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Perceptions of Climate Change in Africa: Regional Agricultural Perspectives

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Abstract
Climate is the primary determinant of agricultural productivity. Poor livestock health, reduced crop yields and a range of other problems are attributed to climatic factors, especially wind. There were diverse and mixed views about the causes and indicators of climate change across and within communities in Africa, despite the evidence of a general awareness. It was observed that impacts of climate variability among African communities are highly differentiated according to land tenure, traditional beliefs, resource availability and gender. Despite this, indigenous and other traditional people are only rarely considered in academic, policy and public discourses on climate change.
Key Words: Perceptions, Climate Change, Regional, Agricultural, and Perspectives

1. 0 INTRODUCTION

1.1 *Background*

The most general definition of climate change is a change in the statistical properties of the climate system over periods of decades or longer, regardless of cause (Houghton, 2001). The term sometimes is used to refer specifically to climate change caused by human activity. For example, the United Nations Framework Convention on Climate Change (UNFCCC) 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 (UNFCCC, 1994). In the latter sense climate change is synonymous with global warming.

Climate change or global warming has become a new reality, with deleterious effects: seasonal cycles are disrupted, as are ecosystems; and agriculture, water needs and supply, and food production are all adversely affected. It also leads to sea-level rise with its attendant consequences, and includes fiercer weather, increased frequency and intensity of storms, floods, hurricanes, droughts, increased frequency of fires, poverty, malnutrition and series of health and socio-economic consequences. It has a cumulative effect on natural resources and the balance of nature (Houghton, 2001).
Climate change is an environmental, social and economic challenge on a global scale (Scholze *et al.,* 2006; Mendelsohn *et al*., 2006). Climate change can be exacerbated by human induced actions such as: the widespread use of land, the broad scale deforestation, the major technological and socioeconomic shifts with reduced reliance on organic fuel, and the accelerated uptake of fossil fuels (Millennium Ecosystem Assessment, 2005).
The most devastating adverse impacts of climate change in Africa includes frequent drought, increased environmental damage, increased infestation of crop by pests and diseases, depletion of household assets, increased rural urban migration, increased biodiversity loss, depletion of wildlife and other natural resource base, changes in the vegetation type, decline in forest resources, decline in soil conditions (soil moisture and nutrients), increased health risks and the spread of infectious diseases, changing livelihood systems, etc (Reilly, 1999; Abaje and Giwa, 2007)
Agriculture places heavy burden on the environment in the process of providing humanity with food and fiber. Climate is the primary determinant of agricultural productivity. Interest in this issue has motivated a substantial body of research on climate change and agriculture over the past decade (Lobell *et al.*, 2008; Fischer *et al.*, 2002). Climate change is expected to influence crop and livestock production, hydrologic balances, input supplies and other

components of agricultural systems. However, the nature of these biophysical effects and the human responses to them are complex and uncertain.

It is evident that climate change will have a strong impact on Africa, particularly in the areas of agriculture; land use, energy, biodiversity, health and water resources (IPCC 2007; NEST 2004). To approach the issue appropriately, one must take into account perceptions of climate change in Africa, since human response is critical to understanding and estimating the effects of climate change on production and food supply for ease of adaptation. Accounting for these adaptations and adjustments is necessary in order to estimate climate change mitigations and responses.

1.2 Problem Statement

Africa is generally acknowledged to be the continent most vulnerable to climate change. Recent research has focused on regional and national assessments of the potential effects of climate change on agriculture (Lobell, *et al.*, 2008; Hassan and Nhemachem, 2008; Fischer *et al.*, 2002). These efforts have, for the most part, treated each region or nation in isolation and do not integrate (i.e. combined biophysical and economic) assessment of the potential effects of climate change on proletariat agriculture but mostly focus on world agriculture (ODI, 2007).

Consequently, this study seeks to answer some of the following questions: what is the awareness and knowledge levels of farmers in Africa; how do African farmers perceive the causes and effect of climate change; what are the sources of climate change information by these farmers and are there strategies adopted by the farmers to cope with the changes in the climate? All these will be in a bid to present perceptions of climate change in Africa.

