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The impact of climate change on crop production in Nigeria

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Abstract

Climate change exerts adverse effects on crop production in Nigeria. This study highlights the processes, mechanisms, and traits that will ensure future sustainability of crop quality and yield in Nigeria. It critically evaluates recent advances in our understanding of climate change impact on soil fertility and plants, within the context of climate-smart agriculture. It further identifies soil fertility as another critical concern which can be influenced by climate change and thereby affect crop production in Nigeria. Soil degradation has been discovered to negatively affect crop production in Nigeria. In agricultural ecosystems depleted of soil organic carbon, it will be increasingly difficult to produce higher yields. The impact of climate change is felt profoundly on crop production in Nigeria which leads to food insecurity. This study is therefore very significant as it explores the mitigation and adaptation strategies to the impacts of climate change on crop production in Nigeria.

Keywords: Adaptation, climate change, crop production, education, mitigation

Introduction

Climate change is a rising global concern; it refers to changes in atmospheric gaseous composition by anthropogenic activities, in addition to natural climate variability (Moser and Dilling 2004; Lorenzoni *et al.* 2007; UNFCCC 1994) ^[12, 10]. The earth's atmosphere is majorly composed of nitrogen, oxygen, argon and the concentration is as follows, 78.09%, 20.95%, and 0.93%, respectively. The minor gases, which are present, are methane (CH₄), carbon dioxide (CO₂), chlorofluorocarbons (CFCs), nitrous oxide (N₂O), and ozone (Qiancheng 1998) ^[19]. These minor gases are called the greenhouse gases (GHG), have high absorption for thermal long wave infrared radiations and increase the temperature of atmosphere, seas, and terrestrial planets. These greenhouse gases in excess lead to global warming and also exert negative effects on crop production in Nigeria. Climate change refers to any change in climate overtime, which may be due to natural variability or as a result of human activity (Inter-government Panel on Climate Change, IPCC, 2001) ^[9]. The United Nations Framework Convention on Climate Change (1992) defines climate change as changes in climate that is usually attributed straightforwardly or not directly to human activity which alters the composition of the overall atmosphere in addition to the usual climate changeability observed over similar periods. The reality of climate change is actually very frightening. We are already in times of terrific climate change, with worse forecast if we continue with business as usual through pouring excessive greenhouse gases into the atmosphere. The natural causes of climate change are as a result of variations in earth's orbit, variation in ocean circulation, variation in albedo of the continents, as well as variation in solar radiation. The human causes are, however, results of deforestation, air pollution, poor agricultural practices such as bush burning, excess and wrong application of inorganic fertilizers, burning of fossil fuels, urbanization, industrialization, inefficient transport system, among others (Anabaraonye, Okafor & Ikuelogbon, 2019) ^[4]. Climate change is one of the most important factors affecting the formation of soil with important implications for their development, use and management perspective with reference to soil structure, stability, topsoil water holding capacity, nutrient availability and erosion. Scientists have predicted that expected changes in temperature, precipitation and evaporation as a result of climate change will cause significant change in organic matter turnover and CO₂ dynamics thereby significantly impacting soil fertility (Okafor, Oladejo, & Ikem, 2019) ^[14]. Climate change is one of the paramount global issues today which threatens the survival and thrive of humans, animals, crops and ecosystems all over the world. Climate change has strong impact on health, water resources and land use, coastal Infrastructure, environment and other sectors

and even a stronger impact on agriculture especially in developing countries like Nigeria (Onu & Ikehi, 2016) ^[17]. Crop production is affected by some climatic factors which include temperature, rainfall and other extreme weather events (Onu & Ikehi, 2016) ^[17]. The impact of climate change on crop production in Nigeria requires urgent actions to be taken by farmers, educators, government agencies and non-governmental organizations to stop a global warming too unbearable for mankind and to achieve sustainable economic growth in Nigeria (Anabaraonye, Okafor & Hope, 2018) ^[3].

