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Climate Change and Small Holder Agricultural Production

Ettah, O. I.[1*], Uwah, E.D.[1], Igiri, J.A.[1] Agbachom, E.E.[1] and Ettah, G. I.[2]

[1]*Department of Agricultural Economics, Faculty of Agriculture, University of Calabar, Calabar, Nigeria.*
[2]*Department of Public Administration, Faculty of Management Sciences, University of Calabar, Calabar, Nigeria.*

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***CORRESPONDING AUTHOR:**
ettahotu@gmail.com

ABSTRACT

This paper reviewed climate change and small holder agricultural production in Nigeria, a topic carefully chosen because of emerging challenges of climate change on the agricultural sector in Nigeria. The impact on agricultural sector employment in Nigeria is evidence in yield changes that may necessitate alterations in labor demand leading to job losses or shifts in employment patterns. Also changes in climate patterns might exacerbate resource scarcity, leading to increased input costs for farmers which can potentially affect employment levels in the sector. The poor performance of the sector is in response to the vagaries of weather, which causes farmers to make decisions based on imperfect information and knowledge, resulting to agricultural 'injury' or loss. The vulnerability of the existing technologies and adaptive capacity of farmers exacerbate the performance of the sector. Effective adaptation and mitigation strategies are crucial in coping with climate change menace to farmers. A sustainable livelihoods framework (SLF) which offers a comprehensive perspective on the intricate interplay between climate change, agricultural sector employment, and sustainable livelihoods (food production) is advocated as a way out of the climate change and agricultural performance quagmire. The following are recommended based on this review: phasing out fossil fuels to prevent global warming, which is one of the main causes of climate change, advocacy to farmers for a shift from industrial modes of agriculture to regenerative forms that improve on the ecosystems and governments should support by way of grants, credit, subsidy, etc. investment in food production that promotes biodiversity.

INTRODUCTION

Climate change poses a major threat in Nigeria in the 21st Century Intergovernmental Panel on Climate Change (IPCC), 2022). Small holder farmers (who constitute the bulk of the poor in Nigeria), face prospects of tragic crop and animal failures, reduced agricultural production and productivity, culminating to increased hunger, malnutrition and diseases. For food security concerns that are central to economic and sustainable development agenda, to be attended to, it is desirable to also address climate change and small holder agriculture production (Agbachom, Amalu, Uzoikwe, Ettah and Ubi, 2018). Abraham (2018) noted that competition for resources among farmers and pastoralist is a direct consequence of climate change problems which has caused clashes between ethnic groups living next to Fulani herdsmen. Constant conflict over land and water resources between herdsmen and farmers will have negative effects on food production and animal yield. Climate change phenomena like rising temperatures, changing rainfall patterns, and more frequent extreme weather events will likely reduce crop yields, farm profits, and agricultural employment. Higher temperatures, reduced rainfall, and increased climate extremes

can lower crop yields by disrupting growth cycles, increasing water stress, and enabling pests (Matemilola, Adedeji, Elegbede and Kies, 2019). Also deforestation and overgrazing have led to increased carbon emissions into the atmosphere and also affects the local weather and climate systems in the concerned regions through moisture fluxes and energy change.

Climate change is expected to have a significant impact on agricultural sector employment in Nigeria, which employs over 70% of the population (Food and Agriculture Orgainisation (FAO), 2022). The sector is highly vulnerable to climate change, as it is heavily dependent on weather conditions and climate-sensitive resources, such as water and land (Echendu, 2020). One of the channels through which climate change is expected to impact agricultural sector employment in Nigeria is through changes in crop and animal yields. Enete and Onyekuru (2018) averred that climate change is expected to lead to more extreme weather events in Nigeria, such as droughts and floods, which can damage crops and reduce yields. These yield changes may necessitate alterations in labor demand within the sector, potentially leading to job losses or shifts in employment patterns.

Changes in climate patterns might exacerbate resource scarcity, such as water shortages or soil degradation, leading to increased input costs for farmers. Elevated input costs can influence labor demand due to changes in agricultural practices or technology adoption which can potentially affect employment levels in the sector (Ettah and Ukwuaba, 2017). Another channel through which climate change is expected to impact agricultural sector employment in Nigeria is through changes in land use. Climate change is expected to lead to changes in temperature and precipitation patterns in Nigeria, which could make some areas less suitable for agriculture. As a result, farmers may be forced to abandon some land or switch to crops that are more tolerant to climate change (Tarfa, Ayuba, Onyeneke, Idris, Nwajiuba and Igberi, 2019). This could lead to job losses in the agricultural sector, as fewer workers will be needed to farm less land.

