

An Overview of Climate Change and Food Security: Adaptation Strategies and Mitigation Measures in Nigeria

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Abstract

Climate Change is caused by the release of billions of tons of carbon dioxide (CO₂) and other heat trapping gases known as Green House Gases into the atmosphere. This results in depletion of ozone layer leading to increase in the earth's surface temperature due to direct heating of earth's surface by the sun. This paper discusses the impact of climate change on food security. Climate change impacts on food security in a number of ways. Climate change is impacting on oceans, seas, lakes and rivers and on the animals and plants that are found and/or cultured in them. In Nigeria, thousands of people and their families whose livelihood depend on fishing and aquaculture are affected by climate change as fish become less abundant because many migrate to other areas due to extreme weather events, droughts and the warming of waters. Furthermore, climate change results in low agricultural productivity increase in agricultural pests and diseases, hunger and starvation and in extreme cases death. Various adaptation strategies for coping with the effects of climate change on food security are discussed among which are: use of more efficient crop varieties, more efficient irrigation and watershed management, efficient use of climate data and forecasts, through early warning systems, changing planting dates, and introducing irrigation into current rain fed systems.

Keywords: Climate Change, Food Security, Adaptation Strategies, Mitigation Measures.

Introduction

Climate change is the biggest environmental problem of our time that is threatening the existence of man and the environment. It is a major threat to agricultural system and food security in many countries in sub-Saharan Africa (Nigeria inclusive). Climate change or global warming refers to all changes in climate as a result of natural variations and human activities. Natural variation is due to increase in the concentration of carbon dioxide and other heat trapping gases (such as methane, ozone, nitrous oxide, carbon monoxide and water vapour) in the atmosphere. These heat trapping gases are known as Green House Gases (GHG) and occur naturally in the troposphere. The green house gases prevent the direct heat of the sun from heating the surface of the earth but allow sufficient heat to keep the earth warm enough for survival of life. The increased emission of carbon dioxide into the atmosphere results in the depletion of the ozone layer and this leads to increase in the earth's surface temperature due to direct heating of the earth's surface by the ultra-violet radiation of the sun. Climate change is also caused by human activities such as large scale deforestation, wide-spread use of land, over-population, reduced reliance on organic fuels and accelerated uptake of fossil fuels. These activities lead to increased emission of Green House Gases into the atmosphere (troposphere) which in turn increases the average surface temperature of the earth.

Climate change is a threat to food security because of its impacts on the agricultural system. Agricultural production in most Sub-Saharan African Countries (Nigeria inclusive) is dependent on weather. Climate change has a direct impact on the productivity of physical production factors such as soil's moisture and soil fertility and this affects farming outputs which in turn impacts negatively on food security. In other words, the food security of a nation depends on the stability and sustainability of sufficient food from the agricultural sector. This paper seeks to provide answers to the following disturbing questions about climate change and food security. What is climate change? Is Nigeria vulnerable to climate change? How does climate change impact on food security in Nigeria? What are the mitigation measures and adaptation strategies for coping with the impact of climate change on food security in Nigeria? The paper concludes that the development of appropriate policy instrument that will effectively address adaptation challenges to climate change is inevitable if Nigeria must attain her much desired goal of insuring food security for her teeming population of 167 million.

1. What is Climate Change?

Over the past 100 years, the earth's average surface temperature has risen by 0.75°Celsius. This rise in the temperature of the earth has brought some changes in the global weather pattern by affecting natural resources and balance of nature, upsetting seasonal cycles, disrupting the ecosystem and water supply, causing sea levels to rise, affecting agricultural productivity and food security. The Inter-governmental Panel on climate change

defined climate change as statistically significant variations that persists for an extended period, typically decades or longer. It includes shifts in frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature [1]. United States Global Climate Change Programme defined climate change as Extreme reactions of the weather phenomenon which creates negative impact on agricultural resources, water resources, human health, depletion of ozone layer, vegetation and soil, leading to doubling of carbon dioxide concentration in the ecosystem [2]. Some researchers [3], [4] are of the view that global temperature will rise further if the factors implicated in climate change are not urgently addressed. Furthermore, that these are likely to be more instances of extreme weather events (such as floods, landslides), drought, storms, increasing rise in sea levels, increase in environmental degradation, increase in pest and diseases infestations of agricultural crops and animals, poor agricultural productivity, poverty, hunger and starvation and food insecurity. The sectors which are considered most vulnerable to climate change are agricultural and food security, water resources and habitat.