Methodology

Data used for this study is derived from published works including academic journal articles, conference papers, textbooks and internet materials. The researchers gathered a lot of materials for the research but summarized the characteristics of the papers that centred more on the adaptation and mitigation strategies to the impacts of climate change on crop production in Nigeria. This enabled the researchers to generate the synthesis of various researchers' views on the subject matter.

Mitigation and adaptation strategies to the impact of climate change on crop production in Nigeria

Nigeria's agricultural sector is broadly divided into four segments namely- crop production, livestock, fishery and forestry amongst which Crop production is the largest segment accounting for about 87.6% of the sector's total output (Oyaniran, 2020) ^[18]. Between the third quarter of 2019 to the second quarter of 2021, agriculture has contributed an average of 25.52% to the GDP in Nigeria (Statista, 2021) ^[22] largely through the production of food and cash crops. There is no doubt there has been some changes in climatic variables in Nigeria, which has affected crop production in Nigeria. Low harvest or yield of crop has led to hike in prices of crops in Nigeria and in extreme cases scarcity. Nigeria is gradually heading to a serious case of food insecurity. The United Nations through its Department of Economic and Social Affairs (UNDESA) presented and provides substantive support for the Sustainable Development Goals (SDGs) of which goal 2 emphasises "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" by the year 2030 (UNDESA, 2021) ^[23], which is why it is important to discuss issues bothering on crop production. The agricultural sector in Nigeria contributes effectively to the economy of the country, likewise, encounters different setbacks such as unfavourable land tenure system, inadequate irrigation, climate variability and land contamination which impedes productivity (FAO, 2021) ^[7]. It becomes imperative to address some of the issues related to crop production in Nigeria of which climate change is one of them.

Climate change refers to changes or obvious variations and alterations in climatic factors such as temperature, rainfall, solar intensity, and relative humidity, over a long period of time. Climate change is one of the paramount global issues today which threatens the survival and thrive of humans, animals, crops and ecosystems all over the world. Most predominantly in developing nations like Nigeria, climate change strongly impacts on various sectors including health, water and land resources, and agriculture (Onu & Ikehi, 2016) ^[17]. Some climatic factors majorly temperature and

rainfall to a great extent influences crop production (Onu & Ikehi, 2016) ^[17].

Soils are very crucial in crop production in Nigeria and changing climate has effect on soil fertility and the output of crops planted on them. Projected changes in temperature and evapo-precipitation affiliated to climate change has been predicted by researchers and consequently, impact negatively on soil fertility due to changes in recycling of organic matter and Carbon dioxide dynamics (Okafor, Oladejo & Ikem, 2019) ^[14]. Soils are intricately linked to climate system through the biogeochemical cycles such as carbon, nitrogen, and hydrologic cycles (Shourine & Singh, 2021) ^[20]. Climate change invariably has a great effect on soil processes and properties (St.Clair & Lynch, 2010) ^[21]. Erosion rates, organic-carbon losses, root growth and function, root-microbe associations, soil moisture and plant phenology are all impacted on by climate change and are correlated to the mineral nutrition of soils (Gupta, Sundaram, Mishra, Saggu, & Thakur, 2021) ^[27]. In developing countries, Nigeria inclusive, the negative impacts of climate change on soil fertility and mineral nutrition of crops outweighs the beneficial effects, which consequently escalates food insecurity (Shourine & Singh, 2021; Gupta, Sundaram, Mishra, Saggu, & Thakur, 2021) ^[20, 8]. Studies have also predicted that over a long-run climate change factors such as carbon dioxide emission, rainfall, temperature and carbon emission (due to manufacturing and industrial activities) will have a significant influence on crop production (Agba, Adewara, Adama, Adzer, & Atoyebi, 2017) ^[1]. Climate change affects soil from its formation to its level of plant production and inversely, Soil affects climatic changes directly and indirectly as it is the main place of different biological and biochemical cycles (Shourine & Singh, 2021) ^[20]. Mondal, (2021) ^[11] opined that owing to the glaring facts that soils are interrelated to climate system in a very complicated way through biogeochemical cycles, global climate change is predicted to have a possible impact on soil fertility through the physical, chemical, and biological properties of soil since there is rise in temperature, alternation in precipitation pattern, increase in greenhouse gas concentration in the atmosphere, etc.