It is also expected that changing climate can impact agricultural sector employment in Nigeria through changes in labor productivity. Nigeria Erosion and Watershed Management Project (NEWMAP) (2022) noted that climate change could lead to increased heat stress and other health problems for agricultural workers in Nigeria, which could reduce their productivity. Additionally, climate change could damage agricultural infrastructure, such as irrigation systems and roads, which could also reduce labor productivity. The impact of climate change on agricultural sector employment is expected to be particularly severe in rural Nigeria, where the agricultural sector is the main source of employment. As a result, climate change could lead to widespread unemployment and poverty in rural Nigeria.

Changes in agricultural sector performance due to unpredictability of climatic outcomes have remained a dominant issue in low income countries including Nigeria as both flora and fauna are sensitive to climate change. Agriculture is an inherently risky business because of climate change. Its biological nature owing to climate change has made economic performance of production very uncertain. This is because agriculture is climate dependent; the vagaries of weather, resulting to pests and diseases outbreak to crops and livestock enterprises, widespread changes in rainfall, temperature patterns, technologies, health conditions (sickness and even death) in agriculture are all outcomes of climate change (Enete and Onyekuru, 2019) . When all these occur, which is almost inevitable, farmers are forced to make decisions based on imperfect information and knowledge, hence there is therefore the possibility of agricultural 'injury' or loss. Studies by Tarfa *et al*. (2019) shows that about 85% of these losses are attributed to weather related incidences, of which floods, droughts and diseases are the key players and are directly related to climate change. National Bureau of Statistics (NBS) (2021) predicted that crop yield in Nigeria may decline by 15 to 30 percent or even up to 50 percent by 2040 due to climate change. This is why in Nigeria, experts have advocated technological improvements in agricultural production through genetically modified crops or irrigation systems, climatic conditions and weather patterns as key elixirs to food production potentials (Abraham, 2018).

According to Eneji, Onnoghen, Acha and Diwa (2020) inconsistency of climatic conditions or changing weather events can alter the productive capacities of farmers, especially when the potential capacity to adapt to changing weather conditions are lacking and affect agricultural output severely. Increasing atmospheric carbon dioxide emissions, higher temperature, variation in annual and seasonal precipitation patterns amongst others seem to threaten the quantity of food production and natural environment. Altogether, the impact of climate change is very comprehensive but its far reaching effects are now clearly visible on agricultural sector, on which relies the food production and economy of the world. The severity of the effects of climate change in agriculture depends largely on the vulnerability of the existing technologies and adaptive capacity available to farmers considering the dynamism of agricultural environmental conditions (Onoja and Achike 2019). A situation therefore arises of uncertain availability of adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways.

Climate change is less severe in developed economies due to relative high adaption techniques, endowed advantage, high technology and mechanized agricultural system, awareness and income status (Weber, 2020). Contrariwise, developing economies including Nigeria are at the precipice of adverse effects of climate change considering the prevalent high level of temperature, poor adaptation capacity, absence of early warning and poor income status. It is therefore not surprising that African countries including Nigeria have in recent time experienced some adverse effects of climate change due to the dynamics of drought, rainfall, relative humidity and temperature amongst others (Ojoyi and Mwenge, 2018). Farmers in these climes are frequently exposed to the uncertainties of weather and live on the edge of extreme risk and uncertainty, sometimes falling just below, and sometimes rising just above the threshold of survival. Farmers do not know whether rainfall will be good or bad over a season; they do not know the prices they will receive for their produce; and they do not know whether their crops will be infected by disease (Ofoebu and New, 2021). These risks and uncertainties are not under the control of farmers though some of them have developed ways of adapting and managing them. Risk disrupts the most crucial decisions of the farming households whose prospects could be to make farming a life business venture. This is one of the reasons which have not allowed investors to benefit from the great potential in agriculture in the developing world. To this end therefore, farmers need to understand climate change phenomena in order to better anticipate problems. They also need to acquire more professional skills especially skills bordering on adaptation and management practices to reduce consequence of climate change.

