



Climate Change and Adaptation Measures in Northern Nigeria: Empirical Situation and Policy Implications

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Table of Contents

Acknowledgement	4
Executive Summary	5
List of Acronyms	6
1. Introduction	7
2. Literature Review	12
3. Methodology	20
4. Results & Discussions	22
5. Conclusions & Recommendation	28
References	29

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Executive Summary

The major aim of this research project was to assess the incidence of climate change and indigenous innovative adaptive measures in northern Nigeria. The specific objectives of the study were to: examine the level of awareness of climate change impact in the area; examine the nature of climate change impact; identify the different practices that exacerbate the impact of climate change in the area; identify and describe the indigenous adaptation practices used by farmers in the area; determine the factors affecting the peoples' adoption of various adaptation strategies in the areas; identify the problems farmers face due to the effects of climate change; improve the capacity of young professionals and women in adapting to climate change; and enhance behavioural changes towards climate change adaptation measures by the individuals.

Data was drawn from both primary and secondary sources; using both qualitative and quantitative approaches. Multistage (random) sampling technique was used in selecting 500 respondents for the study. Simple descriptive statistics were used for data analysis.

Findings show that respondents were aware and knowledgeable on the issue of climate change; and sourced information mainly from mass media. The study shows that there was an increase in the incidence of climate change in the area as typified by low rainfall, higher temperature and desertification. The study further revealed that the perceived causes of climate change included: overgrazing of farmland by livestock, deforestation and bush burning. The findings also noted that key problems associated with the changing climate were: increase in cost of farm inputs, poor crop yields, and increase in pest and disease incidence and loss of forest resources. The adaptive measures being used by respondents were changes in planting and harvesting dates, afforestation, use/planting by wetland/fadama and use of resistant varieties. The major constraints respondents faced in their bid to adapt to the impact of climate change were: poor access to information, poor/low extension services and limited adaptation measures.

List of Acronyms

CTA	Technical Centre for Agriculture
ACP	African, Caribbean and Pacific
IPCC	International Panel on Climate Change
UNFCCC	United Nations Framework on Climate Change Committee
FAO	Food and Agriculture Organization
GHG	Green House Gas
CFC	Chlorofluorocarbon
F&D	Finance and Development
GDP	Gross Domestic Product
LEISA	Low External Input and Sustainable Agriculture
CEEPA	Center for Environmental Economics and Policy in Africa
DFID	UK Department for International Development
USDA	United States Department of Agriculture

1. Introduction

1.1 Background of the Study

Climate change is the greatest challenge facing man's existence on earth in this century. It is a process of global warming, in part attributable to the 'greenhouse gases' generated by human activity. The impacts of climate change are being felt by both developed and developing countries. These impacts are likely to be felt more by developing countries not necessarily because they are the highest contributors to climate variations but because they lack economic, social and political infrastructures to respond adequately to the effects of climate change. Climate change impacts are felt on agricultural production, health, biodiversity, social and economic conditions and affect people and the environment in general. Climate change is predicted to worsen the incidence of drought and desertification and millions of people will become refugees as a result.

The 2005 FAO Global Forest Resources Assessment showed that forest and woodland in sub Saharan Africa presently cover about 530 million ha, compared to 710 million ha in 1975. This ongoing degradation of natural resources is reducing the resilience of the agro-ecosystems to drought, further undermining the region's future capacity to cope with climate change (Anuforum, 2009). According to the World Health Organization (2004) skin eruptions, heat fatigue, heat cramps, heat syncope, heat exhaustion and heat stroke are classical heat related illnesses which are resultant from climate change variations.

According to Centre for Technical Agriculture (CTA) (2008) climate change has led to a reduction in livelihood options in many ACP countries. Migration within rural communities as a response to the impact of climate change on the productivity of local resources, have left many households without young and able bodied labour. De Chavez and Tauli-Corpus (2008) asserts that climate

change results to socio-economic impacts in loss of revenue, economic opportunities and the practice of traditional culture which are expected to increase the social and cultural pressures on indigenous people. The out migration of indigenous youths to seek for economic opportunities elsewhere because of climate change has further limited opportunities in their own communities; this could lead to erosions of indigenous economies and culture.

