, thereby threatening agricultural productivity and human settlements. Other impacts may include; changes in rainfall patterns and increase in soil erosion, storms, floods and drought. The ultimate result at the end would be a deepening food crisis, as well as worsening weather, energy decrease and general environmental breakdown throughout the world.

2.2 Causes of Climate Change

According to the summary of the Intergovernmental Panel on Climate Change (IPPC) 4th Assessment Report (IPCC, 2007), human actions are very likely the cause of global warming; meaning a 90% or greater probability is attributable to human action A comprehensive assessment by the IPCC of the scientific evidence suggests that human activities are contributing to climate change, and that there has been a discernible human influence on global climate (www.gcrio.org). Climate changes caused by human activities, most importantly the burning of fossil fuels (coal, oil, and natural gas) and deforestation, are superimposed on, and to some extent masked by, natural climate fluctuations.

Climate change and global warming are caused by the build up of greenhouse gases (GHGs) such as carbon dioxide, nitrous oxide, chlorofluorocarbons (CFCS) and methane, in the atmosphere as a result of human activities among them, the burning of fossil fuels, bush burning, use of machines that produce smoke, cooking etc (http://www.news.dailytrust.com). The planet (earth) is surrounded by an atmosphere containing gases that regulate temperature. Various activities carried out by man have varying contributions to the changes in the climate systems. The burning of coal, oil, and natural gas, as well as deforestation and various agricultural and industrial practices, are altering the composition of the atmosphere and contributing to climate change (www.gcrio.org). These human activities have led to increased atmospheric concentrations of a number of greenhouse gases.

According to De Chavez and Tauli-Corpus (2008) GHGs are chemical compounds such as water vapour, carbon dioxide, methane, and nitrous oxide found in the atmosphere. These are gases that are able to absorb and radiate heat. Many greenhouse gases occur naturally such as water vapour, carbon dioxide (CO2), methane (CH4), Ozone (O3) and nitrous oxide. Others such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) result exclusively from human industrial processes. All of these gases are responsible for greenhouse effect, but water vapour and CO2 contribute 90% of this effect (www.undp.org, www.gcrio.org). In their direct contribution of these greenhouse gases, CO2 contributes 55%, methane 15%, CFCs 7%, CFC (11 and 12) 17%, and N2O 6% (www.undp.org).

Natural changes in climate result from interactions such as those between the

atmosphere and ocean, referred to as internal factors, and from external causes, such as variations in the sun's energy output which would externally vary the amount of solar radiation received by the earth's surface (www.eoearth.org/articles/causes-of-climate-change) and in the amount of material injected into the upper atmosphere by explosive volcanic eruptions (www.gcrio.org).

2.3 Effect of Climate Change on Crops

According Zhu (2005) climate change has both positive and negative effects on farming, but there could be a more negative influence in the long run, which may lead to food scarcity if there are no immediate efforts to confront these problems. Crop yields are affected by many factors associated with climate change which includes: temperature, rainfall, extreme weather events, climate variability and even carbon dioxide concentration in the atmosphere which is predicted to cause global warming that will have a significant impact on crop production (USDA, 2007).

According to Brett (2009), 75 to 250 million Africans are projected to be exposed to an increase of water stress due to changes in rainfall pattern, and the amount and availability of water stored in the soil which is a crucial input to crop growth, which will be affected by changes in both the precipitation and seasonal annual evapo-transpiration. Agricultural production and access to food in many African countries is projected to be severely compromised by climate variability and change in precipitation. The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020 (Brett, 2009).

