COMBATING CLIMATE CHANGE FORSUSTAINABLE FOOD SECURITY IN NIGERIA: INTERSECTING SCIENCE WITH THE LAW.

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Abstract

Climate change has threatened the world's environment, rendering human life vulnerable across all regions of the globe. The trend is not different in Nigeria, where drought, heavy flood, desertification, recession of the Lake Chad and other water sources, etc, have all combined to threaten sustainable food security. Climate change is a global issue currently. Environmental engineers and space scientists insist that climate change is persistent. Its impacts are not limited to agricultural production and prices, trade and food sufficiency but extend also to environmental conditions like water resources, land use and coastal infrastructure, among others. Addressing climate change concern to promote sustainable food security and the overall environmental sanity requires the law as an instrument of social engineering to intersect with science to guarantee tangible progress on implementation of mitigation and adaptation strategies in the environment and agricultural sector in particular. This paper is imperative in this era when states are facing food shortages and famine due to draught, flood and allied adverse weather conditions occasioned by climate change. Doctrinal research method was adopted to explore the role of the law in combating climate change for sustainable food security in Nigeria relying on information from primary, secondary and interdisciplinary sources. It was found, *inter alia,* that science needs to intersect with the law for improvement of agricultural infrastructure, adaptation and mitigation strategies for rapid responses and innovations in agriculture. We recommended, *inter alia*, agricultural research funding and development of new agro-technologies, ecological agriculture, mechanization of agriculture and engaging more youth in agriculture; establishment of legal and institutional framework necessary for effective implementation of adaptation and mitigation strategies to address the impacts of climate change in Nigeria.

Keywords: Climate Change, Law, Environment, Sustainability and Food Security.

1. Introduction

Climate change is one of the greatest challenges facing mankind in the present generation. It is a process by which the Earth's climate system responds to altered concentration of greenhouse gases (GHGs) in the atmosphere.[1] Science proves that the greenhouse effect is a natural process that regulates the earth's temperature by keeping the earth warmer than it ordinarily ought to be, thus

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[1]O. G. Amokaye, *Environmental Law and Practice in Nigeria* (Lagos: University of Lagos Press, 2004), 405.

enabling the earth to absorb energy from the sun in the form of solar radiation. When this happens, about one-third of this energy is reflected leaving the rest to be absorbed by different other components of the climate system such as the atmosphere, the ocean, the land surface, and the biota.[2] The energy so trapped by the earth is then balanced over a period of time by outgoing radiation of the earth's atmospheric system which takes the form of long waves and invisible infrared energy. The magnitude of the outgoing radiation is affected partly by the temperature of the earth's atmospheric system.[3]Similarly, anthropogenic factor contributes to increasing atmospheric concentration of GHGs and aerosols which could occasion regional and global warming.[4]There is observed increase in the altitude of climate change impacts in Nigeria as well as in other developing countries over the years.[5] Seasons of the year are occurring irregularly, there is more frequent occurrence of drought, heat is becoming more intense, there is unprecedented level of flooding in coastal areas, rainfall starts late and ends earlier than usual, there is persistent low crop yield, high level of pests and diseases invasion of farms, etc. All these are products of climate change feedbacks. Climate change is in turn necessitated by both anthropogenic and natural factors.[6]The Intergovernmental Panel on Climate Change reports three key findings in relation to climate change as follows:

a. Human influence on the climate system is manifest;
b. The more we disrupt our climate, the more we risk severe pervasive and irreversible impacts;
c. We have the means to limit climate change and build more prosperous, sustainable future.[7]

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[2]*Ibid*

[3]J. T. Houghton, B. A. Callander and S. K. Varney (eds.) *Climate Change: The Supplementary Report to the IPCC Scientific Assessment, IPCC 1992* (Cambridge: Cambridge University Press, United Kingdom and New York, NY, USA, 1992), 200.

[4]Global warming is used to describe an increase in the average global temperature, climate and climate related parameters such as temperature, precipitation, soil moisture and sea level. The major anthropogenic (man-made) GHGs which contribute to global warming and should be regulated include: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O) and Chlorofluorocarbons (CFCs).

[5]S. Weart,*The Discovery of Global Warming* (Cambridge: Harvard University Press, 2003), 240.

[6]Data from the National Bureau of Statistics (NBS - a Nigerian data gathering agency) indicate variation in such climatic elements as rainfall and temperature. For example, the mean annual rainfall in Akwa Ibom, Ondo and Rivers States was as high as 2,618.6mm, 1,699.5mm and 1,644.8mm respectively in 1994. This decreased to 180.2mm, 121.2 and 203.1mm respectively in 2004 (NBS, 2005; 2007). It is obvious from the foregoing that both local and global actions exert negative consequences on the climatic conditions of Nigeria.

[7]IPCC 5th Assessment Report of November 2014.

Scientists and Space Engineers maintain that the average temperature of the earth is on the increase.[8] Environmental experts posit that there is continuous emission of greenhouse gases into the environment due to industrialization and urbanization culminating in global warming.[9]Global warming has been linked to the emission of greenhouse gases which produce greenhouse effects and heat up the environment. Among other gases of greenhouse effects include: carbon monoxide and carbon dioxide which are produced by power stations, industrial processes and transportation; methane arising from decomposition of organic wastes in landfills, herds of cattle; nitrous oxide arising from livestock production; chlorofluorocarbons (CFCs) which depletes ozone layer – the natural layer that shield the earth from the ultra violet rays of the sun, etc.[10]These Climate Change vagaries which are manifestly evident in our everyday lives motivated this paper. Apart from being the researcher's contribution to the climate change campaign, this paper will apprise both policy makers, policy executors and the general public on the need to revert climate change altitude and avert its attendant multidimensional impacts.

2. Conceptual Framework

2.1 Conceptualizing Climate Change

The concept of climate change is often used to denote changes in the statistical distribution of weather patterns occurring for an extended period of time.[11] The Intergovernmental Panel on Climate Change (IPCC) sees climate change as a variation in the mean state of the climate, persisting for an extended period of time (typically decades or longer).[12] According to the United Nations Framework Convention on Climate Change (UNFCCC), climate change is a change of climate 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.[13] Nwosu observes that climate change is 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

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[8]The US National Aeronautic and Space Administrator and the British Meteorological Office reported in 1991 that the earth was overheating since the previous years.

