CLIMATE CHANGE, THE ECOLOGICAL/BIODIVERSITY CHALLENGE AND FOOD SUFFICIENCY: REINVIGORATING THE FADAMA/TASSA AGRICULTURE SYSTEM.

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ABSTRACT

Extant studies have shown that, despite the availability of arable farmland, other natural resources, and manpower,Nigeria has not attain food sufficiency. This has been attributed to the new wave of climate change and the ecological/biodiversity challenges in the area. The paper examines the impact of climate change on agriculture in northern Nigeria area; evaluate the relevance of Fadama and Tassa farming systems; analyse the implications of food security in Northern Nigeria; evaluate the relevance of Fadama and Tassa farming system to food security; and assess the compatibility of agrovoltaic systems with Agenda 2063 goals. The research is based on data obtained from primary and secondary sources. Primary data was collected using semi-structured interviews with individuals. Secondary data includes historical documents from the national archives, previous research conducted on the study area, documentary data taken from newspaper accounts, diaries, letters, and verbal reports. The data was analysed using narrative historical approach. The paper suggests that adopting technology, in line with the African Union's Agenda 2063, which envisages agricultural advancement through an extension of technological support with small-scale irrigation schemes (combining it with the already available natural and human resources as well as indigenous farming technology - Fadama and Tassa), Nigeria can attain the much-needed food sufficiency/security. The paper opines that, considering the nature of the area (dryland with little rainfall), agro-related technology can complement Fadama and Tassa farming using advanced technological methods, especially the use of solar-powered irrigation and the shading effects of photovoltaic panels, in improving food

security within these traditional/indigenous farming systems. It concludes by arguing that, with human and natural resources abundant in the country, solar energy can be integrated into traditional agricultural practices to enhance productivity.

Keywords: Climate Change, Fadama, Tassa, Agro-related technology, Food Security, Agenda 2063.

INTRODUCTION

Historically, it has been established that, as far as the Nigerian economy is concerned, agriculture wasoneofthe major sectors, while other important real sectors include crude petroleum, mining and quarrying, manufacturing, and building and construction (Nwagbo, 2000, Akubor 2010). Nigeria's agricultural economy is built around agroecological zones. Each zone has a distinct combination of climate, soil, and geography, which influences the types of crops and farming practices appropriate for the region.The economy of Nigeria has been significantly driven by agriculture since the precolonial period, and it remains an important economic building block and a fundamental source of income for a large portion of the population. This sector employs nearly 70% of the total workforce, with the country's small farms averaging 80% of the total food production (Akubor, 2021, 2025 Akubor and Akubor, 2021; Olodunmi, A. A, Usman, A.H et al, 2022; Tauna Amos, 2024; Chima C,2024; Chima A, 2024, Akubor 2025).

CONCEPTUAL CLARIFICATION

Climate Change

Climate Change is the change in the general circulation of the atmosphere on which climate ultimately depends, and it involves not only the atmosphere but also the hydrosphere, lithosphere, biosphere and cryosphere. These are the components that make up the climate system. The phenomenon of Climate Change and its implications for agriculture and food security in Nigeria have become a matter of immense concern in recent years. Human activities have altered atmospheric conditions. The entire globe is warming in response to gases, particularly carbon dioxide, that are emitted into the atmosphere. The result is an alteration in atmospheric conditions. While this gives rise to extreme temperatures in Northern Nigeria, Southern Nigeria is bedeviled by acid rain and excessive flooding. In Nigeria, agricultural development, innovation and production are impeded by climate change, soil carbon dynamics, land degradation, low adoption of biotechnologies in farming and local food systems, poor irrigation systems, insufficient financial investment in research and other factors (Akubor, 2021, 2022, 2024; Akubor & Akubor, 2021).

In line with the above, the general argument among scholars is that Climate Change has led to ecological/biodiversity loss. In this way, the most significant threats to biodiversity are habitat loss and fragmentation, driven by human activities such as deforestation, forest degradation, urbanisation, and agricultural expansion. As habitats shrink and become disconnected,

threatened, and endangered species lose their homes and struggle to find food, shelter, and mates, leading to population declines and potential extinctions, a problem that could be greatly mitigated by increased efforts to conserve biodiversity (Lewis, 2025). In Nigeria, northern Nigeria is one of the most nature-depleted regions due to its long history of climate change, coupled with the destruction of natural habitats by humans in their quest for survival.