Considering the adverse effects of climate change on agricultural performance and economic growth, adaptation of management practices should be highly integrated into policy actions of governments geared towards stimulating agricultural production (Ettah and Chima, 2018). This is unarguable owing to important role played by agriculture in food security and poverty reduction in most developing economies. In a twist from being very vulnerable to climate change, agriculture has equally been identified as one of the causes of climate change in recent years. Weber (2020) held that the traditional and seemingly outdated agricultural methods employed by farmers tend to worsen the incidences of climate change in developing economies. These activities increase the tendencies of greenhouse gases concentrations in the atmosphere which cause global warning. Increase in emissions of greenhouse gases will continue as long as farming and other climate change driven agricultural activities continue in the model of business-as-usual. The commitment made at national and State levels seems inadequate to engender efficient adaptations of the agricultural sector to climate change scenarios. More importantly, the policy environment required for the development of dynamic agricultural systems in view of the growing climate change seems to be sub-optimal in Nigeria. Weak infrastructural development and inconsistent policies of climate change adaptation of management practices have been identified as major impediments to agricultural development in Nigeria Nigeria Erosion and Watershed Management Project (NEWMAP) (2022).

Climate Change and Management Practices

Nigeria is one of the countries with the greatest biophysical potential for climate management from natural climate solutions, such as increased trees in agricultural lands, reforestation, and improved natural forest management. Effective adaptation and mitigation has been identified by both climate change scholars and policy makers as crucial in coping with climate change menace by farmers, especially in a climate sensitive agricultural system like Nigeria. Reports indicates that most of the problems (or constraints) encountered by farmers in adaptation of management practices to climate change are associated with poverty (Uyigue and Agbo, 2020). This is because poor and hungry farmers would naturally divert their limited farm income towards the basic necessities like feeding and medication rather than ploughing them into climate change adaptation measures. As climate is a natural phenomenon, it is impossible for man to stop it, but measures can be used to reduce the effects. Mitigation and adaptation of management practices are two central issues to tackle climate change, there is the need for an emphasis on "anticipatory mitigation and adaptation of management practices", that is the proactive rather than the reactive management of climate change risk United Nation Framework Convention on climate change (UNFCCC), (2017). This can only be feasible if the potential problems/challenges to mitigation and adaptation are preemptively analyzed. Adaptation of management practices is one of the policy responses projected with the goal of maintaining the capacity to deal with current future changes (Eneji et. al., 2020). The terms coping, adaptation and mitigation strategies are often used interchangeably and refer mainly to short-term actions taken to counteract the immediate negative impacts of climate variability including flood.

Coping and adaptation can also be differentiated in terms of the institutional aspects that need to be considered. Coping strategies are taken within the existing institutional structures of the system under consideration, while adaptation strategies may demand some transformation in terms of the structures' composition and functioning (Terfa et. al., 2019). Some scholars believe that adaptation strategies are more tactical in action and futuristic while coping strategies may be changed into adaptive strategies through institutional support. Adaptation is defined as initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. On the other hand, according to Enete and Onyekuru (2019) mitigation to climate change involves actions that are designed to limit the amount of long-term climate change effect. It is widely agreed that there is a limit to what adaptation can achieve and that mitigation measures must be undertaken in parallel to prevent the negative impact of climate change on agricultural practices.

Both the existing international and local institutions that are available for supporting adaptation and mitigation actions in developing countries like Nigeria fall far short of what is required (IPCC, 2022). The region should enhance institutional capacity to make better use of existing and potential international and local funding sources. This is because as noted by IPCC, (2022); the pathways by which economic and sectorial reforms can influence climate policy depend on the existing institutional framework. With appropriate institutions, a high degree of consistency between development and climate policies can be achieved and without these, there will be considerable conflicting approaches of our farmers towards solving the problem of climate change on their agricultural practices.

The level of climate variability stress or the effects of the shock will depend on what coping strategies are available to the farmers to respond to or buffer the effects. Farmers' ability to perceive the effects of climate variability on livelihood and the farm is a key precondition for the choice of strategies to cope with or mitigate the effects (Ettah and Chiemela, 2018). In order to develop effective adaptation strategies or mitigation strategies that would reduce vulnerability and cope with unavoidable consequences as well as exploit opportunities, a sound scientific knowledge of the country's climate as well as the possible impacts of its variability and changes on the various socio-economic sectors is necessary. The vulnerability of the developing countries like Nigeria is worsened by heavy reliance on renewable natural resources for livelihoods, employment and income. Agriculture and food security is a sector that is most sensitive to global warming in