[9]J. T. Houghton, B. A. Callander and S. K. Varney, *op. cit.*

[10]O. A. Fagbohun, "Law and Climate Change in Nigeria" A Paper presented at the 2010 Edition of the Faculty of Law, University of Ilorin Law Workshop on the 13th May 2010; available at http://www.africaportal.org>publicationspdf. Accessed last on August 4th 2020.

[11] "Climate Change" available at http://www.en.wikipedia.org/climate-change. Accessed last on 10th August 2020.

[12]IPCC 5th Assessment Report of November 2014

[13]United Nations Framework Convention on Climate Change of 21st March, 1994.

results in degradation of an environment.[14]According to Ikehi and Zimoghen, climate change refers to the variation in the statistical distribution of the average weather conditions over a prolong period of time.[15]Climate change, in the words of Onu and Ikehi, is weather changes, including steady alteration in usual temperature (rise or fall), rainfall regime (pattern or intensity), wind, relative humidity and solar radiation over time.[16]Climate change is one of the foremost environmental problems threatening the survival of the earth. Emeka posits that climate change '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 life on earth.'[17]

2.2 The Law

The hurdle of dissecting jurisprudence in order to expose the theories on the meaning of law is considered outside the scope of this paper. We rather intend to give a brief outline of such meaning of law that meets the precision of this context for the sake of our non-legal readers. Malemi sees law as a rule regulating the behaviours of persons and bodies in order to ensure an orderly, safe, progressive and free society.[18]Nnabue defines law as a rule of human conduct, imposed upon and enforced among the members of a given state.[19]According to Omeregbe, law prescribes how things should be done or how men should behave.[20]Nnabue is of the firm belief that law is a window through which one views the values of life and whose foremost function is to translate societal values into legal norms.[21] Such legal norms are distinguished from social and moral norm by its obligatory nature which obligation is enforced with sanction or threat of same for effective enforcement. By law therefore, we mean any organized rules or codes

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[14]L. E. Nwosu, "Climate Change and Food Security: Implication for Effective Agricultural Extension Services in Nigeria. Proceedings of the 17thAnnual National Conference of Agricultural Extension of Nigeria (AESON) 2012.

[15]M. E. Ikehi and J. Zimoghen, "Impacts of Climate Change on Fishing and Fish Farming in the Niger Delta Region of Nigeria."(2014) *Direct Research Journal of Agriculture and Food Science*; 3(1), 1-6.

[16]F.M. Onu, M. E. Ikehi, "Mitigation and Adaptation Strategies to the Effects of Climate Change on the Environment and Agriculture in Nigeria" *(2016) Journal of Agriculture and Veterinary Science (IOSR-JAVS) Volume 9, Issue 4 Ver. I; 26-29*

[17]D. O. Emeka, "Impact of Climate Change on Livelihood Sustainability in the Lake Chad Region of Nigeria"In: L. Popoola, (ed.) Proceedings of 32ndAnnual Conference of Forestry Association of Nigeria (FAN), Umuahia, Abia State 20– 24 November, 2008; 152-153.

[18] E. Malemi, *The Nigerian Legal System* (2nd edn., Lagos: Princeton Pub., 2012), 5 & 7.

[19] U. S. F. Nnabue, *Law and Legal Process* (Rev. edn., Owerri: Global Press Ltd., 2004), 20.

[20] J. Omeregbe, *An Introduction to Philosophical Jurisprudence* (Lagos: Joja Publishers, 1994), xvi.

[21]J. Omeregbe, op cit., 7.

promulgated by the state and acted upon by the court as a means of regulating human conducts for peace and orderliness in a given society.

2.3 Sustainable Food Security

Food security denotes two things: (a) availability of food (b) accessibility to food by household.[22] Any household is said to be food secured if its occupants do not

live in hunger or fear of starvation. The World Food Summit of 1996 asserts that food security entails all people at all times having access to sufficient, safe, nutritious food to maintain a healthy and active life.[23]Commonly, the concept of food security is defined as including both physical and economic access to food that meets people's dietary needs as well as their food preferences. Food security incorporates a measure of resilience to future disruption or unavailability of critical food supply due to various risk factors including droughts, shipping disruptions, fuel shortages, economic instability, and wars. The World Food Summit of 1996 asserts that

> …neither food nor famine can be used as a national or international political weapon. Access to food cannot be denied to any nation, ethnic or social group for political, economic, religious or other reasons. Economic embargoes or international sanctions affecting populations are incompatible with food security. Those currently in place must be terminated.[24]

The United Nations expressed keen concern that by the end of 2013 that worldwide around 852 million people are chronically hungry due to extreme poverty, while up to 2 billion people lack food security intermittently due to varying degrees of poverty. 17,000 children die of hunger and malnutrition related diseases every day, which equals 6 million children who die of hunger every year. This situation is an affront to human dignity, a social disease and a threat to democracy. The UN recommended urgent strong measures to deal with the

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[22]Food stability, food access and food availability are associated terms. While food stability has to do with the ability to obtain food over time, food access denotes the affordability and allocation of food, as well as the preferences of individuals and households and food availability involves the supply of food through production, distribution, and exchange.

[23]Report of the World Food Summit13-17 November 1996, UN FAO (Rome: FAO, 1996) available online at: http://www.fao.org/3/w3548e/w3548e00.htm; accessed on 26th Sept, 2020; T.J. Ballard, A.W. Kepple, C. Cafiero, *The Food Insecurity Experience Scale: Developing a Global Standard for Monitoring Hunger Worldwide*(Rome: FAO, 2013), 1 – 10.

[24] Report of the World Food Summit, op cit. note 23.

persisting hunger and food insecurity which may otherwise worsen dramatically in some regions of the world.[25]

Food security is therefore not just a poverty issue but a more encompassing issue that involves the whole food system and affects every one of us in some way.

Issues such as whether households get enough food; how such food is distributed within the household and whether that food fulfills the nutrition needs of all members of the household, show that food security is clearly linked to health. Global Food Security must exist to meet the challenge of providing the world's growing population with a sustainable, secure supply of good quality food.[26]The United States Department of Agriculture (USDA) explains that food security for a household means access by all members at all times to enough food for an active, healthy life.[27]The Food and Agriculture Organization of the United Nations (FAO) identifies the four pillars of food security as availability, access, utilization, and stability.[28]The United Nations recognizes the Right to Food in the Declaration of Human Rights in 1948 and has since said that it is vital for the enjoyment of all other rights.[29]Two key elements of this definition are: (a) the ready availability of nutritionally adequate and safe foods. (b) an assured ability to acquire acceptable foods in socially acceptable ways (that is, without resorting to emergency food supplies, scavenging, stealing, or other coping strategies).

