



## Influence of global warming and climate change on Nigeria's agro-economy

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### Abstract

As greenhouse gas (GHG) concentrations continue to rise owing to natural and human factors, it triggers global warming causing phenomenal effects climate change, which has assumed a pervasive issue of global concern (UNFCCC. 2017; UNICEF. 2021) [45, 46]. Since agriculture is critical component of Nigeria's GDP, this study examines the multifaceted implication of climate change on her agro-economy, emphasizing the opportunities and obstacles for adaptation strategies. Water shortages, soil degradation, pest and disease proliferation, poor agricultural productivity, alarming food insecurity, low economic returns on agro-based investment, and capital loss have been triggered by climate change. The study made extensive use of online resources, expert opinions, grey literature through thematic review and systematic assessment of resource materials about climate change. Exploring the tenets of vulnerability and diffusion of innovation theories, this study found that climate change has significantly reduced agricultural output and farmers revenues, especially in rural areas. Additional findings include worsening food insecurity, and multi-dimensional vulnerability, including exacerbating overall economic outlook in Nigeria. The study concludes that immediate policy changes are necessary to lessen the escalating effects of climate change in Nigeria in line with the assertion of World Health Organization (WHO, 2018). The study recommends community-based awareness drive, immediate adoption of climate-resilient smart agriculture methodology and incentives, improved seedlings and farm inputs as well as improved weather forecasting and early warning systems.

**Keywords:** Agro-economy, global warming, climate change, vulnerability, ecosystem

### Introduction

Global warming and climate change have become an issue of major concern globally, with far-reaching implications for the environment, economy, and human societies (Intergovernmental Panel on Climate Change [IPCC], 2020) [21]. Nigeria, like many other developing countries, is highly vulnerable to the impacts of climate change due to its geographical location, limited economic resources, and inadequate infrastructure (Adejuwon, 2006).

With an estimated 234 million multiethnic and multicultural citizens, Nigeria is a country in the southern Sahel with a vast amount of fertile land (924 square meters) that can be used for agriculture. In actuality, Nigeria's economy depends primarily on agricultural production, followed by oil and its derivatives. This emphasizes how the nation's economy would suffer greatly from anything that impacts agriculture.

As greenhouse gas (GHG) concentrations continue to rise, there is increasing agreement that the globe is warming and will continue to do so (Mendelsohn 2009). Evidently, there is now enough empirical data to confirm that long-term changes in climate patterns and variability have occurred globally, with a sharp acceleration in recent decades (Hassan 2010). Significant changes have been noted in the average long-term temperature and precipitation, sea levels, the frequency and severity of floods and draughts, and their variance (IPCC 2007b, 2007c). This foretells significant consequences for Nigeria and other agricultural dependent nations and economies in the world.

In view of the wide-ranging risks at global and sub-regional levels, climate change is one of the most important and prevalent concerns of concern among world leaders and international organizations (Reuters. (2025, May 8) [40]. It is regarded as a colossal threat to our contemporary world, permeating every fiber and inch of the planet, impacting all

living forms, and endangering people in both developed and developing nations. Agriculture, which is unquestionably essential to all races of humans, is particularly vulnerable to climate change. Temperature rise with attendant increasing heat waves and shifting weather patterns can have far-reaching long-term negative impacts on agricultural productivity and sustainability – leading to food shortage (food insecurity) and enormous pressure on the global economy.

Nigeria is not exempted from the dire effects of climate change and global warming (Adejuwon, 2006). In actuality, it is particularly mind-trembling for Nigeria since the country's economy is agro-dependent since agriculture supports millions of people and accounts for over 20% of the gross domestic product (GDP) in addition to ensuring food security (Central Bank of Nigeria [CBN], 2020) [11]. However, the negative consequences of climate change and global warming poses growing danger to the agro-industry as rising temperatures, unpredictable rainfall patterns, and extreme weather conditions and other risk associated with climate change hamper agricultural outputs – leading to crop failures, lower yields, joblessness, significant financial losses, and eventually food poverty (Meyer & Schulz, 2017) Consequently, this study was designed to fill a gap on the far-reaching effects of climate change on our gro-economy and by extension food security as well as overall economic outlook. It also aims to examine whether local farmers know about climate-resilient strategies and find out how to proactively deal with any existing knowledge gap through efficient communication channel-mix.

### Statement of the Problem

Despite the pivotal contribution of agriculture to Nigeria's economy (CBN 2020), the sector faces huge threats from global warming and climate change (Oyekale & Olagunju,

2017). The effects of climate change on agriculture are multidimensional, ranging from life-threatening changes in temperature and heatwaves, precipitation patterns to rising frequency of extreme weather conditions (Adelekan, 2015) [3].

Additionally, there exist a lack of comprehensive research tailored to the influence of global warming and climate change on Nigeria's agro-economy (Olanrewaju *et al.*, 2018). This dovetails into paucity of data and strategic information to guide profitable agriculture practices. This knowledge-gap (lacuna) hinders development and implementation of effective strategies to mitigate the impacts of climate change on agriculture that guarantee food security and sustainable economic development through agricultural output. Consequently, this study has been designed to galvanize empirical knowledge to address this gap and also serve as a springboard for further studies by researchers.

