

Mitigation and Adaptation Strategies to the Effects of Climate Change on the Environment and Agriculture in Nigeria

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Abstract: *Climate change has been threatening the global environment, in particular agricultural sustainability in Nigeria and other vulnerable regions of the world. Climate change affects not only agricultural production and prices, trade and food sufficiency but also environmental conditions like water resources and coastal infrastructure. Addressing climate change issues and promote sustainability in agricultural sector and the environment requires tangible progress in implementing mitigation and adaptation strategies in the environment and agricultural sector. This short note relied on literature and participant observation to highlight the various efforts to combat the effects of climate change on the environment and agriculture in particular.*

Keywords: *Climate change, Agriculture, Ecosystem, Flooding, Mitigation, Adaptation.*

I. Introduction

Climate change is one of the major global problems threatening the survival of the human, animals, crops and intact ecosystems. It is one of the global threats with serious implication on agriculture, natural ecosystem, water supply, health, soil and atmosphere, which are all elements that constitute the support for long term sustainability of most production processes on earth (Emeka, 2008). Climate change refers to a deviation from the normal weather conditions of an area over time, whether due to natural conditions or as a result of human activities which results in degradation of an environment (Nwosu, 2012). Climate change is the variation in the statistical distribution of the average weather conditions over a prolong period of time, usually 30 years (Ikehi & Zimoghen, 2014). It refers to weather changes, including steady alteration in usual temperature (rise or fall), rainfall regime (pattern or intensity), wind, relative humidity and solar radiation overtime.

Climate change poses serious threats to agricultural sustainability and poverty alleviation in the poorest and most vulnerable regions as impacts affect the dependence on rain fed agriculture, results to increased level of poverty, low level of human and physical capital development, inequitable land distribution and poor infrastructure development (Ikehi, Onu, Ifeanyiyeze & Paradang, 2014). Although climate change has strong impact on health, water resources and land use, coastal infrastructure and environment, the most affected is agriculture especially in developing countries like Nigeria where irrigation is seldom practiced (Ifeanyiyeze, Ikehi & Isiwu, 2014). Agriculture is highly sensitive to climate change variability and weather extremes such as droughts, floods, and severe storms. Climate change can manifest as fewer wet days and higher rainfall, flooding, increasing surface air temperature, sea level rise and accelerated soil erosion depending on the region (Ikehi, Ifeanyiyeze & Ugwuoke, 2014). These can result in adverse consequences in human livelihood such as poor yields of crops and animals, loss of revenue by individuals and communities, increased poverty and hunger, and cause damage to existing infrastructure.

Crop yield are affected by many factors associated with climate change which include temperature, rainfall, and other extreme weather events. Farauta, Egbule, Idrisa and Agu (2011) explained that climate change is a contributing factor to food price crises, and its impacts on agriculture in developing countries in expected to get more serious. From the foregoing, it becomes imperative that adequate adaptation and mitigation strategies be explained to help cope with the challenges and impacts of climate change on the environment and agriculture. To address the issues of adapting to and mitigating climate change, the paper highlights the following: causes of climate change, effects of climate change on the environment and agriculture, mitigation and adaptation strategies, conclusion and then recommendations.

Causes of Climate Change

According to Intergovernmental Panel on Climate Change (IPCC, 2007), the causes of climate change can be linked basically to factors such as:

1. Industrial revolution; The activities of automobiles, jet-trails and other industrial acts have led to emission of several gases like carbon dioxide into the atmosphere which over time affects the composition of greenhouse gases leading to altered climate.
2. Burning of fossil fuels by oil producing companies and refineries which emit greenhouse gases directly into the atmosphere. For example, the Niger Delta region is reported to have over 123 gas flaring sites, making Nigeria one of the highest emitters of GHG in Africa (Akinro et al., 2008). Nigeria accounts for roughly one-sixth (1/6) of worldwide gas flaring; Nigeria flares about 75% of her gas (World Bank, 2008), and all take place in the Niger Delta region. Some 45.8 billion kilowatts of heat are discharged into the atmosphere of the Niger Delta, from flaring 1.8 billion cubic feet of gas every day (Olurin & Agbola, 2003). Between 1970 and 1986, about 125.5 million cubic meters of gas was produced in the Niger Delta region of which about 102.3 (81.7%) million cubic meters were flared (World Bank, 2008). The flares, due to the existence of oil industries in the region, have apparently contributed to the increase of GHG which alters climatic composition over time.
3. Land use change such as deforestation and desertification, watering of deserts, sand-filling of natural water bodies, all of which singly and/or complementarily leads to climate change, and
4. Agricultural activities such as bush burning, fertilizer application, fermentation among others, as anthropological

influencers they, contributes to climate change.

