

THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Climate Change and Nigeria's Development: The Challenges and the Prospects of Agricultural Adaptation

E. C. Nwankwo

Assistant Registrar & Ph.D. Candidate, Department of Agricultural Economics and Extension,
Anambra State University, Nigeria

Abstract:

The continued slide in the price of crude oil has had a devastating effect on the socio-economic development of Nigeria. This has engendered with greater sense of urgency the need to diversify the nation's economy. An important aspect of the diversification efforts is the agricultural sector which in the past was the mainstay of the nation's economy. Today, however, this sector which is dominated by smallholders is further faced with even greater challenges posed to it by climate change with even greater consequences for the socio-economic development of Nigeria. Indeed, there is today an overwhelming scientific consensus that global climate is changing with unusual rapidity and negative consequences. In spite of these consensuses, there is an apparent denial of or at best lukewarm attitude to, the challenges posed by climate change among third world nations, nay Nigeria, who see climate change as the problem of developed economies. This paper takes off from the established scientific consensuses and examines the dialectical relation between climate change and Agriculture with particular reference to Nigeria where responses to climate change has been very slow. It examines the socio-economic impact of the slow response, identifies the challenges facing agricultural adaptation to climate change in Nigeria, investigates how the dominantly smallholder farmers are adapting to the changes, and interrogates the extent to which the measures and government policies meet the challenges of climate change. It finally makes recommendations based on the findings.

Keywords: Agriculture, diversification, climate change, policy, adaptation

1. Background

There is today an overwhelming scientific consensus that global climate is changing. Although this "change" is often seen as a recent phenomenon its roots are actually far older and has been discussed for more than 150 years (www.britannica.com). Without going deep into this history, let it suffice to note that from the 1920s onwards, meteorologists had begun to realize that the climate of various regions had changed. At the same time some other scientists had started measuring carbon dioxide in the air. It took an amateur meteorologist Guy Callendar to put the puzzle together to come to a conclusion that increase in the atmospheric carbon dioxide (CO₂) was warming the planet (www.history.noaa.gov/nwsbios/). Today, there is a consensus among scientists that the unusual rapidity of this Warming of the planet has been amplified by human activities.

We have used the term amplified above because other natural processes like volcanic eruptions, variations in earth's orbit or change in the sun's intensity are possible causes. However, it is emissions from human activities that have increased the process. Among these human induced processes can be counted over population, increase in CO₂ and other greenhouse gasses emissions through burning of fossil fuel and pollutants from industrial activities as well as agricultural activities. Agricultural activities' contributions, according to Wikipedia (2015), encompass

- CO₂ releases linked to deforestation
- Methane releases from rice cultivation
- Methane releases from enteric fermentation in cattle;
- Nitrous oxide releases from fertilizer application (en.wikipedia.org)

Together, according to Intergovernmental Panel on Climate Change (IPCC) these agricultural processes comprise 54% of methane emissions, roughly 80% of nitrous oxide emissions and virtually all carbon dioxide tied to land use.

According to Polma (2015), though the Earth is going through periods of warming and cooling, the warming process is happening faster than it was in the pre-industrial times. This he basically attributed to man-made emissions. Wheeler (2015), also acknowledged that the problem of rapid climate change is inextricably entwined with the challenges of development. No doubt, the developed countries such as United State of America, Canada, Germany, Japan, Britain etc. contribute high percentage to climate change, but the developing countries like those in Africa are not left out. Their (developing countries) contributions to climate change are more due to their over-dependence on natural resource-base for livelihood. Agricultural practices in Nigeria, for instance, induce climate change.

The traditional and predominant method of clearing farm land, is through bush burning. The use of firewood as cooking energy source has recently gained predominance, because of high cost and non-availability of other cleaner sources such as natural gas and kerosene, even when Nigeria is an exporter of crude oil. These activities increase the concentration of greenhouse gases (GHGs) in the atmosphere, causing global warming, climate change and sea level rise (Medugu, 2009). There is equally the problem of deforestation. The current annual deforestation rate is on the increase. According to Garba (2006), one of the major causes of poverty is destruction of natural resources, leading to environmental degradation, high temperature and drought.