No part of Nigeria is safe from climate change. For instance, more than two thirds of the country is prone to desertification. States, such as Borno, Sokoto, Jigawa, Zamfara, Kebbi, Yobe, Kaduna, Kano, Bauchi, Adamawa, Niger and others are at risk. In the Sahel zone of northern Nigeria, the most pronounced climate change-related forms of land degradations are wind erosion and related sand dune formation, drought and desertification. In south-eastern Nigeria, sheet erosion which is the complete removal of arable land is a major threat to agriculture in the region. Apart from the effects on cropping pattern, climate change brings with it proliferation of pests and diseases; these can hinder storage when the need arises because of temperature increases. Diseases tend to spread to area where they were previously unable to thrive. A good example is the spread of tse tse fly to the drier regions of northern Nigeria from the southern part. This change also affect the agro-pastoral system as animals have to trek very long distances in search of green grass (De Chavez and Tauli-Corpus, 2008). These movements of the animals also contribute to spread of disease causing organisms and leads to conflict on available resources. The impacts of climate change is not limited to cropping and agro-pastoralism, it is being felt on fisheries and aquaculture.

1.2 Problem Statement

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 Sudan Sahel region of Nigeria has suffered decrease in rainfall in the range of 3-4 percent per decade since the beginning of the nineteenth century.

The Director-General, Nigerian Meteorological Agency highlights that analyses of rainfall data (1911 -2000) in three 30 year intervals - 1911-1940; 1941-1970; 1971-

2000 show that many more places are recording late onset of rains, early cessation of rain, shortened length of the rainy season and reduced annual amount of rain especially in the northern part of the country. He also observed more frequencies of drought, more persistent harmattan haze and increasing temperature trends (Mohammad, 2009).

The concern with climate change is heightened given the linkage of the agricultural sector to 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. Over 80% of Nigeria's population depends on rain-fed agriculture and fishing as their primary occupation leading to a high risk of food production system being adversely affected by the variability in timing and amount of rainfall, frequent outbreaks of crop pests and diseases and heat stress. Food shortages will increase and many farmers could lose their sources of livelihood due to climate change

Low levels of education and poorly developed communication and marketing infrastructures further complicates the task of developing location-specific responses that effectively address the impacts of climate change. The lack of reliable communication channels and delays in forecast dissemination has also contributed to increased vulnerability of communities in remote areas to climate related disasters. Poorly developed communication infrastructures are making complex the task of developing location specific responses that can effectively address the impacts of climate change. The role of information in moving forward the climate change agenda and communicating relevant information to the public is very crucial (CTA, 2008); if there should be appropriate utilization of the abundant knowledge and information on the effects of climate change on agricultural production systems and human survival. Although Nigeria has made some efforts to adapt and mitigate climate change risks, the efforts are still rudimentary especially when compared with the intending catastrophe. There is therefore need to identify and document the incidence of climate change and indigenous innovative adaptation measures used by rural dwellers, in the drier parts of Northern Nigeria, to cushion the effects of climate change on their livelihoods, especially as the area is prone to desertification.

1.3 Objectives of the Study

The specific objectives of the study are to:

- 1) examine the level of awareness of climate change impact in the area;
- 2) examine the nature of climate change impact in northern Nigeria;
- 3) identify the different practices that exacerbate the impact of climate change in the area;
- 4) identify and describe the indigenous adaptation practices used by farmers in the area;
- 5) identify the problems farmers face due to the effects of climate change;
- 6) determine the factors affecting the peoples' adoption of various adaptation strategies in the areas;
- 7) improve the capacity of young professionals and women in adapting to climate change and
- 8) enhance behavioural changes towards climate change adaptation measures by the individuals and institutions.

1.4 Significance of Study

The beginning of the mitigation and adaptation to climate change is the baseline sensitization of the populace. There is an urgent need for advocacy in the area of climate change, in order to enlighten the people on the dynamics of climate change; this cannot be done effectively without any evidence. We therefore need research in this area for evidence-based advocacy. It is these facts that this work wants to provide. It will therefore be very useful for local planning in order to develop early warning strategies for the people.

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 documenting scientifically what the existing situations in northern Nigerian agrarian communities are as regards the various indigenous innovative technologies and adaptation measures embarked upon to combat the negative effects of climate change. The need for such baseline information, especially relating to designing appropriate strategies for mitigating its effect on agriculture, cannot be overemphasized.