Food security, as defined by the United Nations' Committee on World Food Security, means that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life. Over the coming decades, a changing climate, growing global population, rising food prices, and environmental stressors will have significant yet uncertain impacts on food security. Adaptation strategies and policy responses to global change, including options for handling water allocation, land use patterns, fo od trade, postharvest food processing, and

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[25]*Food and Agriculture Organization (November 1996).* "Rome Declaration on Food Security and World Food Summit Plan of Action*;* accessed on 26th Sept, 2020.

[26]*Food and Agriculture Organization (November 1996).* "Rome Declaration on Food Security and World Food Summit Plan of Action" accessed 26th Sept. 2020.

[27]*USDA*."Food Security in the United States: Measuring Household Food Security"*; available at* https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/measurement.aspx*; .accessed on 26th Sept. 2020*

[28]UN*FAO,* Declaration of the World Food Summit on Food Security (Rome: FAO, 2009). accessed 26th Sept. 2020

[29]International Covenant on Economic, Social and Cultural Rights 1966: article 2(1), 11(1) and 23

food prices and safety are urgently needed.[30]Food security is affected by such factors as:

a. **Global Water Crisis**. Climate change has affected water distribution patterns and availability of rain. Seasons now occur irregularly; rainy seasons now start later and end earlier usually with heavy flood in Sub-Sahara Africa. Lake Chad is receding, water table reserves are falling in many other countries like Northern China, the United States of America and India due to widespread over-pumping and irrigation.
b. **Climate Change**. Rising global temperatures are beginning to have ripple effects on crop yields, forest resources, and water supplies and altering the balance of nature.
c. **Land Degradation**. Intensive farming leads to a vicious cycle of exhaustion of soil fertility and decline of agricultural yields. Industrialization and urbanization have taken heavy tolls on land availability for farming. Bush fallow and crop rotation.[31]
d. **Greedy Land Deals**. Corporations and Governments buying rights to millions of acres of agricultural land in developing countries to secure their own long-term food supplies affect food security. Also use of land for recreational facilities and other allied uses have affected availability of land for food production.

Developing nations, Nigeria inclusive, are more vulnerable to climate change effects and more incapable of battling the resultant challenges owing to paucity of fund, insufficient technology, and poverty and population pressures.[32] These developing nations are highly dependent on climate-induced activities. Nigeria, for instance, is dependent on rain-fed agriculture, livestock and hydropower generated energy for electricity.

3. Theoretical Underpin

3.1 Anthropocentric Theory

The anthropocentric philosophy postulates a separatist approach to environmental components. Accordingly, man is presented as being separate from the rest of other components of the environment and nature. This theory, in effect, believes that the rest of the earth's resources are means to human end and should be seen and utilized as such. This is human-centered to the effect that the welfare and

[30]International Food Policy Research Institute, Food Security available at https://www.ifpri.org/topic/food-security; accessed on 26th Sept, 2020.

[31]Land practices that help land regain its fertility are no more practicable presently due to land unavailability.

[32]U. Cubasch and R. Voss, "The Influence of Total Solar Irradiance on Climate" (2000)*Space Sci. Rev.*94, 185–198.

needs of mankind should be accorded a prime of place in any environmental regime. Once the welfare, needs and wellbeing of the mankind is achieved, whatever becomes of the environment is secondary and immaterial.[33]Ardent anthropocentric philosophers believe that man is the central unit of the environment. This school, though, does not deny other non-human components of the environment their intrinsic value; however insist that the values of the nature's resources are dependent on the extent to which they can satisfy human primary interests.[34] The dominion principle was further articulated into mechanistic philosophy to advance the course of industrial revolution by the early philosophers. According to Bacon,[35] "all creation had meaning only in relation to humanity". Advancing his position further, he maintained that "[M]an, if we took to the final causes, may be regarded as the centre of the world in so much that if man were taken away from the world, the rest would seem to be all astray, without aim of purpose." This view, from all intents and purposes, regards the earth as a fertile gift to be unlocked and exploited through the scientific tapping of both its physical and chemical dynamics.[36]Keles summarizes the gamut of this theory thus:

> As is well known, anthropocentricism assumes that nature exists to serve man...to attribute value to things of nature based on whether or not they benefit human beings is regarded as investments of man's survival or well being. This is the basis of the anthropocentric view which presupposes that the effects of our actions in non-humans are morally significant only if they have consequences for human.[37]

3.2 Ecocentric Philosophy

This theory firmly believes that man, animals and plants have their innate values as part of the ecosystem. This is a more holistic approach to the environment. Natural ecosystem is assigned intrinsic value vis-a-vis animals and mankind. Proponents of this philosophy maintained that plants have intrinsic rights to conservation not dependent upon the uses to which they can be made by animals

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[33]J. Thornton and S. Beckwith, *Environmental Law*, (2nd Edn,London: Sweet & Maxwell Ltd, 2004), 10.

[34]O. G.Amokaye, *Environmental Law and Practice in Nigeria* (Lagos: University of Lagos Press, 2004), 11.

[35]AD 1561 – 1626

[36]D. Pepper,*Modern Environmentalism: An Introduction* (1st edn, Oxfordshire: Routledge, 1996), 35.

[37]R. Keles, "Biocentric Ethics and its Relevance to the Goals to Biopolitics Education" In: Laszlo Kapolyi (ed.), *Bio-Politics: The Bio-Environment* Vol. 7. Budapest, Hungary andAthens, Greece, 1999),14.

and humankind. All the species of the ecosystem ranging from the smallest unicellular organism to the biggest multi cellular organism and all kinds of plants play assigned roles in the food chain, food web and energy release, conditioning and assimilation processes for a balanced earth. Again, Keles posits that:

> Economic ethics is certainly a holistic rather than an individualistic ethics and as such, it serves a better reminder of our responsibilities to the natural world and to animals. It seeks to avoid the moral hierarchy implicit in traditional theories. It suggests giving moral considerations non-human objects and ecological systems. The preservation of biological values and diversity is the main goal of this approach.[38]

3.3 Sustainable Development Theory

While anthropocentrism places man at the centre of his environment and measure the innate values of other components of the environment by the extent to which man can utilize them to satisfy his needs, the deep ecologists focuses mainly on the ecosystem presenting man as a mere sub-set of the natural order. Eco-centric proposition therefore has a long term perspective, albeit, does not correctly demonstrate the dynamics of ecosystems, since *aprori*, it denies the possibility of harmonizing, or the interplay of the natural and socio-cultural development.[39]The position of the eco-centric philosophy could not fill the *lacuna* in the interface and interplay of the natural resources, environmental justice and order especially given the uniqueness of man from other living organisms.