2. Vulnerability of Nigeria to Climate Change.

Vulnerability is the degree to which a system is susceptible to or unable to cope with adverse effects of climate change including climate variability and extremes [5]. Most countries in sub-Saharan Africa (including Nigeria) are likely to suffer the effects of climate change more than other countries in the world. This is due to their geographical location, low income, low institutional capacity as well as their greater reliance on climate sensitive renewable resources [6]. Nigeria like other countries in Sub-Sahara Africa is highly vulnerable to the impacts of climate change [7]. Many towns and villages in Nigeria lie along the coastal, littoral states of the south and Northern front line states. These communities are exposed to climate variability or extremes such as shift in temperature, rainfall, storms and rise in sea levels. These changes in weather patterns impact negatively on agricultural activities and food security. The six geopolitical zones in Nigeria are vulnerable to climate change. The degree of vulnerability to climate change in the six geopolitical zones in Nigeria varies from zone to zone. The South-South and South-West geopolitical zones for example, are mainly affected by sea level rise and deforestation-induced change, the South-East zone is affected mainly by erosion, flooding and land degradation, the North-Central is affected by changes due to deforestation and over-grazing, the North-East by drought, desertification and heat-stress and the North-West is also affected by drought, desertification and heat stress [8]. An assessment of some aspects of Nigeria's vulnerability to climate change carried out by [9] using a wide range of data available at National and Regional levels reveals that vulnerability varies across the country with the North-East zones of Nigeria being more vulnerable to climate change than the South-West and the South-East. The North Central zone, has a relatively more favourable condition and this could be attributed to the presence of earth dams. The Earth dams could have influenced the volume of rainfall in the North-Central Zone hence they have a better prospect for enhanced livelihood than the North-East and North-West Zones of Nigeria. The findings of the study further reveals that the critical vulnerability factors in the South East Zone include delayed onset of rains, early retreat of rains, unsteady growing season and other extreme climate events, such as large scale distribution of acid soils, extensive gully erosion, and few water reservoirs to support irrigation. Furthermore, many parts of Anambra and Enugu States of Nigeria are ravaged by sheet and gully erosion. Some of the worst-hit areas include the Agulu-Nanka axis, the area around Nkisi River, Amawbia and Ozubulu areas of Anambra State. The Northern part of Nigeria, is also seriously affected by climate change. In the Sahel regions of Northern Nigeria, invasion of sand is a threat to human activities and food security. Farmlands and houses are frequently submerged or buried annually by sand from the Sahara desert [10]. The encroachment of the Sahara desert on one's fertile land used for food production is a serious threat to food security in Nigeria. Thus, the most vulnerable regions are the desertification prone areas in the Northern part and the erosion prone areas in the southern parts of Nigeria. The vulnerable communities are farmers, fishers, pastoralists, hunters, the elderly, women, children and very poor people.

3. Impact of Climate Change on Food Security in Nigeria

Agricultural production in Nigeria is rain-fed hence it is dependent on weather. Climate change is a serious threat to agricultural production and food security. Food security refers to availability and accessibility to enough food by all people at all times for an active and healthy life. A country is considered food secure when its population does not live in hunger or fear of starvation. Food security is important in any consideration of wealth and economic sustainability of a nation. The economy of Nigeria depends heavily on the agricultural sector though her development funds are derived from petroleum, oil and gas exploitation. Furthermore, estimates from the 1991 National Population Census in Nigeria indicate that 69% of the population engages in agricultural activities and 40% of the nation's Gross Domestic Product (GDP) is derived from agricultural sector [11]. Climate variability and extremes impact more on the agricultural sector than any other sector. These impacts are manifested in changes in frequency and intensity of rainfall, droughts, floods, changes in soil moisture and nutrient, increase in pests and diseases of crops and livestock, desertification, land degradation, heat stress, rise

in sea level and erosions. These adverse weather events constitute important challenges to crop and livestock production, fish farming and hunting in Nigeria. Climate variability and extremes impact on food security in Nigeria in the following ways.