This work therefore, will go a long way to providing 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. It will also provide information about the nature and extent of desertification and climatic variations in the area. 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 Concepts, Causes and Impacts of Climate Change

2.1.1 Concepts of Climate Change

According to Intergovernmental Panel on Climate Change 4th Assessment Report (2007), between 75 and 250 million people in Africa may be exposed to increased water stress due to climate change by 2020 and this will adversely affect livelihoods in the region. The area suitable for agriculture, the length of growing seasons and yield potentials, are expected to decrease due to climate change. Yields from rain-fed agriculture in some countries could be reduced by up to 50%. Thus, climate change may have particularly serious consequences in the developing world, where some 800 million people are undernourished. According to World Bank (2008) 75% of the world's poor live in rural areas in developing countries and most depend on agricultural activities for their livelihoods.

According to Nenibarini (2007) climate refers to the long time (about 35 years) average weather conditions of a region including typical weather patterns, the frequency and intensity of storms, cold spells and hot weather. The climate is the manifestation of a highly complex system consisting of five interacting components: the atmosphere (air), the hydrosphere (water), cryosphere (frozen part of the earth), the land surface, and the biosphere (part of the earth where life exists) (De Chavez and Tauli-Corpus, 2008). Weather itself is the daily fluctuating state of the atmosphere around us, characterized by the temperature, wind, precipitation (rainfall), clouds and other weather elements. Climate change refers to a change in climate that is attributable directly or indirectly to human activities; it affects the atmospheric conditions of the earth thereby leading to global

warming. Climate change has the potential to affect all natural systems thereby becoming a threat to human development and survival socially, politically and economically.

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.

2.1.2 Causes of Climate Change

According to the summary of the Intergovernmental Panel on Climate Change (IPCC) 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. 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 buildup 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 vapor, 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 the greenhouse effect, but water vapor and CO₂ contribute 90% of the total GHG emissions. In terms of direct contribution of these greenhouse gases, CO₂ contributes 55%, methane 15%, CFCs 7%, CFC (11 and 12) 17%, and N₂O 6% (www.undp.org).

Carbon dioxide is produced when coal, oil, and natural gas (fossil fuels) are burnt to produce energy used for transportation, manufacturing, heating, cooling, electricity generation, and other applications. Fossil fuel currently accounts for 80 to 85% of carbon dioxide being added to the atmosphere. Clearing land for logging, ranching, and agriculture, also leads to carbon dioxide emissions. Land use changes are responsible for 15 to 20% of current carbon dioxide emissions (www.gcrio.org). Methane (natural gas) is the second most important of the greenhouse gases resulting from human activities (http://www.eoearth.org/article/Causes_of_climate_change). It is produced by

rice cultivation, cattle and sheep ranching, and by decaying material in landfills. Methane is also emitted during coal mining and oil drilling, and by leaky gas pipelines. Nitrous oxide is produced by various agricultural and industrial practices (<http://climate.jpl.nasa.gov/causes>). Chlorofluorocarbons (CFCs) have been used in refrigeration, air conditioning, and as solvents. Ozone in the lower part of the atmosphere is another important greenhouse gas resulting from industrial activities. It is created naturally and also by reactions in the atmosphere involving gases resulting from human activities, including nitrogen oxides from motor vehicles and power plants (www.gcrio.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).

2.1.3 Climate and Agriculture in Nigeria

Our climate is changing both naturally and due to human exploitation. There is already undeniable evidence that animals, birds and plants are being affected by climate change in both their distribution and behaviours. Unless greenhouse gas emissions are severely reduced, climate change could cause a quarter of land animal, bird life and plants to become extinct (<http://www.climateandweather.net/global-warming/effects-on-animal.htm>).

Nigeria is predominantly still an agricultural society despite her heavily dependence on oil industry for its budgetary revenues. Approximately 70 percent of the population engages in agricultural production at a subsistence level. Agriculture accounted for 41 percent of Nigeria's total gross domestic product (GDP) in 1999. This percentage represented a normal decrease of 24.7% from its contribution of 65.7% to the GDP in 1957. The decrease may continue because, as economic development occurs, the relative contribution of the agriculture sector to the economy usually declines.

