

Est.
1841

YORK
ST JOHN
UNIVERSITY

Terdoo, Fanen and Adekola, Olalekan
ORCID logo ORCID: <https://orcid.org/0000-0001-9747-0583> (2014)
Perceptions, Knowledge, Adaptation and Socio-Economic Cost of
Climate Change in Northern Nigeria. *Journal of Agricultural
Science*, 6 (8). pp. 60-71.

Downloaded from: <https://ray.yorks.ac.uk/id/eprint/4110/>

The version presented here may differ from the published version or version of record. If
you intend to cite from the work you are advised to consult the publisher's version:

<http://www.ccsenet.org/journal/index.php/jas/article/view/38551>

Research at York St John (RaY) is an institutional repository. It supports the principles of
open access by making the research outputs of the University available in digital form.
Copyright of the items stored in RaY reside with the authors and/or other copyright
owners. Users may access full text items free of charge, and may download a copy for
private study or non-commercial research. For further reuse terms, see licence terms
governing individual outputs. [Institutional Repository Policy Statement](#)

RaY

Research at the University of York St John

For more information please contact RaY at ray@yorks.ac.uk

Perceptions, Knowledge, Adaptation and Socio-Economic Cost of Climate Change in Northern Nigeria

Fanen Terdoo¹ & Olalekan Adekola²

¹ Department of Geography and Regional Planning, Federal University Dutsin-Ma, Katsina State, Nigeria

² Department of Geography, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria

Correspondence: Fanen Terdoo, Department of Geography and Regional Planning, Federal University Dutsin-Ma P.M.B. 5001, Dutsin-Ma, Katsina State, Nigeria. Tel: 234-805-328-8794. E-mail: fterdoo@fudutsinma.edu.ng

Received: February 19, 2014 Accepted: March 25, 2014 Online Published: July 15, 2014

doi:10.5539/jas.v6n8p60

URL: <http://dx.doi.org/10.5539/jas.v6n8p60>

Abstract

The objective of this paper is to assess the perceptions and determine the ability of farmers in rural Northern Nigeria to explain climate change, and to ascertain the socio-economic cost of climate change to them. The study also sought to understand how farmers have adapted to climate change and assess barriers to adaptation. The study is based on a survey of farmers in two rural communities in Northern Nigeria. The results reveal that the people generally associate climate change with changes in temperature, precipitation and vegetation. A significant number of farmers believe that temperature is increasing and that precipitation is declining. Those with the greatest experience of farming were more likely to notice climate change and have detailed explanation for its occurrence. The results also showed that there were important differences in the propensity of farmers of different age groups to adapt and there may be institutional impediments to adaptation. Although experienced farmers were more likely to perceive climate change, it is the younger farmers who were more likely to respond by making at least one adaptation, while the older ones often fell on safety nets of their social networks for survival. Although, large numbers of farmers perceive no barriers to adaptation, those that do perceive them tend to cite their age, lack of credit facilities, high level of illiteracy, high incidences of theft, soil erosion, large family sizes, lack of farm inputs and poor access to markets for their produce. About a fifth of the respondent although perceive climate change but are unable/fail to respond. This category may require particular incentives or assistance to do what is ultimately in their own best interests. While it is important to encourage improved farmer education, this alone is not adequate to enhance farmers' adaptation to climate change. There is room for better adaptation if government intensify activities of extension workers and encourage planting of different varieties of the same crop which the farmers are used to cultivating, enhance weather forecasting potentials and make such information available to farmers to enable them adapt to changing planting dates. There is also need to integrate adaptation strategies to fit the peculiarities of the culture and customs of the societies concerned.

Keywords: Temperature, precipitation, vegetation, desertification, adaptation, climate change, Nigeria

1. Introduction

It is suggested that public knowledge of, perceptions and impacts of climate change are critical components within which climate change adaptations and mitigation should operate (Lorenzoni & Pidgeon, 2006; Fernandez-Gimenez, 2000). This is important because a person's behaviour can be strongly influenced by their knowledge and perception (Ferguson & Bargh, 2004). The implication is that if a person has weak knowledge of an issue such as climate change he or she may behave in a manner that encourages climate change. Likewise, if he/she has a poor perception of climate change he/she may behave in a carefree attitude towards issues of climate change.

It is on record that people in many parts of Sub Saharan Africa, one of the regions facing impacts of climate change, (Schlenker & Lobell, 2010) are illiterate and lack western style education. This may affect their perceptions and behaviour towards issues of climate change. However, on the other hand many people of Africa rely on their traditional institutions are highly knowledgeable of happenings and changes in their environment. Knowledge is even much more important in African society where many farmers who are often accused of clearing vegetation are the least educated. In the context of African rural communities, knowledge and perceptions of climate change are critical for at least three reasons. Firstly, the majority of the people (mostly

