THE CONCEPT OF VALUE CHAINS IN AGRICULTURE, CLIMATE ACTION AND ENVIRONMENTAL RESOURCES

GLOBAL ISSUES & LOCAL PERSPECTIVES

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Published By:

Society for Agriculture, Environmental Resources & Management (SAEREM)

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

First published 2024

SAEREM World

Nigeria

Typeset in Times New Roman

THE CONCEPT OF VALUE CHAINS IN AGRICULTURE, CLIMATE ACTION AND ENVIRONMENTAL RESOURCES (GLOBAL ISSUES & LOCAL PERSPECTIVES)

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Printed at: SAEREM World

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

TABLE OF CONTENTS

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

[1]Dr. Nwizia, Baribefii Paagolah & [2]Mbube, Baridanu Hope (Ph.D.)

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

Food safety challenges of antibiotic-resistant foodborne pathogens in street vended foods and report on evolving remedies

[1,*]Clement Olusola Ogidi, [1]Oluwatoyin Ajoke Oladeji, [2]Olubukola Olayemi Olusola-Makinde, and [1]Adeyanmola Oluwaseyi Faturoti

Chapter Ten

The Role of Remittances on Economic Growth in Nigeria 1980-2022

Atiman Kasima Wilson PhD

Part two: THE CONCEPT OF CLIMATE ACTION

Chapter Eleven

Financing Climate-Smart Agriculture for Sustainable Food Security in Nigeria: Practices, Risks, Responses, and Enabling Policies

Odili, Okwuchukwu *Ph.D*[1]* and **Okoro Kelechi Okoro**[2]

Chapter Twelve

Climate Change and Pollution Appraisal: Scientific and Social Approaches

[1]Salami, K. D., [2]Akinyele, A. O., [1]Muhammad, Y. K. and [1]Lukman, A. T.

Chapter Thirteen

Climate Change and Small Holder Agricultural Production in Nigeria

Ettah, O. I. and Edet, E. O.

Chapter Fourteen

Geese Production for Food Security

Balogun, B.I. PhD

Chapter Fifteen

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

Part three: THE CONCEPT OF VALUE CHAINS AND ENVIRONMENTAL RESOURCES

Chapter Twenty One
Forest Ecosystem Approach toward Food Security

Adebayo, D.O, Bolaji, K.A, and Akanni, O.F

Chapter Twenty Two

Nutrient Profiling of Avocado (*Persea americana*) and African Pear (*Dacryodes edulis*): A Comparative Study for Food and Nutritional Security

Simpson Victor Bamidele[1], Yusuf Ahmed Saliu[2], Akemien Nerioya Neri[3], Akhideno Lawson Oseigbokan[4], Alli Sheriffdeen Abiola[5].

Chapter Twenty Three

Sustainable Poultry Production: The Guinea Fowl Alternative

Balogun, B.I. PhD

Chapter Twenty Four

"A Study on the Anticariogenic Efficacy of Some Ethnobotanical Plants on Oral Bacteria: A Review"

Simpson Victor Bamidele[1], Akemien Nerioya Neri[2], Akhideno Lawson Oseigbokan[3], Alli Sheriffdeen Abiola[4], Adeleye Opeyemi Adebola[5].

Chapter Twenty Five

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

Resilience and Restoration: Tropical Ecosystems in the Face of Human Impact

[1,4]Salami, K.D. [2]Akinyele, A.O. [1]Lawal, A. A. [3]Abubakar, A. W. [1]Jibo, A. U.
[3,4]Adeniyi, K. A.

Chapter Twenty Six

Effect of Tigernut on Reproductive Indices of *Clarias Gariepinus*

[1] Tusayi, B.W, [2]Onyia, L.U., [3]Musa, M., [4]Bello, H.A, and [5]Ndibrimta, N.

Chapter Twenty Seven

Assessing Agroforestry Practices Impact on Environment, Income and Food Production In Southwest Nigeria.

Bolaji K.A., Jatto K.A and Adebayo D.O.