The full scale impact of climate change is hard to predict far in advance, but each year scientists learn more of how climate change is affecting the planet in the areas of water resources, energy supply, transportation, agriculture, ecosystem, human health (www.nrdc.org/globalWarming/fcons/asp) Indeed climate change is the most environmental threat facing the activities of entire globe and agriculture in particular. It has impact on global weather systems causing everything from unexpected rainfall to extreme heat waves, (Hoffmann, 2013). Seasons are shifting, temperatures are climbing and sea levels are rising. As also noted by Intergovernmental Panel on Climate Change (2013) the effects of climate change are felt in form of ice caps in the polar areas and increased variability of temperature, rainfall and storm in virtually all the regions. Collectively, these phenomena continue to alter the lands and waters on which humans and indeed all living things depend for supply of water, air, food, safe places to live (<http://www.nature.org>) and thus endanger global existence.

IPCC, (2007) regarded Africa as one of the most vulnerable continents to climate change, because of multiple stresses and its low adaptation capacity. Orindi and Murray (2005) observed that in Africa climate change has directly affected climate-dependent activities and indirectly impacted on social systems such as poverty, conflict, education and health. Nigeria as a developing nation is not left out. In this era of dwindling oil economy, agriculture, the bedrock of Nigeria's economy and which is dominated by smallholders, faces serious threats from climate change. Over the years, flooding has been recorded every year in all the states along Niger River and its tributaries, frequently causing disasters (Nigerian Environmental Study Team, NEST, 2004). Ikeme, (2009) observed increase in incidence of disease, declining agricultural productivity, increasing number of heat waves, unreliable weather patterns, flooding, declining rainfall in already desert-prone areas of the North thus causing increasing desertification, decreasing food production in the central regions and destruction of livelihood by rising waters in the coastal areas where people depend on fishing and farming. The recent menace and conflict orchestrated by the Fulani herdsmen as they traverse regions in search of pastures is not unconnected to climate change.

Deutsche Bank Research (2009) also found out that Nigerian agriculture is experiencing climate change in the form of late arrival of rain and early retreating of rains, increasing annual temperature, thunderstorms, heavy winds, flooding, etc. even though farmers have not considered its deeper implication. They argued that, for instance, higher temperature lowers the yield of desirable crops while encouraging weeds and pests' proliferation and changes in precipitation patterns, increase the likelihood of short-run crop failure and long-run production declines, thus creating a huge challenge to food production and livelihoods. If these effects of changing climate on Nigerian economy persist, they could pose significant setbacks for meeting development targets like Nigerian's aspiration to be among the twenty best performing economies of the World by the year 2020 and achievement of sustainable Development Goals.

While scientists have given much attention to causes of climate change and with governments discussed mitigation process, not much of such scientific effort and discourse has been given to adaptation strategies, particularly in the field of agriculture. Adaptation is the principal way to deal with the impacts of a changing climate. It involves taking practical actions to manage risks from climate impacts, protect communities and strengthen the resilience of the economy. What the forms of these adaptive strategies in Nigeria are and the extent to which the measures and government policies meet the challenges of climate change is the focus of this paper.

2. Concept of Climate Change

'Climate change', as the name suggests, refers to the changes in the global climate which result from the increasing average global temperature. For example, changes in precipitation patterns, increased prevalence of droughts, heat waves, and other extreme weather, etc. (www.skepticalscience.com). It is not just any change in the climate but such change over a period of time (FAO, 2006). According to IPCC (2001), it is any change in climate overtime due to natural variability or as a result of human activities. It may be a change in average weather conditions or in the distribution of climate around the average conditions (Wikipedia, 2015). Along these lines, Nwaleji, Uzuegbunam and Ezigbo, (2004) defined it as a significant and lasting change in the distribution of weather patterns over periods ranging from decades to millions of years.