farmers) who engage in forest clearing are uneducated, at least in the western style. Their activities (agriculture) is a major cause of deforestation. Agriculture is currently the world's main cause of climate change, alone accounting for nearly 25% of global emissions (Hickman et al., 2011). Secondly, most of these same people fingered as the cause are the most vulnerable and are often too poor to adapt, a situation which may further be detrimental to their livelihoods. Thirdly, many African governments have approached climate change in a manner that suggest that the local people are very knowledgeable and have a positive perception of climate change issues. For instance, the Nigerian government has launched many federal programmes aimed at controlling climate change at local level. Most of these policies emphasises the need for the populace to act, as though they have a good grasp of the issues at stake. An example is the popular tree planting campaigns (Chokor, 1993), where locals are encouraged to plant trees. Even if the trees are planted during official launch, they soon die off as the local people who are expected to tend them do not know why they should spend their time on trees. This led to the failure of tree planting campaigns in Nigeria. Furthermore, in 2001 the Nigerian government emphasised its commitment to reduce climate change from agriculture by encouraging farmers to change their farming practices such as bush fallowing which encourages land clearing and encroachment into marginal lands (Enete & Amusa, 2010). However in all these policies little or no attention is paid to the knowledge of the farmers concerned. Clearly, the knowledge and perception of the population of rural Nigeria who are mainly farmers will play a critical role, both in terms of their farming activities/practices, their direct consumption of fossil fuels and resulting greenhouse gas emissions.

Despite the importance of incorporating knowledge and perception of rural farmers in climate change management in developing societies, there are only a few studies assessing people's knowledge and their perception of climate change in Nigeria. Even the few studies focus on western part of the country (Apata et al., 2009) and where there are studies from the north, it is often too general (Ishaya & Abaje, 2008; Nyong et al., 2007). There is need to understand these issues at local community level in this highly climate change prone northern Nigeria. This is a region recognised as not only vulnerable but also a region contributing to climate change. The lack of such local based study has made it impossible to downscale existing regional studies which often lack local context. This paper seek to provide insight into these issues of public perception and knowledge of climate change and assess people's adaptation strategies to the impacts of climate change in agrarian northern Nigeria community.

2. Method

2.1 Study Area

About 70% of Nigeria's land mass falls within the Northern Nigeria region. The study community is made up of two small farming settlements namely Dabawa and Garhi located in Dutsin-Ma Local Government Area of Katsina state, Nigeria (Figure 1). The area extends between latitudes 12°27'18" and 12°27' north of the equator and longitude 07°29' and 07°30' east of the Greenwich meridian. The population of Dutsin-Ma area is estimated to be 169, 671 (National Population Commission, 2007). The community comprise of Hausa and Fulani ethnic groups while Islam is the predominant religion. The vegetation of the region is predominantly of savannah type having only about three months of rainfall annually. According to Tukur et al. (2013) the climate of the area is semi arid classified as tropical wet and dry climate (AW) in the W. Koppens' scheme with maximum day temperature OF up to 38 °C in the months of March, April and May and with minimum temperature of about 22 °C in December and January. Agriculture often combined with petty trading is the main economic activity in which virtually every household participate. Crop production and animal rearing are practised in combination by farmers in the community. There is few household engaged in traditional fishing from the Zobe Dam which is close to the community.



Figure 1. Map of Katsina State Showing the Location of Dutsin-Ma

2.2 Sampling and Data Collection Procedure

Data were collected using a combination of approaches that include questionnaire survey, informant interviews and field observation. Potentially, all farming households in Dutsin-Ma fall into the sample frame for this study. It was not possible to get a list of all farming household, hence we decided to interview the farmers on their farmland. Therefore, the interviews and questionnaires were administered early in the morning (before 10 am) and later in the evening (between 5 pm and 7 pm) when the farmers are on the farm. The questionnaire was administered to randomly chosen respondents; it was strongly aimed to be administered *face to face* by the researcher to the head of households in the presence of household members. Major advantage of the face-to-face method in this study was that it allows elicitation of more data, which might be respondent specific and was omitted in the questionnaire design; high response rate and ability of the researcher to make side notes while interview is conducted, however it was time consuming, thus limiting number of households that can be sampled. Farmers were selected for the study using a systematic random sampling technique whereby farms were selected after every n^{th} (3^{rd}) farmland. In a situation whereby the owner of the n^{th} farm is not willing to participate in the study, it was left out and the next willing farmer will be selected. In total 49 farming households were interviewed directly (face-to-face) between March and June 2013. The questionnaire was structured into three

sections: the first section captured demographic and socio-economic characteristics of respondents; the second dealt with respondent's knowledge and perception of climate change; and the third section asked detailed information on climate change impact and their economic implications. The questionnaires were administered to head of households and when possible done in the presence of other household members. These questionnaires were complemented by interviews with key informants and direct field observation.

As questionnaires were being administered in the field, data collected was inputted into an already prepared Microsoft Excel file developed at the beginning of the questionnaire interview. These were then then summarized using descriptive statistics such as percentage and means. Results of these analyses are presented in tables and graphs. The interviews which were recorded were then transcribed using the slow function on an auto player. The transcripts were then coded and analysed.

3. Results

3.1 Profile of Respondents

All the respondents were male. This was due mainly to the *Pudah* system being practised by the dominant Islamic religion in the study area. This is a situation whereby women are not allowed to be seen in public nor act as the head of households. The finding that majority (92%) of the farmers are married explains the high average household size of ten person per household. In many part of Nigeria, large households are considered blessed in terms of labour force, however large household could also find it challenging to adapt and cope with impacts of climate change. Especially, where adopted strategy does not provide adequate cash income to support the large household. The monthly average household income in the area is estimated at ₦20,000 (\$120). This suggests that most of the household in the area are poor and live well below the popular poverty threshold of a dollar per person per day. The respondents has an average age of 43 with over 65% without any formal education.