1.3 Objectives

Most research on people perception of climate changes were carried out in the developed countries of the world which dominate the uppermost northern region of the earth where the relationship between scientists and indigenous peoples is high (Jan and Anja, 2007). Though the hope in this devastating scenario of climate change lies with the indigenous peoples themselves, who are very successful at preventing deforestation and managing natural environment, those in the developing countries are rarely considered (Jan and Anja, 2007).

The objective of this study is to survey the perceptions of climate change in Africa in order to guide policy makers on ways to promote adaptation. Despite the fact that efforts have been made towards fighting climate change from scientific views, research and policies directed towards indigenous knowledge and perception are highly needed. It is, therefore, important to understand indigenous perceptions of climate change and their preferences of strategies towards adaptation.

The broad object of the study is to survey the perceptions of climate change in Africa and their coping strategies to the changes. Specific objectives of the study are to determine; (i) Awareness and knowledge of climate change among small-scale farmers in Africa; (ii) Identify their perception of the effects of climate change on them and their farming activities; (iii) Identify the farmers' coping strategies for the changes in the climate and (iv) Ascertain possible sources of information on climate change by the farmers.

2.0 Review of Perception of Adaptation to Climate Change

The 2007 IPCC Third Assessment Report concluded that the poorest countries would be hardest hit, with reductions in crop yields in most tropical and sub-tropical regions due to decreased water availability, and new or changed insect pest incidence. In Africa and Latin America many rain-fed crops are near their maximum temperature tolerance, so that yields are likely to fall sharply for even small climate changes; falls in agricultural productivity of up to 30% over the 21st century are projected. Marine life and the fishing industry will also be severely affected in some places (IPCC, 2007).

Climate change induced by increasing greenhouse gases is likely to affect crops differently from region to region. For example, average crop yield is expected to drop down to 50% in Pakistan according to the UKMO scenario whereas corn production in Europe is expected to grow up to 25% in optimum hydrologic conditions. More favorable effects on yield tend to depend to a large extent on realization of the potentially beneficial effects of carbon dioxide on crop growth and increase of efficiency in water use. Decrease in potential yields is likely to be caused by shortening of the

growing period, decrease in water availability and poor vernalization. In the long run, climatic change could affect agriculture in several ways (IPCC, 2007):
productivity, in terms of quantity and quality of crops, agricultural practices, through changes of water use (irrigation) and agricultural inputs such as herbicides, insecticides and fertilizers, environmental effects, in particular in relation of frequency and intensity of soil drainage (leading to nitrogen leaching), soil erosion, reduction of crop diversity, rural space, through the loss and gain of cultivated lands, land speculation, land renunciation, and hydraulic amenities, adaptation, organisms may become more or less competitive, as well as humans may develop urgency to develop more competitive organisms, such as flood resistant or salt resistant varieties of rice.

Crops such as these sunflowers can be affected by severe drought conditions in Australia (SICRR, 1994). Between 1996 and 2003, grain production has stabilized slightly over 1800 millions of tons. In 2000, 2001, 2002 and 2003, grain stocks have been dropping, resulting in a global grain harvest that was short of consumption by 93 millions of tons in 2003 (NASA, 2003).

The Earth's average temperature has been rising since the late 1970s, with nine of the 10 warmest years on record occurring since 1995. In 2002, India and the United State suffered sharp harvest reductions because of record temperatures and drought. In 2003 Europe suffered very low rainfall throughout spring and summer, and a record level of heat damaged most crops from the United Kingdom and France in the Western Europe through Ukraine in the East. Bread prices have been rising in several countries in the region (NASA, 2003).