In normal daily communication, climate change is used interchangeably with Global warming. These two phenomena though related are not exactly the same. To fully understand climate change, it is therefore, important to draw the distinction between it and global warming. Global warming describes the increase in the Earth's average temperature as a result of changes in the total amount of energy that is kept within the Earth's atmosphere. It refers to the long-term trend of a rising average global temperature. The change in energy is spread out around the globe mainly by ocean currents as well as wind and weather patterns to affect the climates of different regions (UNESCO/UNEP, 2011). Put differently, human greenhouse gas emissions are causing global warming, which in turn is causing climate change. Thus Climate change refers not only to global changes in temperature but also to changes in wind, precipitation, the length of seasons as well as the strength and frequency of extreme weather events like droughts and floods. Simply put, global warming causes climate change. Accordingly, we define climate change with Allison (2010) as when the average long-term weather patterns of a region are altered for an extended period of time, typically decades or longer. Examples include shifts in wind patterns, the average temperature or the amount of precipitation. These changes can affect one region, many regions or the whole planet.

3. Climate Change and Agriculture: The Dialectical Relationship

There is a dialectical relation between climate change and agriculture. On the one hand agriculture contributes to climate change. This as was earlier noted come by anthropogenic emissions of greenhouse gases (GHGs) and conversion of non-agricultural land (e.g. forest) into agricultural lands. Agriculture, forest and land-use change, contributed around 20 to 25% to global annual emissions in 2010 (Wikipedia, 2015). On the other hand, climate change affects agriculture. Climate change affects agriculture in a number of ways including changes in average temperatures, rainfall and climate extremes (e.g. heat waves), changes in pests and diseases, changes in atmospheric carbon dioxide and ground level ozone concentrations, changes in the nutritional quality of some foods, and changes in sea level (Hoffman 2013).

For each plant variety, there is an optimal temperature for vegetative growth. Growth drops off as temperature increases or decreases. Similarly, there is a range of temperature at which a plant will produce seed, outside of which the plant will not reproduce. Despite technological advances, such as improved varieties, genetically modified organisms, and irrigation systems, weather is still a key factor in agricultural productivity, as well as soil properties and natural communities. The effect of climate on agriculture is related to variability in local climates rather than in global climate patterns (Wikipedia, 2015). According to IPCC (2007), climate change exerts multiple stresses on the biophysical as well as the social and institutional environment that underpin agricultural production.

The interrelated processes between agriculture and climate change is taking place on a global scale and, therefore, felt, even when to varying degrees in various regions of the earth. According to Unilever (2015) the entire earth is getting hotter, the earth has "Fever". In Africa and Latin America, many rainfall crops are near maximum temperature tolerance, so that yields are likely to fall sharply for every small climate change (IPCC, 2001). Dai, (2011) observed that drought have been occurring more frequently because of global warming and they are expected to become more frequent and intense in Africa, Southern Europe and the Middle-east, most of the Americas, Australia and South Asia.

The impacts are aggravated as a result of increased water demand, population growth, urban expansion and environmental protection efforts in these areas. It is reported that up to 11% of arable land could be highly affected by climate change in the countries (FAO, 2007). A decrease of up to 30% in World food production due to climate change is generally predicted (IPCC, 2007). Evidence from the IPCC suggested that areas of the Sahara are likely to emerge as the most vulnerable to climate change with agricultural losses of between 2 and 7% of affected countries' GDP. In China, natural disasters hit 24.89million hectares of crops in 2014. This has caused China a direct economic loss of 83.6 billion Yuan (over 13 billion dollar). In Turkey, delayed harvest in the Black sea region in 2014, made Turkish tea products suffer a loss of over 15% of their annual income, due to heavy frost.