### Research Objectives

This study is guided by the under listed research objectives and corresponding question:

The research objectives include:

1. To evaluate the knowledge/Awareness of global warming and climate change among respondents
2. To identify the perceived causes of climate change in Nigeria
3. To examine the impacts/effects of global warming and climate change on agricultural productivity in Nigeria.
4. Evaluate the effects of climate change on food security and livelihoods of farmers in Nigeria.
5. Examine the vulnerability of different agricultural types (i.e. crops, livestock farming etc) to climate-related shocks in Nigeria.
6. Identify the adaptation strategies being employed by farmers in Nigeria to cope with the impacts of climate change.

### Conceptual Clarification and Review

The concept of Nigeria's agro-economy refers to the economic system that encompasses the production, processing, distribution and marketing of agricultural products in Nigeria.

The agro-economy is a critical sector in Nigeria overall economy, accounting for over 20% of the country's GDP and employing about 70% of the workforce (Central Bank of Nigeria, 2020) [11].

According to Okumadewa (2015) [32], the agro-economy in Nigeria is characterized by a large number of small-scale farmers who produce a significant portion of the country's food crops. These farmers face numerous challenges, including limited access to credit, inadequate infrastructure, and climate change (Adelekan, 2015) [3].

This explains why the Federal Government (FG) has continued to implement various initiatives to promote agricultural development and improve the livelihoods of farmers, including Agricultural Transformation Agenda (ATA) launched in 2011 (Federal Ministry of Agriculture and Rural Development, 2011) [15], Anchor Borrowers' Programme (ABP) and the National Agricultural Land Development Authority (NALDA), which aims to promote agricultural development and reduce poverty (Central Bank of Nigeria, 2020) [11].

Even with all of the recent scientific discoveries, technological developments, and creative agricultural approaches, such as the utilization of improved fertilizers, contemporary cultivation and growing of first-period agricultural products, intercropping, the use of enhanced seedlings, growth in watering systems, genetically engineered organisms, and more, weather remains an important factor in achieving lucrative agricultural products. (Marković, Šošarić, Josipović & Atilgan (2021) [25]. Similarly, Ikhiede (2025) [18] emphasized how irregular rainfall and rising temperatures have altered conventional or traditional farming seasons, resulting in poor harvest outcome.

Weather in this context covers the immediate conditions in the atmosphere at a specific time and place, including temperature, wind, humidity, cloudiness, precipitation, and atmospheric pressure. Climate is the long-term manifestation of weather and other atmospheric variables in a certain location (Copernicus Climate Change Service, CPS, (2022) [13]. The main emphasis is long-term evidence or indications of weather. Therefore, a region's climate is defined as its long-term average weather. Ngigi (2009) defines climate change as any change in the composition of the earth's atmosphere that causes global warming that has been either directly or indirectly linked to the actions of humans. In alongside the fluctuations in the climate seen over similarly long periods, change in the climate is defined by the United Nations Framework Convention on Climate Change (UNFCCC, 2019) as an alteration in weather that is either directly or partially caused by the actions of humans that modifies the makeup of the atmosphere around the world. These results are in line with this definition.

Examining the concept of climate change, the American Meteorological Society (AMS) describes its root causes and indicators. Climate change is the term used to describe modifications to the climate system of the planet, such as variations in precipitation, temperature, sea level, and various other elements of the environment that last for a period of time or more. Both natural phenomena, like lava flows and shifts in the trajectory of the Earth, and activities performed by humans, such as the combustion of petroleum and coal and forest loss, can contribute to climate change (AMS, 2020).

Climate change is the ongoing warming of the earth's surface that is mainly brought about by a rising quantity of carbon dioxide and other pollutants throughout the Earth's environment according to the National Aeronautics and Space Administration (NASA). Global temperatures rise as a result of these gases, which include methane and carbon dioxide, trapping solar heat and preventing it from going back into space. Increased water levels, greater severity and frequency of storms, and modified patterns of precipitation are only a few of the major effects that climate change could be having on ecosystems (NASA, 2020).

It is important to examine the contributions of the international body for environmental protection such as environmental protection agency (EPA) to the discourse on global warming climate change. According to the EPA, climate change describes the prolonged warming of the planet resulting mostly from rise in concentrations of greenhouse gases (GHG) in the surrounding environment (EPA 2020) [48]. It further emphasizes that global temperatures increase as a result of these pollutants, which include the gases methane and carbon dioxide, trapping

solar heat and preventing it from going into orbit. (EPA, 2020)<sup>[48]</sup>

Drawing from the diverse viewpoints of these thought leaders as well as the established causes, indicators, and effects of the phenomenon effectively validates the complexity and diversity of climate change – on the planet itself, economic activities and mankind. Time is a common element throughout all definitions, indicating that climate changes occur over extended periods of time, ranging from decades to hundreds of years. It is typically triggered by biotic processes (people, animals, etc.), changes in the amount of solar energy that the planet receives, volcanic eruptions, and a number of other factors or variables.

It is crucial to underscore that climate change has many negative effects, such as disturbing seasonal cycles, unsettling ecosystems and water supplies, causing erosion and flooding, droughts, and off-season rainfall, to name a few. This would undoubtedly throw off the seasons, which foretells dire repercussions for nations like Nigeria that rely on rain-fed agriculture and use the rain to their advantage. It is also important to highlight that climate change has caused lakes to dry up and rivers to flow less in some areas, which has reduced the amount of water available for agricultural production (Ozor, 2009).