3.2 Farmers' Knowledge and Perceptions About Climate Change

The results of this study carried out in the Savannah region of Nigeria to assess farmers' knowledge and perception about climate change show that all of the respondents are aware of climate change. However, less than 10% are aware of some of the scientific controversies surrounding climate change debate. Most of the respondents (96%) have heard about climate change and are aware of its occurrence and impacts in their community. About 44% of these have heard of climate change for the first time through word of mouth from relatives, friends, government officials and officials of non-governmental organisations. A further 31% heard of climate change for the first time on radio while 26% heard about climate change for the first time on television. The people generally associated climate change with temperature and precipitation. More than half of the respondents associate climate change with vegetation change; however none of the respondents associated climate change with wind pattern. The statement by one of the respondents captures the general feeling of respondents.

“in this place [community] one can never predict rainfall and temperature conditions anymore ... there is change every time for the last few years ... the temperature has been increasing with increasing period of dry season, but last year was different ... the rain was so much that all our farmlands and houses were washed away ... now even to get firewood is a problem”.

There is a general consensus among respondents that temperatures have increased over the years. About 85% of respondents associated climate change with rising temperature and/or longer dry seasons. Respondents were further asked to describe the nature of temperature. There was 87% of them who believed that dry season temperature was increasing, while 13% believed that dry season temperature had not changed. Rainy season temperature was perceived to have increased by 63% of respondents while about 22% of respondents believe there had been no change in rainy season temperature. The remaining 15% perceived rainy season temperature to be decreasing (Figure 2).

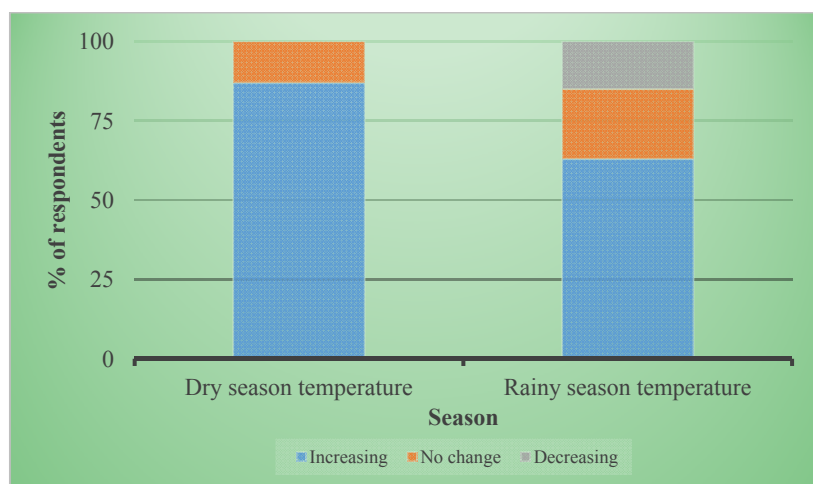


Figure 2. Respondents perception of changes in dry season and rainy season temperature

A similar set of indicators were used to capture respondent's perception of changes in precipitation. The result of this showed that majority of respondents (88%) perceived annual precipitation to be on the decrease. While only 5% believed annual precipitation is increasing. Also respondents believed the length of dry spells during rainy season had increased (Figure 3). The implication of this is that respondents had to wait longer periods between incidences of rainfall. Interestingly more respondents believed that rainfall intensity had increased when it rained. Incidences of flooding were also reported to have increased. According to one of the respondents "the type of rain we had this year is such that we have never experienced before

"... government just fold their arms until all our farm lands and crops were completely washed away ... Some of us even our animals that could have been our last hope died...some of our buildings were destroyed ... the increased rainfall intensity (flooding) has made life much more difficult for us than before...young people are leaving our community to cities every time to look for new opportunities."

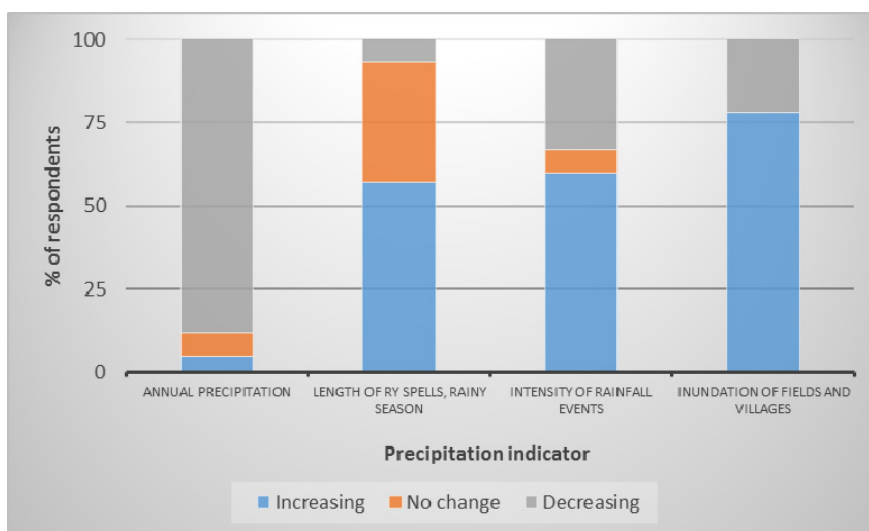


Figure 3. Respondents perception of changes in precipitation

It was interesting to find that most of the older farmers were better able to explain the phenomenon of climate change in a more detailed manner. This may be unconnected with their years of experience and knowledge of previous climatic condition in the region. While the younger farmers emphasises the changes without giving much explanation the older ones often backed up their claims with evidences.