As a means of survival in the harsh conditions imposed on the people and their environment, the agricultural communities evolved a peculiar agricultural system through which they have maintained crop production over the years. These systems have been broadly described as Fadama and the Tassa Systems of Agricultural Production.

Fadama Farming

In Hausa, "Fadama" means irrigable lowland, usually the low-lying plains that overlay shallow aquifers that straddle Nigeria's major river system. Fadama is Hausa word meaning a valley-bottom, flood plain, or a lowland around a river that floods or becomes wet when the river is high. Fadama is defined as flood plains and lowland areas underlined by shallow aquifers and found along Nigeria's rivers system. Analysis shows that in the pre-industrial Hausaland (Kasar Hausa), the society was able to provide for themselves as well as enough for export through farming especially through the Fadama system which was practiced by community as well as family units. Fadama is any low-lying land which is subject to seasonal flooding or waterlogging and includes the floodplains of streams and rivers which have been inundated together with seasonal pools and depressions where land is moistened due to the rise in the water table (Swindell, 1986, Akubor, 2025).

In present-day Nigeria, "Fadama" refers to floodplains and low-lying areas underlain by shallow aquifers along Nigeria's river system (World Bank, 2001; Abubakar et al., 2014). These river valley areas are seasonally flooded or have high water tables for all or most of the year. Fadama irrigation is an age-old tradition in the Nigerian Hausa land, and the seasonal flooding of the valley floor allows for the cultivation of a variety of crops through small-scale irrigation (Abubakar et al., 2014). The National Fadama Development Program (NFDP) was designed to assist some of the Federation's States through the World Bank-supported Agricultural Development Program (ADP) network. The assistance varies, but may include: financing the provision of shallow tube wells in Fadama lands for small-scale irrigation; simplifying drilling technologies for shallow tube wells; constructing Fadama infrastructure; organizing Fadama farmers for irrigation management, cost recovery and better access to credit, marketing and other services; and the provision of vehicles, pumps and other equipment (Abubakar et al, 2014).

TASSA Farming System

Closely related to the Fadama Farming system is the Tassa system. The Tassa is a traditional practice in the Sahel that involves planting pits to reclaim land lost or at risk of degradation. Zaï, or Tassa, is a farming technique that involves digging pits (20-30 cm long and deep, spaced 90

cm apart) in the soil during the preseason to catch water and concentrate compost (UNEP, 2016). This method is as old as the history of farming in the area, and as a result of its effectiveness as compared to the modern system, it led farmers to revive and adoptTassa, a traditional soil and water conservation practice, at a surprising rate in the Niger. The technique is traditionally used in the western Sahel (Burkina Faso, Niger, Mali) to restore degraded drylands and increase soil fertility.The modern, improved practice of Tassa in Niger can be traced to the predominantly Muslim Yatenga province in Burkina Faso. Burkina Faso, it can be said, learnt the hard way: earlier on than Niger; At the core of agricultural efforts at the local and community level are traditional farming techniques. Traditional or indigenous knowledge-based agricultural practices are easily accessible and inexpensive, and governments that have supported citizens in building on or scaling up traditional farming practices have recorded successes. Tassa is a traditional soil and water conservation practice stemming from the Sahel region of Africa. Farmers hand-dig small pits uniformly across a field to collect rainwater and place manure at the bottom of each pit to increase soil fertility. Seeds are then planted along the ridges of each pit. When rain falls, the pits fill with water,providing a nutrient-rich source to support growing plants. This simple and inexpensive traditional technique has resulted in major increases in crop yield and helped farmers build resilience against drought (Swindell, 1986, Akubor 2025).

Generally, the table below summarises the nature of the area, the farming circle, and the situation in the area.