developing economies like Nigeria, due primarily to the heavy reliance on rain-fed agriculture, thus, the need for conscious adaptation to cope with the changes occasioned by climate change or a long term shift in the climatic pattern of an area as a result of man's activities and natural variability (Ettah and Ukwuaba, 2017). Effective adaptation to climate change is therefore crucial. It would involve adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Research efforts indigenous to Nigeria, have identified common climate change adaptation measures such as: intensification of irrigation, crop diversification, multiple/intercropping, agro-forestry/aforestation, mulching, use of new crop varieties and livestock species that are more suited to drier conditions, increased seed rate, crop diversification, crop rotation, tree planting, mixed crop livestock farming systems, changing planting dates and use of family labour (Terfa *et al*., 2019, Abraham, 2018, Weber, 2020, Eneji etal.,2020).

In Nigeria, rural farmers are faced with numerous challenges which affect climate change adaptation. Majority of these rural farmers lack the necessary capacity to adapt to climate change, in addition to limited policy response, weak institutional arrangements and poorly conceived interventions not carefully matched to needs. Some of the reported challenges and factors affecting climate change adaptation include but not limited to: land tenure system, access to weather information, cooperative societies, poor infrastructure, access to credit facilities and extension services, educational training and development, access to processing and storage facilities, age, sex, farm size, labour availability and poverty (IPCC, 2022). Some of the ways to achieve adaptation of management practices according to Uyigue and Agho (2020) are: biocontrol and crop rotation to ensure pest control instead of excessive use of pesticides and conservative tillage should be engaged to maintain physical properties of the soil. Also concepts such as climate-smart agriculture (CSA) emerged to bring about an adjustment in agriculture to enhance food production while dealing with the changing climatic conditions and their increasing variability. CSA as a concept, is aimed at helping farmers adjust to climate change and minimize its plausible unfavorable effect on their agricultural activities and livelihoods. The concept focuses on three main goals, which are:

(i) a sustainable increase in agricultural productivity to enhance income levels, food security, and development
(ii) climate change adaptation and resilience from the micro to the macro level and
(iii) a reduction or total removal of greenhouse emissions where possible.

CSA as a concept enhances the resilience of agricultural systems by balancing the priorities between adaptation, mitigation, and food security. There are some productivity-enhancing adaptation of management practices adopted by farmers in Nigeria, which fall within the CSA framework. Many farmers, especially those in areas with lower rainfall, have substituted crops requiring a high level of water with those requiring a lesser degree of water for cultivation. Farmers in areas with frequent flooding have shifted to short-cycle crops. Some farmers have moved to crop diversification, changing plant days and mixed cropping, etc.

The cumulative effects of lack of adaptation and management strategies have led to food crisis, water scarcity, high temperature and humidity which often lead to loss of lives and other resources. This is so because climate change exerts great influence on resource use efficiency in agricultural productivity, thereby affecting the income of farmers by reducing the profit they make from their production. Hence investigating the effect of climate change in this part of the world becomes imperative as this will provide realistic information on the changes of major climate elements that affect agricultural production. Experts have averred that understanding the overall effect of climate change on agricultural production is still ambiguous to farmers in this part of the world, because increase in temperature and carbon dioxide can be beneficial for some crops in some places (Ojoyi and Mwenge, 2018; Abrahm, 2018; Ettah and Chiemela, 2018).

Theoretical Framework for Adaptation and Management Practices

The theoretical framework is the sustainable livelihoods framework (SLF) to proffer solution to the melee of climate phenomena. It offers a comprehensive perspective on the intricate interplay between climate change, agricultural sector employment, and sustainable livelihoods (food production) in Nigeria (Ettah and Chiemela, 2018). It should take into account five key types of assets crucial for livelihoods, including human, social, natural, physical, and financial capital. In the context of agriculture, these assets are essential for adaptation to climate change and the sustainability of employment in the sector. Human capital involves the knowledge and skills needed for climate-resilient farming practices, while social capital supports knowledge-sharing and community support. Natural capital encompasses land and water resources that can be affected by climate change, and physical capital includes critical infrastructure for agricultural activities. Financial capital is related to income and access to credit and is vital for investments in climate-resilient agriculture.

Livelihood strategies, vulnerability context, and transforming structures and processes are examined within the framework, emphasizing the importance of adapting livelihood strategies in response to climate change, recognizing external influences, and considering institutional support for sustainable agriculture and employment. The framework's relevance in the context of Nigeria is evident as climate change poses challenges to the agricultural sector. Shifts in rainfall patterns, temperature, and extreme weather events can impact crop yields and water resources, leading to vulnerability among smallholder farmers and disruptions in employment. Government policies and support structures play a significant role in enabling adaptation to climate change and sustaining employment in the agricultural sector.