Chapter Twenty Eight

Breaking Barriers: Gender Dynamics and Opportunities for Women's Empowerment in Agricultural Value Chains

[1]Mbube, Baridanu Hope, [2]Odekunmi, Seyi Adeloba, [3]Utoko, Vincent Agu & Usman, Christiana Ilebaye

Chapter Twenty Nine

Ecological Perspectives on Reducing Post-Harvest Losses in Agricultural Value Chains: Implications for Climate Action and Environmental Sustainability

[1]Mbube, Baridanu Hope, [2]Abdulsalam, Rabiu Anate, [3]Ojumu Adedotun Omobayo & [4]Moses, Nueebu Mon

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It is eschews pedantry and lays bars the issues in such clarity that conduces to learning. The book elaborates on contemporaneous ***The Concept of Value Chains in Agriculture, Climate Action and Environmental Resources*** issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which climate change, food security, national security and environmental resources issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue climate change, food security, national security and environmental resources necessary in policy making process that will stimulate increase in food production and environmental sustainability.

The Concept of Value Chains in Agriculture, Climate Action and Environmental Resources: Global issues and Local Perspectives is organized in three parts. Part One deals with The Concept of Value Chains in Agriculture, Part Two is concerned with The Concept of Climate Actions and Part Three deals with the Concept of Value Chains and Environmental Resources.

Eteyen Nyong/ Ignatius Onimawo

April 2025

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

Chapter Eleven

Financing Climate-Smart Agriculture for Sustainable Food Security in Nigeria: Practices, Risks, Responses, and Enabling Policies

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1.0 INTRODUCTION

Climate change is a serious environmental problem because of its uncertain time- frame, scales of occurrence, differences in vulnerabilities and shocks. The growth in global emissions of carbon dioxide (CO_2) is increasing, and emissions in 2020 are more than 60 per cent higher than their level in 1990 (Climate Scorecard, 2020). Forest and its resources are lost at a very high rate in most parts of the world. Overexploitation of aquatic resources and fish stocks has also resulted to diminished yields and some species going into extinction. Some of the earth's land and marine areas are under legal protection, but birds, mammals and other species are heading for extinction at fast rate, with reduction in populations and geographical distribution, while human population and activities are increasing, causing over use of natural resources, disruption of the natural ecosystem and variability in climate. Climate change has undermined development and increased environmental risks on the poor who are more vulnerable to weather catastrophes, desertification, and rising sea

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

levels, but whose activities have contributed the least to the problem of global warming, a precursor of climate change. Combating climate change is a socioeconomic, technological, institutional, and policy challenge, and for the developing countries, it is mainly financing problem (World Bank, 2020).

Climate finance is the use of financial instruments specially aimed at improving climate change resilience, mitigation and adaptation goals. Climate change financing is a means of fostering investment and development in renewable energy infrastructure, sustainable agriculture, or other adaptations to climate change. Financing climate mitigation would correspond to fund activities that contribute to low carbon, a transition to a net-zero carbon emissions economy, enable low-carbon emission or substantial emissions reductions through avoided emissions (African Development Bank (AfDB), 2020). Activities contributing to climate change adaptation include activities that would prevent or reduce the risk of adverse effect of present and expected future climate change on the environment, people or economic assets. An important area that the world has shifted its attention to in combating climate change through adaptation and mitigation effort is "Climate-Smart Agriculture". Climate-Smart Agriculture (CSA) aims at making agricultural systems more resistant to the impacts of global warming a precursor of climate change. CSA is based on three cardinal pillars: mitigation of Green House Gas (GHG) emissions through agriculture, resilience and adaptation of agricultural practices to climate change, and increase in sustainable agricultural productivity to support food security.

2.0 CLIMATE CHANGE AND FOOD SECURITY RISKS

There are four dimensions of food security: availability, accessibility (economically and physically), utilization, and stability of these three dimensions. Food security exists when people have physical and economic access to sufficient food that meets their dietary needs and food preferences for a healthy and active life (World Food Summit, 1996). According to FAO (2015) and the assessment report of the Intergovernmental Panel on Climate change (IPCC, 2019), climate change intensifies risk to food security and a disincentive to livelihood for the most vulnerable countries and populations. Four risks caused by climate change IPCC (2019) have direct impact on food security: Loss of farmers' income and livelihoods; Loss of aquatic and coastal ecosystems; Loss of terrestrial and inland water ecosystems; Food insecurity and breakdown of food value

chain. The arid and semi-arid areas, landlocked countries and Small Island developing states are the most vulnerable and the inhabitants are exposed to climate variability shocks.