Local people's perception of climate change, its impact and adaptation practices in Norway, revealed that, more than 80 percent have perceived increased temperature and expressed low amount snowfall in High mountain and rainfall in Mid mountain and Terai region over the last five years. Low amount of snow fall in the Himalayan region affected the Nomad groups due to low grass available to feed their livestock (Krishna *et al.,* 2010).
Adaptation measures such as use of water source, community forest management, planting trees and grasses in the farm land, crop diversification were practiced by local people in their farm land as well as communal land. Natural resource degradation, poverty are already severe problems in this region, and there will be more severe problems in future if present scenario continues, particularly because small farmers do not have adequate resources to adopt to cope with climate change impact. Furthermore, no any policies and programs have been formulated for adaptation strategy in this region. It is suggested that policy and program should formulate holistic approach and develop low cost technology for adaption to climate change impact and improve livelihood of the local communities (Krishna *et al.,* 2010).
Indigenous People who are vital and active part of many ecosystems may help to enhance the resilience of these ecosystems. Their livelihoods depend on natural resources that are directly affected by climate change, and they often inhabit economically and politically marginal areas in diverse, but fragile ecosystems. In addition, they interpret and react to climate change impacts in creative ways, drawing on traditional knowledge as well as new technologies to find solutions, which may help society at large to cope with the impending changes.

Africa's geography makes it particularly vulnerable to climate change and seventy per cent of the population relies on rain-fed agriculture for their livelihoods. The literature for this study can be reviewed under the following headings:

2.1 East Africa

A study to analyze determinants of farm-level climate adaptation measures in Africa using a multinomial choice model fitted to data from a cross-sectional survey of over 8000 farms from 11 African countries, indicate that specialized crop cultivation (mono-cropping) is the agricultural practice most vulnerable to climate change in Africa. Warming, especially in summer, poses the highest risk. It encourages irrigation, multiple cropping and integration of livestock. Increased precipitation reduces the probability of irrigation and will benefit most African farms, especially in drier areas. Better access to markets, extension and credit services, technology and farm assets (labor, land and capital) are critical for helping African farmers adapt to climate change (Rashid and Charles, 2008).

An analysis of perception and adaptation to climate change in the Nile basin of Ethiopia revealed that age of the household head; wealth, information on climate change, social capital and agro ecological settings have significant impact on the perception of farmers to climate change. Moreover, the analysis of factors affecting adaptation to climate change indicates that education of the head of the household, household size, gender of the head of the household being male, livestock ownership and extension on crop and livestock production, availability of credit and temperature have positive and significant impact on adaptation to climate change. Additionally, the main barriers to adaptation identified include lack of information on adaptation methods and financial constraints to using the methods (Temesgen, 2008).

Tanzania's official report on climate change suggests that the areas that usually get two rainfalls in the year will probably get more and those that get only one rainy season will get far less. The net result is expected to be that 33% less maize—the country's staple crop—will be grown (Peter *et al*., 1999). An increase in the frequency of seasonal floods has led participating farmers in Tanzania to demand technical and institutional support so that they can begin producing rice. In dry years, a major source of vulnerability is the increase in transmission of cattle diseases due to the congregation of large numbers of cattle at water holes (Paul *et al*., 2008).

2.2 Southern Africa

Climate change phenomenon affects agriculture in a number of ways. For example, uncertainties in the onset of the farming season, due to changes in rainfall characteristics (early rains may not be sustained, and crops planted at their instance may become smothered by heat waves) can lead to an unusual sequence of crop planting and replanting which may result in food shortages due to harvest failure. Extreme weather events such as thunderstorms, heavy winds, and floods, devastate farmlands and can lead to crop failure. Pests and crop and diseases migrate in response to Climate Changes and variations (e.g. the tsetse fly has extended its range northward) and will potentially pose a threat to Agricultural activities in Africa.

A study published in science suggest that, due to climate change, "southern Africa could lose more than 30 percent of its main crop, maize, by 2030 and in South Asia, losses of many regional staples such as rice, millet and maize could top 10%" (Forest *et al*., 1999). In parts of central Mozambique, tradition does not allow for farmers to grow pearl millet (due to bird problems), despite its apparent superiority over maize in terms of drought tolerance. Selection and testing of drought-tolerant maize varieties was one of the key priorities to emerge, together with education of farmers and local leaders on the need for alternative crop types such as sorghum and millets. Farmers in Zimbabwe previously in maize-dominated high rainfall zones have begun experimenting with sorghum, millet and drought-tolerant maize. Early planting was identified as a major adaptive strategy, but some farmers, notably women-headed households, cannot meet this challenge due to other demands on their labour (Paul *et al*., 2008).