Effective policies that promote climate-smart agriculture, enhance access to credit, and improve market opportunities are critical for achieving sustainable livelihoods are advocated (Enete, 2018). Transforming the agricultural sector towards climate-resilient practices is essential for safeguarding employment opportunities and overall well-being amid climate challenges. In summary, the SLF provides a holistic approach to understanding how climate change affects agricultural sector employment and livelihoods in Nigeria. It emphasizes the importance of adaptation and management strategies, institutional support, and the management of various assets to enhance the resilience and sustainability of livelihoods in the face of climate change impacts in the agricultural sector.

Empirical framework that can be relied upon for solutions to climate change problems in agriculture and the environment may include: the role of meteorological stations in providing weather information for farming and other agricultural activities is not just desirous but a necessity especially in the developing country like Nigeria where majority of the people are predominantly farmers as stated earlier, who engage in agriculture as a means of livelihood (Enete and Onyekuru, 2019). It is in an effort to deal with the challenges posed by climate change that the Federal Government of Nigeria considered as a necessity, the establishment of meteorological stations across the states and local government areas through the agency known as NIMET (IPCC, 2017). The agency was charged with the responsibility of measuring weather elements, forecasting and disseminating critical weather/climate information through a designated medium such as radio, internet, periodic publications, etc. to the relevant bodies such as farmers. As part of their responsibility, meteorological stations act as a guide to farmer, through the provision of climate change and adaptation information that will help farmers to improve strategies for adaptation in their farming operations. The present government effort at improving agriculture production, will remain a mirage if concerted effort is not made on strengthening NIMET and climate change and adaptation information that will aid farmers in planning and minimizing risk inherent in farming activities that emanate from climate change (NEWMAP, 2022).

Some other experts Ofoebu and New (2021), Enete and Onyekuru, (2019), Eneji *et al.,* (2020) and Ettah and Chima (2018) in climate change have advocated the following:

i. phase out of fossil fuels and leapfrog into renewables in a just and inclusive way: Nigeria could leverage its vast renewable energy potential and pivot from coal, oil, and gas that could engineer to 100 per cent renewables, addressing both climate and sustainable development goals and solar should be set to overtake oil production investment.

ii. strengthen alignment between biodiversity and climate: Nigeria's biodiversity and natural resources are its strongest allies in the fight against climate change. Nigeria is a front runner in delivering nature-based solutions through initiatives such as the Nigeria Forest Landscape Restoration Initiative.

CONCLUSION

Climate change noticeably in temperatures rise and precipitation patterns shift has become a new normal, therefore farmers are facing devastating new challenges such as severe drought, floods, and pest infestations, along with increasing desertification and dwindling groundwater supplies. These shocks come at a time when food production to feed the growing human population and curb the ongoing hunger crisis. There is need for a favourable climate as an all important ingredient or input in agriculture, which can only be guaranteed by climate. The effect of climate, a major requirement in agricultural production need not be over emphasized. This is in consideration of the crucial roles of its various elements, especially rainfall, in relation to agricultural production. The post-primary effect of climate change in Nigeria is also raising competition for available resources and extinction of biodiversity. This situation calls for a significant transformation in the agricultural sector to ensure adequate food supplies for increasing demand. It is time more than ever for concerted efforts toward more appropriate agricultural production practices for sustainable food production for the growing population, characterized by economically beneficial, environmentally friendly and socially fair agriculture for providing the nutritional needs of the people of Nigeria, thereby guaranteeing food security.

RECOMMENDATIONS

The following are recommended:

i. The surest way to protect agriculture is by phasing out fossil fuels to prevent catastrophic levels of global warming, which is one of the main causes of climate change.

ii. There should be a sustained advocacy to farmers for a shift from industrial modes of agriculture that degrade the environment and fuels the climate crisis to regenerative forms of agriculture that rather improve on the ecosystems.

iii. Governments at all levels should support by way of grants, credit, subsidy, etc. investment in food production that promotes biodiversity.

iv. Farmers should also be encouraged to engage in climate-smart agriculture (CSA), which emerged to bring about an adjustment in agriculture to enhance food production.

v. There should be technological improvements in agricultural production through genetically modified crops or irrigation systems, climatic conditions and weather patterns.

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