Effects of Climate Change on the Environment and Agriculture in Nigeria

The effects of climate change on agricultural production vary from one region to another depending on the prevailing climate of the region hence affects agricultural productivity differently. Nigeria, like all other countries of sub-Saharan Africa, is highly vulnerable to the impact of climate change especially the coastal low lying states. Climate change variations between 1960 and 1999 in parts of Nigeria showed visible occurrences of drought for a cumulative period of approximately 8-18 years in most of Adamawa, Bauchi, Borno, Jigawa, Kano, Kastina, Sokoto, Yobe and Zamfara states of Nigeria (Obioha, 2009; Muhammed et al., 2011). Unlike the northern mentioned states, the Niger Delta states like Bayelsa, Delta, Edo and Rivers, among others had flooding and overflowing seas. Niger Delta like most coastal low lying regions of the world is constantly faced with flooding of various degrees. Due to increased and varying extent of precipitation attributable to climate change, the occurrence of flooding has increased with rivers and oceans easily overflowing their banks. This was observed in the 2012 flooding that impacted negatively on agriculture in the region. The flood ravaged farmlands, storage buildings and farmers houses. Climate change resultant scenarios like excessive rainfall, flooding, excessive temperature, rising sea levels and water scarcity affects agricultural production and causes rises in price of agricultural productions. For example, uncertainties in the onset of the farming season, due to changes in rainfall pattern can lead to a usual sequence of crop failure which results in food shortages due to poor harvests; early rain may not be sustained, and crops planted at that instance may become smothered by heat waves. Increase in rainfall also is conducive for proliferation of pests and diseases, which in turn are detrimental to crop production. In other words, pest and crop diseases migrate in response to climate change and variation e.g Tse-tse fly has extended its range northwards and will potentially pose threat to livestock in the drier northern states of Nigeria (Food and Agricultural Organization, FAO, 2002).

Excessive flooding can also lead to soil erosion and destruction of farmlands. Aluko, Opeyemi and Ologunagba (2008) opined that climate change has significant impact on fragile soil and traditional farming systems. The author explained that small rural farmers and communities no longer produce sufficient quantities of the food needed to sustain their populations. Also extreme weather events such as thunderstorms, heavy winds, and floods, devastate farmlands and can lead to crop failure. Flooding could destroy the infrastructure used to store or transport food from production areas to markets thereby acting as disincentive to farmers who could produce more food (Ifeanyieze, Alkali, Okoye & Ikehi, 2016). Climate change affects livestock especially in dry weather conditions or desert-prone zones/regions where longer period of drought adversely affect the availability of fodder. Furthermore, increased temperature and accompanying decrease in water availability tend to reduce the length of growing seasons and yield potential with attendant low agricultural productivity. Admittedly, too, global warming has threatened the aquatic ecosystems with the consequential low production of sea foods and aquatic plants that may be of socio-economic importance. Climate change resultant effect of hunger and malnutrition are now adversely affecting the livelihood and well being of a massive number of people and inhibiting the development of many poor countries (Ikehi, 2014). It is quite obvious that the most serious challenge facing agricultural production and indeed mankind, worldwide and Nigeria in particular is climate change, thus the necessity to adapt.

Mitigation and Adaptation Strategies

Developed and developing countries alike are working hard to find solutions to the effects of climate change, as the impacts vary in extent and nature. In order to address the resulting impacts, adaptation practices should lay emphasis on community interest to encourage sustainable development. It is suggested that adaptation strategies will be more successful if they are identified and presented to local users for vetting to ensure their consistency with local priorities, norms, goals and institutions (Newton, Paci & Ogden, 2005). Community-based adaptation has become an important term in the climate change debate (Uyigüe & Agho, 2007). It recognizes the fact that environmental knowledge and resilience to climate change lay within societies and cultures (IPCC, 2001). Furthermore, an understanding of how communities cope with environmental changes is important when developing community-based adaptation projects to mitigate the effects of climate change for the local farmers and their families. The goal of community-based adaptation is to increase climate change resilience of communities by enhancing their capacity to cope with climate related issues such as less predictable rainfall patterns, frequent droughts, stronger heat wave, invasion of diseases and weather hazards of unprecedented intensity (IPCC, 2001). Staying informed about climate change and supporting efforts to slow its progress are things necessary to be done. The climate is already changing because of the existing build-up of GHGs in the atmosphere, therefore it is important to prepare for and adapt to those changes. While actions now to reduce emissions is critical, the existing build-up of GHG concentrations means that some effects of climate change are inevitable in this and coming decades and planning must start now on adapting families, production processes, economy and the society to these changes (Onu, Alaribe & Ikehi, 2016). Agriculture depends largely on environment, thus any prolonged fluctuations in average weather can affect its productivity. To address climate change and promote sustainability in agriculture, adaptation and mitigation approaches needs to be well publicized and pursued, such as those discussed below;