Cline (2008) looked at how climate change might affect agricultural productivity in the 2080s and concluded that global agricultural productivity could be negatively affected by climate change, with the worst effects in developing countries. Lobell *et al.* (2008) assessed how climate change might affect 12 food-insecure regions in 2030 and found that without sufficient adaptation measures, South Asia and South Africa would likely suffer negative impacts on several crops which are important to large food insecure human populations. IPCC (2007:13) projected that climate variability and change in Africa would severely compromise agricultural production and access to food. This projection was assigned "high confidence". Lobell, Burke, Tebaldi, Mastrandrea, Falcon and Naylor (2008) in their study suggested that, due to climate change, "southern Africa could lose more than 30% of its main crop, maize, by 2030. In South Asia losses of many regional staples, such as rice, millet and maize could top 10%".

The findings of IPCC in respect of Africa as a whole is most certainly the case in Nigeria where agriculture is a source of food and employer of 60 to 70% of labour force, and where the socio-economic context of farmers is precarious. Since, it is rain-fed and significant sector of the economy, it follows, therefore, that any change in climate is bound to impact on its productivity and other socio-economic activities in the country. Already as expressed by Adejuwon (2004), the impact could be measured in terms of effects on crop growth, availability of soil water, soil erosion, incident of pests and diseases, sea level rises and decrease in soil fertility. The Northern region of the country is increasingly becoming an arid environment at a very fast rate. This according to Fesona and Omojola (2005), is occasioned by fast reduction in the natural regeneration rate of land resources. This zone faces the threat of desert encroachment (FME, 2004). The Southern area of the country, largely known for high rainfall is currently confronted by irregularity in the rainfall. It has been on the weather forecast that River-line dwellers are expected to experience heavy flooding this year. In addition, temperature is gradually increasing in the Guinea Savannah zone of the country.

The threats that climate change pose to agricultural production does not limit to the area of crop husbandry but also includes livestock, fishery, forestry and in fact the totality of agricultural sector. Climate change has far-reaching consequences for diary, meat and wool production (Rawlinson, 2008). International Fund for Agricultural Development, IFAD (2007) opined that climate change poses a severe threat on livestock production which is an important element of the Nigerian economy. Climate change affects livestock both directly and indirectly (Adams, 1999, Mannina and Nobrew, 2001). Direct effects of climate variables such as air, temperature, humidity, wind speed and other climate factors influence animal performance such as growth, milk production, wool production and reproduction. According to Niggol and Mendelsohn, (2008), climate change can affect quality and quantity of feed stuffs – such as pasture, forage and grain and also the severity and distribution of livestock diseases and parasite. The continued existence of these live stocks is in serious doubt with increasing climate change. IPCC predicted that by 20100, the increase in global average surface temperature maybe between 1.8^{0c} and 4.0^{0c}. With increase of 15^{0c} to 25^{0c}, approximately 20 to 30% of animal and plant species are expected to be at risk of extinction (FAO, 2007b), with severe consequences for food security in developing country like Nigeria.

Fish production has contributed little to the cause of climate change but will be amongst the first sector to feel its impact (IFAD, 2007). A study carried out by Nwalieji, Uzuegbunam and Ezigbo, (2004), showed the negative effects of climate change on fish farming to include reduction in fish farming activities, low stocking rate, increase in fish mortality, poor distribution of fish in water, alteration in fish growth and reproductive capacity, high incidence of disease infestation, decrease in water quality, specie migration

among others. Kibuka-Musoke, (2007) identifies both positive and negative impacts of climate change on fisheries. The consequences of climate changing will be negative for fish at low latitude. In contrast, fish farmers at low latitude may benefit from expansion of the areas which fish farming is viable due to increase in temperatures and rising sea levels but these benefits may be tempered by reduced water quality and availability, increased disease incidence and damage to fresh water fish production by salinization of ground water (IFAD, 2007). World Fish Centre, (2007) opined that rising sea levels could also affect important fishery nursery areas and warming can increase disease transmission and have an influence on marine pathogens.