In other words, man-made systems have special features and potentialities and influence on the earth, thus, cannot be dismissed with a wave of the hand. Man continuously pursues his desires for survival, which survival, man now sees in technological development which inherently is a corollary to proliferation of factories, smelters, oil refineries, noisy machinery and blasting, which also contribute in no mean measures to the degradation of the environment.[40]Realistically, the coexistence of man-made systems and the ecosystem is attainable and this depends primarily on the harmonization of decisions to achieve a balanced order. In response to this therefore another school of thought, the sustainable development school was developed. The postulation of

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[38]R. Keleş, "General Legal Framework For Sustainable Land-Use and Management as Designed by International Environmental Law" (2008), 36th International Symposiumof the European Faculty of Land-Use and Development, Zurich, Switzerland, September 25–27.

[39]Amokaye, *op. cit*., 14

[40]*Ibid*

this school tends to strike a balance between anthropocentrism and economic theory. This school posits that the link between man and his natural environment is sustainable development. Development is traditionally conceived in terms of a country's ability to provide for her citizens all the basic needs of life – food, clothes and shelter. It also means availing her citizens with the opportunity to contribute to the very process through employment as well as scientific and technological breakthrough.[41] Development similarly encapsulates the process by which the national government provides infrastructural facilities and mechanisms for the diversification and dissemination of the productive base of the state in order to ensure the attainment of the pressures and the necessities of such a state for the present and future.[42]The UN Declaration on the Right to Development declares that:

> Right to development involves the interest of developing countries to control and enhance their own development (including the right to exploit its natural resources, the right of all people to enjoy a minimum quality of right[43]
>
> From the Declaration above, it is evident that development is a comprehensive process that involves political freedom and equality of opportunity for all in their quest to access the basic resources - education, health services, food, housing, employment and the fair distribution of income.[44]Each human being is so entitled to participate in, contribute to and enjoy economic, social, cultural and political development through which the full realization of all human rights and fundamental freedoms is possible. The strategy should foster participation and ownership and should embrace the public and private sectors, the community, families and the individuals. This approach would place the human person at the centre of the development paradigm:[45]
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> Development in a broader international perspective embraced four related concept of peace and security,

[41]M.Decleris,The Law of Sustainable Environment, General Principles: A Report for the European Commission (Luxumburg: 2000) available at <http:/www/eoropa.en.int> visited last on 14th Sept. 2016.

[42]*Ibid*

[43]Amokaye, *Op. Cit*.

[44]*Ibid*

[45]UNGA Resolution 41/128 Annex, Dec. 4th 1986.

> economic development, social development, and national governance that secure peace and development.[46]

Sustainability on the other hand is concerned with harmonization and attainment of equilibrium between man and his environment for the realization of continued co-existence of both within the earth's surface. In the words of the BrudthlandReport, it means 'development that meets the needs of the present without compromising the ability of the future generation to meet their own needs...'[47]

Sustainability includes:

> a process of change in which exploitation of resources, the direction of investments, the orientation of technology development, and institutional change are all in harmony and enhance both current and future potentials to meet human needs and aspirations.[48]

Sustainability therefore embraces the conservation of the ecosystem as an eternal source of natural resources for man. Sustainability of the ecosystem is said to exist where restraints is exercised in the exploitation of the natural resources of the earth by man for any kind of development. It is usually conceived in terms of (a) conservations and recovery of the adequate natural resources to enthrone a qualitative development policy (b) integration of environmental, cultural, social and economic criteria in the planning and execution of developmental policies in both public and private sector.[49]

4. Right to Food

Both international and municipal legal regimes provide for right to food. Right to food is guaranteed by sustaining global food security as well as that of a given state. The Universal Declaration of Human Rights (UDHR) 1948[50] provides that:

> Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family,

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[46] *Ibid*

[47] C. A. Omaka, *Nigerian Conservation Law and International Treaties* (2nd edn, Princeton & Associates Publishing Co. Ltd, 2018), 11.

[48] C. A. Omaka, op cit. This is also captured in the Bariloche Report which stresses the restructuring of the world's economy to deal with the twin objectives of providing human needs as well as safeguarding the environment.

[49] M. Robinson, "Constructing an International Financial Trade and Development Architecture: The Human Right Dimension" in H. I, Steiner and P. Alson (eds) International Human Rights in Context, Law, Politics and Morals, 2nd edn (London: OUP, 2002),1311 – 1312.

[50] Article 25(1).

> including food, clothing, hou sing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.'

Article 11 (1) and (2) of the International Covenant on Economic, Social and Cultural Rights (ICESCR), 1976 recognizes "the right of everyone to an adequate standard of living for himself and his family, including adequate food and the fundamental right of everyone to be free from hunger" The UN Committee on Economic, Social and Cultural Rights (CESCR) in its General Comment No. 12of 1999 noted that right to adequate food:

> …is indivisibly linked to the inherent dignity of the human person and is indispensable for the fulfillment of other human rights enshrined in the International Bill of Human Rights. It is also inseparable from social justice, requiring the adoption of appropriate economic, environmental and social policies, at both the national and international levels, oriented to the eradication of poverty and the fulfillment of all human rights for all.[51]

Although the General Comments are not binding *per se*, they constitute the authoritative interpretation of legally binding treaty provisions, issued by the UN body responsible for monitoring the application of the treaty.[52] The Convention on the Rights of the Child (CRC) 1989[53] provides for the right of every child to a standard of living adequate for the child's physical, mental, spiritual, moral and social development.[54]Article 24(2)(c) of the CRC requires states to combat child malnutrition and to take appropriate measures to assist parents in fulfilling their primary responsibility to implement children's right to an adequate standard of living particularly with regard to nutrition.[55]The Convention on the Elimination of all Forms of Discrimination against Women (CEDAW)1979[56] requires states to

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[51]Paragraph 4 of the UN Committee on Economic, Social and Cultural Rights (CESCR) General Comment No. 12of 1999available online at: https://www.refworld.org/pdfid/4538838c11.pdf; accessed on 2nd, October, 2020.