However, Nigeria's wide range of climate variations allows it to produce a variety of food and cash crops. The major food crops include cassava, yam, corn, cocoyams, cowpeas, beans, sweet potatoes, millet, plantains, bananas, rice,

sorghum, and a variety of fruit and vegetable. The leading crops are cocoa, citrus; cotton groundnuts (pea nuts) palm oil, palm kernel, benniseed, and rubber (Encyclopedia of Nations, 2008). A significant portion of the agricultural sector in Nigeria involves cattle herding, fishing, poultry, and lumbering, which contributed more than 2% to GDP in the 1980s. In 1987, it was estimated, there were 12.2million pigs, 700,000 donkeys, 250,000 horses, and 18,000 camels, mostly in northern Nigeria, and owned mostly by rural dwellers rather than by commercial farms/companies. There are current estimates that the output of agricultural produce have fallen due to environmental degradation and water pollution as a result of changes in climate (Encyclopedia Nations, 2008).

2.1.4 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 are 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).

Temperature is an important determinant of the rate at which a plant progresses through various phonological stages towards maturity. According to International Fund for Agricultural Development (IFAD, 2009), increase in temperature increases plant tissues and thus reduces the digestibility and rate of degradation of plant species. However, this temperature generally hastens plant maturity, especially in crop species, shortening the growth stages during which pods, seed and grain can absorb photosynthetic products. Temperature determines the potential length of growing and grazing seasons and generally has as strong effect on timing of developmental processes and on rates of expansion of plant leaves. The effect of this development on plant biomass depends on whether the growth habit of plant is determinant (that is, it has a discrete life) cycle which ends when the grains is mature such as in cereals) or whether it is indeterminate (that is, it continues to grow and yield throughout the season, such as in grasses and root crops). In fact, temperature reduces the combined production of wheat, corn and barley – cereal grains that form the foundation of much of the world's diet by 40m metric tons per year (Lorraine, 2007).

In the Sahara region of Africa, high temperatures have led to a reduced length of growing season with detrimental effect on crops (IPCC, 2007), and both mean and extreme temperature that crops experience during the growing season will change in both temperate and tropical areas. Extreme temperatures are important because many crops have critical threshold both above and below which crops are damaged. Critical stages for high temperature injury includes: seedling emergence in most crops, silking and tasseling in corn, grain filling in wheat, and flowering in soya beans and also lead to heat stress for plants, increasing sterility and lowering overall productivity, increases evaporation from plants and soils and increasing water requirements while lowering water availability (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).

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 will be affected by changes to both the precipitation and seasonal annual evaporation respiration. Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability 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).

However, the concomitant increases of atmospheric carbon dioxide and ozone have been observed during the past century and are predicted to continue (USDA, 2007). As CO₂ levels change, optimal growth ranges for different species also change; species alter their competition dynamics and the composition of mixed grasslands changes. Proportion of browse in rangelands will increase in the features as a result of increased CO₂ levels (IFAD, 2009). Carbon dioxide, in addition to being a greenhouse gas, can also directly affect plant life because plants take up CO₂ during photosynthesis to produce sugar for growth.

The magnitude of the CO₂ fertilization effect varies tremendously among plant species and from variety to variety. Moreover, research carried out by the Ministry of Environment of the Federal Government of Nigeria (2003) showed that significant effect of climate change due to increased CO₂ would be reflected in the production of both C₃ crops (plant species with three carbon atoms in their biochemical sequence of reaction such as; cowpea, wheat, soya bean, rice, potatoes, cassava and yam) and C₄ crops (plant species with four carbon atom in their biochemical sequence of reaction such as: sorghum, sugar cane, millet and maize). Plant with C₃ photosynthetic pathway with exception of corn, can show productivity increase of 20 to 30% or more when grown at twice current CO₂ level and at optimal conditions with C₄ crops (USDA, 2007). Most plant growing in enhanced CO₂ exhibit increased rates of net photosynthesis, the higher photosynthesis rates are then manifested in higher leaf area, dry matter production and yield for many crops. Even increases in ozone concentrations reduced dry matter and grain production of all crops but it is likely that stress induced by exposure to ozone in all crops will be reduced by increased atmospheric carbon dioxide concentration (USDA, 2007) and higher CO₂ often improves water-use efficiency (that is the ration between crop biomass accumulation of yield and the amount of water used in evapo-transpiration), and reduces transpiration (water loss) per unit leaf area by causing partial closure of leaf stomata (the small openings on the leaf surface).