The impact of climate change of soil fertility and crop production in general would vary from the North to the Southern part of Nigeria since their climatic characteristics are clearly distinct. In as much as more rainfall would favour the soil with better hydration it would lead to erosion, flooding and high rates of leaching-out of soil nutrients mostly in the southern part of the country. Likewise high temperatures invariably result to reduced soil organic matter content. A study was made to assess the potential impact of climate change on the main crops that characterize Nigerian agriculture in the framework of the Project Climate Risk Analysis in Nigeria (founded by World Bank Contract n.7157826) and it was revealed that there would be a general reduction in crop yields in particular in the dryer regions of northern Nigeria (Ayinde, Muchie, & Olatunji, 2017) ^[6]. Anabaraonye, Okafor, Ewa, and Anukwonke (2021) ^[2] posed an argument that the rate in agricultural productivity was consistently higher between 1981 and 1995, followed by a lesser growth rate in the 1996-2000 sub period with variations in the rainfall patterns and temperature. Rainfall had positive effects while temperature had negative effects on agricultural

productivity. However, rainfall from the previous year negatively influenced the current year's agricultural productivity (Anabaraonye, Okafor, Ewa, & Anukwonke, 2021) ^[2].

Usman, *et al.*, (2013) ^[26] in their study sought the perception of farmers about the impact of climate change and soil degradation. The farmers were of the opinion that soil and its properties has changed as a result of soil erosion, desertification, dessert encroachment, leaching, and other related issues, and subsequently have resulted to reduced soil quality, crop performance and crop yield in Kebbi State (Northern Nigeria).

From the above-stated facts it becomes pertinent to highlight some mitigation and adaptation strategies to aid Nigerians to cope with the impact of climate change on crop production. These mitigation and adaptation measures are either simple conventional/indigenous planting methods or emerging advanced technological methods and practices. Some of the measures identified from empirical review includes the following but are not limited to:

1. Changes in planting and harvesting periods in order to grow crops according to the prevailing climate condition.
2. Mixed cropping, multiple cropping, planting of cover crops and crop rotation.
3. Use of resistant improved varieties and early maturing crops.
4. Tree planting and afforestation.
5. Use of wetland or river valley.
6. Irrigation practices and water shed management.
7. Increased frequency of weeding.
8. Indigenous land husbandry practices (which comprises of microclimate management and ethno-engineering).
9. Strengthening research and development for new technologies.
10. Strengthening the establishment and implementation of laws and regulations.
11. Intensify ecological agriculture.
12. Effective soil management practices.
13. Education and trainings for farmers and stakeholders.
14. Use of Agricultural Extension Services.
15. Establishment of functional metrological centres in the rural areas to improve accurate and Timely Weather Forecasting.

[Okpe & Aye (2015) ^[16]; Nwaiwu, *et al.*, (2014) ^[13]; Onu & Ikehi (2016) ^[17]; Okoli & Ifeakor, (2014) ^[15]

Conclusion

The impact of climate change on crop production in Nigeria is very profound. Educating farmers in rural and urban areas in Nigeria on climate change adaptation and mitigation strategies is an urgent task which needs to be undertaken by governmental agencies, NGOs, community leaders, and passionate climate change professionals for our sustainable economic growth and development in Nigeria (Anabaraonye, Okafor, & Hope, 2018) ^[3]. Grants and Loan facilities should be readily available for farmers in both rural and urban areas to support them in adaptation and mitigation of the impact of climate change on crop production in Nigeria. Environmental Leadership summits for farmers on climate change and environmental sustainability, intensive awareness outreach, climate change poems and blogs, are recommended as important tools

which can be used in climate change education in rural and urban areas in Nigeria for sustainability locally, nationally and globally (Anabaraonye, Nji & Hope, 2018) ^[5]. Education is seen as a human right, a key to civilization and enlightenment and as source of wealth and power. It is the cornerstone of the growth and development of any country's social, economic and political institutions.

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