Forest sector is not left out of impact of climate change. Forests are highly sensitive and dependent on climate in their function (e.g. growth) and structure in terms of species composition (IPCC 2001). Both natural and modified forests are vulnerable to climate change. According to Encyclopedia of Life Support System (EOLSS), individual trees are highly susceptible to climate and expected to cause significant changes in forest distribution and in the internal character of forests. Nigerian forests are being depleted because of rising population, migration, land hunger, poverty and starvation. (Akah, 2010). This will mean significant changes in the ecosystem and life support services provided by forests. It is estimated that diverse climate change impacts will contribute to the destruction of forest and thereby promote the emission of greenhouse gases, which in turn will increase global warming (FAO, 2007).

4. Climate Change and Agricultural Adaptation in Nigeria

Adaptation is the principal way to deal with the impacts of a changing climate. It generally involves taking practical actions to manage risks from climate impacts, protect communities and strengthen the resilience of the economy. In the specific case of agriculture conditions, adaptation helps farmers achieve their food, income and livelihood, security objectives (Kandlinkar and Risbbey, 2000). Indeed, following the negative impacts of climate change on agriculture, climate change adaptation is increasingly becoming an area of growing interest and engagement for many developing countries that unfortunately bear the brunt of an over-heating planet (Stanley, 2012). Adaptation is therefore critical and of great concern in developing nations, especially in Nigeria where agriculture is still predominantly rain-fed, high vulnerability and low adaptation capacity (Hassan and Nhemachina, 2008).

Over the years, human societies have developed the capacity to adapt to environmental changes and climate variability. Such adaptations as practicing shift cultivation, adopting new crop, varieties, modifying grazing patterns and crop rotation are familiar even at a time when climate change was not an issue as it is today. In Nigeria, such common adaptation measures include the use of new crop varieties, irrigation, crop diversification, mixed-crop-livestock farming system and changing planting dates (Bradshaw, Dolan and Smith, 2004). FAO (2009) however opines that these traditional coping mechanisms which are generally prevalent in Nigeria are not sufficient for dealing with medium to long-term impacts of climate change. The speed and intensity of climate change are outpacing the speed of those autonomous actions and threaten the ability of poor and rural societies to cope. Hence innovative or modern technology is expected to play a critical role in the mitigation of an adaptation of climate change (IISD, 2005). Unfortunately, there is paucity of relevant government policies in this regard.

To cope with or mitigate the impacts of climate change on livestock, a number of adaptation measures have also been adopted in Nigeria. Brussel (2009), opined that providing shelter to livestock, introducing more heat tolerant livestock breeds, and adapting heat. Stress conditions can reduce the effects of climate variability on livestock. Nwalieji et al, (2014) observed effective adaptation measures to fish farming as improved varieties of fish, stopping environmental stresses such as habitat destruction, pollution and over-fishing among others. Nwosu and Ogbu, (2011), suggested the following measures – environmental modification, selective breeding and modification in the nutritional environment of animals. To note is that this is a suggestion and therefore not in place to the level of impacting positively as expected.

With regard to forestry, the situation is much more pathetic. The demand for energy among the rural populace, the unregulated logging and others, have not helped matters. FAO is closely involved with UNFCCC efforts to reduce emissions from deforestation in developing countries. This is aimed at mitigating climate change, and has adaptation capacity of preserving specie richness, continuity of forest ecosystem and resilience. As noted above by IPCC (2007), agriculture is responsible for over a quarter of total global greenhouse gas emissions, therefore innovative agricultural practices and technologies can play a role in climate mitigation and adaptation. Such innovative technologies and practices include improved weather prediction, water conservation, sustainable soil management and improved crop varieties among others.