Table I: Farming System / Distribution in Sudan Savanna Area

S/ no	System	Features	Main Ethnic Group	Distribution
1.	Firki Flood retreat	Residual Moisture	Shuwa, Kanuri	West and South of Lake Chad
	Montane	Terraces, Continuous cultivation	Chadic speaking especially Laamang, Sukur	Mandara
	Agro-pastoral	Opportunistic cereal cropping, large cattle herds	Koyam, Shuwa, Fulbe	Central Borno
	Savannah	Rain-fed agriculture	All groups	Gongola, Southern Borno
	Swamps	Riverine, based on natural flooding	Hausa, Fulbe, Chadic and Adamawa speakers	Gongola
6.	Dry-Season gardens	Riverine, using irrigation and shaduf/pumps	Hausa, Fulbe, Jukun and sporadic among other groups	Gongola

Source: Blench, 1997

Although both the Fadama and Tassa systems of agriculture have sustained the societies of these areas and even beyond, the increasing global population, as well as the rising level of globalisation, demand changes in production methods. This is because, while both Fadama and Tassa have worked for communities within the region and sub-region, it is clear that, to sustain the increasing world population in an era of globalisation, there is a need to modernise the system for greater efficiency and effectiveness. In line with this, the paper considers the argument of the African Union's AGENDA 2063.

African Union AGENDA 2063

The African Union, with the document 'The Agenda 2063, The Africa We Want',presented it to its member states and received collective appreciation. The first aspiration seeks to "build a prosperous Africa based on inclusive growth and sustainable development." This aspiration is further subdivided into seven main goals. The sixth goal focuses on "modern agriculture for scaled-up production, improved productivity and value addition through commodity transformation and services, contributing to farmer and national prosperity and food and nutrition security" (AU, 2015).One major crisis in Africa is people living in abject poverty, which is reflected in the world's social development indices, and the plight of hunger keeps deepening. There have been several projections that the situation could worsen by 2030 if not addressed in due course. Hence, the African Union'sAgenda 2063 intends to take advantage of its arable land for food security within the first 10 years of implementation through modern productivity. It is projected that by 2063, countries in Africa will be ranked among the top performers in global competence in life sustainability. The African Union Commission posited that by 2063, Africa will be a continent that has stamped out all systems of food insecurity and hunger way back by 2025, coming out as a nourished continent (AUC, 2014). Agenda 2063, with seven aspirations, was launched in 2015 to address these challenges and enhance inclusive growth, providinga global strategy to optimise the use of Africa's resources. The challenge remains that countries like Nigeria, with one of the humongous economies, may not have aligned with the collective structure of Agenda 2063 on modern agriculture to explore the gains efficiently.

THEORETICAL FRAMEWORK

This research is based on the Diffusion of innovations theory, which seeks to explain how, why, and at what rate new idea and technology spread and is applied to enhance human existence and sustenance. The theory was popularized in 1962 by Everett Rogers (Roger, 1962, 1983). The main argument of theoryrevolves around the process by which an innovation is communicated through certain channels over time among the participants in a social system. The innovation must be widely adopted in order to self-sustain. Within the rate of adoption, there is a point at which an innovation reaches the most affected in the society. The origins of the diffusion of innovations theory are varied and span multiple disciplines. The criterion for the adopter categorization is innovativeness, defined as the degree to which an individual adopts a new

idea.This concept has also influenced modern design and human-computer interaction. The theory is considered most suitable considering the fact that both the Fadama and Tassa agricultural system have proven to be very effective in the area of food production and security from historic time.

In line with the above, the paper examines the impact of climate change on agriculture in northern Nigeria area; evaluate the relevance of Fadama and Tassa farming systems; analyse the implications of food security in Northern Nigeria; and assess the compatibility of agrovoltaic systems with Agenda 2063 goals.

MATERIALS AND METHODS

The research is based on data obtained from primary and secondary sources andwasconductedusing an analytical and narrative historical approach. This includes historical, descriptive and analytical approaches based on gathered evidence. The primary source for this research is based on field investigations conducted in the area and surrounding territories (among farming communities in Zaria, Gombe and Maiduguri area). Among other things, the data collection process includes semi-structured interviews with individuals. The research also uses historical documents from the national archives, drawing on prior research on climate change, agricultural production, and the Sudan Savannah area, as well as documentary data from newspaper accounts, diaries, letters, and oral reports.

RESULT

In sum, the studies observed that as far as agricultural advancement is concerned, Climate Change over the years have been a major impediment. Climate change has been largely due to human reckless activities in the area, especially the alteration of the natural environment, exposing it to harmful agents that are not favourable to crop and animal production. This is particularly true of northern Nigeria, which accounts for over 75% of the nation’s agricultural output. In northern Nigeria, the agricultural systems of the Fadama and Tassa areas have been adversely affected, so much so that agricultural production has been hindered compared to what it used to be. The paper thus argues that effective implementation of the African Union Agenda 2063 (especially in terms of technological applications in agriculture) would benefit the agricultural industry as a whole.