3.1 *Effect on Crop Production*

Climate change can adversely affect crops at any stage of production starting from cultivation through growing period to harvest. When crops are adversely affected by water shortage (insufficient rainfall), or heat stress (excessive high temperature) crop yield becomes poor and there is increased risk of hunger and starvation. As temperature increases and rainfall patterns become more unpredictable, crop yields drop significantly. Extreme weather events such as thunderstorms, heavy winds and floods devastate farm lands causing crop failure and serious agricultural losses and this impact negatively on food security. Variations in rainfall patterns in Nigeria also affect crop production in varying ways depending on location. However, even if there is sufficient rain, its irregularity can affect yields adversely. In other words, if the rains arrive late or fail to arrive during the crucial growing stage of the crops, yields will definitely be affected and this in turn impacts on food security. Change in crop development and phenology due to climate change can cause shortening or lengthening of crop cycles and this can lead to decreases or increases in productivity [12]. Variations in temperature and rainfall expose crops to new crop pests and diseases that flourish only at specific temperatures and humidity. These crop pests and diseases pose new risks for food safety, food security and human health.

3.2 *Effect on Livestock Production*

Livestock production system in Nigeria is vulnerable to climate change. A decrease in rainfall especially in the Sudan Sahelian Zone in Northern Nigeria leads to a reduction in available pasture land, a decline in the available surface water and an increase in the salinity of water resources available to animals. These adverse environmental conditions affect livestock production and availability of animal species as food. Some species may not be able to adapt quickly enough to the changing environment and an alternative habitat may not be readily available for them to move into, hence such species may be threatened by an increase risk of extinction. Increase in temperature and shortage of water have adverse effect on livestock production though this effect is not uniform across agro-ecological zones. This means that varying environmental condition have varying effects on livestock depending on the agro-ecological location. Furthermore, changes in weather conditions of a place usher in new pest and diseases of livestock and pose new risks to food production, food safety and food security.

3.3 *Effect on Fish Farming and Aquaculture*

Fish farming is an important source of revenue and employment in Nigeria. Climate change is having an impact on oceans, seas, lakes and rivers and on the animal and plants that are found and are cultured in them. Climate change is affecting millions of people in Africa (including Nigeria) whose livelihood depends on fishing and aquaculture. This is because some fish resources are becoming less abundant while important species move to other areas where they are less accessible to fish farmers due to water shortage and changes in the temperature, salinity, wind speed and direction, ocean currents and strength of upwelling due to climate change sharply alter the abundance, distribution and availability of fishes in the country [12]. Furthermore, changes in ocean dynamics lead to change in migrating patterns of fish and possible reduce fish landing especially in coastal fisheries.

Aquaculture practices are threatened by increased extreme weather events, droughts and warming of waters. All these impact negatively on food security and on livelihood as it becomes more difficult for many fishing communities to provide fish for feeding their families or make a living, from fish farming. Coastal communities are displaced by rising sea levels and forced to find new places to live and new ways to earn a living. All these directly or indirectly affect the livelihoods of fish farmers, their immediate families, their dependants and food security in Nigeria. It also affects the revenue sustenance of those who work or trade on fishery resources. Fishery resources are highly sensitive to marine environmental changes. Although fishes had always coped with these changes, future climate changes will likely be so extreme that it may be difficult for them to cope with. Hence, identification of proper mitigation measures and adaptation strategies is a high priority to ensure continued food security in Nigeria.

3.4 *Effects on Forestry and Hunting*

The forest reserves in Nigeria are not left out in the threat posed by climate change. Climate change affects agriculture and forestry through higher temperatures, elevated carbon dioxide concentration, precipitation changes, increased weeds and increased pests and diseases of plants. All these adversely affect food production and food security in Nigeria in diverse ways. Deforestation whereby forests are cut down faster than they are replaced is a major contributor to climate change. Deforestation accounts for 20 percent of the world carbon emissions because trees absorb carbon dioxide as they grow and use them for the synthesis of organic food

substances. If there are fewer trees left to absorb carbon dioxide then carbon dioxide will build up in the atmosphere. Various agricultural activities, industrialization, increase in population do not only damage the earth's ability to absorb carbon dioxide but often cause an additional problem by producing emissions of their own. Furthermore, cutting down of forest vegetation for whatever reason makes the wild life to relocate to new habitat. This affects hunters who depend on hunting of these animals for livelihood. Consequently, deforestation affects food securities as meat becomes less available to the masses.