According to Adejuwon, S.A. (2004), the survival and growth of Nigerian agriculture depend on a favorable climate because the two are interconnected because they occur worldwide. Nigeria's agricultural industry is in grave danger due to the effects of climate change and global warming resulting in low agricultural production because the country's food crop variety rely on rainfall (Intergovernmental Panel on Climate Change, IPCC, (2019)<sup>[20]</sup>. This explains the nation's growing food insecurity and the rising cost of staple foods (food inflation). Consequent upon this perspective, in May 2024, the National Bureau of Statistics estimated Nigeria's food inflation rate as 40.6% (NBS, 2024).

In the last quarter of 2024, the National Bureau of Statistics (NBS) reported that 22.61% of Nigeria's gross domestic product (GDP) came from Agric sector (NBS, 2024). This viewpoint aligns with the submission of CBN that agriculture accounts for more than 20% of Nigeria GDP (CBN, 2020). Therefore, agriculture is a major factor in Nigeria's economic projections and permutation (Ogungbangbe2024; World Bank, 2025)<sup>[30]</sup>. The implication is that the consequences of global warming and climate change affect not just the food industry but the overall economy of the nation (Coker,2025; Adamu & Baba, 2025)<sup>[1, 12]</sup>. To put it another way, Odekunle (2014) asserts that the national economy is greatly impacted by the imminent danger that climate change poses to the efficiency of agriculture.

### Empirical Review

The focus of effort here is to intentionally and systematically examine the contributions of thought leaders, existing body of knowledge as well as the reports of international organizations and conferences as it relates to climate change and the implications, particularly with respect to agricultural economy. This provides insights about knowledge-gap and justification for this study. This empirical review is presented under relevant subheadings to enhance reader-friendliness and assimilation.

### The Triggers of Climate Change

According to Botkin and Keller (2010), there are two possible explanations for the phenomenon of climate change: natural and human-caused. They highlighted human activity and natural processes to be the major triggers of increasing rate of climate change. More specifically, the scholars identified the following as some of the reasons for climate change:

1. Unabating greenhouse gas (GHG) emission. The term "greenhouse gases" (GHGs) describes the gases in the earth's atmosphere that have a propensity to absorb and release radiation, trapping heat and causing the Greenhouse Effect (Botkin and Keller, 2010). Experts' opinion from thought leaders affirm that greenhouse gases are integral component of earth's climate ecosystem caused by natural heat-trapping properties and increased concentrations from anthropogenic (human triggered) sources (such as fossil fuel, combustions, deforestation etc) whose combined effects have significant implications for global climate change as contained in the Encyclopedia of Sustainable Management (SpringerLink. (2020)<sup>[44]</sup>. Again, Intergovernmental Panel on Climate Change (IPCC, 2021)<sup>[22]</sup>, explains greenhouse gases (GHGs) as "clouds and some aerosols absorbed from terrestrial radiation emitted by the Earth's surface and elsewhere in the atmosphere." The most common greenhouse gasses are:
  - a. CO<sub>2</sub> (carbon dioxide). This is the most prevalent long-lived greenhouse gas in the atmosphere, accounting for over 65% of warming brought on by humans. It is released by burning fossil fuels, clearing forests, and altering land use.
  - b. Methane (CH<sub>4</sub>) is thought to be responsible for 20% of the warming caused by humans, making it the second most significant greenhouse gas after carbon dioxide. Landfills, natural gas production and transportation, and agricultural operations all emit it. (EPA, 2020, page 2)<sup>[48]</sup>.
  - c. About 5% of the warming generated by humans is driven by the powerful greenhouse gas nitrogen oxide (N<sub>2</sub>O). In most cases, fossil fuel combustion, industrial operations, and agriculture all release it. (Page 6 of IPCC, 2013).
  - d. According to IPCC, 2013 and IPCC, 2021, there is a class of strong greenhouse gases known as fluorinated gases (F-gases) including sulfur hexafluoride (SF<sub>6</sub>), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). They are part of the chemical component of daily household products like air conditioners, refrigerators, and several electrical equipment. The usage of these product which releases them into the atmosphere. (Page 7 of IPCC, 2013).
  - e. Ozone (O<sub>3</sub>). A greenhouse gas called ozone (O<sub>3</sub>) is created in the stratosphere when oxygen molecules and UV light interact. Pollutants and sunshine combined to create it equally in the troposphere.
  - f. Chlorofluorocarbons (CFCs): Before the Montreal Protocol phased down their manufacturing, a class of powerful greenhouse gases known as chlorofluorocarbons (CFCs) were widely utilized as propellants and refrigerants.
2. Global temperature rise. Intergovernmental Panel on Climate Change (2021)<sup>[22]</sup> underscores a long-term trend of rising global temperatures, resulting from