Additionally, the CO₂ fertilization effect cannot compensate for negative effect from other environmental stress. For example, multi-year field and greenhouse studies with potato and dry beans conducted at Ithaca, New York showed significant yield increase for both potatoes and beans at twice current CO₂ levels when day time maximum temperature were allowed to occasionally reach 95of

during time of pod formation, there was no yield benefit from higher CO₂ (Peet and Wolfe, 2000; Jifon and Wolfe, 2005).

2.1.5 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 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 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).

2.1.6 Adaptation Measures to Climate Change

1. Pastoralists adapt to climate extremes by making use of emergency fodder, culling of weak livestock for food, and multi-species composition of herds to survive climate extremes. They also try to move from the dry northern areas to the wetter southern areas during drought season in order to survive and sustain their domestic animals.
2. Women plant crops that are more resistant to droughts and pests, providing a reserve for extended periods of economic hardships. They also select and save seeds for planting each year. They preserve a variety of seeds that will ensure resistance to the range of conditions that may arise in any given growing season.
3. Other indigenous strategies include controlled bush clearing; using tall grasses for fixing soil surface nutrients which have been washed away by runoff; erosion-control to reduce the effects of runoff; restoring lands by using green manure; constructing stone dikes; managing low-lying lands and protecting river banks (IPCC, 2007).

3 Methodology

3.1 Population and sample

Multistage random sampling technique was used to select the respondents for this study.

- > In the first stage, four states were selected for the study, one from each of the ecological zones.
- > The states were: Adamawa, Borno, Kaduna and Kogi. In the second stage, a single local government area was randomly selected from each of the senatorial zone of each state (there are three senatorial zones in each of the states). 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.

3.2. Data collection technique

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.

3.3. Measurement of variables

The interview schedule divided into eight sections (A-G). However, only sections

B, E and F were used for the purpose of this working paper. Section B determined rural households' level of climate change awareness. Respondents' were asked to tick against a response option of “Yes” or “No” to indicate their awareness on climate change.

Section E elicited indigenous and emerging adaptation measures adopted by the farmers to mitigate the negative effects of climate change in their communities. Here, the respondents' were required to tick on the response options of “used” or “not used” to listed adaptation measures provided.

Section F sought information on factors affecting the adoption of climate change adaptation strategies. Respondents' were required to tick against a response option of a three point Likert – type scale of “Very Serious” (3); “Serious” (2) and “Not Serious” (1). Factors with mean scores greater or equal to 2.0 were regarded more serious, while factors lower than 2.0 were regarded as not serious.

3.4. Data analysis

Data analysis was performed using simple descriptive statistics, including analysis of means, percentages, standard deviation and frequencies. The results were presented in form of charts, graphs and tables.

4. Results & Discussion

4.1. Respondents' Knowledge and Awareness of Climate Change

Results shows that about 84% of the respondents were aware of climate change, and 79% also affirmed that they had knowledge of the changing climate (Figure 1.). This knowledge can be deduced from observation. About 81% of respondents also noted that they had in various times experienced the incidence of climate change. The respondents (80.2%) noted that they receive information on climate change. This implies that the respondents were aware and knowledgeable on the issues of climate change. This awareness is a necessary step in adapting to the changing climate.