[52]*Lottie Lane, "*A Comparative Analysis of the General Comments and Jurisprudence of Selected United Nations Human Rights Treaty Monitoring Bodies" *European Journal of Comparative Law and Governance*Vol. 5 iss. 1(2018) pp. 5-88

[53] This became operational in 1990.

[54]Art. 21(1)

[55]Art. 27(3)

[56] This became operational in1981

ensure that women have adequate nutrition during pregnancy and lactation.[57] At the domestic level, the Constitution of the Federal Republic of Nigeria 1999 as amended provided for economic objective in section 16. According to section 16 (2)(d), 'the state shall direct its policy towards ensuring that … suitable and adequate food… are provided for all citizens. Section 13 places a duty on all arms of the government, all authorities and persons exercising legislative, executive and judicial powers to conform with, observe and apply chapter two of the constitution of Nigeria. Section 20 enjoins state to protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria. The combined effects of the foregoing provisions as well as Section33 of the constitution therefore places legal duty on the Nigerian state to manage her environment in a sustainable manner to guarantee food, healthy and humane living conditions for the citizens.

Climate change however poses a serious threat to agricultural sustainability and poverty alleviation on the poorest and most vulnerable regions as impacts affect the dependence on rain fed agriculture, results to increased high level of poverty, low level of human and physical capital development, inequitable land distribution and poor infrastructure development.[58] 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 were irrigation is seldom practiced. Agriculture is highly sensitive to climate change variability and weather extremes such as droughts, floods, and severe storms.[59] 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. 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 damager to existing infrastructure. Crop yield are affected by many factors associated with climate change which include temperature, rainfall, and other extreme weather events. Climate change is a contributing factor to food price crises, and its impacts on agriculture in developing countries in expected to get more serious.[60] From the foregoing, it becomes imperative that adequate adaptation and

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[57]Art. 12(2)

[58]A. P. Aluko, B. Oyeleye, O. N. Sulaiman, and I. E. Ukpe, "Climate Change: A Threat to Food Security and Environmental Protection. Proceedings of the 32ndAnnual Conference on Forestry Association of Nigeria. October, 2008.

[59]*Ibid*.

[60]B. K. Farauta, C. I. Egbule, Y. L. Idrisa, and V. C. Agu, "Perception of Climate Change and Adaptation Strategies in Northern Nigeria: An Empirical Assessment" African Technology Policy Studies Network Research Paper No. 15. 2011; available online at: http://www.atpsnet.org/Files/rps15.pdf; accessed 2nd October, 2020.

mitigation strategies be evolved to cope with the challenges and impacts of climate change on the environment and agriculture.

5. Manifestation of Climate Change

a. **Extreme Weather Intensity**: Warmer temperature can lead to more vigorous hydrological cycle yielding more severe droughts. This is consequent on the melting of glaciers and mountains snow caps that feed the world's rivers and supply greater portion of fresh water for drinking and irrigation; alteration in the occurrence or geographical distribution of hurricanes and other tropical storms, coastal flooding consequent upon the rise in sea level due to the melting of ice-based land sheets in Greenland and Antarctica causing coastal overflow and storm in many Islands and coastal areas.[61] It is predicted that if the trends of melting subsists, water stress may affect as much as 75 – 250 million people in Africa alone by year 2020.[62]

b. **Desert and Desertification:** Warmer temperatures render deserts more extremely hot. Trees are rendered more stunted and may wither and die in the long run. Temperature increase poses serious threat to organisms that exist near their heat-tolerance limits. Desertification may lead to increase in threatening "bad weather" events as heat waves, droughts, floods and severe storms.[63]

c. **Low Agricultural Productivity**: Climate change affects agricultural yield in many ways. Adverse weather conditions are counterproductive to agriculture. For instance, flood, droughts, erosion, windstorm, heat wave, pests and diseases are all products of climate change. It is projected that if this trend weather variability persists, food security will be threatened to as much as 50 percent yield decline by year 2020.[64]

d. **Loss of Forests:** Persistent increase in the mean annual temperature by as little as 1^0C can spark off significant changes in the growth and regenerative capacity of most tree species. This can greatly alter the function and composition of forests in several regions and cause forest covers to disappear entirely in other regions. This will also result in habitat loss for most species, social dislocation and high extinction rate of species due to their inability to adapt to rapidly changing climate and habitat conditions. It

[61]There is flood disaster in many parts of Nigeria affecting coastal cities like Jos, Makurdi and many parts of Benue, Lokoja and many parts of Kogi, Lagos, Ogun, Cross River, Ebonyi, Niger, Imo, Anambra, Delta, etc. even as we write this research.

[62]O. G. Amokaye, *op. cit.*

[63]In most parts of Nigeria, including Ebonyi State, there is severe drought and rain shortage from April to early August 2017 leading to crop failures.

[64]O. A, Fagbohun, *op cit.*

will as well interfere with natural processes like oxygen-carbondioxide balance and finally lead to the irreversible loss of biodiversity.[65]

e. **Loss of Biodiversity**: Climate change affects the distribution, population size, population density and behaviour of wildlife and, of course, vegetation. Climate change affects the temperature level of water. When fresh water is heated up, it leads to upwards movement of the boundaries of freshwater fish distribution. Fresh water or cold and cool water fishes lose habitat while warm water fishes gain habitat.[66] This means loss of habitat for fresh water fishes and could pose a threat of extinction to this class of fishes in the long run, thus loss of biodiversity.

f. **Loss of Pastures**: Again, loss of pastures for grazing is another direct effect of climate change, especially in Nigeria. Because climate change induced factors like the problem of rainfall variability and consequent drought causes depletion of pastures especially in the north, herdsmen in the core north, now push down South more frequently, in order to feed their cattle. Apart from long term effects of grazing to climate change, the issue of clashes between herdsmen and farmers, posing serious and prevailing social and security threat in Nigeria is another resultant off-shoot of this movement. This has metamorphosed over time to grazing on people's farms and destruction of investments and efforts, while frequent and lethal attacks on outspoken farmers leading to loss of hundreds of lives brutally in Benue, Taraba, Nasarawa, Ogun, Enugu and several other states has inundated print and electronic media.