- human actions that triggers emission of greenhouse gases into the environment, such as carbon dioxide and methane. This is consistent with IPCC (2007) report which identified the main source of GHG emissions as the combustion of petroleum-based products, such as oil, natural gas, and coal.
3. Land-use changes and deforestation are important contributors to climate change (IPCC, 2022). The report further highlighted Agriculture, Forestry, and Other Land Use (AFOLU), notably deforestation was responsible for about 45% of total AFOLU carbon dioxide (CO<sub>2</sub>) emissions from 2010 to 2019 (IPCC, 2022). This aligns with the initial report from IPCC (2013) highlighting land degradation and deforestation as significant contributors to greenhouse gas emissions (IPCC, 2013, p. 10). This reinforces the critical role of well-planned and efficient implementation of land-use practices play in influencing climate dynamics. Undoubtedly, indiscriminate modifications to land use, such turning natural ecosystems into cities or reclaiming and sand filling coastal lines for smart cities portends huge risks for climate change (IPCC, 2013, p. 11).
  4. Industrial Processes. The production of cement is a major source of greenhouse gas emissions, mainly because carbon dioxide is released during the calcination process during production (IPCC, 2013, p. 12). Similarly, the production of steel is a significant source of greenhouse gas (GHG) emissions, mainly because fossil fuels are used in the production process (IPCC, 2013, p. 13). Industries are a major culprit when it comes to environmental pollution and gaseous emission.
  5. The production of livestock, for example, is known to release methane and nitrous oxide into the atmosphere, according to the Intergovernmental Panel on Climate Change (IPCC, 2013, p. 14). In addition, rice cultivation is a major source of greenhouse gas emissions due to methane discharge (IPCC, 2013, p. 15). Agricultural activities are also known to contribute significantly to greenhouse gas emissions.
  6. Earth's tilt and precession, as well as variations in the earth's orbital shape (eccentricity), all have an impact on how much sunlight reaches the planet's surface.
  7. Variations in sun intensity: Warming (when the intensity of the sun is higher) or cooling (when sunlight strength is lower) can result from variations in the strength of the sun. The amount of daylight that hits the surface of the planet can vary depending on alterations that occur within the solar.

The IPCC (2007) and Nzeh (2008) state that logging, ecological shifts, contamination of waterways, and farming methods are examples of human-induced processes that reduce the quantity of carbon sources. It has been demonstrated that these human behaviors are a contributing factor to Nigeria's continuous warming temperatures. Industrialization, which the combustion of petroleum and coal, combustion of gases, development, and shifts in worldwide land use and agricultural patterns are further human activities that contribute to significant greenhouse gas emissions.

**Climate Change Effects on Nigeria's Agriculture Sector**  
Nigerian Bureau of Statistics (NBS, 2024) emphasized that significant amount (22.61%) of Nigeria's GDP come from

agricultural sector. This is consistent with the report of Oxford Business Group indicating that agro-contribution to Nigeria's GDP in 2023 was estimated at 25% (www.oxfordbusinessgroup.com retrieved on January 10, 2025). Like many African nations, particularly those in the sub-Saharan region, Nigeria is heavily exposed to the adverse consequences of climate change (IPCC 2019). In fact, Nigeria is particularly susceptible to variations in temperature and precipitation due to its varied agro-ecological zones, which span from dry to humid tropical regions (IPCC 2007). Further to this established standpoint, the Intergovernmental Panel on Climate Change (IPCC, 2013) predicted that extreme weather events including droughts and floods would become more frequent and intense in Nigeria, along with increased temperatures and distorted rainfall patterns. Without a doubt, this will have a remarkable effect on the agriculture industry in Nigeria, which is poised to have negative multiplier effect on the stability and overall economic growth of the nation with respect to agriculture and its varied contribution to the economy.

#### **Climate Change Effect on the Agriculturist Population**

The majority of Nigeria's rural population make their living from the production and sale of agricultural products, and climate change has increasingly decimated this sector. Fishing is impacted when lakes, streams, and other natural water sources dry up. In a similar vein, crops that rely on precipitation suffer from decreased rainfall. Many agricultural plantations and farm communities are being overrun or submerged by flooding caused by rising sea levels and ocean levels. Diseases and pests are on the rise due to climate change, which lowers agricultural output. The effects of climate change are too evident to be ignored, particularly in a developing nation like Nigeria (IPCC 2019).

Oluwafemi, 2019 and Balogun, 2020 <sup>[8]</sup> emphasizes that rising temperatures, changing unpredictable rainfall patterns as well as prolonged drought contributes to desertification threats in northern Nigeria. Consequently, as desertification worsens in parts of northern, herdsmen and their livestock are compelled to relocate southward due to the drying of lakes and streams, which has several negative effects – including but not limited to communication difficulties, cultural conflicts, destruction of crops, cow rustling, insecurity, and ethno-religious problems as herders are predominantly Muslims (Maiangwa, B., & Ahmadu, F. (2010) <sup>[24]</sup>. Due to climate changes, individuals in coastal communities who rely on fishing for their livelihoods as fishermen have been forced to relocate and look for alternate means of subsistence – leaving the country's traditional food basket empty and hungry.

People are moving from rural to urban areas (urbanization) as a result of the growing consequences of climate change on agricultural production, according to Ikpi (2010). The increased urbanization undoubtedly put the cities under immense pressures because of infrastructural decay, rising crime rate, unemployment, and the high cost of living caused by escalating urbanization.