Brussel(2009)noted that adaptation measures to climate change in agriculture ranges from technological solutions to adjustments in farm management or structures and to political changes such as adaptation plans. The practice of organic agriculture is one of the most important measures for adaptation to climate change used by farmers. According to International Federation of Organic Agricultural Movement, IFOAM (2007), organic agriculture is a holistic production management system which enhances agro-ecosystem health, utilizing both traditional and scientific knowledge. This prevents nutrients and water loss through high organic matter content and soil fertility is maintained mainly through farm internal inputs (organic manure, legume production, wide crop rotation), rejection of energy demanding synthetic fertilizers and plant protection agents with less or no use of fossil fuel (FAO, 2008).Unfortunately, most of the agricultural businesses prevalent in Nigeria are smallholding. They lack the technology and even the wherewithal to engage in organic agriculture. The consequence is that they have impacted positively little on mitigating the impact of climate change. Government focused policy response and action are near to absent

5. Dealing with the Challenges of Agricultural Adaptation

We can sum the challenges facing agricultural adaptation in Nigeria under the rubrics of socio-cultural, economic and political factors. Socio-culturally, the prevalent land tenure and fragmentation system limits the capacity of farmers to adapt to climate change. Fragment nature of farmland hinders the farmers` capacity to adopt innovative farming practices that may be necessary for climate

change adaptation. IFAD (2010) reported that about 90% of Nigerian food is produced by small holder farmers who cultivate small plots of land, usually less than 1 hectare of land per household. Lack of education, information and training are also frequently key limiting factors to climate adaptation.

Economically, lack of access to credit or saving is a major factor limiting farmers' adaptability to climate change. Deressa (2008) in his analysis of barriers to adaptation to climate change in the Nile basin of Ethiopia indicated that lack of money is a major constraint to adaptation by farmers. This equally applies to Nigeria. There are scanty and ill-equipped weather stations and agricultural infrastructure (Odjugo, 2010).

Politically, lack of conducive and stable policy environment has generally been lacking in Nigeria as successive governments most often make a u-turn on policies put in place by predecessors. Atser (2007) stated that weak infrastructure and inconsistency in government policies has always been a major snag in the development of agriculture in Nigeria.

To deal with the challenges, there is, firstly, the need to radically depart from reliance on rain-fed food production through heavy utilization of irrigation. Also the need for adequate drainage infrastructure. These are regarded as crucial for climate change adaptation. Secondly, Nigerian government should take bold steps to establish better-equipped weather stations as against the scanty and ill-equipped ones that are currently in Nigeria. With this accurate weather-forecast, predictions will be possible and this will help to prevent weather-related disasters through early warning and effective response adaptation system. Getting the necessary information to the illiterate smallholders becomes also pertinent. Thirdly, with increasing rate of current rainfall patterns, drought and desertification, drought resistant and short duration high yielding crops should be developed through research efforts and made available to farmers. This challenges research institutions in Nigeria which are presently not doing enough in this regard. Fourthly, improved agricultural technology by government and other stakeholders are very necessary for agriculture to be able to cope with climate change. Government and industries, especially the finance sectors are not doing enough. Finally, government must develop the will to make and enforce relevant laws and maintain policy consistency. The problem of Nigeria is not in making appropriate laws. In fact, it can be argued that Nigeria has fairly significant number of laws to deal with impact of climate change. What Nigeria lacks is the will to invoke and enforce laws. This must change.

6. Conclusion

Climate change is already beginning to transform life on earth including Nigeria. If Nigeria doesn't act now, climate change will rapidly alter the lands and waters she depends upon for survival. Climate change and agriculture are inter-related processes. Agricultural practices such as bush burning deforestation, use of chemical fertilizers, which are rampant in Nigeria, are found to induce climate variability and agriculture in turn bears the brunt effects of this climate change with consequences for the economy. The negative effects of climate change are felt in form of temperature variability, heavy flooding, increase in incidence of diseases and pests, crop failure, late arrival of rain and early retrieval of rain, poor livestock performance, desertification, fish mortality and low stocky rate among others.