In Nigeria, some areas like the Niger Delta regions receive more than normal rainfall while some areas in the Northern region receive almost no rainfall as a result, growing seasons are changing, ecological zones are shifting, and rainfall is becoming more unpredictable and unreliable both in its timing and its volume (Brett, 2009). The crop water regime may be affected by changes in seasonal precipitation, within- season pattern of precipitation, and inter annual variation of precipitation. Too much precipitation can cause disease infestation in crops, while too little can be detrimental to crop yield leading to decline in agricultural productivity (IPCC, 2007), especially if dry periods occur during critical

development stages. For example, moisture stress during the flowering, pollination, and grain-filling stages is very harmful to maize, soya bean, wheat and sorghum even rice which feeds more than half of the world's population can also be jeopardized (Lorraine, 2007).

2.4 Effect of Climate Change on Soil

Change in climate will also have an effect on the soil. Soil structure is affected by variation is temperature and rainfall, particularly during hotter and dryer season; there is an increased tendency for subsoil to become strong making it more difficult for roots to penetrate. Some soils are likely to form impenetrable caps, increasing the risk of run-off and subsequent pollution events and floods are projected to affect local crop production negatively, especially in subsistence sectors at low latitudes (Brett, 2009). Others may form cracks through which any rainfall will pass, reducing the trapping effect of the surface layers, further increasing risk of drought in the following year and also reducing the filtering effect of soil and increasing pollution risk.

In general, climate change is a contributory factor to food price crisis, and its impacts on agriculture in developing countries is expected to get more serious, for instance disease outbreak which may put the local and rare breed (plants and animal) at risk of being lost through the impact of climate change and diseases epidemics. Also expansion of vectors during wetter years reaching to large outbreak of disease expansion to the North (Lancelot, Rocque and Clievalier, 2008).

2.5 Climate Change Adaptation

Adaptation to the adverse effects of climate change is a key issue for all countries, especially developing countries, which are often the most vulnerable and at least equipped to adapt. Adaptation is widely recognized as a vital component of any policy response to climate change because it helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socioeconomic conditions, including climate variability, extreme weather conditions such as droughts and floods, and volatile short-term changes in local and large-scale markets (Kandlinkar & Risbey, 2000).

Studies show that without adaptation, climate change is generally detrimental to the agriculture sector; but with adaptation, vulnerability can largely be reduced

(Easterling, Crosson, Roseberg, MicKenny et al. 1993; Rosenzweig and Parry 1994; Reilly and Schimmelpfennig 1999; Smit and Skinner, 2002). The degree to which an agricultural system is affected by climate change depends on its adaptive capacity. Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences (IPCC, 2001). Thus, the adaptive capacity of a system or society describes its ability to modify its characteristics or behaviour so as to cope better with changes in external conditions (Glwadys, 2009).

Adaptation to climate change requires that farmers and / or communities first notice that the climate has changed, and then identify useful adaptations measures and implement them (Maddison, 2006). Adaptation to climate change refers to any adjustment that occurs naturally within ecosystems or in human systems in response to climatic change that either moderates harm or exploits beneficial opportunities in response to actual or expected climate related environmental changes (Intergovernmental Panel on Climate Change (IPCC), 2007). It looks into ways of responding to changes that pose greater risks to life and livelihood and increasing damage-related costs such as climate change effects on rainfall, the strength and distribution of tropical storms, sea levels and glacier melt.

Adaptation measures always seek to reduce the risks and impacts of climate change, to moderate the negative effects, and to exploit beneficial opportunity. Adaptation is a proactive process because it envisages possible future changes in the climate . The devastating effects of climate change can be reduced if appropriate adaptation measures are employed. Many agricultural adaptation options have been suggested in the literature. They encompass a wide range of scales (local, regional, global), actors (farmers, firms, government), and types: (a) micro-level options, such as crop diversification and altering the timing of operations; (b) market responses, such as income diversification and credit schemes; (c) institutional changes, mainly government responses, such as removal of present subsidies and improvement in agricultural markets; and (d) technological developments—the development and promotion of new crop varieties and advances in water management techniques (Smith and Lenhart 1996; Mendelsohn 2001; Smit and Skinner 2002; Kurukulasuriya and Rosenthal 2003).