4. Mitigation Measures and Adaptation Strategies in Climate Change

Climate change is perhaps the most serious threat to the fight against hunger and starvation, malnutrition, poverty and diseases in Africa (Nigeria inclusive). Climate change is global but its adverse effects are felt mainly by developing countries, especially those in Africa due to their low coping capabilities. As the planet warms, rainfall patterns shift and extreme events such as droughts, floods, erosions and forest fires become more frequent. Tragic crop failures and reduced agricultural productivity results in food insecurity. Consequently, there is increased hunger and starvation, poverty, malnutrition and diseases in Africa. It is projected that due to climate change, crop yield in Africa may fail 10-20% by 2050 or even up to 50% [13]. This is because agriculture in Africa is predominantly rain-fed, hence depends on the vagaries of weather. Climate change impoverishes Africa by retarding economic growth and undermining sustainable development. There is need therefore to seek for ways of coping with the adverse effects of climate change. Two main categories of measures taken to address climate change are mitigation and adaptation.

4.1 What is Mitigation?

According to IPCC, mitigation refers to activities aimed at reducing green houses gases emission directly or indirectly. This can be achieved either by avoiding GHG emissions or capturing those gases before their release into the atmosphere or by trapping GHG already present in the atmosphere by increasing carbon dioxide sink such as forests and use of carbon capture and storage (CCS). Reduction of emission of Green House Gases (GHG) can be achieved by avoiding deforestation and forest degradation, use of other technological devices and dissemination of new technologies such as use of LED lamp, and improved cook stoves.

4.2 Mitigation Measures

Mitigation measures aim at reducing loss of life and property by lessening the impact of disasters. It is taking action now-before the next disaster to reduce human and financial consequences later. It entails analyzing risk, reducing risk and insuring against risk. The recent flood disaster in Nigeria in 2012 had far reaching human, financial, economic, health and social consequences on Nigerians. Many farm lands and agricultural products were washed away by flood, property worth billions of naira was destroyed, many communities were submerged in the flood and thousands of people were rendered homeless. Effective mitigation entails an understanding of local risks especially the risks that would be faced by rural farmers should such disaster reoccur and how best to reduce the effect of a reoccurrence of such disaster. Mitigation measures are necessary to reduce the rate and magnitude of climate change. Some suggested mitigation measures to cushion the effect of climate change include:

- i. Construction of wide drainage channels for flood control and clearing all drainage ways for easy flow of water,
- ii. Dissemination of information about climate change in local dialects at the grass root.
- iii. Campaign against over stocking of livestock and overgrazing of a piece of land as a way of avoiding land degradation.
- iv. Use of gingles, advertisements and bill boards to disseminate information about climate change to all parts of the country.
- v. Mounting of robust enlightenment campaign before and during disasters through the use of community radios and other indigenous communication systems like: use of town criers, gongs, and bells to announce to the people about an impending disaster.

5. What is Adaptation?

Adaptation refers to adjustments in practices or structures in response to projected or actual changes in climate with the goal of maintaining the capacity to deal with current and future changes and/or take advantages of new opportunities that may be presented. Adaptation includes activities that are taken before impacts are observed (anticipatory) and after impacts have been felt (reactive). It is any response to improve an outcome [14]. Adaptation also refers to the decisions that people, communities, business, institutions and governments take to prepare for and respond to a changing climate. In addition to mitigation measures being developed to combat climate change, adaptation to the anticipated climate change is essential. While mitigation is necessary to reduce the rate and magnitude of climate change, adaptation is essential to reduce the damages from climate change that

cannot be avoided.