"... there are changes generally in the way we are experiencing rainfall and heat season in our village these days, things doesn't use to be like this before ... I believed these changes have natural causes"

However, on the other hand the older ones appeared to be more sceptical about the relationship between the changes they have experienced and climate change as they believed the changes were due to nature. Although, they often included in their discourse the idea that it was human induced.

“... for me I think the changes in rainfall and heat conditions we are experiencing recently in this community is further caused by the release of smoke into the atmosphere from bush burning, indiscriminate cutting of trees for both domestic and commercial uses and over-grazing of animals ...”

3.3 Impacts of and Adaptations to Climate Change

Generally, because of the agrarian nature of the communities, the impact of climate change has been mostly felt in the agriculture activities. Respondents complained of low yields as a result of poor irrigation of their farmlands resulting from unpredictable rainfall regimes and increased incidences of pests and crop diseases. Livestock farmers reported that the climate change and climate variability had led to decreased livestock weight and an increase in livestock death. These implied loss of farm income and a great strain on the major sources of livelihood for the majority of the rural population; hence, a general deterioration in their welfare.

Respondents also complained that as a result of changes in the climate regime of their community, the youths were losing interest in farming and migrating to nearby towns to serve as motor bike riders (popularly called Okada in Nigeria). An elderly respondent complained that his son had abandoned him and farming after he experienced poor yields for three years in a row and had moved to nearby urban centre to work as a motorcycle operators, a rather booming business in the region. The elderly man complained that many of them are not trained or experienced bike riders and jumped into the business. As a result many have even being injured or lost their lives. This will suggest that the effects of climate change can even lead indirectly to loss of lives. The ones that are too old to migrate stay behind and are unemployed as they might have lost their entire seedling to crop failure in previous years. This is a dimension through which climate change has caused massive unemployment and underemployment in these communities.

Some respondents also identified impact on water resources scarcity as most of the few ponds nearby were drying up. They have had to walk longer distances to reach alternative sources of water. The scarcity of water had been one source of conflict in this and many communities in northern Nigeria. Declining vegetation and loss of fauna were also mentioned as impacts of climate change. One respondent retorted “at least before we can still get one or two animals (popularly called bush meat in Nigeria) now we don’t even get any animal again”.

Because of these reasons farmers have adopted adaptation measures or coping mechanisms to dampen the adverse effects of climate change. The adaptation strategies and coping mechanisms adopted have led many of the farmers to move into marginal lands, digging of wells and spending more time on their activities. In addition many of the respondents have had to diversify their activities or taken up new ones entirely. Some others have changed their activity.

Some indicated their knowledge and readiness to switch to crops (such as maize and tomatoes) with reduced precipitation needs, however, they had lost so much they are often not able to fund purchase of new seedling. Also farmers have had to adjust to changing their planting period to coincide with onset and cessation of rainfall. The main challenge to this is that such information is not readily available and they have to rely on their indigenous knowledge which is often wrong.

In terms of economic cost, respondents were asked to estimate how much they have lost in the last year as a result of climate change. Respondents estimated it would have cost an average of about \$1,160 per farming season equating to about £2,320 per annum. This is a lot considering that most of these households live below the poverty line. The major reason for the loss is due to epileptic rainfall and outbreaks of pests and diseases in the area. Considering the fact that the central and local governments are not funding projects aimed at controlling pests, this figure will potentially increase in the future if nothing is done. In addition to loss, respondents have also had to spend about a third (£705) of what they have already lost in coping i.e. while acquiring new lands etc. This is why most of the people clamour for government support in terms of finance and extension service.

3.4 Perceived Barriers to Adaptation to Climate Change

With regard to barriers to adaptation, farmers were asked to identify the challenges they faced while adapting to the adverse impacts of climate change phenomena in the area. Accordingly, three sets of barriers, namely: social, environmental and economic were identified by the respondents (Table 1). These challenges synergistically undermined the efforts of the community members especially farmers to quickly adapt to climate change. This also increased their degree of susceptibility to the impacts of climate change in the area.

Table 1. Barriers to climate change adaptation

Social Barriers	Environmental Barriers	Economic Barriers
Old age	Soil erosion	Lack of credits facilities
High level of illiteracy	Soil infertility	Lack of farm inputs
High incidences of thefts	Water scarcity	Poor markets
Large family size	Flooding	High level of poverty
Unemployment	Outbreaks of diseases and pests	Limited access to Farm lands