In September 2024, the flood situation in Nigeria escalated into a serious humanitarian disaster, affecting 180 local government areas (LGAs) and 31 states, according to the United Nations Office for the Coordination of Humanitarian Affairs (OCHA, 2024). The report claims that the unrelenting rains affected more than 1,083,141 persons,

resulting in widespread displacement, fatalities, and the destruction of homes and means of livelihood. The floods caused 2,504 injuries, 641,598 displacement, and 285 fatalities. With 98,242 dwellings impacted, homes, farms, and vital infrastructure were not spared (retrieved from <https://www.unocha.org> on January 15, 2025).

The aforementioned analysis supports the claim that Nigeria is experiencing devastating effects from climate change and global warming. The government shouldn't be the only one handling it; it can't be treated like a child. The organized private sector (including NGOs and CLOs), and forward-thinking high-net-worth citizens must all support the efforts of government.

### Climate Change Effects on Agriculture

According to Ikeme (2009), Nigeria is currently facing a number of challenges, including a decline in agricultural productivity, a rise in heat waves, unpredictable weather patterns, a decline in rainfall in the North's desert-prone areas, which contributes to desertification, a decline in food production in the central regions, and the destruction of livelihoods due to rising water levels in coastal areas where people rely on farming and fishing. According to recent research, climate change has a wide range of effects on agriculture, such as modified growing seasons, more frequent and severe droughts and floods, and significant adjustments to rainfall patterns due to warming temperatures.

Climate change may influence the kinds, occurrences, and severity of various livestock and crop pests, as well as the availability and timing of irrigation water supplies and the extent of soil erosion (Challinor and Wheeler, 2008). The amount and quality of forage from grasslands may be impacted by climate change in two ways, which is crucial to highlight. The first is that increased temperatures may cause the grasses to dry up, which would reduce the nutritional content of livestock feeds.

### Climate Change Effects on Crop Production

One technique for researching the effects of climate change on agriculture is crop yield analysis, which calculates how different environments affect crop productivity levels (Shirley, Pope, Bartlett, Oliver, Quadrianto, Hurley & Bacon, 2020) <sup>[43]</sup>. The scholars concludes that temperature and precipitation affect crop yield significantly. Shirley *et al.* (2020) further asserts high temperatures accelerate the rate at which organic matter is broken down by microorganisms, which has a detrimental effect on soil fertility over time with a corresponding impact crop production. Parry (2007) argues that the effects of carbon dioxide (CO<sub>2</sub>) enrichment, even in the absence of corresponding climatic changes, would probably be advantageous to agriculture.

Climate change is known to cause sporadic changes in the seasonal patterns of rainfall, intense precipitation events, and flooding leading to late planting as well as delayed harvesting period (Olayide, Tetteh & Popoola.2016) <sup>[35]</sup>. This is consistent with the viewpoint of Nwafor (2017) <sup>[27]</sup> that, "Nigeria's agricultural calendar has been increasingly destabilized due to erratic rainfall, floods, and shortened growing seasons caused by climate change". Agricultural experts and researchers such as Hatfield and Dold (2019) <sup>[17]</sup> affirms that variations in soil evaporation and plant transpiration are caused by the impact of climate change on soil water balance. Subsequently, agricultural growth

periods may be shortened, which would lower crop yields (Akinseye, Ajayi & Adiku 2016) <sup>[7]</sup>.

Because climate change shortens the agricultural rotation period, farmers must consider when to plant different crop varieties and how much fertilizer to use. Growing temperatures and shorter crop growing periods have an impact on food quality. Crop yield may decline as a result of changes in growing season length or plant photosynthesis rates brought on by variations in temperature and precipitation patterns (Oladoye & Oyebande, 2017). Higher rates of soil erosion and agricultural chemical leaching may result from increased rainfall in some areas.

### Climate Change Effect on Livestock Production

The influence of climate change on animal husbandry, whether for commercial or personal use, is undeniable (Nwafor & Ozor2019) <sup>[28]</sup>. The scholars argue that, "Climate change poses serious risks to animal husbandry, including heat stress, disease outbreaks, and scarcity of pasture and water—all of which reduce livestock productivity". This is consistent with the assertions of scholars like Rojas-Downing, Nejadhashemi, Harrigan and Woznicki (2017) <sup>[42]</sup> who argued that "Climate change significantly affects livestock production by altering animal health, feed availability, water resources, and overall productivity". The scholars also emphasized that both small-scale and commercial livestock operations are vulnerable to the implication of climate change in Nigeria. More specifically, some of the impacts of climate change on livestock production includes but not limited to:

1. Constant exposure of animals to high temperatures is linked to direct effects. This is the cause of weight loss, decreased feed intake, decreased growth and production, etc. When exposed to heat stress, cats have been shown to display well-known traits. These include less time spent grazing since the animals might have to look for cover from the heat. Reduced feed intake is closely linked to this. For example, heat stress lowers the amount of milk produced by dairy cows as well as the milk's fat and protein composition. It lowers the rate of reproduction as well. In a similar line, heat stress affects pigs and chickens by lowering their activity levels and fertility as well as their feed intake and laying effectiveness. Additionally, it raises mortality. Animals' reactions to high humidity are influenced by air temperature, evaporating surface area, body water content, and air movement. Black-skinned animals in Nigeria are susceptible to sunburn and skin cancer due to solar exposure. Solar radiation has less of an impact on animals with white, glossy skins than on species with dark, coarse skins or hair coats.
2. Indirect effects include how climate change impacts the quantity and quality of forage available to animals; plants grow faster in regions with high rainfall than in arid regions with little to no rainfall; and high temperatures and humidity provide an ideal environment for the growth of bacteria, fungi, and parasites, both internal and external, which affect livestock.
3. Ocean acidification and warming temperatures are two more important factors to take into account. The data that is currently available supports Nzeh and Eboh's (2011) assertion that climate change is drastically changing aquatic ecosystems. The implications of

climate change include notable changes in fish distribution and freshwater and marine species production. Calcification, the process by which marine animals like shrimp, oysters, and others develop their shells, is made more difficult by the increasing acidity of the ocean.

The overall output of fish production worldwide, including in Nigeria, is changing quickly as a result of this dilemma, endangering the livelihood and financial stability of communities who rely on fisheries. Further to the study of Hale and Keller (2008), inland or freshwater fisheries and aquaculture are impacted by shifting rainfall patterns and water use, whereas coastal fishing communities are at the vanguard of climate change due to sea level rise.

### Effects on Food Security and Food Inflation

International organization such as Food and Agricultural Organization, World Food Programme and World Health Organization affirm that climate change will undoubtedly affect food security all over the world, including Nigeria and the rest of sub-Saharan Africa (FAO, IFAD, UNICEF, WFP, & WHO, 2020) <sup>[14]</sup>. Subsequently, Oluoko-Odingo (2019) <sup>[36]</sup> explains that climate change exacerbates food insecurity in sub-Saharan Africa through drought, desertification, floods, and displacement. Food insecurity manifests as rising cost of food because of supply shortfall thereby exacerbating hunger and poverty, particularly among vulnerable population. A study by Okoro *et al.* (2017) found that climate change significantly decreased agricultural productivity in Nigeria, highlighting reduced crop yields and rising hunger. This aligns with the outcome of the research by Oyekale *et al.* (2018) which showing that climate change affects food availability and affordability in Nigeria, particularly for rural households. Closely related to food insecurity, food shortage or food scarcity is food inflation as explained in elementary economics. Food inflation in Nigeria reached all-time high in October 2024 (39.16%) according to National Bureau of Statistics (NBS 2024). This aligns with the report by Nigerian Economic Summit Group indicating the Food inflation in Nigeria as at September 2024 was estimated at 39.1%. (NESG, 2024). The common denominator here is that food inflation is hitting the roof as result of climate change related effects.

### Climate Change Effects on Nigeria Economy

Climate-related disasters, including floods and droughts, have destroyed many agricultural plantations and farm settlements, resulting in economic losses. A report attributed to the Nigerian National Emergency Management Agency (NEMA, 2024) estimated that the economic losses resulting from climate-related disasters in Nigeria were approximately \$9 billion. In addition, a study by Adebayo *et al.* (2019) <sup>[2]</sup> shows that climate change significantly impacted Nigeria's economic development negatively, particularly in the agricultural and manufacturing sectors. Scholars like Ogunjobi and Oladeji (2022) emphasize that "flooding, desertification, and droughts which are direct consequences of climate change are significantly undermining Nigeria's economic output." Subsequently, Nwankwo and Eze (2020) documented empirical evidence linking climate variability to reduced productivity, loss of arable land, and low industrial outputs in South-East and Northern regions of Nigeria. The scholars assert that

"Nigeria's reliance on climate-sensitive sectors like agriculture and small-scale manufacturing exposes the economy to frequent shocks" (Nwankwo & Eze 2020). Aremu and Adeyemi (2018) also emphasized that "climate change slows Nigeria's economic development, particularly through adverse effects on agriculture and manufacturing". The scholars further submit that "extreme weather conditions reduce agricultural output, while irregular energy supply due to environmental disruptions affects industrial productivity." In view of these overwhelming empirical evidence highlighting some of the numerous adverse effects of climate variability on our national economy, it calls for collective and urgent attention to forestall further damaging consequences.

### Climate Change Effects on Health

The World Health Organization (WHO 2021) <sup>[50]</sup> underscored the connection between climate change and increased exposure to health consequences in developing countries, including Nigeria; emphasizing conditions like water-borne diseases, malnutrition, and mental health stress. Similarly, Ezeh and Onuoha (2019) linked exacerbating health complications and vulnerabilities in urban slums to rising temperatures and flooding, highlighting the connection between climate change and increased incidences of diseases such as malaria, cholera, and respiratory infections in Nigeria. This is consistent with the findings of Akinbami and Oke (2021) whose study associated climate-induced environmental degradation to poor air quality and heat stress in Lagos and the northern regions, emphasizing a relationship between climate variability and increased hospital admissions. A team of international team of health researchers, Watts, Amann, Arnell, Ayeb-Karlsson, Belesova, Boykoff and Costello (2018) noted that "Nigeria is among the countries with high exposure to climate change risks, particularly vector-borne diseases, malnutrition, and heat-related mortality."