So many adaptation measures have been put in place to tackle or mitigate the effects of climate change in agriculture, both traditional and Technological measures such as – shifting cultivation, mix cropping, modifying grazing pattern, adopting new breeds of livestock and crop varieties, irrigation and organic agriculture. Selective breeding was found to reduce the effect of climate change on livestock. Improve varieties of fish and stopping of environmental distresses such as habitat destruction, pollution and over-fishing and finally reduction of emissions from deforestation. These adaptations when available in Nigeria are not without challenges. Land tenure and fragmentation systems, lack of access to credit or savings, and unstable government policies were found to be limiting factors and must be addressed for the betterment of the socio-economic development of Nigeria.

7. References

- i. Ajodejuwon, S.A. (2004). The Impact of Climate Change variability and climate change on crop yield in Nigeria. Contributed to the standard Workshop on Assessment of Impact and Adaptation to Climate Change (ALACC)Obafemi Awolowo University
- ii. Allison, I (2010).The science of climate change: questions and answers. Canberra: Australian Academy of Science.
- iii. Atser, G. (2007), Stakeholders: Demand Scrutiny of 2007 Budget. Retrieved June 7, 2015 from <http://www.budgetmonitoring.ng.org>.
- iv. Bradshaw., B, Dolan, H. & Smit; B. (2004). Farm-Level adaptation to climate variability and change: Crop diversification in the Canadian prairies. *Climate Change research*. 67: 119 – 141.
- v. Cline, W.R. (2008), *Global Warming and Agriculture, Finance and Development* (International Monetary Fund) 45 (1). Accessed 17 August.
- vi. Dai, A (2011) Drought under global warming: A review. *Wiley Interdisciplinary Reviews: Climate change* 2: 45 – 65
- vii. Dresser, T. Hassen, R.M; Alemu, T; Yesuf, M and Ringler, C (2008). Analysing the determinants of Farmers' Choice of Adaptation Method and Perceptions of Climate change in the Nile Basin of Ethiopia. International Food Policy Research Institute (IFPRI) Discussion paper. No 00798. Environment and Production Technology Division, IFPRI, Washington D.C.
- viii. Eze, C.E.P. C. Eboh, O.R. (2011). Technological Challenges of climate change adaptation in Nigeria: Insight from Enugu State, African technological policy studies network. Technology brief No. 24.
- ix. Fesona M, and Omojola S. A (2005). Climate Change Human Security and communal clashes in Nigeria
- x. Food and Agriculture Organization, FAO, (2006). Livelihood adaptation to climate variability and change in drought-prone areas of Bangladesh, Rome