In terms of social barriers, those identified by the respondents to limiting their efforts to adapt to climate change impacts in the area included: old age, high level of illiteracy, high incidences of theft cases, large family size and unemployment in that order. The older farmers were limited by physical strength (physical power to carry out farming activities such as tilling the soil, weeding, threshing, etc.) which is a function of age. This so because farming in northern Nigeria is still at subsistence level with little or no mechanisation. As a result, human labour is the major means of carrying out farming operations. Apart from old age, high level of illiteracy supported the prevalence of traditional farming methods and techniques among farmers. This also made adoption of new and modern farming techniques and technologies difficult in the area. High level of illiteracy also made the young people unemployable especially in the non-agrarian sectors in the area except for those requiring no education. Another barrier limiting farmers from adapting to climate change impacts as quickly as expected is the increase in the incidences of theft in the area. By way of getting fast income to support their pressing needs, some people in the area turned to social vices such as stealing of animals and farming produces. The situation seriously limited the ability of some farmers to cope with the impacts of climate change, seeing the time and cost of farming and rearing animals in the area which are stolen at the end by other people. Furthermore, respondents considered large family size as one of the barriers limiting their ability to adapt. As productivity of crops and animals keep reducing and fluctuating in the area as a result of climate change, supporting large families with little output or dwindling income is becoming difficult. In addition, large family size also limited the ability of farmers to easily diversify from farming to non-agrarian means of livelihood such as trading for a fear of not being able to produce food for their families. Lastly, respondents considered lack of existence of non-agrarian employment (public and private sector jobs) as another barrier hindering them from adapting to climate change in the area. However, this may be connected to rural nature of the area and not to high level of illiteracy experienced in the area.

Furthermore, environmental barriers limiting the ability of the respondents to adapt to adverse impacts of climate change in the study area were investigated as well. Farmers identified soil erosion as the major challenge confronting them. Next was poor soil infertility, water scarcity, flooding and outbreak of diseases and pests respectively (Table 1). Accordingly, both soil erosion and poor soil fertility were observed to reduce crop productivity area and consequently farmers' ability to continue to produce certain crops in the area. Water scarcity usually hindered continuous farming (even in dry season) in the area. Both crop farming and animal rearing was seasonal. Crop and animal farmers most times travelled long distances/and or migrated to coastal areas in search of wetlands (Fadama lands) to farm or feed their animals during dry season because of the increasing challenge of water scarcity. In contrast to the prevailing water scarcity in the area, farmers were frequently confronted with the challenge of flash floods which often resulted in high intensities of rainfall in the area. This has lead to inundation of farmlands and washing away of farm lands as well as destruction of crops and loss of animals. Lastly, frequent outbreaks of infectious diseases among livestock's and pests which resulted in high mortality rates of livestock and destruction of crops have limited the ability of farmers to adapt to climate change in the study area. This is due to loss of household capital which would have been useful in funding adaptation strategies.

Lastly, farmers were asked to mention the perceived economic barriers undermining their ability to easily adapt to climate change in the area. Interestingly, lack of credit facilities was the most mentioned. Lack of farm inputs was second. This was followed by poor markets in the third position, then high rates of poverty in the fourth and limited access to farm lands in the last position respectively. Lack of credit facilities for example, affected the entire effort of community members to easily adapt to climate change impacts as most of available adaptation strategies such use of improved seeds/genetically modified organisms (GMO), increasing farm size, purchase of farm inputs, digging of well, etc were often capital intensive which would ultimately depend on the degree to which farmers could freely access credits/soft loan facilities in the area. Lack of access to farm inputs such as

fertilizers, herbicides, insecticides, etc. also constituted a challenge to farmer's adaptation plan in the area. Usually, poor output and input commodity markets were observed to consistently limit farmers' ability to effectively adapt to climate change impacts. For example, after farmers have managed to produce amidst unfavourable environmental and inputs markets conditions, they ended up selling their produce at a give a way price because of lack of markets (patronage) for local products. Sometimes, farmers were left by the government to compete with subsidised imported products which were of better quality compared to the local products. The situation finally made farmers poor without adequate income to provide quality education for their family members and a decent living condition. High levels of poverty in the area were also identified to limit farmers' ability to cope with climate change impacts. Because of poverty, most people were incapacitated to do any meaningful work to earn a living. For they lack the capacity to continue once they were confronted with a major shock like crop failure or loss of livestock. Lastly, lack of access to farm lands is as well considered by the respondents to limit the ability of the people generally to cope with the impacts of climate change in the area. For instance, the event of flooding and washing away of farm land frequently being experienced in the area, most farmers no longer had access to farm lands easily as in the past. This situation limited their adapting capacity as well.

Respondents were asked how they responded to climate change and the results showed that a fifth of respondents rather waited on faith while others made efforts to adapt the raging scourge. Some of the steps taken included engaging in other activities such as riding motor bike during the dry season and in the evening when they did not need to be on the farm. Others have worked as labourers on constructions sites in nearby urban centres during dry seasons. While some lazy type took on begging as immediate means of survival. One important issues to note here is that these non-agrarian activities engaged by the respondents in the study area to adapt to impacts of climate change were highly associated with seasonal migration which is mostly undertaken by the young people (who have the physical strength for such jobs). However, the older and the serious minded ones in the area preferred to stay put and rather increase their acreage and use improved seeds/GMO to get more crop output. Some who sought for themselves additional sources of water engage in digging of well for irrigation purposes and household uses. While some borrowed money or took some loan to farm. Lastly, some engaged in petty trading apart from farming. This enabled them to diversify their means of livelihoods and spread the risks in an event of crop failures so that they had something to fall back on.