Globally, climate change is modifying the conditions under which agricultural activities are conducted and has direct and indirect consequences on agricultural production systems. Direct consequences include shocks caused by a modification of physical characteristics such as temperature levels and rainfall distribution on specific agricultural production systems. Indirect consequences are those that affect farming through changes on other organisms such as pollinators, pests, disease vectors and invasive species. Impacts on production translate into economic and social impacts, influencing food security and creating series of additional risks on availability of food, access to food and utilization of food, as well as stability of these characteristics, for farm and non-farm households.

Exposure to risks is a disincentive to investment in production systems, often with negative impacts on long-term productivity, returns and sustainability. Risks to agricultural income have also been shown to have negative effects on household capacity and willingness to spend on health and education. Evidence from analyses of the impacts of various types of weather anomalies on farm income indicates that the impacts are greatest for the poorest farmers (Evans, 2012). The sequence of climate change impacts on food security and nutrition as conceptualized by Food and Agriculture Organization of the United Nations (FAO, 2015) is presented in figure 1.

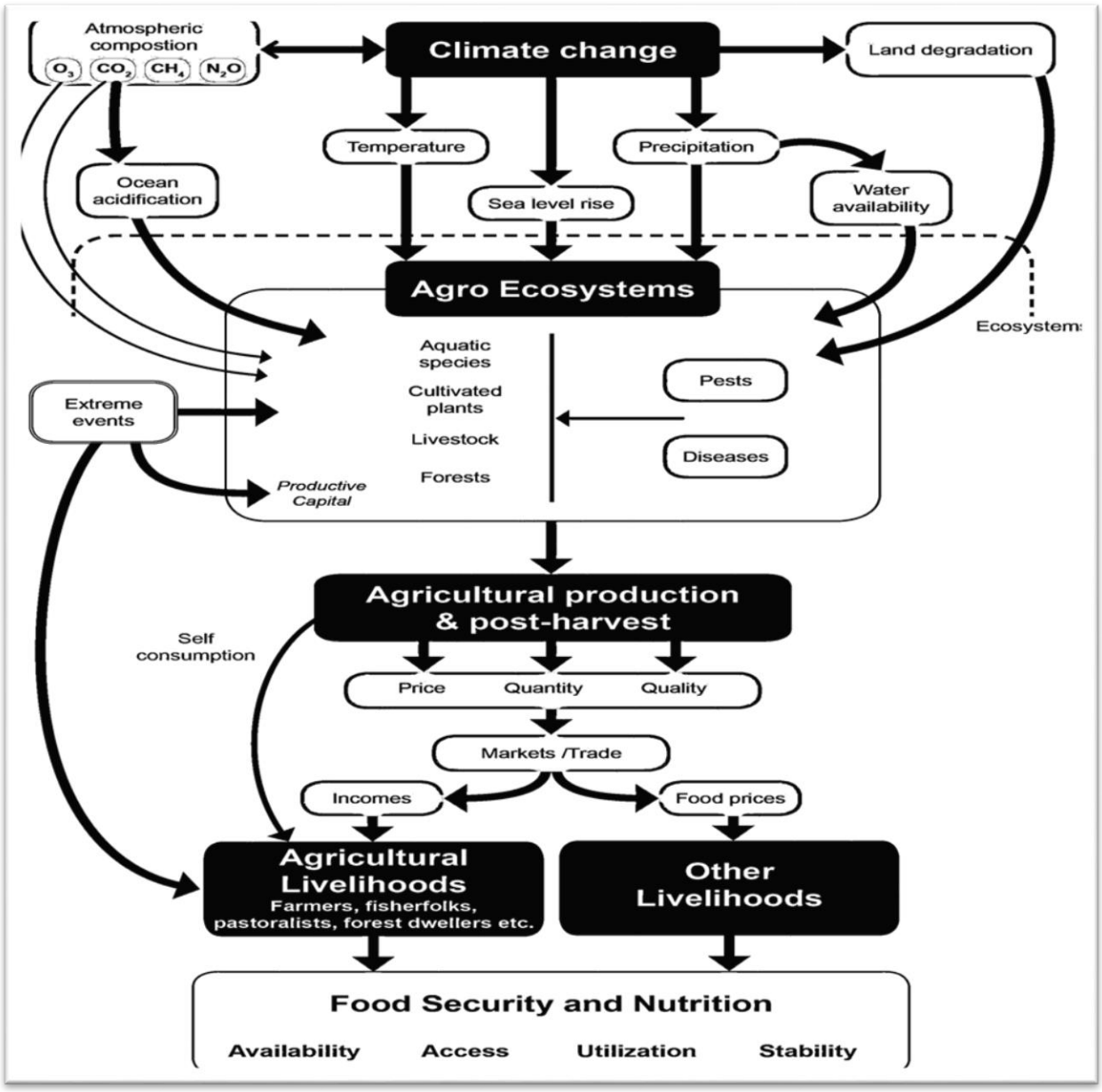

Figure1. Schematic representation of the sequence of climate change impacts on food security and nutrition.
Source: Food and Agriculture Organization of the United Nations (FAO, 2015), *Adopted*