DISCUSSION

Traditionally, Northern Nigeria, with its large landmass, has been credited with agricultural prowess. Over the years, the area has contributed meaningfully to Nigeria's agricultural production. Although the area is considered dry, the predominantly agricultural population has developed and relies on traditional agricultural methods, which have been shown to positively impact farming output. This has been the Fadama and Tassa farming system. Scholars have argued that both Fadama and Tassa cultivation embrace a diverse range of farming methods and

crops, which rely on farmers having detailed knowledge of the extent of surface flooding, water-table levels, slopes, bunding, and building raised beds, water-lifting, well-digging, and the use of crop mixtures and relays. Swindell (1986) notes that all of the 19th-century travelers who passed through Hausaland and the Sokoto region were impressed by both the techniques and the diverse range of crops they encountered on their journeys. Fadama land may be cropped almost continuously as swamp rice can be grown in the wet season and then followed by variety of dry-season crops which rely on accumulated soil moisture or irrigation Water is lifted from perennial streams by shadufs or more frequently by buckets on poles from shallow wells alternatively farmers use floodland retreat and sites where moisture is retained in the soil long enough during the dry season to grow crop Fadama farms which are irrigated are known as lambuna sing lämbu and are generally extremely small ranging from 0.05 to 1.5 ha. In the Sokoto close-settled zone Fadama land comprises the floodplains of the Sokoto-Rima basin and land along the tributaries together with shallow depressions and valley heads which dissect the upland Only small percentage of the Fadama is used on the Sokoto-Rima floodplain as the area is vast up to km wide north of Sokoto also the amount of labour required for dry-season work is considerable while the market for vegetables is more limited than that for cereals During the dry season there is considerable competition for labour as this is traditionally the time when men take non-farm work in the towns or in commercial-crops zones further south Cultivation along the main floodplain of the Sokoto and Rima rivers around Sokoto and below towards Birnin Kebbi is also limited by the erratic flooding which occurs the wet season the rivers are badly braided and the main channels divide and constantly shift across the floodplain Swamp rice is restricted to selected patches along the margins or to small islands or tributary valleys ((Swindell, 1986).

However, over the last two decades, these systems have been threatened by the severe climate change experienced in the area. The immediate impacts are ecological and biodiversity losses, leading to declining agricultural production and a rising number of unemployed youths in this part of the country. Most of these have found solace in the emerging insurgent groups, who have promised them another source of livelihood. It is therefore in line with this that there is an urgent need to revitalise this system to improve the already dying agricultural and food-producing life of the people and their land (Swindell, 1986, Akubor 2025).

Nigeria and the Quest for Agricultural Development: Motion without Movement

A historical analysis of the evolution of agricultural policies in Nigeria and categorization, has indicated that it can be divided in to four main phases: the first from 1960 to 1969 immediately after independence; the second from 1970 to 1979, the period of the oil boom; the third from 1980 to the late 1990s, during the structural adjustment program (SAP); and the current NEEDS framework (Sanyal & Babu, 2010). A breakdown of these categories based on extensivehistoricization of agricultural programshas been summarized in a tabular form as shown below:

Table 2: Historicized Table of Agricultural Programs in Nigeria since 1960

S/no	Heads of State/ Presidents	Year of Establishment	Name of Agricultural Program/Policy	Aim of Agricultural Program/Policy
1	NnamdiAzikiwe and Tafawa Belewa (1960-1966)	1962/1963	Regional Agricultural Program (RAP)	This program was formulated to maximize agricultural production and export
2	General Yakubu Gowon (1966-1975)	1972	National Accelerated Food Production Programme (NAFPP)	The aim of this Programme is to educate farmers on methods of food crop production. Organize workshops/seminars for farmers and encourage large-scale Irrigation and export.
3	General Yakubu Gowon (1966-1975)	1963 with involvement in the Lake Chad Basin and River Niger Commissions	The River Basin Development Authorities (RBDAs)	To provide Irrigation facilities and to bring more land under cultivation. Again, it aimed at increasing the total output per farmer, construction of feeder roads to the rural areas as well as the construction of fish ponds.
4	General Yakubu Gowon (1966-1975)	1974 by the WB, FGN, State and Local Governments	Agricultural Development Projects (ADP)	To emphasized modern and high Input technology in order to boost production by engaging in commercial agriculture. Geared to mechanize and technological agriculture.
5	General Olusegun Obasanjo (1976-1979)	Launched in 1976	Operation Feed the Nation (OFN)	The programme was launched in order to bring about increased food production. It was introduced