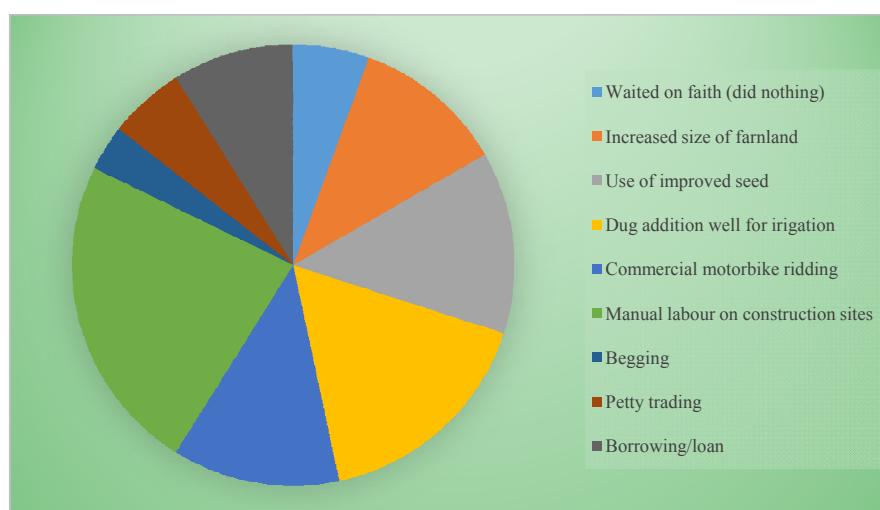


Figure 4. Adaptation measures taken by farmers in the area

Interestingly, all of those that had not taken any step to adapt were over 50 years is this age. This may not be unconnected with the fact that most of the available adaptation avenue involved youthful energy. It therefore becomes imperative to create avenue for the older ones to have alternative livelihood avenue. This is where the social networks have come into play in this society as they have relied on relatives for support.

Obviously old age has been one of the most mentioned barriers to adaptation (especially among the aged). In addition, the lack of credit facilities, high level of illiteracy, high incidences of thefts and poor markets were also been mentioned. Prevalence of such barriers in the study area were a reflection of institutional malfunctioning

and breakdown. Farmers' inability to access agricultural loan schemes was inhibited by a number of bureaucratic bottlenecks on the part of government and commercial banks in Nigeria generally. Some of the bottlenecks included: high lending interest rates which were sometimes above 20%, short repayment periods, and demand for quality assets such as houses and plots in urban centres for collateral which are beyond the reach of most farmers. High levels of illiteracy was fast growing among rural farmers in the area. This is because agricultural extension service department of the local government area no longer worked effectively. Therefore, the basic farming training and education for introduction of new seeds, farming techniques and technologies, etc. to farmers in the area were grossly lacking. Similarly, the collapse of market institutions at both local and state government level contributed to the prevailing poverty among farmers and hence their capacity to respond quickly and effectively to the adverse impacts of climate change in the area. For example, the output markets where farmers use to sell their produce before were then regulated at the local and state government. The situation was very beneficial to farmers because it saved farmers from the exploitative tendencies of the agents. It also helped farmers to sell at an appreciable profit margin. The same condition was applicable to input markets where prices of basic inputs such as fertilizer, herbicides and insecticides were all fixed and regulated at local and state government levels. The effects of collapse of both government and traditional institution in the study area as discussed has given rise to a desperation among some community members who have resulted in stealing in order to meet their basic needs. There is growing concern for a need to revitalise these institutions to enable farmers to effectively adapt to the growing impacts of climate change in the study area.

Although the community members made efforts to adapt to the impacts of climate change in the area (Figure 4), the efforts were influenced by socio-economic and biographical factors discussed above. For example, most of the farmers (especially the older ones) in the area were very pessimistic about adopting technologies, such as GMO and improved seedlings, though these technologies have capacity to boost their farm output. Instead, they often opted for increased acreage to boost output, even though more challenging and time consuming. This is because they felt this would be detrimental to their land and farming and may not suit their environment.

"... we are not very used to some of these new innovation you people are talking about like using improve seeds/GMO ... we do not even have the technological knowhow to use them ... Sometimes we feel they are the ones that absorb too much water in our farm lands and make the soil dry too fast as before ... we are just sceptical about it adopting them"

On the other hand, the younger ones are adapting faster by taking on other non-agrarian occupation such as serving as commercial motorbike drivers or even migrating to urban centres to work on construction sites. While the older ones who have spent most of their lives farming are finding it more difficult to adapt especially when it involves taking on new activities different from farming.

"... most young people in the community are no longer interested in farming due to frequent failure in crops and animals output resulting from climate change, time involved in farming and cost of buying inputs ... except for us older farmers who have taking farming as a way of life ..."

Another barrier impeding rapid uptake of adaptation options among the older members of the community in the area was social capital (networks) such as one farmer informing the other about negative aspects of an adaptation that happened at the end of farming seasons when the older farmers sit down to discuss and exchange farming experience. Also, because of high rates of illiteracy in the area, customs and traditions constituted serious barriers to adaptation in such an environment. The older people saw change as been against the culture of the land, even if it meant to bring improvement in the living standard of the people. This was eminent in the manner by which the adoption of modern technologies and farming techniques had been perceived by the community members.

"... Here in this community, we carried out our farming activities in the way that we were taught by our ancestors (using traditional farming methods and techniques) ... once in a time people do bring some new methods but we do not usually accept anything outside the ones we are used to ... due to the prevailing beliefs that at the end of the day they will not yield any good results ..."