6. Climate Change, the Environment and Sustainable Food Security in Nigeria

The degree to which climate change affects agriculture, thus, sustainable food security varies according to regions. Regional overall climate change feedbacks depend on the widespread climatic condition of the regions. Agricultural productivity is therefore differently affected based on the degree and manifestation of these feedbacks. In Nigeria and indeed other countries in Sub-Saharan Africa, there is high vulnerability to the impact of climate change. Fluctuation in the total production of local food has remained visible over the years.[67]Visible incidences of drought have remained persistent for a period of approximatingbetween8-18 years in parts of Nigeria including Adamawa, Bauchi, Borno, Jigawa, Kano, Kastina, Sokoto, Yobe and Zamfara states due to climate

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[65]O. G. Amokaye, *op. cit.*.408.

[66]C. A. Omaka, *The Nigerian Conservation Law* (Lagos: Lions Unique Concepts, 2004), 17 – 33.

[67]E. E. Obioha, "Climate Variability, Environmental Change and Food Security Nexus in Nigeria."*Journal of Human Ecol*ogy 26(2), (2009), 107-121.

change variations.[68] Climate change feedbacks such as ozone layer depletion, glaciations, green-house effects result in excessive temperature, drought, erosion, excessive rainfall and flooding, rising sea levels and water scarcity which all bear negative brunt on agricultural yield. Low agricultural output manifests rise in prices of agricultural products, hence, poses threat to food security and rights to food.

Changes in rainfall pattern may lead to nonconforming sequence of crop failure with its attendant poor harvest and food scarcity. Upward drift in rainfall aids proliferation of pests and diseases which affect the quantity and quality of crop and animal production. Also pests and diseases tend to spread according to climate change variations. The Food and Agricultural Organization (FAO) reports potentially threat to livestock in the drier northern states of Nigeria due to recent prevalence of tsetse fly in northwards fringes.[69]Intensive flooding similarly results to soil erosion and destruction of farmlands. Aluko notes that climate change impacts on fragile soil and conventional farming systems are quite significant.[70]Aluko also observes that rural farmers and communities are now robbed of the capacity to produce such quantity of food sufficient enough to sustain rural populations.[71] In addition, extreme weather resulting to thunderstorms, heavy winds, and floods usually wrecks farmlands and occasions crop failure. Excessive flooding oftentimes wrecks havoc on social infrastructure, thus, render roads impassable or disconnect rural communities such that storage or transportation of food to storage points or markets becomes inhibited. When this happens, agricultural products are usually wasted and this introduces disenchantment on the farmers and reduces their potentials to produce more food.

Climate change invariably affects livestock in that drought and desertification affect in the negative the availability and quality of folder. More so, increase in temperature results in decrease in water availability and this affects length of seasons and prospective yield, hence, low agricultural output. Climate change induced global warming has also affected the aquatic ecosystems such that sea foods and aquatic plants of socio-economic importance are seriously threatened. All these plummet to hunger and malnutrition on the populace. The high

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[68]G. Muhammed, M. M. Jaliye, S. Usman, and E. Baniwa, "Adaptive Strategies to Climate Change Variability and Change in Rural Communities." Proceedings of the 16th Annual National Conference of Agricultural Extension of Nigeria (AESON), March 2011.

[69]Food and Agricultural Organization of the United Nations, *The State of Food and Agriculture* (Rome: Food and Agricultural Series No. 34 of 2002), 65-88

[70]A. P. Aluko, B. Oyeleye, O. N. Sulaiman, and I. E. Ukpe, "Climate Change: A threat to Food Security and Environmental Protection" Proceedings of the 32nd Annual Conference on Forestry Association of Nigeria. October, 2008.

[71]*Ibid*

dependence of agriculture on environment renders agriculture highly responsive to climate change variability. Slight or prolonged fluctuations in weather conditions affect food production in commensurate terms. Developing nations, Nigeria inclusive, are more vulnerable to climate change effects and more incapable of battling the resultant challenges owing to paucity of fund, insufficient technology, and poverty and population pressures.[72] These developing nations are highly dependent on climate-induced activities. Nigeria, for instance, is dependent on rain-fed agriculture, livestock and hydropower generated energy for electricity. More so, Nigeria also depends on the developed nations for technology to drive her economy in the areas of air, land and water transportations, commerce and industries, household appliances, etc.[73] Most of the times, these machines and equipments are substandard or of second hand quality and are not environmentally friendly. In Nigeria presently, environmental problems such as coastal flooding, desertific

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urban pollution have almost tripled the threat to national development since the last decade.[74] Nigeria's contributions to the percentage increase in global greenhouse gases has been induced by factors such as land and agricultural practices, population pressure, energy generation and consumption and oil exploration and refining. For instance, Nigeria boasts of the total national population of over 170 million people and projected to be about 238.4 million by the year 2025.[75] This rapid population rate in a country with limited resources, crude technology, and high rate of corruption and lack of clear-cut development plan has the consequence of putting additional pressure on the existing infrastructure and increased environmental degradation. Population explosion means increased demand for food which in turn leads to land fragmentation, degradation and deforestation. Deforestation on its own depletes reservoirs needed to reduce and improve greenhouse gases.[76]

Reports of the World Energy Resources indicate that Nigeria's energy production and consumption is on the upward surge since the last two decades.[77] This means

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[72]U. Cubasch and R. Voss, "The Influence of Total Solar Irradiance on Climate" (2000) *Space Sci. Rev.*94, 185–198.

[73]O. G. Amokaye, "Implementing Climate Change Convention at Domestic Level: Problems and Prospects in Nigeria" A Research Paper Submitted to UNFCC Secretariat Bonn, 31st October, 1999.

[74]C. A. Omaka, *op. cit.*, 66.

[75]United Nations Population Fund (UNPF) reports 2016 available at http://www.unfpa.org-annual-report. Accessed last on 2nd August 2017.