				purposely to reduce the cost of bread basket for the average family unit in Nigeria, by cutting down on the demand for certain food items.
6	AlhajiShehu Shagari (1979-1983)	June 3, 1980	The Green Revolution Programme (GRP)	GRP was to ensure that Nigeria attains self-sufficiency in food production within five years by providing agrochemicals, improved seeds/seedlings, irrigation system and favourable pricing.
7	General Muhammadu Buhari (1983-1985)		Back to Land (BL)	To revive the agricultural sector and to produce sufficient food for all. It was also aimed at encouraging Nigerians to go back to farm to reduce over dependence in oil and help the rural farmers to increasing their production.
8	General Ibrahim Babangida (1985-1993)	January 1986	Directorate for Food, Roads and Rural Infrastructure (DFRRI)	To improve the quality of life and standard of living of the rural dwellers through the use of many resources that exist in the rural areas and mass participation of the rural people.
9	General Ibrahim Babangida (1985-1993)	1986	Structural Adjustment Programme (SAP)	To provide strategies on food crops, livestock, industrial raw materials, wildlife, forestry and fish production. It also provides policies on

				support services such as agricultural extension, technology development and transfer, etc.
10	General Ibrahim Babangida (1985-1993)	1987	Better Life for Rural Women (BLRW)	To stimulate and motivate rural women towards achieving better standards of living and sensitizing the rest of Nigerians to their problems.
11	General Ibrahim Babangida (1985-1993)	Early 1990s	National Fadama Development Project (NFDP)	To promote simple low-cost improved irrigation technology under World Bank financing.
12	General Ibrahim Babangida (1985-1993)	1992	National Agricultural Land Development Authority (NALDA)	To give strategic support for land development, promoting better uses of rural land and their resources. Targeting and assisting in achieving food security through self-reliance and sufficiency.
13	General Sani Abacha (1993-1998)	1996	Family Support Programme (FSP)/ Family Economic Advancement Programme (FEAP)	The programme stressed on areas like health, education, women in development, agriculture, child welfare and youth development, disability, destitution, and income generation.
14	Chief Olusegun Obasanjo (1999-2007)	1999	National Economic Empowerment and Development Strategy (NEEDS)	To offer farmers improved irrigation, machinery and crop varieties which would help to boost agricultural productivity and

				tackle poverty head on since half of Nigerian's poor people are engaged in agriculture.
15	Chief Olusegun Obasanjo (1999-2007)	January 2002	National, Special Programme on Food Security (NSPFS)	The broad aim of the programme was to increase food production and eliminate rural poverty
16	Chief Olusegun Obasanjo (1999-2007)	16th April 2003	Root and Tuber Expansion Programme (RTEP)	To achieve 13 economic growth, improve access of the poor to social services and carry out intervention measures to protect poor and vulnerable groups. It also aim to achieves food security
17	AlhajiUmaru Musa Yar'adua (2007-2010)		Seven-Point Agenda. (SPA) Food Security	To enhance agricultural production that would lead to enough food production for local consumption and export. It aimed at strengthening agribusinesses through institution of profitability and price support mechanism, land tenure changes, aggressive development and supply of new land.
18	Goodluck Ebele Jonathan (2010-2015)		Agricultural Transformation Agenda (ATA)	The focus is to assure food security, reduce expenditure of foreign exchange on food imports, diversify the economy, generate foreign exchange and create jobs.

19	Muhammadu Buhari (2015-2016) Agricultural		Transformation Agenda (ATA). Adopted	It aimed at subsidizing the costs of major agricultural inputs, such as fertilizer and seedlings for farmers. ATA continuation policy include developing domestic value chains for commodities like rice, wheat, maize, and soya beans; strengthening agricultural export markets for products including cocoa, cassava, oil palm, and sesame.