4. Discussion

The results on the perceptions, knowledge, and adaptation to climate change of this study as presented above reveal a very high level (96%) of awareness of climate change occurrence and its impacts on the area. Thus indicated a rapid expansion in knowledge and understanding of the occurrences of climate change and its impacts on the rural livelihoods especially on smallholder farming among rural communities in northern Nigeria. This result is consistent with that of a study carried out to access farmers' perception of climate change and adaptation strategies in Sub-Saharan West Africa. In which the results revealed a similar high level (98%) of

awareness on farmers' perception of climate change in Sub-Saharan West Africa (comprising of five countries, namely: Benin, Burkina Faso, Ghana, Niger and Togo) (Akponikpè et al., 2010), 2% slightly above the one (96%) revealed by this study.

Furthermore, while there is a general consensus between the result of this study and the results of several other studies carried out to assess farmers' perceptions and adaptation to climate change in the Sub-Saharan Africa generally (Acquah-de Graft & Onumah, 2011; Deressa et al., 2008; Fosu-Mensah et al., 2010; Mandleni & Anim, 2011; Acquah-de Graft, 2011; Akponikpè et al., 2010); the results of some of the findings of studies on farmers' perceptions and adaptation to climate change phenomena partly agreed and differed with the findings of this study. For example, Acquah-de Graft (2011) finds that majority of farmers in Bawku Municipality district in the Upper Eastern Region of Ghana associated climate change with increase temperature (60%) and decrease in precipitation (49%). Similarly, Acquah-de Graft and Onumah (2011), finds that majority of the farmers in Shama, Western part of Ghana perceived climate change to be associated with increased temperatures (49%) and decrease in precipitation (37). Similarly, a study carried out in Sekyedumase district in Ghana shows that majority of farmers perceived climate change over the years to be associated with increased temperatures (92%) and a decrease in precipitation (87%) (Fosu-Mensah et al., 2010). In addition, the results of assessment of farmers' perception of climate change and adaptation strategies in Sub-Saharan West Africa carried out by Akponikpè et al. (2010) similarly indicated that the majority of farmers (Benin 71%, Burkina Faso 95%, Ghana 54%, and Niger 90%) in the region to have perceived a decrease in rainfall generally except for Togo where majority of farmers (43) perceived an increase in rainfall and at the same time perceived climate change to be associated with increase in temperatures (Benin 77%, Burkina Faso 79%, Ghana 70%, Niger 71% and Togo 57). In the Eastern Cape Province of South Africa, perception of cattle and sheep farmers on climate change and adaptation were assessed. The results indicated the majority farmers to have associated climate change with increase (85.70%) in temperature and drought (57%) (Mandleni & Anim, 2011).

The results of three studies carried out in Ghana (Acquah-de Graft & Onumah, 2011; Fosu-Mensah et al., 2010; Acquah-de Graft, 2011) and that of the two carried out in the Sub-Saharan West Africa and in the Eastern Cape Province of South Africa (Akponikpè et al., 2010; Mandleni & Anim, 2011) on farmers' perceptions and adaptation to climate change discussed above partly agreed with the findings of this study. The people generally perceived climate change to have been associated with increase temperature (85%) and decrease precipitation (88%). Consequently, the results of the last two studies carried in Sub-Saharan West Africa and in the Eastern Cape Province of South Africa (Akponikpè et al., 2010; Mandleni & Anim, 2011) on farmers' perceptions and adaptation to climate change also differ with this study. For example, in the case of Togo where majority farmers (43%) perceived climate change to be associated with increase in rainfall (Akponikpè et al., 2010) while majority farmers (57%) in the Eastern Cape Province of South Africa associated climate change with drought in addition to increase in temperature (Mandleni & Anim, 2011) respectively.

Conversely, the results of this study differ significantly with the results of all the studies on farmers' perception and adaptation to climate change phenomenon in the Sub-Saharan Africa discussed above, where farmers perceived climate change to be associated with a new important indicator-vegetation change which had not been identified by the previous studies. This is the contribution of this study to the existing studies on the subject matter.

This study underscored the importance of knowledge and perception and showed that most of the local farmers have some positive perception of and were rather knowledgeable about climate change. Unfortunately, most of the activities of government and non-governmental organisations in Nigeria have focused on educating farmers about climate change. Going by the result of this study, this is an aspect of little importance. The main area of need is helping farmers adapt to climate change. As such it is important relevant stakeholders to strategize and focus needed energy and zeal in adaptation strategy rather than merely educating the farmers to enhance their perception and knowledge.

5. Conclusion

Much has been said about the need to enhance rural farmers' capacity to adapt to climate change, especially across Africa. While most of rural African farmers are illiterate and often did not know the best way to respond to climate change, we found that they are very knowledgeable of its occurrence in their environment and were able to explain the phenomenon using local concepts and ideas. This underscored the need to often emphasise western knowledge and concepts when dealing with issues across rural Africa and rather give needed focus to local knowledge and concepts. This study underscored the importance of perception and showed that most of the people were rather knowledgeable, hence education may not be a critical need as often suggested. The crux is

how to enhance perception positively. Social factors, such as information sharing within and between networks is one factor identified as influencing people's perception and as such there is need to focus on social groupings. Unfortunately, this has not been the focus of many studies.