### Climate Change Effects on Society

Climate change has been observed to affect social cohesion, cultural heritage, and human well-being (UNESCO. 2021) <sup>[47]</sup>. Increased frequency of extreme weather events leads to loss of life, property damage, and displacement, causing social and cultural disruption (Olaniyan & Akinbobola 2019). It is natural that people along coastal line displaced by flooding will be forced to migrate to another settlement. This action comes with a lot of social implications like social and cultural integration. A study by Ajibade *et al.* (2020) <sup>[6]</sup> found that climate change as a major factor affecting social cohesion in Nigeria, particularly in communities with limited access to resources. Additionally, Ogunbode *et al.* (2020) <sup>[29]</sup> revealed that climate change is a huge threat to cultural heritage in Nigeria, particularly in areas with significantly strong cultural and historical importance. As climate change continue to trigger displacement and forced migration, there is bound to be cultural dilution or complete cultural loss as people move away from their traditional. Understandably so, because their culture may not be welcome or acceptable in their new host community.

### Theoretical Consideration

Diffusion of innovation (DOI) and vulnerability theories provides the theoretical framework for analyzing climate

change information as well as how resilience or adaptation strategies are communicated, adopted, and internalized by farmers and other stakeholders in Nigeria agricultural ecosystem. The Vulnerability theory is an ecological and environmental theoretical framework that offers insights about potential risk exposures associated with global warming and climate change and the intersectionality with Nigeria's agricultural economy. Meanwhile, Diffusion of innovation theory (DOI) provides insight about how the new climate resilient agricultural practices and emerging technologies are being embraced by farmers and other stakeholders. These theories serve as the foundation for this study.

### The Theory of Vulnerability

This theory is also referred to as the vulnerability framework. It offers an empirical conceptual framework for analyzing and comprehending how vulnerable people, communities, or even institutions are exposed to external stressors or risk factors like climate change. It argues that exposure, sensitivity, and adaptive capacity combine to influence how vulnerable a people, community and institutions may be to the risk factors.

It may be difficult to credit or attribute the vulnerability theoretical framework to a single person because of several contribution of various scholar over time. It is equally important to acknowledge input of researchers and organizations, such as Blaikie *et al.* (1994) <sup>[10]</sup>, the IPCC (2001), and Adger (2006) <sup>[5]</sup> into the contemporary concept of the theory as it relates to climate change and disaster risk reduction.

Adger's work on "Vulnerability" in which he gave a thorough overview of the concept of vulnerability and its application to climate change and sustainable development, further supports the idea that the vulnerability framework is well suited for this study because its basic tenets are relatable to the current issues in Nigeria's agricultural sector (Adger, 2006) <sup>[5]</sup>. In particular, the vulnerability framework is deemed appropriate due to:

- One of the main drivers of the Nigerian economy is agriculture, which is made even more vulnerable to climate-related hazards by government initiatives to diversify the economy away from oil by increasing the country's agro-base.
- **Evidence of climate variability:** Nigeria is already facing climate variability, which includes but is not limited to extreme weather events, temperature increases, and rainfall variability. As a result, Nigeria and Nigerians are at risk from concerning climate change-related hazards.
- **Limited ability to adapt:** The agricultural industry in Nigeria has limited ability to adapt, as evidenced by the lack of access to climate information services, irrigation systems, and climate-resilient technologies.

### Theory of Diffusion of Innovation (DOI)

Researchers like Greenhalgh, Wherton, Papoutsis, Lynch and A'Court (2017) <sup>[16]</sup> affirm that Everett Rogers' Diffusion of Innovations Theory remains a foundational framework for understanding how innovations spread across social systems, highlighting its relevance in health, climate, technology, and organizational change. Mahajan and

Peterson (2020) <sup>[23]</sup> emphasize that diffusion of innovation provides theoretical understanding of innovation spread and gains traction and adoption by their targets. The theory was put forward by Everett Rogers in 1962 <sup>[41]</sup> as a framework to explain how new concepts, practices, or technologies spread and gain acceptance (adoption) by individuals, communities, and institutions (Wherton *et al.* (2017). The scholars identified the following factors as major determinants consideration for the application.

- The extent to which an innovation is thought to be superior to current procedures or technological advancements is known as its relative advantage. The degree to which an invention aligns with current requirements, values, and practices is known as compatibility.
- **Triability:** The extent to which a new idea may be tried out or evaluated before being adopted.
- **Observability:** The extent to which an innovation's effects are apparent to other people.

Since the idea of climate-resilient agricultural practices is relatively new to many farmers, the diffusion of innovation theoretical framework was deemed appropriate. The theory would be useful to evaluate the adoption of climate-resilient agricultural practices and technologies, which would provide insights into the climate change adaptability by Nigerian farmers. Diffusion of innovation is crucial because Nigerian farmers are known to have minimal access to relevant and timely information, particularly about improved and pest resistant seedlings, climate-resilient technology and practices. Therefore, the theory explains how climate-resilient practices and technologies can be adopted and spread among Nigerian farmers, while Vulnerability Theory helps identify the exposure, sensitivity, and adaptive capacity of Nigerian farmers to climate-related stressors. Both theories are appropriate for comprehending the effects of climate change on Nigeria's agro-economy.