Figure 1 shows that climate change affects food production, and thus food availability. Climate change impacts the livelihoods and income of small-holder food producers and thus, through high food price increases and volatility, the livelihoods of food buyers, reducing access to food. Net

consequences of climate change on food security depend on exposure of affected systems. The populations at greatest risk are those that are dependent on agriculture and natural resources, and who have very limited capacity to respond. In regions with high levels of food insecurity and inequality, extreme weather conditions may disproportionately affect women, given their vulnerability and restricted access to economic resources. Gender and social differences discriminate people's access to adaptation options, or even information, such as weather and climate data (NAP Global Network, 2017). Native people, who depend on the environment and its biodiversity for their food provision, are at high risk– especially those living in areas such as the Arctic, mountain areas, the Pacific islands, coastal and valley areas.

3.0 NIGERIA'S VULNERABILITY AND RESPONSES TO CLIMATE CHANGE

3.1 Nigeria's Vulnerability to Climate Change

Eckstein, Hutfils, and Wings (2019) in "Climate Risk Index", classified Nigeria as a region of high risk, and stated that the country is one of the top most vulnerable countries in the world.

Nigeria's natural capital (land, forests, landscapes, water, and fisheries), physical capital (cities, infrastructure, and other produced capital), and human capital are highly susceptible to the impact of climate change due to a combination of frequent natural disasters, large population, poor infrastructure and low resilience to economic shocks.

3.2 National Response to Climate Change

The Government of Nigeria has initiated a number of measures to address the challenges of climate change. These actions are in the following areas:

Institutional framework: The Department of Climate Change (DCC) in the Federal Ministry of Environment is the nation's Focal Point to the UNFCCC and drives the national response to climate change at the national and international levels. It is the Designated National Authority (DNA) for the Clean Development Mechanism and works with other Ministries through the Inter-Ministerial Committee on Climate Change.

Climate change policies and programmes: A number of enabling policies and programmes that are related to climate change mitigation and adaptation have been adopted. Development policies that have clear implications for climate change adaptation in Nigeria include: (i) Vision 20:2020; (ii) the Transformation Agenda (2011 – 2015); and (iii) Economic Recovery and Growth Programme (ERGP) (2017 – 2020).

Nationally determined contribution (NDC): NDCs are countries self-defined national climate pledges under the Paris Agreement, detailing what they will do to help meet the global goal to pursue 1.50C adapt to climate impacts and ensure sufficient finance to support these efforts. Nigeria developed its NDC in 2015 towards the ratification of the Paris Agreement on Climate Change aimed at reducing its greenhouse gas (GHG) emissions intensity of GDP by 20% by 2030 relative to the emissions intensity of GDP in the base period 2010 to 2014 on an unconditional basis as well as a further 45% on a conditional basis consequent upon receiving climate finance, technology transfer and capacity building from the developed countries.

Climate change financing: Nigeria recognizes that to respond effectively to climate change mitigation and adaptation challenges, require financial resources beyond what governments at all levels can provide. To this end, the government of Nigeria launched and issued Green Bonds as innovative means and alternative way of raising climate finance, and released the guidelines for the Green Bonds that target about $250 million in climate finance to support national projects in key areas environment, agriculture, power and energy efficiency-transportation (CBI, 2022).

Global and regional cooperation: Nigeria is strongly committed to the achievement of an effective and equitable international agreement on climate change. Nigeria is meeting up to its obligations to the United Nations Framework Convention on Climate Change (UNFCCC), and supporting the implementation of climate change initiatives of ECOWAS and African Union.