De Chavez and Tauli-Corpus (2008) noted that in Africa, local farmers are practicing zero-tilling practices in cultivation, mulching, and other soil-management techniques. These activities are known to moderate soil temperatures, suppress diseases and harmful pests, and conserve soil moisture.

3. Methodology

3.1. Area of Study

The study was carried out in the northern Nigeria, an area which lies predominantly across four ecological zones, from Kogi State in the humid to Borno State in the semi- arid zone.

3.2. Population and Sample

A multistage random sampling technique was used to select the respondents for this study. In the first stage, four states were randomly selected for the study, one from each of the ecological zones, as follows: Semi-arid zone – Adamawa; Dry sub-humid – Borno; Sub-humid – Kaduna; and Humid – Kogi. Since there were over-laps in the states belonging to different zones, a state may belong to more than one agro-ecological zone. Hence those that belong to the previous zone from which a state was selected were removed from the list of states belonging to the next. This was to make sure that only states that have predominantly the characteristics of such ecological zone are considered in the selection and that states that are selected do not have the same characteristics with respect to agro-ecological delineations.

In the second stage, one local government area was randomly selected from each of the senatorial zone of each state. This constituted the sampling frame. Hence, a total of 12 local government areas were sampled. From each of the three LGAs in each state, three communities were randomly selected. The last stage was the selection of 45 farmers from each LGA, giving a total of 540 respondents for the study. The data for the analysis were based on a cross-sectional farm household survey in the different local government areas. In all a total of 500 completely filled interview schedules were used in the analysis.

3.3. Data collection

Tools of participatory research namely: semi structured interview schedule, key informant interviews and focus group discussions (FGDs) were used in data collection. These instruments contained both open ended and semi structured questions.

3.4. Measurement of Variables

The interview schedule was divided into seven sections but only four sections were used for this research paper. The first section sought information on the nature and extent of climate change impacts using a five point Likert-type scale. Each respondent was required to respond by ticking any of the options namely: "To a very great extent", "To a great extent" "To some extent", "To a little extent" and "To no extent". Values assigned to these options were 5, 4, 3, 2 and 1 respectively. These values were added to obtain a score of 15, which was then divided by 5 to obtain 3.0, taken as the mean. Factors with mean score less than 3.0 were taken as those with less extent of change while those with mean score equal or above 3.0 were taken to have large extent of impacts on climate change.
Section B sought to elicit information on respondent's perceived causes/different practices that exacerbate the impact of climate change. This was achieved on a three point Likert –type scale. Each respondent was required to indicate his/her responses by ticking any of the options namely: "Often", "Seldom" and "Never". Values assigned to these options were 3, 2 and 1 respectively. These values were added to obtain 6, which were divided by 3 to obtain 2.0, which was regarded as the mean. Factors with mean score less than 2.0 were not perceived as causes of climate change while those with mean score equal or above 2.0 were taken as perceived causes of climate change.

Section C of the interview schedule sought information on the adaptive measures being used to adapt to the negative effects of climate change. A list of measures was provided and the respondents were required to tick against an appropriate option of "Yes" and "No". The options provided on the list included: mulching, processing to minimize post harvest loss, use of resistant varieties, increased weeding, changes in planting and harvesting dates etc.

Section D of the interview schedule sought to elicit information on problems encountered by rural communities in adapting to the effects of climate change. Respondents indicated the extent to which variables like poor access to

information, lack of financial resources, poor/low extension services, risk of adaptation, limited knowledge on adaptation measures etc acted as constraints to climate change adaptation on a three point Likert type scale of “Very serious”, “Serious”, and “Not serious”. Values assigned to these options were 3, 2 and 1 respectively. These values were added to obtain 6, which were divided by 3 to obtain 2.0, which was then regarded as the mean. Factors with mean score less than 2.0 were as not considered as serious problems while those with mean score equal or above 2.0 were taken as serious problems.