Mitigation Strategies to Address the Impacts of Climate Change in Nigeria

1. Indigenous land husbandry practices

Land husbandry is the implementation and management of preferred system of land use in order to prevent degradation and improve land quality in terms of stability, usefulness and productivity for the chosen land (Chukwu & Okoro, 2006). Consequently land husbandry encompasses microclimate management and ethno-engineering which are briefly discussed below

a. Microclimate management

Microclimate management involves all sustainable farming practices aimed at deliberately changing the flow of energy, sunlight, humidity, and other climate conditions in a small localized area, to forestall adverse effects in agriculture (Stigler, 1987), as summarized in table below;

Table 1: Microclimate management practices

Management technique	Examples
Manipulation of radiation to reduce sunlight intensity	Shading Cover to reduce radiation loss at night
Manipulation of heat or radiation flows	Tillage Mulching Windbreaks using shelter from trees Protection for ripening purposes Using warmed air for field and stored drying
Manipulation of Mechanical impacts of wind and rain	Planting in lower places Where deep rooting is possible: Improving soil conditions by natural deposits Protecting crops and produce against impacts by rain or wind.
Miscellaneous methods	Fitting cropping periods to these seasons Making use of super human interventions (Cosmo vision)

Source: Stigler (1987)

b. Ethno-Engineering adaptation

Ethno-engineering according to Jodha (1990) is a term that covers indigenous conservation practices such as terracing, contour/mountain slopes cultivation, harvesting run off water and developing small drainage system.

2. Activities aimed at improving agricultural infrastructure

Such activities include, accelerating the construction of support facilities for large scale water-saving for irrigation, building water harvesting schemes, water storage ponds and improve irrigation and drainage systems to combat drought and flood as they occur. Efforts need to be made to build new small-scale irrigation and drainage projects in areas that are currently not irrigated to fight drought. Accelerating the construction of water collective and utilization engine in hill mountainous areas. All these are meant to solve water availability for agriculture.

3. Strengthening research and development for new technologies

Government and non-governmental organizations should invest in the research and development of agricultural technology especially in systems that are dominated by small holder investments and large private agricultural reproduction/propagation research companies. Specifically, efforts should be made to expand breeding programs to encourage research on seed and offspring varieties with traits that promote resistant to drought, high temperature, diseases and pests, and water logging for plants and animals. In addition to these programs, the government should encourage research to better understand the magnitude, source and mechanism of climate change and its consequences. For technologies already developed, there is need to establish the means for transferring and promoting them to all farmers.

4. Strengthening the establishment and implementation of laws and regulations

Nigeria should improve its system of laws and regulations based on existing regulations on land use. It should create a policy that promote the protection of farmland and pasture land and strictly control any redevelopment of land that is being used for carbon storage or as part of a fragile ecosystem. As well as promulgating and adopting laws to reduce activities influencing climate change such as gas flaring and burning of fossil fuels.

5. Intensify ecological agriculture

Nigeria should begin to implement projects to prevent and control agriculture non-point source pollution and extend technologies concerning the reasonable use of chemical fertilizers and pesticides to improve the farm land quality and reduce carbon-emission. Farmers should be taught how to better manager fertilizer application and promote the increased use of organic fertilizer as a means of increasing soil fertility and reducing emissions of nitrous oxide.

6. Planting of crops according to prevailing climate condition

A change in weather condition could influence the type crops grown or animals reared. For farmers to adapt to the impacts of climate change, those (farmers) who are currently experiencing warmer environment due to shift or drastic rise in temperature, should shift to planting of crops that can survive in the current trend in their places e.g. cotton, wheat, oil crops and maize for the drier north. In wet locations, farmers are more likely to plant rice, soybeans, sugar, vegetables and potatoes which are water loving plants.

7. Breed stress-resistant varieties

Select and cultivate new well-bred animal and crop varieties with high yield potential and quality, superior integrative stress resistance and wide adaptability. Select and cultivate stress resistant varieties with specific abilities of resistance to drought, water-logging, high temperature and diseases and pest invasion.

8. Prevent aggravation of grassland desertification

Prevent further development of desertification by building artificial grassland, controlling grazing intensity, recovering vegetation and increasing vegetation coverage of grassland. Strengthening the development of animal husbandry in the farm belt to improve the productivity of animal husbandry.

II. Conclusion And Recommendations

Climate change as an adverse change in weather impinges on human, environmental and agricultural activities. Some of the consequences on livelihood are drying of streams, flooding, damaging of roads and general damage to the ecosystem. The effects of climate change on agricultural productivity are numerous, including decrease in crop yields, altered crop growing period, decrease in water availability for irrigation, among others. The focus of adaptation is to help human, agriculture and other production activities in the environment to survive the current trends in climate as the altering in climate will continue due to the existing causatives. Mitigation is aimed at reducing the causatives of climate change now, to reduce the impacts it will have in the future. Nigeria as a developing country, should aim at enlightening the populace, update farming practices through informed extension service.

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