3.3 State of Climate Finance in Nigeria

With greenhouse gas (GHG) emissions rising continually since 2009 in Nigeria – the third highest in Africa after the Democratic Republic of the Congo and South Africa (ClimateWatch, 2019) – Nigeria needs to ensure prospective growth that follows a low-emissions development pathway, preventing carbon lock-in as the country undergoes further industrialization and urbanization. In 2019/2020, an average USD 1.9 billion per year of public and private capital was invested in climate-related activities in Nigeria. This is only 11% of the estimated USD 17.7 billion needed annually to meet the conditional Nationally Determined Contribution (NDC) target of reducing emissions 47% below business-as-usual by 2030 (DCC, 2021). The tracked USD 1.9 billion of climate finance flowing to and within Nigeria is minimal relative to the size of the country's economy, with a GDP of USD 432 billion (World Bank, 2020), and the opportunities for low-carbon development. Fossil-fuel financing in Nigeria continues to dominate: Nigeria was ranked second in Africa in terms of the number of fossil fuel projects financed between 2016 and 2021,

with one liquefied natural gas (LNG) project therein receiving USD 2.77 billion alone; more than the total climate finance tracked in 2019/2020 (Geuskens & Butijn, 2022). The investment gap for priority sectors looms large in the Nigerian climate finance landscape, given the estimated USD 17.7 billion needed annually to deliver on the conditional NDC. At USD 663 million, adaptation finance is not consistent with the extent of the country's vulnerability to climate change. In order to attain the adaptation priorities outlined in, and integral to, Nigeria's NDC, adaptation finance must be significantly scaled-up in parallel to mitigation finance, which totaled USD 1.1 billion in 2019/2020 (CCCD, 2022; Nwankpa, 2022). Concessional debt is predominantly used to channel climate finance (46%), followed by non-concessional debt (25%). Grant- and equity-based finance currently plays a relatively minimal role in Nigeria's climate finance ecosystem, at 5% and 12% respectively. Private sector investment significantly lags behind public investment, accounting for 23% of total climate finance committed in 2019/2020 (CCCD, 2022).

4.0 CLIMATE-SMART AGRICULTURE

4.1 Dimensions of Climate-Smart Agriculture

Climate-Smart Agriculture is a comprehensive strategy for managing farming activities (crops, livestock, fishery, and forestry) that opposes the negative impacts of climate change on agricultural productivity. It is an approach to transform farming that aims to deliver positive outcomes on three impact dimensions or pillars, namely, intensification, adaptation, and mitigation to support food security under the new realities of climate change.

Intensification: Climatically smart agriculture works to intensify the overall agricultural productivity and provide greater food security by enhancing crop, fish, livestock, and forest resource production and farm profitability.

Adaptation: CSA aims to fortify agricultural infrastructure against the destructive effects of global warming. This entails taking measures to increase resilience and minimize vulnerability and susceptibility to climate-related threats like floods, droughts, or extreme heat.

Mitigation: Climatically smart agriculture focuses on reducing the amount of greenhouse gases released into the atmosphere because of farming activities, including methane emissions from livestock, paddy rice cultivation, and synthetic fertilizer.

The three dimensions of CSA are interrelated, combining traditional and contemporary knowledge and technologies to create agricultural practices robust to global warming effects. CSA simultaneously addresses the global concerns of food security, ecosystem management, and climate

change, therefore incorporating the three dimensions of sustainable development - economic, social, and environmental conditions. At the grassroots, CSA is intended to improve livelihoods through food security mostly among the small-scale farmers. This is by improving the management of natural resources and shifting to suitable technological approaches for the production, processing, and marketing of farm produce. Relatedly, at the national level, CSA is tailored to prompt mainstreaming of policy, technical, and financial mechanisms that facilitate a base for operationalization of climate change adaptation within the agriculture sector. There are many CSA technologies that can be used singly or in combination in response to various environmental conditions (Teklewold *et al.*, 2017). The adoption of CSA technologies among farmers differs based on cultures, preferences, awareness, socioeconomic backgrounds, and resource availability (Maguza-Tembo *et al.*, 2017). However, successful CSA requires appropriate financing for the sustainability of agricultural production technologies, social, economic, and environmental conditions.

4.2. Climate-Smart Agricultural Practices

CSA practices are similar to precision agriculture in that it focuses on understanding the elements that influences crop output, soil health, air pollution, and other farming outcomes. It incorporates practices like boosting soil carbon absorption and reducing greenhouse gas emissions to mitigate climate change's detrimental effects and boost agricultural production and profitability. Farmers who adopt climate-smart agriculture practices see a rise in income while also helping to combat climate change and strengthen global food security. CSA practices include:

Cultivating climate-resilient crop varieties: Growing crops that are resistant to extreme weather conditions can help farmers mitigate the impact of global warming on crop production. Improving yield stability and minimizing susceptibility to climate hazards can be achieved through climate-smart agricultural practices like the selective breeding of crop varieties with features appropriate to the local environment, selection of early-maturing and/or cold-resistant hybrid and shifting of planting schedule or preparation for additional irrigation.