These adaptation strategies must not be used in isolation. For instance, the use of early maturing crop varieties must be accompanied by other crop management practices such as crop rotations or the use of cover crops. This, however, requires additional institutional support, such as credit, access to both input and output markets and information. This will enable farmers to increase and sustain their productivity and production in the wake of changing climatic conditions. Migrant farmers are more vulnerable to the adverse effects of climate change than native farmers, because the majority of them do not have secure access to land. Their adaptive capacity is also low, due to low levels of human, financial, institutional and technical capabilities as well as limited access to markets.

A research on farmers' perceptions and adaptations to climate change and variability in South Africa indicated that, indeed, the analysis of farmers' perceptions of climate change is in line with the climatic data records. However, only approximately half of the farmers have adjusted their farming practices to account for the impacts of climate change. Lack of access to credit was cited by respondents as the main factor inhibiting adaptation. The results highlighted that household size, farming experience, wealth, and access to credit, access to water, tenure rights, off-farm activities, and access to extension are the main factors that enhance adaptive capacity (Gbetibouo, 2009).

2.3 West Africa

West Africa is one of the most vulnerable to the vagaries of the climate, as the scope of the impacts of climate variability over the last three or four decades has shown (IPCC, 2007). It is estimated that by 2100, West African countries are likely to have agricultural losses of up to 4% of GDP due to climate change (Mendelsohn et al., 1998). A study of sixteen sites in five countries and 1,500 households in the Sudan-Sahel zone of West Africa on farmer and

pastoralist perceptions of climate variability and change and the consequences thereof for natural resources in the communities surveyed indicates that, there is a clear trend that farmers and pastoralists capture the observed changes in climate well. They perceive the environmental change mainly as land degradation and poor soil fertility though recent in some areas intensification of agriculture counters this effect and has led to increased vegetation cover in marginal areas. They identified erratic climate, agricultural policies, insufficient food production and desire to increase income as the main drivers of change (Ole *et al*., 2009).

Farmers in the Sahel have always been facing climatic variability at intra- and inter-annual and decadal time scales. While coping and adaptation strategies have traditionally included crop diversification, mobility, livelihood diversification, and migration, singling out climate as a direct driver of changes is not so simple.
An analyzes of the perceptions of climate change and the strategies for coping and adaptation by sedentary farmers in the savanna zone of central Senegal reports that, households are aware of climate variability and identify wind and occasional excess rainfall as the most destructive climate factors. Households attribute poor livestock health, reduced crop yields and a range of other problems to climate factors, especially wind. Households and groups assign economic, political, and social rather than climate factors as the main reasons for change. It is concluded that the communities studied have a high awareness of climate issues. Change in land use and livelihood strategies is driven by adaptation to a range of factors of which climate appears not to be the most important. Implications for policy-making on agricultural and economic development will be to focus on providing flexible options rather than specific solutions to uncertain climate (Mertz *et al.,* **2010).**

Climate change is expected to have serious environmental, economic, and social impacts on Ghana, particularly on rural farmers whose livelihoods depend largely on rainfall. The extent of these impacts depends largely on awareness and the level of adaptation in response to climate change and variability. A hundred and eighty farming household were interviewed in February and October 2009. Results showed that about 92 percent of the respondents perceived increases in temperature while 87 percent perceived decrease in precipitation over the years. The major adaptation strategies identified included crop diversification, planting of short season varieties, change in crops species, shift of planting date, reduction in farm size, among others. The results of analysis indicated that the level of education, gender, age, soil fertility, farm size, farming experience, land tenure, access to extension services and credit, all influence farmers perception and adaptation (Benedicta et al., 2010).