- xi. Food and Agriculture Organization, FAO (2007). Climate Change and food Security, United Nations Joint press for Ball Climate change conference 3 – 14 December, 2007
- xii. Food and Agriculture Organization FAO (2009). Climate change and agriculture policies; How to mainstream climate change adaptation and mitigation into agriculture policies, Rome: FAO
- xiii. Garba A. (2006). Alleviating Poverty in Northern Nigeria. Being a paper presented at the Annual Convention of Zumunta Association at Minneapolis United State of America from July 28 – 29, 2006.
- xiv. Hassan R and Nhemachina C. (2008). Determinants of African farmers' strategies for adapting to climate change: Multinational choice analysis. *African Journal of agricultural and resource economics*. 2008; 2 (1): 83 – 104.
- xv. Hoffmann, U (2013). Agriculture - a key driver and a major victim of global warming, in: Lead Article, in: Chapter 1, in Hoffmann, U. ed., *Trade and Environment Review 2013: Wake up before it is too late: Make agriculture truly sustainable now for food security in a changing climate*, Geneva, Switzerland: United Nations Conference on Trade and Development (UNCTAD)
- xvi. Ikeme, J. (2009). Assessing the future of Nigerian's economy: Ignored threats from the global climate change debacle. *Africa Economic Analysis* vol. 1.2
- xvii. International Federation of Organic Agriculture Movement, IFOAM (2007). Organic agriculture's role in countering climate change. IFOAM, Germany.
- xviii. International Institute for Sustainable Development, IISD (2005). Climate Change and Technology (paper 2), 161 Manitoba, Canada.
- xix. Intergovernmental Panel on Climate change, IPCC (2001). Climate change 2001: Impacts, adaptation, vulnerability. Contribution of working Group 1 to the third assessment report of the intergovernmental panel on climate change, Geneva: UNEP/WMO
- xx. Intergovernmental Panel on Climate Change, IPCC (2007). Summary for Policymakers: Current knowledge about future impacts. M.L. Parry et al. (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- xxi. Kandlinka M and Risbey J (2000). Agricultural Impacts of climate change: If adaptation is the answer, what is the question. *Journal of agriculture and environmental*, vol. 10, ppp 100 – 110.
- xxii. Lobell DB, Burke MB, Tebaldi C, Mastrandrea MD, Falcon WP, Naylor RL (2008). Prioritizing climate change adaptation needs for food security in 2030". *Science* 319 (5863): 607–10.
- xxiii. Medugu, N.I (2009). Nigeria Climate change, threat to the country's Development Retrieved from <http://www.allafrica.com>. on 15th of June 2015
- xxiv. Nhemachena, C. C. Hassan., (2007). Micro-Level Analysis of farmers' adaptation to climate in Southern Africa. IFPRI Discussion paper No 00714. International food research Institute. Washington D.C
- xxv. Nigerian Environmental Study Team (2004). Regional Climate Modeling and Scenarios development in support of vulnerability and adaptation studies. Outcome of a regional climate modeling efforts over Nigeria, Nigerian environmental study/action team (NEST), Ibadan
- xxvi. Nwalieji H.U, Uzuegbunam Co. O and Ezigbo R.C. (2014). Effect of Climate Change on fish farming in Anambra State, Proceedings, 19th Annual National Conference of the Agricultural Extension Society of Nigeria held at the Federal University of Agriculture, Owerri, Imo State from 27th – 30th April, 2014
- xxvii. Nwosu C.C. and Ogbu CC, (2011). Climate Change and Livestock production in Nigeria: Issues and concerns. Vol. 10 No 1
- xxviii. Nzeh, C.E.P & Eboh, O. R (2011). Study of Technological and Farming Systems Adaptation to Climate Change in Farming Communities of Enugu State, Nigeria. African Technology Policy Studies Network, Research Paper No. 5 Published by the African Technology Policy Nairobi, Kenya
- xxix. Obiorah, E. (2008). Climate change, population drift and violent conflict over land resources in North Eastern Nigeria: *Journal of human ecology*, 23 (4): 311 – 342.
- xxx. Odjugo, P.A.O (2010). General overview of Climate change impacts in Nigeria. *Journal Human Ecology*, 29(1): 47 – 55
- xxxi. Orindi A. V & Murray, L.A. (2005). Adapting to climate change in east Africa: A strategic approach, gatekeeper services, 117, International Institute for environment and development, IIED, London
- xxxii. UNESCO/UNEP (2011). Climate Change Starter's Guidebook: An issues guide for education planners and practitioners. Paris: United Nations Educational, Scientific and Cultural Organization and the United Nations Environment Programme
- xxxiii. Unilever (2015). What is Climate change. How can we take action? Retrieved from <http://brightfuture.unilever.us/stories/423885/what-is-climate-change-how-can-we-take-action.aspx>
- xxxiv. Wikipedia (2015), Climate Change and agriculture Retrieved from <http://en.m.wikipedia.org/wiki/climatechangeandagriculture> Retrieved 28/9/15.
- xxxv. www.britannica.com
- xxxvi. www.history.noaa.gov/nwsbios/
- xxxvii. <http://www.nature.org>
- xxxviii. www.skepticalscience.com
- xxxix. www.nrdc.org/globalWarming/fcons/asp