This paper further determined the economic cost and the link between socio-economic characteristics and adaptation, perception and knowledge. The high economic cost of climate change to poor rural farmer was relatively high and that dragged them further into the poverty trap. While many farmers have made attempts to respond to climate change, there are older ones who were not able to respond because of their age or some institutional impediments. These adaptations seemed geared to enhance livelihoods and provide more income for the household. However, this category of people has large safety net. There was significant amount of evidence showing that older people were more likely to be sceptical about the idea of climate change and this might be affecting their propensity to adapt.

The results of this study make it clear that at least while education is an important ingredient to enhance sustainable agriculture, it may not be the most important in such society. What is mostly needed is to provide means of adaptation and alternative sources of livelihoods for farmers caught in the web of climate change impact. Most importantly, there is need to have special programme targeting different age groups as the study found some disparity between the older farmers and the younger ones. There is need to create institutional structure that will enhance older farmers' access to social welfare. There is room for better adaptation if government enhance activities of extension workers and encourages planting different varieties of the same crop which the farmers are used to cultivating, enhance weather forecasting potentials and make such information available to farmers to enable them adapt their changing dates of planting. There is also need to integrate adaptation strategies to fit the peculiarities of the culture and customs of the societies concerned. Rather than focusing only on the farmers it might be important to also focus on the traditional authorities because of the institutional basis of many African societies such as this.

References

- Apata, T. G., Samuel, K., & Adeola, A. (2009). Analysis of climate change perception and adaptation among arable food crop farmers in South Western Nigeria. *Contributed paper prepared for presentation at the international association of agricultural economists' 2009 conference, Beijing, China, August 16.*
- Chokor, B. A. (1993). Government policy and environmental protection in the developing world: The example of Nigeria. *Environmental Management, 17*, 15-30. <http://dx.doi.org/10.1007/BF02393791>
- De-Graft Acquah, H., & Onumah, E. E. (2011). Farmers perception and adaptation to climate change: An estimation of willingness to pay. *Agris on-line Papers in Economics, 3*, 31-39.
- De-Graft Acquah, H. (2011). Farmers perception and adaptation to climate change: A willingness to pay analysis. *Journal of Sustainable Development in Africa, 13*(5), 150-161.
- Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yusuf, M. (2008). Analysis of the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile Basin of Ethiopia. *IFPRI Discussion Paper No. 798, Washington, DC: International Food Policy Research Institute.*
- Enete, A. A., & Amusa, T. A. (2010). Challenges of Agricultural Adaptation to Climate Change in Nigeria: a synthesis from the literature. *The Journal of Field Actions, 4.*
- Ferguson, M. J., & Bargh, J. A. (2004). How social perception can automatically influence behavior. *Trends in Cognitive Sciences, 8*, 33-39. <http://dx.doi.org/10.1016/j.tics.2003.11.004>
- Fernandez-Gimenez, M. E. (2000). The role of mongolian nomadic pastoralists' ecological knowledge in rangeland management. *Ecological Applications, 10*, 1318-1326. [http://dx.doi.org/10.1890/1051-0761\(2000\)010%5B1318:TROMNP%5D2.0.CO;2](http://dx.doi.org/10.1890/1051-0761(2000)010%5B1318:TROMNP%5D2.0.CO;2)
- Fosu-Mensah, B. Y., Vlek, P. L. G., & MacCarthy. (2012). Farmers' perception and adaptation to climate change: a case study of Sekyedumase district in Ghana. *Environ Dev Sustain, 14*, 495-505. <http://dx.doi.org/10.1007/s10668-012-9339-7>
- Hickman, J. E., Havlikova, M., Kroeze, C., & Palm, C. A. (2011). Current and future nitrous oxide emissions from African agriculture. *Current Opinion in Environmental Sustainability, 3*, 370-378. <http://dx.doi.org/10.1016/j.cosust.2011.08.001>
- Irenikatchè Akponikpè, P. B., Johnston, P., & Agbossou, E. K. (2010). *Farmers' perception of climate change and adaptation strategies in Sub-Saharan west-Africa.* 2nd International Conference: Climate, Sustainability and Development in Semi-arid Regions, August 16-20, 2010, Fortaleza-Ceará, Brazil.

- Ishaya, S., & Abaje, I. (2008). Indigenous people's perception on climate change and adaptation strategies in Jema'a local government area of Kaduna State, Nigeria. *Journal of Geography and Regional Planning, 1*, 138-143.
- Lorenzoni, I., & Pidgeon, N. F. (2006). Public views on climate change: European and USA perspectives. *Climatic Change, 77*, 73-95. <http://dx.doi.org/10.1007/s10584-006-9072-z>
- Mandleni, B., & Anim, F. D. K. (2011). Perceptions of cattle and sheep farmers on climate change and adaptation in the Eastern Cape Province of South Africa. *J. Hum. Ecol., 34*(2) 107-112.
- Nyong, A., Adesina, F., & Elasha, B. O. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change, 12*, 787-797. <http://dx.doi.org/10.1007/s11027-007-9099-0>
- Schlenker, W., & Lobell, D. B. (2010). Robust negative impacts of climate change on African agriculture. *Environmental Research Letters, 5*, 014010. <http://dx.doi.org/10.1088/1748-9326/5/1/014010>
- Tukur, R., Adamu, G. K., Abdulrashid, I., & Rabi'u, M. (2013). Indigenous trees inventory and their multipurpose uses in Dutsin-Ma area Katsina State. *European Scientific Journal, 9*(11), 288-300.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).