### Methodology

The study adopted a qualitative research approach, primarily a thematic and systematic review of published resources on climate change and its causes as well as effects on agricultural output. The thematic review involved a comprehensive and extensive reading and review of existing literatures on the impact of global warming and climate change. According to Creswell (2014), a thematic review is an effective method for identifying key themes and patterns in existing research.

In line with the recommendations of researchers like Bramer, Rethlefsen, Kleijnen and Franco (2017), the study adopted combined systematic search across multiple electronic databases including PubMed, Scopus, Google scholar and Web of Science, using relevant keywords such as "effect of climate change on Nigeria," "Impact of climate change on agriculture", "Consequences climate change and global warming on Nigeria Agriculture", "Climate Change Adaptation for Nigerian Farmers."

The study equally examined a wide range of online resources relevant to the topic, including experts' opinions and grey literature on climate change and global warming and their effects on agricultural productivity and practices.

A total of twenty-two online journal was systematically reviewed in the course of the study. Thereafter, thematic analysis was deployed to identify, analyze and interpret the content of the various source documents for the study leading to the categorization and development of the various themes presented in this article.

Data Analysis for the thematic review involved a qualitative analysis of the existing literature, using thematic analysis techniques to identify key themes and patterns (Braun & Clarke, 2013).

### Conclusion

Nigeria's agro-economy and overall economic growth and stability faces enormous risk from climate change and global warming. Evidently, Nigeria agricultural sector is already hit, particularly in the rural areas and farming settlements by disturbing prevalence of agro-related diseases, rising heat waves, unpredictable weather patterns, and decreasing rainfall resulting in decreasing agricultural productivity.

Undoubtedly, declining agricultural produce affects food prices (food inflation) which many families are currently grappling with. It is therefore, incumbent the leadership of Nigeria to prioritize solution based agricultural practices that guarantee food security, sustainable growth, and social stability. This is achievable by stimulating the agriculture industry through government interventions, encouraging climate-smart farming methods, making investments in robust infrastructure, and bolstering early warning systems.

### Recommendations

As part of the short-term recommendation, immediate intentional efforts should be directed to address the awareness challenges through rural community engagement. The use of narrative communication should be deployed to engage relevant stakeholders and opinion leaders within the agricultural ecosystem to deepen the penetration of climate discussions at the grassroot. This requires curated communication targeting market and town union leaders, farmers' association leaders and president-general (PG) in farming communities to educate and recruit them as climate change ambassadors. As opinion leaders who exert a significant influence in their communities, they can convey climate-resilient initiatives to their areas of influence thereby enhancing the penetration and adoption of climate-smart ideas at the grassroot. They can equally mobilize and sensitive people at the rural framing communities to attend climate change sensitization events.

In curbing the consequences of climate change on Nigeria's agro-economy such as poor farm yields, food inflation resulting from food scarcity, the researcher recommends promoting sustainable and climate-smart agricultural (CSA) methods including agroforestry as well as crop modification and expansion to reduce reliance on climate-sensitive crops. The implementation of fertility management and soil conservation techniques is known to improve soil health, reduce erosion, and increase agricultural productivity. Additionally, the study proposes adoption of water harvesting and storage techniques to minimize the effect water scarcity and extreme weather conditions occasioned by climate change. This strategy will increase agricultural productivity and food surplus.

This has proven to lower emissions of greenhouse gases, increase the condition of the soil, and boost agricultural

productivity. By initiating weather projections and advance alert mechanisms, farmers can also receive accurate data about climate-related hazards and take preventative action to lessen their impact. Nigeria can also ramp up agro-economy resilience by constructing irrigation infrastructure, encouraging crop or farm insurance and risk management, and offering farm extension training (services) and capacity-building initiatives.

In addressing the adaptation objectives of the study, the following adaptation strategies are proposed:

1. Initiate and enforce policies and bye-laws that prohibits indiscriminate removal of trees for commercial purpose in the rural areas. Narrative communication and traditional channels of communication comes handy here.
2. Deliberate actions and policies to preserve and protect our natural vegetation and ecological ecosystems such as forests and vegetations, grazing reserves, wetlands, and mangroves, which act as natural barriers against climate-related disasters like deforestation and flooding. This may be achieved by recruiting, training and engaging the teeming unemployed youths in the rural areas as forest guards.
3. The introduction of climate-resilient infrastructure that can withstand climate change, such as droughts, extreme weather events, and sea level rise. Examples of climate-resilient infrastructure include levees and sea walls designed to protect coastal communities from storm surges and flooding. Flood-resistant buildings designed to withstand flooding may be considered in flood-prone farm settlements. These infrastructural interventions are known to provide reliable and efficient sources of energy thereby reducing reliance on fossil fuels which are known to exacerbate climate change.
4. Consider the creation of national climate change policy and action plan that prioritizes the agro-economy and offers a framework and legislative backbone for addressing the impacts of climate.

Finally, this study examined the consequences of global warming and climate on the Agro-economy of Nigeria, highlighting the causative factors as well as the ravaging effects on humans, ecological ecosystem and animals. It is important for other scholars to consider further studies at a larger scale using different methods, such as quantitative research approach with robust sample size to allow for wider generalization. This will allow for adequate comparative analysis of research findings.

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