3.5. Data analysis

Simple descriptive statistics were used in the data analysis. Objectives 1, 2 and 4 were analysed using mean scores, while objective 4 was realized using percentage calculations.

4. Results & Discussion

4.1. Incidence of Climate Change

The mean scores of respondent's perceived prevalence of climate change (Table 1) reveal that they noted that the incidence of climate change in the study area manifests as uncertainties in the onset of farming season, extreme weather events and increase in farming problems. Factors that informed them of the incidence of climate change with regards to uncertainties in the onset of farming season include unusual early rains that are followed by weeks of dryness (M=2.84), higher temperature (M=2.81), delay in onset of rain (M=2.72), less rainfall (M=2.70), erratic rainfall pattern (M=2.66), long period of dry season (M=2.62), no or reduced harmattan (M=2.23), long period of harmattan (M=2.23) and heavy and long period of rainfall (M=2.12).

The factors which support their understanding of climate change with regard to extremities of weather events were desertification (M=2.83), heavy rainfall (M=2.77), increase in atmospheric temperature (M=2.73), drought (M=2.68) among others. Also, the respondents noted that the incidence of climate change reflects as increased farming problems: loss of soil fertility (M=2.90), reduction in farm yields (M=2.68), high rate of disease incidence (M=2.67) etc. This finding is supported by Hir (2010) which noted that sand dunes and the harsh arid climate in Sahel area of Toshua in Yobe State of North-Eastern Nigeria, is another climate change reality. The report further noted that for the third consecutive year, this area in the extreme North East recorded below normal rainfall and higher than normal temperatures during the hot season. In addition to the low rainfall, desertification (as a result of wind erosion), is of particular concern as encroaching sand dunes threaten the few surviving oases and even houses within the settlement.

Table 1: Mean distribution of respondents' perception of changing climate phenomenon

Worsening climate phenomenon*	M	Standard Deviation
Uncertainties in the onset of farming season		
Unusual early rains that are followed by weeks of dryness	2.84*	0.46
Erratic rainfall pattern	2.66*	0.60
Delay in the onset of rains	2.72*	0.57
Long period of dry season	2.62*	0.67
Heavy and long period of rainfall	2.12*	0.47
Less rainfall	2.70*	0.60
No or reduced harmattan	2.23*	0.74
Long period of harmattan	2.23*	0.72
Higher temperature	2.81*	0.48
Extreme weather events		
Unusual dust that covers the atmosphere making it difficult for people to work	2.36*	0.67
Thunderstorms	2.11*	0.60
Heavy winds	2.50*	0.65
Floods and erosion	2.61*	0.60
Drought	2.68*	0.58
Heat waves	2.53*	0.77
Increase in atmospheric temperature	2.73*	0.58
High sun intensity	2.77*	0.51
Heavy rainfall	2.18*	0.45
Desertification or lost of forest resources	2.83*	0.44
Increase in the volume of sand encroachment	2.41*	0.71
Increase in farming problems		
High rate of disease incidence	2.67*	0.61
Increase weed infestation	2.62*	0.60
Loss of soil fertility	2.90*	0.36
Drying up of streams/rivers	2.81*	0.46
Overflowing of streams/rivers	2.14*	0.54
Reduction in farm yields	2.68*	0.59

Source: Field survey, 2010

Figure 1: Shrinking River Bed

4.2. Extent of Climate Change on Farms

As shown in Table 2, the respondents noted that changes due to uncertainties in the onset of farming season reveal that factors like higher temperature (M=3.68), unusual early rains followed by weeks of dryness (M=3.63), long period of dry season (M=3.57), delay in onset of rain (M=3.50), less rainfall (M=3.41) among others informed them that the climate has changed to a considerable extent.

The data further revealed that the respondents noted that extremities of weather events: high sun intensity (M=3.77), desertification or loss of forest resources (M=3.68), increase in atmospheric temperature (M=3.55), droughts (M=3.44) and heavy winds (M=3.18) etc have increased to a large extent.