[76]O. G. Amokaye, *op cit.*

[77]World Energy Resources 2016 available at http://www.aben.com.br>arqivos Accessed Last on August 4th 2017; see also: World Energy Statistics – International Energy Agency available at http://www.iea.org>publication>Key... Pdf. Accessed Last on August 4th 2017; World Energy Resources /2016 – World Energy Council available at http://www.worldenergy.org>2016/10 pdf.

that during the period under consideration, fuel production has continued to dominate the total energy production while gas took the second lead. This shows that out of the total carbon dioxide (CO_2) emission rate of 2.331kg per 1 litre of petrol, 2.772kg per 1 litre of diesel and 317kg per 1 litre of crude oil,[78] Nigeria is one of the major contributors of carbon emission globally. Though Nigeria is a signatory to the Paris Accord on Climate Change and came up in her Intended Nationally Determined Contributions to declare commitment to reducing GHGs by twenty percent (20%) unconditionally and by forty-five percent (45%) conditionally by the year 2030, there is still a dearth of legal instruments on control of climate change at the municipal level. There exist legislations on air and water pollutions in addition to some administrative policies and measures aimed at reducing greenhouse gas (GHGs)[79] emission but current realities indicate a persistent increase in climate change vagaries at both the global and domestic level.

The IPCC, in April 2007, maintained that Africa is one of the continents that is most vulnerable to climate change due to "multiple stresses and low adaptive capacity", and that though some adaptation is taking place "this may be insufficient for future changes in climate".[80]Nigeria is susceptible to the impacts of climate change principally due to the fact that about seventy percent (70%) of Nigerians are engaged in small scale rain-fed agriculture. For Nigeria, agriculture is imperative since about forty-two percent (42%) of the country's GDP generates from agriculture and agro-allied undertakings.[81] Climate change impacts are very perceptible in most communities in Nigeria ranging from the Sahel in the north to the rainforest and coastal zone in the south. The population strength resulting in

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Accessed Last on August 4th 2017; "Emissions from Oil and Gas Production Operations" *The PetroWiki* available at http://www.petrowiki.org/Emissions-from-oil-and -gas-production-operations/ Accessed Last on August 4th 2017.

[78]The Quiet Road, "Carbon dioxide emission per barrel of crude: available at www.numero57.net>2008>…>carbon-dioxide-emission-per-barrel-of-crude/ Accessed Last on August 4th 2017;

[79]These include the Environmental Agenda 21 of Nigeria's outlines targeted at stopping gas flaring by 2010 but gas flaring has not stopped by 2017 when this study is being carried out.

[80]IPCC 2007, IPCC Fourth Assessment Report released after the 19th session of IPCC held at Bangkok April 30th; available at https://www.niwa.co.nz>climate/climate/climate-variability-and-change/the-intergovernmental-panel-on-climate-change/ipcc-fourth-assessment-report-2007; see also IPCC 2007: "Impacts, adaptation and vulnerability". Contribution of Working Group II to the Assessment Report of the Intergovernmental Panel on Climate Change. (UK: Cambridge University, Press., 2007) Accessed last on August 4th 2017.

[81]F. M. Onu and M. E. Ikehi, "Mitigation and Adaptation Strategies to the effects of Climate Change on the Environment and Agriculture in Nigeria" available at http://www.researchgate.net/publication/27995746. Accessed last on 5th August 2017.

high poverty level and quest for economic growth are taking huge tolls on Nigeria's natural resources. Climate change impacts similarly compound current pressures on these resources. Drought in the north, for example, has occasioned poor crop yields, water scarcity and compulsory migration. In the south, the persistent rise in sea level has resulted to increased risk of flooding, salt water infringement and dislocation of people and livestock. Erosion allied with heavy rainfall and flooding is currently a recurrent threat in most ecological zones in Nigeria, especially in the rainforest where mudslides is persistent. Loss of biodiversity is now a common phenomenon in all ecological zones of Nigeria and this trend only renders natural resource-dependent communities more vulnerable.[82] Most households in all the uplands, wetlands and fishing communities are vulnerable to flooding, windstorms, erosion and drying of streams. People in the fishing communities are more vulnerable to sea level rise. These hazards may persist in the communities in the future. Mudslides and landslides could similarly arise in their communities due to the current climatic situation.[83] In spite of the global concern and the apparent vulnerability of the Nigerians to climate change, mitigation measures and adaptation strategies have received the least attention even in contemporary times.[84]

7. Combating Climate Change for Sustainable Food Security: Intersection of Science and Law

We have noted that Nigeria depends on rain-fed agriculture for food production. We have also observed that weather change is affecting rain pattern and distribution over the years. This goes to suggest that sustainable food security in Nigeria is possible but dependent on sustainable restoration of the Nigerian climatic conditions in one part and high involvement of science and technology for mechanized agriculture on the other part. In both ways, law and science must intersect to yield the expected outcomes. For instance, we have seen above that law is a normative science which regulates human conducts and daily activities while science helps man to improve on his life patterns. Science and law could therefore intersect to address the twin issues of climate change and food shortages. To effectively tackle climate change and food security, adaptation and mitigation

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[82]G. Muhammed, M. M.Jaliye, S. Usman and E. Baniwa, "Adaptive Strategies to Climate Change Variability and Change in Rural Communities". *Proceedings* of the 16th Annual National Conference of Agricultural Extension of Nigeria (AESON). March 2011; L. E. Nwosu, (2012). Climate Change and Food Security: Implication for Effective Agricultural Extension Services in Nigeria. Proceedings of the 17th Annual National Conference of Agricultural Extension of Nigeria (AESON). March 2012.

[83]E. E. Obioha, "Climate variability, Environmental Change and Food Security nexus in Nigeria" (2009) J. Hum. Ecol. 26(2), 107-121.