The Nigerian agricultural sector of the 21st century is facing two main challenges, namely: the need to increase the nation's food supply as well as adjusting to variation in climate. In most African countries including Nigeria, agriculture is practiced across a broad range of climates and environmental conditions, hence the country need to develop many adaptation options that will meet the different conditions of the different ecological locations of the nation. Adaptation therefore is any response that improves an outcome. Adaptation to impact of climate variations on food security entails direct changes in the agricultural system. Adaptation to climate change or climate variations in recent weather patterns is crucial for agricultural productivity in most developing countries in sub-Saharan Africa especially Nigeria.

5.1 *Types of Adaptations*

There are two basic types of adaptation, autonomous adaptation and planned adaptation.

Autonomous adaptations occur more or less on their own; that is automatically without outside investment or policy intervention. In autonomous adaptation, farmers recognize climate shifts or climate variation and reacts in ways that offsets expected losses. For instance, farmers could react to changing precipitation patterns by changing crops, using different planting/sowing dates and different harvesting date.

Planned adaptation measures are conscious policy options, investments or response strategies, often multi-sectorial in nature and aimed at altering the adaptive capacity of the agricultural system. A lot of adaptation options have been tried on the different areas of agriculture. Some yielded positive results while the effects of the rest are still being observed.

5.2 *Adaptation Strategies to Climate Change*

There are two approaches to adaptation to climate change namely:

(i.) Extant measures and (ii) Ex post responses

Extant measures are actions taken in anticipation of a given climate realization. Ex post responses are measures undertaken after the event is realized. Extant adaptation strategies to climate variability (climate change) are strategies centred or based on diversification. This is based on the fact that a given climate event may have differential effects on different crops and activities in a given years. Hence farmers diversify their farm activities in various ways such as: farmers growing rain-fed crops in a drought-prone environment may choose to diversify the location of their farm plots so as to benefit from the high spatial variability of rainfall, grow a variety of crops with different sensitivity to climate, diversify income sources into non-farm enterprises that are less sensitive to climate, maintain flexibility in decisions about when crops are to be planted and farmers could insure their harvest against failure.

Ex post adaptation strategies are strategies adapted to reduce or decrease crop or welfare losses once climate events have been realized.

Such ex post adaptation strategies include:

- Utilizing cash reserves or stored grain to start all over.
- Borrowing from formal or informal credit markets or family
- Selling assets such as livestock to use the money to start all over again
- mitigating elsewhere in search of job in non-affected regions
- Replanting fast maturing varieties after growing season has started if early season planting fails.
- Planting trees in rows to serve as wind breakers and to check erosion.
- Irrigating where possible if rainfall is meager.
- Using better and wider drainage channels to check floods and erosions.

However, not all strategies are available to all farmers, nor are all available strategies always successful in buffering food security against a variable climate. In wealthier countries, farmers rarely go hungry as a result of drought, flood or other adverse climate events. This is because of the existence of social safety nets and functioning financial markets or can receive help from the government to maintain livelihoods during bad times. In like manner, consumers in rich countries spend only a small percentage of their income on food; hence they are not very sensitive to the food price increases that often accompany droughts or floods. In poor countries (Nigeria inclusive) both extant and ex post adaptation strategies can be used to reduce climate associated losses to some degree. However, the poorest households are unable to withstand the effects of climate variability and this usually have dramatic and devastating consequences as was the case in the drought-related famines in the Sahel and Horn of Africa in the 1980s. The negative impacts of climate variability on economic livelihoods and food security in Nigeria is enormous helping farmers to better adapt to climate variability should be the main concern of government.

6. Suggested Adaptation Strategies for Coping with the Impacts of Climate Change on Food Security in Nigeria

Nigeria has a weak adaptive capacity hence her adaptive capacity need to be strengthened to cope with damages caused by climate change. Many farmers in Nigeria usually become completely helpless when any harvest fails or a disaster occur. Two cases in point are the Sokoto flood disaster in 2010, and the 2012 flood disaster that swept over several states in Nigeria. In each of these two cases flood swept away many farmlands and many houses were submerged, livestock and property worth millions of naira were destroyed and thousands of people were rendered homeless. This disaster left many local farmers economically devastated as they had no significant alternative source of livelihood. Furthermore, the food security of the nation was seriously threatened as food was not available and affordable to the masses. Hunger and starvation, malnutrition, poverty and health problems were on the increase and in severe cases loss of life. In the light of the above, some adaptation strategies that will enable Nigerians cope with the impact of climate change on food security were highlighted in this paper. The recommended strategies may simply be an improvement of an already existing practice in the community or completely new strategies to the community. They are as follows:

- (i) *Use of Accurate and Timely Weather Forecasting*
Timely and accurate weather forecasting is crucial for improving crop performance and yield. There is need to develop human capacity and appropriate infrastructure for weather forecast and dissemination of information about weather. This will enable the farmer to know when and where to grow their crops and types of crops to grow given the weather conditions at the time. In this way, food production is improved and food security is assured
- (ii) *Use of Agricultural Extension Services*
Agricultural extension officers are trained to link farmers with scientific method of improving farm operations as well as providing relevant weather information based on local and indigenous knowledge about adaptive practices. Farmers should therefore utilize the services of the agricultural extension officers for improved crop yield.
- (iii) *Use of Efficient Irrigation Infrastructures*
To eliminate crop failure due to drought and increased evaporation efficient irrigation system should be adopted. It enables farmers to extend their farming into the dry season and not to depend solely on rain-fed agriculture. In this way food production will increase and become more available and affordable by many Nigerians.
- (iv) *Growing of Drought Resistant Variety of Crops*
This strategy could be adopted in drought-prone areas where water stress may be a limiting factor. Switching to new crops that are drought tolerant e.g. cassava and maize is very rewarding because it increases agricultural productivity.
- (v) *Growing more cover crops to Protect the Soil from Erosion and Leaching*
Cultivating spreading crops like potatoes, melons and groundnuts in the farming cycles help to curb loss of top soil through erosion and leaching of food nutrients by heavy down pours.
- (vi) Planting of early maturing varieties like maize and cassava especially when the first crop planted at the beginning of the planting season has failed.
- (vii) Increasing and upgrading storage facilities to preserve crops for longer periods and prevent the destruction of crops by insect pests and excessive heat of the sun. When crops are well preserved, then food availability is ensured for longer period.
- (viii) Control of pest, insects and birds to ensure increased crop yields and high market value of agricultural products.

7. Conclusion

This paper upholds that climate change is real and that Nigeria is highly vulnerable to climate change. Climate change is impacting negatively on food security in Nigeria as shown by low agricultural productivity. A large number of Nigerians are still malnourished, hungry, starving and poor and have various health problems due to food insecurity caused by climate change. Nigeria needs to adopt some adaptation strategies that will enable her cope with the challenges of climate change to ensure food security in the country. To achieve this, there is urgent need for climate change policy at both National, state and local government levels in Nigeria. It is hoped that if the suggestions as made in this paper are effectively pursued, the country's vulnerability to climate change will reduce appreciably and Nigeria's food security will be greatly enhanced.

8. Recommendations

The following recommendations are proffered as ways of coping with the impacts of climate change on food security in Nigeria.

1. Government should set up temporary relief camps or settlements for flood victims or temporarily

- displaced people.
2. Financial support (loans) should be given to farmers affected by disasters caused by climate change to enable them start off again.
3. Government should establish a National climate change commission to handle issues related to climate change.
4. Climate change issues should be infused into the curricula at the various levels of the education systems to enable learners gain knowledge and understanding about climate change. This, it is hoped will enable learners avoid acts that promote climate change in Nigeria.
5. Laws forbidding bush burning and large scale production should be promulgated as a way of checking land degradation and carbon dioxide emission.
6. Climate change adaptation should be mainstreamed into Nigeria educational system to create sufficient knowledge and awareness about climate change among the youths.
7. Government should stabilize gullies and erosion site through better methods of erosion control.
8. Government should improve the monitoring and evaluation of agricultural activities with realistic and measurable indicators to enhance food security in Nigeria.
9. Government should help farmers to secure agricultural insurance and loans in situations of disaster to enable them take off again.
10. Farmers should be encouraged to engage in other businesses other than farming so that incase of disaster, they will still have something else to fall back on.

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