Increase in farming problems: reduction in crop yields (M=3.60), loss of soil fertility (M=3.43), and high rate of disease incidence (M=3.03) also informed them of the large extent of the changing climate. These findings are in support of a work by F&D (2008) which noted that the impacts of climate change could affect

agriculture in a variety of ways. For example, beyond a certain range of temperature level, warming tends to reduce yields because crops speed through their development periods thereby producing less grain in the process. The work also noted that higher temperatures also interfere with the ability of plants to get and use moisture. Evaporation from the soil accelerates when temperatures rise and plant increase transpiration (lose moisture from their leaves) (F&D, 2008). This problem is reflected mainly in reduction in crop yields. There has been a drastic reduction of yields of crops in northern Nigeria, and this is making the realization of attaining food sufficiency in the country unrealizable. Environmental degradation and attendant desertification are major threats to the livelihoods of the inhabitants of the northern states of Nigeria. This will subsequently lead to increase in population pressure, intensive agricultural land use, overgrazing, bush burning; and extraction of fuel wood and other biotic resources.

Table 2: Mean distribution on extent of the changing climate phenomenon

Extent of change*	M	Standard Deviation
Uncertainties in the onset of farming season		
Unusual early rains that are followed by weeks of dryness	3.63*	0.93
Erratic rainfall pattern	3.45*	1.00
Delay in the onset of rains	3.50*	1.11
Long period of dry season	3.57*	1.14
Heavy and long period of rainfall	3.12*	1.26
Less rainfall	3.41*	1.11
No or reduced harmattan	3.00*	1.08
Long period of harmattan	3.21*	1.65
Higher temperature	3.68*	1.11
Extreme weather events		
Unusual dust that covers the atmosphere making it difficult for people to work	3.56*	1.27
Thunderstorms	2.94	1.12
Heavy winds	3.18*	1.11
Floods and erosion	3.16*	1.20
Drought	3.44*	1.26
Heat waves	3.33*	1.15
Increase in atmospheric temperature	3.55*	1.09
High sun intensity	3.77*	1.05
Heavy rainfall	3.27*	1.24
Desertification or lost of forest resources	3.68*	1.22
Increase in the volume of sand encroachment	3.24*	1.24
Increase in farming problems		
High rate of disease incidence	3.03*	1.22
Increase weed infestation	2.91	1.18
Loss of soil fertility	3.43*	1.09
Drying up of streams/rivers	3.52*	1.18
Overflowing of streams/rivers	3.17*	1.19
Reduction in farm yields	3.60*	1.18

Source: Field survey, 2010

4.3. Perceived Causes of Climate Change

The mean scores of respondents in Table 3 reveal that they perceived bush burning (M=2.51), overgrazing of farmland by livestock (M=2.29), continuous cropping (M=2.27), deforestation/indiscriminate cutting down of trees (M=2.34), burning of firewood for cooking (M=2.16), burning of crop/household wastes (M=2.08), use of excess chemicals in farmlands e.g. fertilizers, herbicides, pesticides etc., (M=2.05) as the major causes of climate. This result is in agreement with the fact that deforestation and various agricultural and industrial practices are altering the composition of the atmosphere and contributing to climate change (www.gcrio.org). The above causes of climate change are a reflection of human activities; these activities lead to an increase in concentration of green house gases in the atmosphere.

Table 3: Respondents' perceived causes of climate change

Perceived causes of climate change	M	Standard Deviation
Bush burning	2.51*	0.75
Continuous cropping	2.27*	0.82
Over-grazing farmland by livestock	2.29*	0.80
Burning of crop/household wastes	2.08*	0.77
Gases released from cement production	1.78	0.85
Burning of fossil fuel by industries	1.84	0.88
The use of fertilizers	2.16*	0.80
Use of excess chemicals in farmlands e.g. fertilizer, herbicides, pesticides etc	2.05*	0.83
Burning of fossil fuel from vehicles, machines, (motorcycles) etc	1.84	0.83
Deforestation/indiscriminate cutting down of trees	2.34*	0.87
Indiscriminate use of generators to generate electricity	1.92	0.82
Burning of firewood for cooking	2.16*	0.87
High use of irrigation water	1.67	0.80