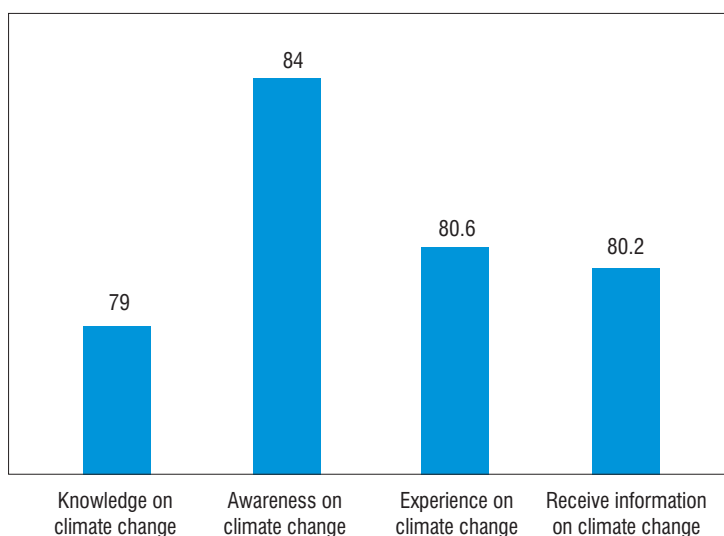


Figure 1: Knowledge and awareness on climate change

4.2 Sources of Information on Climate Change

The respondents sourced information on climate change majorly from radio programmes (81.0%), relations/friends/other farmers (61.8%), and television programmes (53.6%). Other sources include: newspaper (42.0%), group meetings (40.2%), extension agent (39.6%), Ministry of Agriculture (33.8%), Ministry of Environment (32.4%), magazines (30.2%), extension bulletin and handbills (20.2%), internet (18.0%), posters (13.4%) and video shows (11.8%) (Table 1).

These findings reveal that the mass media especially radio and televisions were the major avenues through which the respondents sourced information on climate change from. These findings concur with Isife and Ofuoku (2008), who documented that radio, has the highest audience and has the strength of reaching a large population of farmers and other rural dwellers faster than other means of communication. They also noted that television provides farmers with the opportunity of seeing and hearing in the process of learning new ideas. The implication of this finding is that there is need for extension services to rise up to the challenge of information dissemination, (especially as regards the issues of climate change), as this is the central focus of its services.

Table 1: Percentage distribution on sources of information on climate change

Sources of information	Yes %
Radio programmes	81.0
Television programmes	53.6
Internet	18.0
Video shows	11.8
Magazines	30.2
Posters	13.4
Newspapers	42.0
Group meetings	40.2
Extension agent	39.6
Relations/friends/other farmers	61.8
Agricultural books	24.2
Extension bulletin/handbills	20.2
Ministry of Agriculture	33.8
Ministry of Environment	32.4

Source: Field survey, 2010

4.3. Adaptive Strategies Adopted by Respondents

Table 2a 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 2a: 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

Table 2b shows the emerging adaptive measures being used by respondents, which 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 through tree planting (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 2b: Percentage distribution of 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

4.4. Constraints to Climate Change Adaptation

Table 3 shows that the major constraints farmers face in adapting to climate change, which include 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 on news every day. Access to relevant information, the skills required to apply that information into local practices, the availability of traditional knowledge and experience, the perception of risk, the sense of social identity and the existence of social networks and institutions that can either advise, enable or constrain actions, are just some of the factors that play a role in adaptive decision-making processes. 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) (which represents the public extension service in Nigeria) and NGOs etc should rise up to the challenge and be at the fore front of information dissemination on climate change and adaptation.

Table 3: 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 improved 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-availability 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 inputs	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 Conclusion & Recommendations

Conclusion and Policy implications

The study reviewed the state of climate change and adaptation measures in Northern Nigeria, assessing the empirical situation and policy implications. It was gathered that farmers were aware of the changing climate mainly from radio and television programmes despite the fact that many NGOs and civil organizations have been at the fore front to the create awareness about climate change countrywide. These efforts as needful as they have been have not targeted the rural/farming populations in northern Nigeria. This goes to show that farmers in northern Nigeria have been side lined in the design and debate of climate change programme.

It is evident that farmers had high awareness level on climate change and have been adapting to the changing climate from time immemorial as climate change had long existed before the concept was popularized. This they have done mainly using indigenous approaches. A challenge that this poses to researchers, policy makers and NGOs is the quest for more innovative ways or measures of adaptation to climate change that will boost food security in the country.

Also, evident from the findings are constraints experienced by farmers in adapting to the changing climate. These constraints are a threat to their main source of livelihood. There is an urgent need for government and relevant bodies to bring aids to farmers. These aids should be in the form policy formulation and the strengthening of research institutions in their bid to discover more innovative adaptation measures that are adaptable to the environment. This will minimize the observed constraints farmers in northern Nigeria experience in adapting to the negative consequences of climate change.

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