There are diverse and mixed views about the causes and indicators of climate change across and within communities in Africa, despite the evidence of a general awareness. At a local level, a wide range of indicators for predicting wet and drought seasons were identified. For example, farmers believed that cold winters indicate a drought, while hot summers signify good rains. In addition, farmers identified specific environmental changes that they had observed. In Wenchi, Ghana, farmers listed the following observed changes (Paul *et al*., 2008): Reduction in soil fertility levels, reduction in yields of major staples such as yam and maize disappearance of cocoa as a major cash crop, disappearance of the forest and wildlife, hanges in rainfall pattern, proliferation of disease and insect pests proliferation of obnoxious weeds, e.g. spear grass. Farmers' own responses to these changes included planting different (early maturing) crops, planting earlier and using more agro-chemicals (Paul, *et al*; 2008).
According to the research, the impacts of climate variability among African communities are highly differentiated according to land tenure, traditional beliefs, resource availability and gender. However, this provides opportunities for developing adaptation mechanisms directed at specific vulnerable groups(Paul, *et al*; 2008): in Wenchi district, Ghana, farming is dominated by immigrants who use their agricultural produce as payment for land leased from the landlords, who expect annual payment regardless of whether it has been a good growing season. Short-term climate variations then pose a major threat to the security of tenure for the immigrant farmers.
Recent food crises in countries such as Nigeria are reminders of the continuing vulnerability of the region to the vicissitudes of climatic conditions. This is in large measure due to weak institutional capacity, limited engagement in environmental and adaptation issues, and a lack of validation of local knowledge (SPORE, 2008; BNRCC, 2008; Royal Society, 2005). Accordingly, there is the need to gain as much information as possible, and learn the positions of rural farmers and their needs, about what they know about climate change, in order to offer adaptation practices

that meet these needs.

The most devastating adverse impacts of climate change in Nigeria and other subtropical countries includes frequent drought, increased environmental damage, increased infestation of crop by pests and diseases, depletion of household assets, increased rural urban migration, increased biodiversity loss, depletion of wildlife and other natural resource base, changes in the vegetation type, decline in forest resources, decline in soil conditions (soil moisture and nutrients), increased health risks and the spread of infectious diseases, changing livelihood systems, among others (Reilly, 1999; Abaje and Giwa, 2007).

Much of the Niger-delta wetlands areas of Nigeria are now endangered due to climate variability, as witnessed by the significant reduction of their size in recent years. The maximum flooded area of the inner Niger Delta, which is the second largest wetland area in Africa, has dropped from approximately 37,000 km^2 in the early 1950s to 15,000 km^2 in 1990, coupled with the environmental degradation of crude-oil exploration has done to Niger-delta wetlands areas (BNRCC, 2008).

Evidences in literature revealed the intrusion of salt water in the water table of coastal zones of Ayetoro Community in Ilaje LG of Ondo State, Nigeria, and thus, led to increased salinity in soils. Already, the encroaching water is making life very hard. It is "extremely difficult now for food crops to grow on the island". Salt water sweeps through the land, making it impossible for food to grow (Apata et al, 2009). Residents lamented that "although they have always lived in harmony with the sea, they are now frightened and scared of living on these atolls". The atolls are sinking and despite not knowing the sciences people can see with their naked eyes the impact of the rising sea levels (BNRCC, 2008).The community now have the feeling that the waves will just come one day and swept them over; the community is now feeling restiveness. This area and the people are victims of climate change and rising sea levels.

In addition, almost 68 percent of the land cover in Nigeria is prone to drought and desertification. Its water resources are under threat which will affect energy sources (like the Kainji and Shiroro dam). Moreover, rain-fed agriculture practiced and fishing activities from which 2/3 of the Nigerian population depend primarily on foods and livelihoods are also under serious threat besides the high population pressures of 140 million people surviving on the physical environment through various activities within an area of 923,000 KM^2 (IPCC 2007; NEST 2004).
Alongside other factors, regional climate change - in particular, reduced precipitation - is thought to have contributed to the conflict in Darfur (Judith, 1993). The combination of decades of drought, desertification and overpopulation are among the causes of the conflict, because the Baggara Arab nomads searching for water have to take their livestock further south, to land mainly occupied by farming peoples (Marty, 2006).