Source: Field survey, 2010

4.4. Adaptive Strategies Adopted by Respondents

Table 4a shows the indigenous adaptive measures being used by farmers to cushion the harmful effects of climate change. The measures being used include: changes in planting dates (88.4%), changes in harvesting dates (85.4%), multiple

cropping (cropping of many crops on same piece of land) (81.8%), intensive manure application (69.2%), intercropping main crops planted with subsidiaries at low densities (61.8%), expansion of cultivated land area (59.2%), movement to different site (56.8%) mixed farming (54.6%) and use of wetland/river valley (e.g. fadama) (52.6%).

Table 4a: Percentage distribution of indigenous adaptive strategies used by farmers

Adaptive strategies	Yes %
Mulching	43.2
Use of wetlands/river valleys (e.g. Fadama)	52.6
Contour cropping across slopes	35.8
Planting deeper than the usual planting depth	32.2
Expansion of cultivated land area	59.2
Intensive manure application	69.2
Increased weeding	77.0
Move to a different site	56.8
Changes in the timing of land preparation activities	79.8
Changes in planting dates	88.4
Changes in harvesting dates	85.4
Multiple cropping (planting of many crops in the same piece of land)	81.8
Mixed farming (crop and animal production)	54.6
Relay cropping- planting and harvesting in succession	38.6
Intercropping- main crops planted with subsidiaries at low densities	61.8
Decreasing animal stock	31.8
Change from crop production to animal rearing	17.8
Change from animal production to crop production	21.2
Agro-forestry practice	34.2
Change from production to marketing of agricultural products	20.6
Prayers for God's intervention	88.2

Source: Field survey, 2010

From Table 4b, it is evident that the emerging adaptive measures being used by respondents include: planting of early maturing crops (87.2%), use of chemicals e.g. herbicides and pesticides (79.0%), increased use of fertilizers (78.6%), use of resistant varieties (78.4%), processing to minimize post harvest losses (61.4%), and afforestation i.e. planting of trees (60.4%).

These findings are in support of strategies put forward by First National Communication (2003) and Canada-Nigeria Climate Change Capacity Development project reports (2004). These reports emphasized the need for diversification to new plant species and varieties that would have higher resistance to anticipated temperature increase and reduced rainfall, adopting zero/minimum tillage and other appropriate technologies to reduce soil erosion and loss of organic nutrients, but increase soil moisture availability and reduce weed and pest infestation.

Table 4b: Emerging adaptive strategies used by farmers

Adaptive strategies	Yes %
Purchase/use of water for irrigation	27.8
Construction of drainage or dam within the farm/household	23.2
A forestations: planting of trees	60.4
Use of resistant varieties	78.4
Processing crops to minimize post-harvest losses	61.4
Increased used of fertilizers, seeds	78.6
Cultivation on marginal lands	50.6
Use of chemicals: herbicides, pesticides etc	79.0
Changing of crops formerly grown and replacing with new types	46.0
Total change from farming to other occupations	21.0
Planting of early maturing crops	87.2

Source: Field survey, 2010

4.5. Constraints to Climate Change Adaptation

According to the results in Table 5, the major constraints farmers face in adapting to climate change include the lack of financial resources (M=2.61), non-availability of credit facilities (M=2.50), high cost of irrigation facilities (M=2.45),

absence of government policy on adaptation (M=2.37), lack of access to weather forecasts (M=2.24), poor access to information source relevant to adaptation (M=2.21), poor/low extension services (M=2.14), limited access to improved crop varieties (M=2.09), lack of access to improved livestock breeds (M=2.30), non-availability of storage facilities (M=2.35), limited presence of adaptation measures (M=2.23), poor response to crises related to climate change by the government and interest groups (M=2.39), risk of adaptation (M=2.02), high cost of fertilizers and other inputs (M=2.54), non-availability of farm inputs (M=2.27), non-availability of processing facilities (M=2.42), inadequate knowledge of how to cope (M=2.12), high cost of farm labour (M=2.18), and non-availability of storage facilities (M=2.25).