Sources: Akubor & Akubor, 2017; Yusuf & Francis, 2019

These programmes faced challenges, mainly stemmingfrom corruption, mismanagement, and the problem of technological transfer (Akubor, 2010, 2014, Yusuf & Francis, 2019). Analysis has shown that the agricultural programmes did not help in providing adequate food to all Nigerians due to a lack of continuity in the programmes and further research; the lack of ability and will-power from the managers or managerial staff and unqualified agricultural specialists affected the programmes (Akubor 2010, 2014, Yusuf & Francis, 2019). As far as Akpa (2021) is concerned, this has been due to (among other issues) governments' continual rhetorical support for agriculture as a tool of economic diversification, but they failed to implement policies or provide budgets to match their ambitions. He passionately indicates that the National Assembly should find a way to domesticate policy actions under the Malabo Declaration. Policymakers must also ensure that capital expenditure receives an adequate share. This is a call for regional cooperation.

It was as a way of charting a new path that the African Union, through the Common African Position (CAP) on the post-2015 development agenda, seeks to accelerate Africa's infrastructural development through technological transfer. This is pivotal for connecting African people and economies to help drive development in all its ramifications (AU, 2014). It intends to enhance the development, transfer, and diffusion of technology and innovation in line with each country's development needs, and to improve access to funding for home-grown technological innovations and environmentally sound technologies.

Generally, the areas in which Climate Change have manifested, in the area as identified by scholars, include:

i. Increased Pest: Climate change in Nigeria has led to an increase in pest breeding, affecting animals and food crops, causing undernourishment and food insecurity due to the evolution of different pest species.

ii. Influence on Livestock: Climate change threatens livestock, leading to persistent heatwaves and animal loss. High temperatures, a result of carbon emissions, increase livestock vulnerability to diseases and reduce fertility. Drought worsens food insecurity, as livestock that rely on foliage may endure longer periods of undernutrition.

iii. High demands for Irrigation: Climate change affects precipitation frequency and intensity by increasing the amount of water evaporated into the air, leading to more intense snow and heavy rain. However, it can also reduce rainfall, as seen in the Sudan and the Sahel savanna belts. This has increased irrigation costs, resulting in higher food prices and forced closures for farmers who cannot afford it. This could lead to food shortages (Dauda, R, 2023; Akubor, 2025).

Research has shown that in some parts of Nigeria (Maiduguri and environs), locals are already working towards food sufficiency,despite rapid climate change. This is seen in the production of the MasakwaSoghium. MasakwaSoghium refers to a type of sorghum, specifically a dry-season, dwarf sorghum cultivar, also known as "dwarf sorghum," that is popular in certain regions, particularly in Nigeria. "Masakwa" is a specific name for a type of sorghum, a cereal grain, that is cultivated in certain regions, particularly in the Sahel-Savanna zone of Nigeria. Masakwa sorghum is known as a dry-season sorghum cultivar, meaning it's grown during the dry season. It is also referred to as "dwarf sorghum". Studies have been conducted on Masakwa sorghum production practices, including identifying major productionconstraints and collecting local germplasm. It survives on little water and hashigh yieldpotential. Given this situation and the introduction and use of modern agricultural technology, there is a high likelihood of mass production to meet the needs of the teeming population.

Technology and Nigeria's Path to Food Security/Sufficiency: Agrivoltaic and Agriculture

Agricultural technology involves the use of scientific tools to enhance agricultural productivity and efficiency. Experts describe agricultural technology as including a range of materials, processes, and knowledge. To transfer agricultural technology to end users, different institutional arrangements are needed due to its complexity (Adzenga&Dalap, 2023). It is important to note that agricultural technologies vary in the degree and nature of their sensitivity to local circumstances (Suri & Udry, 2022). The profitability of adopting mechanical field preparation in savannah regions (that is, grasslands with numerous but widely spaced trees), for example, depends on factor prices and topography, but less strongly on local variations in soil characteristics. For this reason, it suffices to say that a technology that is profitable on one set of

farms in a particular year may fail on other nearby farms or in other seasons. It is in line with this that the modernizing of agriculture is highly conceived to be a way out of human drudgery in agriculture, where African agriculture of the future will see the banishment of the hand hoe, and finally render the sector modern, profitable and attractive to the continent's women and youth (AU, 2015). The African Union affirmed further that:

It is believed that this growth would be made possible through broader and deeper continental market integration and facilitated by the establishment of adequate market and trade infrastructure – including roads, railways and transport services; ICT; irrigation, and storage and agro-processing facilities; commodity exchanges, market information and other structured trade facilitation services (AU, 2015). It is indeed possible to achieve this by connecting farmers to local, national and regional markets through an efficient network

It is therefore not surprising that, in recent years, technological innovation in agriculture has advanced through research findings while proffering solutions. One of these research areas is Climate-Smart Agriculture (CSA). According to Adesipo et al (2020):

Climate Smart Agriculture is a transformative and sustainable form of agriculture that aims to improve productivity in food security and production systems, based on coupling the key pillars of climate change (e.g., adaptation, resilience, and mitigation) in addition to smart and advanced technological knowledge, thereby increasing profit and minimizing vulnerability through reducing greenhouse gas emissions.