Conservation agriculture: Zero-tillage cultivation, employing crop leftovers and cover crops to keep the land permanently covered, and crop rotation are examples of climate-smart conservation agricultural techniques and can protect soil quality. By boosting soil health, reducing erosion, and enhancing water absorption and land drainage, these methods promote resilience to climate change in agriculture.

Agroforestry: Agroforestry is the CSA and forestry practice of growing trees alongside crops or livestock. Trees create shade and windbreaks and improve nutrient cycling for their "neighbours", while sequestering carbon dioxide. They also improve biodiversity and soil fertility and can be used to create robust agricultural landscapes.

Water management: This involves providing important information on surface, root zone soil moisture, and cumulative precipitation for monitoring and decision making. Nutrient leaching and water stress on crops can be prevented by fine-tuning irrigation plan based on soil moisture and rainfall data. Precision irrigation, drip irrigation, and collecting rainwater are examples of effective CSA strategies that can be used to maximize water consumption efficiency and reduce negative effects on the environment.

Integrated pest management (IPM): This is a climate-smart farming system for controlling pest, weeds, and diseases that prioritizes ecological safety by combining biological, cultural, and chemical approaches. IPM is effective in lowering the need for synthetic pesticides thereby preserving the ecosystems, increase biodiversity, and shield useful organisms from harm.

Nutrient management: This involves the use of organic fertilizer and employing precision fertilizing and crop rotation in the farming system. This increases soil fertility, and reduces nutrient runoff and the emissions of greenhouse gases, thus ensuring less waste and greater efficiency in their use.

Livestock management: CSA activities such as rotational grazing, specialized feed formulations, and manure management help ranchers in lowering methane emissions and increase livestock productivity. Efficient grazing, improved nutrition, and less waste are the three pillars of sustainable livestock management.

Information and counseling on climate-related issues: To adapt to the changing climate, farmers must use both tried-and-true methods and innovations. Precision agriculture (PA) technology is the science of improving crop yields and assisting management decisions using high technological senor, and analysis tools. PA is a new concept adopted throughout the world to increase production, reduce labour time, and ensure the effective management of fertilizers and irrigation processes. PA can assist farmers and large agro-tech companies in the successful application of CSA practices. Farmers need reliable and timely metrological and climate data to make informed decisions. Weather, climate projections, and advisory help can assist farmers

optimize agricultural practices, prepare for climate-induced hazards, and build resilience. These require huge financial investments.

4.3 Benefits of Climate-Smart Agriculture

Climatically smart agriculture advocates a comprehensive approach that finds a middle ground between economic viability and environmental sustainability to protect ecosystem over the long run. Adoption of CSA practices benefit the environment, boost farmers' livelihoods, and opens up new economic avenues. These could be achieved in the following ways:

Improve agricultural productivity: Adopting SCA and optimizing the use of water, fertilizers, and other agricultural inputs, farmers can increase farm yields while remaining resilience in the face of climate change.

Cutting back on emissions of greenhouse gases (GHGs): Crop rotation, cover-cropping, zero or conservative tillage, and well-planned, precise fertilizer applications are CSA methods recommended to reduce greenhouse gas emissions from agriculture.

Reducing pollution and other environmental hazards: Conservation farming helps keep soils from eroding, preserve land fertility, and save local plant and animal lives. Smart water management conserves water supply, organic farming and IPM reduce the need for harmful chemical treatment which is important for maintaining a balanced biome.

4.4 Challenges in Adopting Climate Smart Agriculture

Problems associated with CSA especially in developing countries are mainly with implementation and they include:

Inadequate knowledge and awareness: There is dearth of information and poor access to established approaches.

High costs at the outset: Most of the farmers are smallholder farmers. CSA practices may call for expensive agricultural innovation, technology or infrastructure and are not within the reach of farmers.

Market barriers: the market for climate-smart agricultural products is still small making it difficult to source for customers.

Obstacles from policy and regulation: Policies and regulations may be in the form of outright ban on some CSA technologies and activities and insufficient funding or technical support from government agencies.