It is a fact that climate change and measures of adaptation and mitigation are current global phenomenon which is covered in the news on a daily basis. This fact notwithstanding, farmers in northern Nigeria are being constrained to adaptation by mere factors as poor access to information source relevant to adaptation, poor/low extension services, inadequate knowledge on how to cope, poor response to crises related to climate change by the government and interest groups etc. Availability and accessibility to adequate and effective information on climate change and adaptation is one of the basic ways of adapting to the changing climate scenarios. Information will keep individuals abreast of current happenings and will also empower them to make the right decisions in case of climate upsurges or emergencies. This makes it imperative that relevant ministries e.g. Ministries of Agriculture, Environment, Agricultural Development Programmes (ADPs) and NGOs etc should rise up to the challenge and be at fore front of information dissemination on climate change and adaptation.

Table 5: Mean distribution of constraints to climate change adaptation

Constraint variables *	M	Standard Deviation
Poor access to information source relevant to adaptation	2.21*	0.74
Type of land tenure system practiced in my area	1.96	0.81
Ineffectiveness of indigenous strategies	1.97	0.76
Traditional beliefs/practices does not allow me use the adaptive strategies	1.58	0.73
Lack of financial resources	2.61*	0.55
Poor/low extension services	2.14*	0.69
Lack of access to weather forecasts	2.24*	0.71
Limited access to improve d crop varieties	2.09*	0.71
Lack of access to improved livestock breeds	2.15*	0.76
High cost of improved crop varieties	2.30*	0.75
Non-availability of storage facilities	2.35*	0.71
Absence of Government policy on adaptation	2.37*	0.68
Non-availabilit y of credit facilities	2.50*	0.63
Limited presence of adaptation measures	2.23*	0.68
Poor response to crises related to climate change by the government and interest groups	2.39*	0.63
Risk of adaptation	2.02*	0.76
High cost of fertilizers and other in puts	2.54*	0.59
High cost of irrigation facilities	2.45*	0.68
Non-availability of farm inputs	2.27*	0.65
Non-availability of processing facilities	2.42*	0.64
Inadequate knowledge of how to cope	2.12*	0.70
Non-availability of farm labour	1.87	0.75
High cost of farm labour	2.18*	0.78
Non-availability of storage facilities	2.25*	0.76

5. Summary & Conclusion

5.1 Summary

This research paper in summary reveals that the incidence of climate change is on the increase as highlighted by low rainfall, higher temperature, desertification and encroaching sand dunes, increased weed infestation and low crop yield etc. Adaptive measures (indigenous and emerging) being used by respondents in cushioning the effects of climate change included: changes in planting and harvesting dates, multiple cropping, use of wetland/river valley (fadama), use of resistant varieties, processing of farm produce and afforestation. The major constraints to adaptation were: poor access to information, poor/low extension services, lack of financial resources, absence of government policy on adaptation, and limited adaptation measures.

5.2 Conclusion

The extent of climate change incidence is on the increase in northern Nigeria. This was shown by the vagaries of climate conditions as reflected by uncertainties in onset of farming seasons, extremities of weather conditions and increase in farming problems. The study revealed that there are various problems associated with the changing climate. These problems ranged from loss of crops and revenue, loss of forest resources, poor crop yield and quality, increase in weed infestation, increase in pest attack and delay in planting time. It is also important to note that these problems result from the perceived causes of climate change. The respondents noted that human activities like bush burning, indiscriminate cutting of trees and overgrazing of farmland by livestock among others were the perceived causes of the changing climate.

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