[84]*Ibid*

strategies need to be adopted. While scientific measures for adaptation and mitigation are prescriptive, legal measures are regulatory in nature. The mixture of the both can effectively tackle climate change over a short period of time and enhance sustainable food security in Nigeria. Science and law can intersect in the following areas to achieve the above:

a. Microclimate management and ethno-engineering which ensures sustainable farming practices aimed at managing the flow of energy, sunlight, humidity, and other climate conditions in a small localized area, to forestall adverse effects in agriculture.[85] This is encapsulated in indigenous land husbandry practices which prevents degradation and improves land quality in terms of stability, usefulness and productivity.[86]

b. **Aforestation Using Trees with High Regenerative Abilities:** science has to develop and recommend trees with high regenerative potentials for plating. Law should come in to regulate deforestation and policy should mandate the planting of trees especially those with high regenerative abilities to replace those cut down for various anthropogenic uses. This will ensure effective recycling of carbon IV oxide and oxygen and help in modulating the climate for positive outcome. Practice of Tangya system will also be popularized among farmer as this will reduce deforestation and help rebuild climate.

c. Efficient System of Weather Forecast: efficient and reliable system of weather forecast will no doubt assist farmers in their yearly farm planning. Knowledge of weather statistics will enable farmers know what crop to plant at what time of the year and this is another preserves of science.

d. Agricultural Biotechnology: Agricultural biotechnology uses a variety of devices, not limited to traditional breeding techniques that revolutionize genetic features of living organisms. Bio-technicians modify crops and animals by editing their genetic characteristics, thus, enhancing plants' or animals' products and improvement. It builds up microorganisms for specific agricultural uses. Biotechnology in modern times involves the process of genetic engineering that makes available to farmers, tools for cheaper and more manageable production. The science of biotechnology should engineer more crops to tolerate specific herbicides for efficient weed control. More

[85]K. Stigter, "Traditional Manipulation of Microclimate Factors: Knowledge to be Used."(1987) cited in A. Ahmed (ed.), *Climate Change and the Dryland Resources of Nigeria* (Mauritius: Lap LAMBERT Academic Publishing, 2019), 11

[86]G. O. Chukwu, and B. O. Okoro, "Sustaining Agriculture in Africa, Needs, Benefits and Methods." Proceedingof the Academic Seminar, Golden Jubilee Edition, Federal College of Agriculture, Ishagu (2006), 90-94.

crops should be engineered to resist specific diseases and pests for effective and efficient pest control. Science should research for effective measures that would decrease the use of synthetic pesticides and herbicides or manufacture pesticides and herbicides that are environmentally friendly. This will increase production and enable Nigeria keep pace with demands for food.

e. Improvement of Agricultural Infrastructure

Science should come up with such measures that would enhance effective water harvesting and utilization for all season farming. Such measures are not limited to the construction of support facilities for large scale water storage for irrigation, building water harvesting schemes like dams, dredging of the river Niger and such other projects that would improve irrigation and drainage systems to combat drought. Science should also ensure that effective measures for regulation of salinisation and alkalinisation are in place in the main grain production areas. Law on the other hand, should regulate the use of water to reduce pollution of water bodies, thus, ensure that unadulterated water sources are available for agriculture at all times.

f. Enforcement of Legal Regime on Environment

Nigeria has problem particularly with enforcement of laws. Laws need to empower and regulate law enforcement agencies in order to improve the system of laws and their enforcement. Laws on the environment, land use, water management, pollution, impact assessment, town planning, agriculture, regulation of standard of products, etc, should be effectively and efficiently enforced. Furthermore, law should generate policies on environment for effective '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.'[87]

g. Scientific Research Especially in the Agricultural Sector

Law should stimulate scientific research by making provisions for research funding and awards in Nigeria. Good funding will, no doubt, increase research the outcome of which would turn around agricultural activities in Nigeria for sustainable food availability. Research is imperative in areas of pollution control, pests and diseases, herbicides, fertilizers, etc, that are environmentally friendly and with potentials to improve the farm land quality and reduce carbon emission. There is also the need to create awareness among farmers on sensitive agricultural management techniques including increased use of

[87]A. Ahmed (ed.), *Climate Change and the Dryland Resources of Nigeria* (Mauritius: Lap LAMBERT Academic Publishing, 2019), 11

organic fertilizer for increased soil fertility and reducing emissions of nitrous oxide that would affect the build-up of the green house gases..

8. Conclusion and Recommendations

There are clear indications of increase in the altitude of climate change impacts in the globe including Nigeria as well as in other developing countries over the years.[88]Climate change, with higher propensity to intensify in the future years, has defied local and traditional knowledge and technologies. This leaves many people with dearth of information and means to deal with the menace.[89]There are similarly too few government policies and strategies to address climate change impacts in Sub Sahara Africa much as same holds sway in Nigeria. Adverse changes in weather statistics affect, to a great extent, agricultural and allied activities in Nigeria. Droughts culminating in the drying of streams, flooding, increased incidence of pests and diseases, glaciations, destruction of roads and other social infrastructure as well as the overall damage to the ecosystem are

some of the manifestations of adverse weather change. Climate change impacts on agricultural productivity cannot be overstretched. Nigeria should therefore implement, as a matter of public policy, all strategies recommended for combating climate change impacts especially in areas of in agricultural production. Government at all level should:

a. Improve on budgets for agricultural infrastructure, support agricultural researches and development of new agro-technologies, strengthen ecological agriculture in areas with production comparative advantages, mechanize agriculture and encourage more youth to engage in agriculture;

b. Establish legal and institutional framework necessary for effective implementation of adaptation and mitigation strategies to address the impacts of climate change in Nigeria, including micro-climate management of laws and regulations, enhance the development, ethno-engineering adaptation, partnering with rural farmers through extension agents and apprising them with the particulars of weather forecast for each farming year and encouraging indigenous land husbandry practices for sustainable agriculture;

[88] S. Weart, *The Discovery of Global Warming* (Cambridge: Harvard University Press, 2003), 240.
[89]Fleming, J. R., *Historical Perspectives on Climate Change* (Oxford University Press, New York, 1998), 208.

c. Improve on agricultural infrastructure like construction and maintenance of large scale water-saving facilities for irrigation, construction of water harvesting facilities, water storage ponds and dams, building and advancing irrigation and drainage systems in high production areas to arrest drought incidences;

d. Government, philanthropic organizations and public spirited individuals should fund agricultural research and development especially in biotechnology and crop improvement technologies that enhances the development of crop and animal varieties with traits resistant to drought, high temperature, pests and diseases, and other adverse weather variables consequent on climate change. Government should also launch researches that advance effective measures to tackle climate change and its consequences. Available technologies with less likelihood to exacerbate climate change should be promoted and transferred by the government to all farmers to enhance output yield;

e. Implementation of projects and introduction of farm practices that control agricultural pollution and carbon-emission, extension and training of farmers on the rational use of organic fertilizer instead of chemical fertilizers and pesticides to improve the quality of soil, soil ph level management, increase soil fertility and reduce emissions of nitrous oxide;

f. Prevent erosion and desertification planting trees, artificial grassland, regulating grazing, recovering lost vegetation, employment and reinforcement of the forest rangers system for effective forest management and regulation of animal husbandry to improve productivity of animals.