3.0 Policy Implication of Perception of Adaptations

The perceptions of climate change in Africa is still low, it is evident that the farmers have been practicing adaptation measures even before the concept of climate change became a topical issue in development policy discourse. A major challenge to researchers, civil society and policy makers in the quest for innovative approaches to food security and agricultural adaptation to climate change in Africa is to involve farmers and learn from the adaptive measures they are already practicing.

Improved farmer education would do most to hasten adaptation. The provision of free extension advice may also play a role in promoting adaptation. More farming experience was found to promote adaptation. Experienced farmers usually have better knowledge and information on climate change and agronomic practices that they can use to cope with changes in climate and other socioeconomic conditions. This suggests that education to improve their awareness of the potential benefits from adaptation is an important policy measure for stimulating farm-level climate adaptation.

The power of the mass media to bring about behavioural change cannot be underestimated. Policy makers could tap into the vast potential of the media to disseminate climate change information and create more awareness about

causes, and consequences of climate change as well as strategies for climate change adaptation in African continent.

Combining access to extension and credit ensures that farmers have the information for decision making and the means to take up adaptation measures. Policies aimed at promoting farm-level adaptation need to emphasize the critical role of providing information (through extension services) and the means to implement adaptations through affordable credit facilities.
The identified indigenous adaptive strategies have Science, Technology and Innovation (STI) policy relevance as such practices of the farmers could inform the design and implementation of future Agricultural and Climate Change Policy in Africa.

Policy options should also include, awareness creation on climate change and adaptation methods, facilitating the availability of credit, investment on yield increasing technology packages to increase farm income, creating opportunities for off- farm employment, research on use of new crop varieties and livestock species that are more suited to drier conditions, encourage informal social net works and investment on irrigation.

Better access to markets reduces transport and other market related transaction costs and enhances the uptake of farm-level adaptation measures. For instance, better access to markets enables farmers to buy new crop varieties, new irrigation technologies and other important inputs they may need if they are to change their practices to cope with predicted changes in future climate.

Larger farm size also encourages the use of multiple cropping and integration of a livestock component, especially under dry land conditions. Large farm sizes allow farmers to diversify their crop and livestock options and help spread the risks of loss associated with changes in climate. This suggests the land tenure system should be such that allows farmers to have access to land. There is an urgent need for meteorological reports and alerts to be made accessible (when necessary) to farmers in an understandable forms.
Empowering communities with information, technological skills, education and employment is the best way to address vulnerability. A location wise action-research is therefore necessary to identify and document climate change impacts and adaptation strategy. The observations described above provide a clear direction for future research and for development planning and adaptation management programs in different ecological regions of Africa. Policy and program should be formulating holistic approach to mitigate climate change and improve livelihood of the African continent.

4.0 Conclusion

Perception of climate change in Africa is crucial to combating climate change and related problems. Against this background, this paper assesses the perceptions of climate change in Africa. Specifically, the study investigated the level of awareness and knowledge, effects, coping strategies and sources of information regarding causes and prevention of climate change. The analyses of the perception of farmers to climate change indicate that most of the farmers are aware of the fact that temperature is increasing and the level of precipitation is declining.
Very little is known about the way agriculturalists update their expectations with respect to climate. And even if they do perceive that the climate has changed they may still, because of any number of market imperfections, be unable to respond in the way that they themselves or society at large would wish. There is a significant amount of evidence detailing the slow uptake of technological adaptations in agriculture during the green revolution, especially in Africa.
Indigenous Peoples have very weak approach towards tackling climate change problems. Poverty and ignorance of various adaptation strategies are the major contributing factors to the impact felt by indigenous people. The knowledge and information gap concerning the effect of climate change, information dissemination, awareness programmes and training programmes calls for immediate action in order to relegate the impact of climate change in Africa.
The overall needs are to setup serious environmental conservation ethic among indigenous people. This can only be possible by first and famous educating the indigenous people on the implication of climate change, educate the indigenous people on the significance of conservation of the natural environment, support the most environmental

friendly people and groups towards achieving set goals and objectives in the study areas.

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