It is in line with the above that the paper argues that with the technological availability within the confines of the Agrivoltaic Technology, the country (with specific reference to northern Nigeria) can successfully overcome the problems associated with Fadama and Tassa farming systems in modern times, as well as improve on this for maximum production. This is because the new technology can facilitate agricultural technology transfer for food self-sufficiency and sustainable agriculture, which, coincidentally, were made priorities by the Agenda 2063 (AU, 2014). In this way, the following will be attained:

i. Enhance the production, storage, transportation, availability, accessibility, utilization, safety and quality of food.

ii. Improve the productivity of smallholder agriculture and livestock through extension of technological support, small-scale irrigation schemes, rural infrastructure, credit and social services. This will be beneficial for small-scale farmers, who have been facing difficulties with irrigation machinery and technology.

iii. Support modernization and diversification of agricultural sectors through: private sector participation in agriculture; agri-business development; improved agroindustry linkages; providing special support to integrate women into agri-business value chains; equitable

access to land; and sustainable land management practices, including on our arable lands, for present and future generations.

iv. Promote agricultural marketing and information flows by establishing national and regional information centres and cooperation mechanisms in agriculture, food and nutrition security.

v. Adopt sustainable agricultural, ocean, and freshwater fisheries practices and rebuild depleted fish stocks to sustainable levels, especially around the dry Lake Chad Basin.

vi. Strengthen resilience to external and climate-related shocks, such as droughts, floods, commodity price volatility, food shortages, and export restrictions, particularly for staple foods.

vii. Urgently call for multilateral partnerships to reduce food loss, build resilience to commodity price fluctuations, and address food shortages and export restrictions during crises.

Evidence of some of these points is already evident in the forecast for the 2025 planting season, as released in a document sponsored by the European Union, the Women Empowerment Program, and Christian Aid titled *When it is right to Plant in 2025*. This is indeed the result of applying technology to the agricultural lives of the people.

CONCLUSION

From the discourse, it is clear that the issue of Climate Change, the Ecological/Biodiversity Challenge and Food Sufficiency is fast attracting global attention as seen in the interest of the African Union and the Agenda 2063. The result is that the African Union, through its Agenda 2063, has set the roadmap and strives to address these agricultural needs of the people. It is also in line with this, that the paper suggests reinvigorating the Fadama/Tassa Agriculture System, which is not completely alien to the people. In this way, Agrovoltic can become a veritable tool towards achieving this noble idea. The modus operandi of the Agrivoltaic Technology fits in perfectly with the African Union frameworks on the Comprehensive Africa Agriculture Development Programme (CAADP), established in 2003, which is an initiative that prioritizes agricultural transformation through innovation and technology. This specifically encourages member states to invest 10% of their national budgets in agriculture, fostering technological research and adoption (AU, 2003). Similarly, the Malabo Declaration reaffirms the commitment to CAADP goals, highlighting the need for increased research, technological innovation, and private-sector engagement to enhance agricultural productivity. There were other frameworks,such as the African Agricultural Technology Foundation (AATF), which were meant to provide platforms for disseminating technological knowledge and fostering regional collaboration (Midega et al., 2017). The CAADP goals are also promulgated in Agenda 2063. On another level, the African Union promotes PPPs as a model for technology transfer, ensuring that innovations are scalable and accessible to smallholder farmers (UNECA, 2019).

Further research has shown that, as part of its mechanisms for agricultural technology transfer, the African Union has collaborated with institutions such as the International Institute of Tropical Agriculture (IITA) and the Forum for Agricultural Research in Africa (FARA) to enhance Research and Development (R&D) capacity. There are empirical results as these partnerships have led to the development of pest control technologies and climate-resilient crop varieties (Adebayo & Olufemi, 2020). This paper thus argues that Agrivoltaic Technology can provide the necessary tools and linkages for maximum achievement.

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