Cultural and social resistance: Conflicts may exist in the implementation of CSA practices due to established farming norms. In addition to personal conflicts, farmers attempting to implement contentious approaches to CSA may encounter pushback from locals.

5.0 THE POTENTIAL OF "CLIMATE-SMART AGRICULTURE FRIENDLY'' FINANCIAL INCENTIVES

5.1 Climate change societal responses: Climate change constitutes new threats to small-scale farmers, and creates opportunities for them (UNDP 2011). It creates opportunities to address the food insecurity and climate vulnerability in most countries especially the developing countries. These opportunities include societal responses that promise new flows of ''climate finance'' to the developing world, coupled with political will to support innovative actions, and secondly, climate-smart agriculture practices for these communities have been identified, to address climate change threats while also delivering direct benefits to communities.

Climate change induces societal responses through mitigation and adaptation actions. Mitigation involves combating climate change by reducing greenhouse gas emissions into the atmosphere or enhancing carbon ''sinks'' via carbon sequestration, while adaptation involves adjusting to climatic changes in order to reduce potential damages, take advantage of new opportunities and cope with any adverse conditions (IPCC 2007). Both adaptation and mitigation are relevant to small-scale farmers, since farmers' actions can either help deliver these outcomes or exacerbate climate change and peoples' vulnerability to it.

Adaptation finance is based on the clear moral obligation of those principally responsible for climate change towards those who suffer most from its effects, coupled with their capability to pay for these damages (Oxfam International 2010). Small-scale farmers in less developed countries are widely recognized as the group most vulnerable to climate change and hence most deserving of adaptation spending (Biagini *et al.,* 2011). Mitigation finance lessens climate variability impacts on global society, and small-scale farmers have a comparative advantage in providing this service, creating donor and private sector interest in making mitigation investments that can be harnessed to benefit farmers.

5.2 Climate-smart agriculture friendly financial incentives

A key determinant of farming input and output is money. Climate-Smart agriculture friendly financial incentives are payments to farmers based on conditions confronting them. These payments have sufficient value to generate meaningful revenue, addresses the costs and risks faced by farmers and encompass a range of activities packaged and implemented domestically. Great obstacle to climate-smart agriculture practices includes initial capital investments in infrastructure, labour, and uncertainty about the results due to its complexity, and a changing nature (Gledhill *et al.*, 2012). Other hindrance to CSA adoption that may be less affected by the provision of capital is associated with poor governance (Kahiluoto *et al.*, 2012). CSA friendly financial incentives to small-scale farmers that will accelerate their adoption of climate-smart agriculture practices have not been exploited in Nigeria.

Climate-smart agriculture practices appear to be in its infant in Nigeria because literature (Onoja *et al.*, 2019; Wahab *et al.*, 2020; Mashi *et al.*, 2022) has revealed that no existing arrangements to foster the adoption of CSA practices by small-scale farmers through financial incentives for farmers on a ‘‘farmer friendly’’ basis exist. Climate-smart agriculture practices are often neglected by agricultural growth and development initiatives for small-scale farmers, which typically focus instead on Green Revolution technologies such as improved seeds, chemical inputs, irrigation, and other agricultural related programmes. Such technologies and programmes can secure impressive productivity gains under favourable conditions, but are not well-targeted to small-holder farmers that have no access to finance. While some Green Revolution technologies foster adaptation to climate change (e.g. drought-tolerant seed varieties), others reduce climate resilience (e.g. reliance on chemical fertilizers, mono-cropping). These technologies may also fail to deliver mitigation gains, since they neither minimize greenhouse gas emissions from soils nor build up carbon stocks in soils and vegetation. Early work on adaptation initiatives does not focus on employing financial incentives as a delivery strategy. Instead, these initiatives typically focus on information provision and capacity building to support the adaptation

efforts of communities.

5.3 Level of adoption of climate-smart agricultural (CSA) practices in Nigeria: Globally, small-scale farming systems are highly susceptible to climate change and variability because they are climate dependent and predominantly rain-fed (Cohn *et al.,* 2017). Most countries in Sub-Saharan Africa including Nigeria operate small-scale agricultural system and are highly vulnerable to climate variability shocks. High rate of population growth also leads to vulnerability of Sub-Saharan African countries as it leads to increasing food demand and competition over water use (Cooper *et al.,* 2008). Nigeria is an agrarian country (70% of their populations are farmer) with about 88.4% operating small-holder farms and a rapidly growing population (UN, 2022). FAO developed the concept of Climate-Smart Agriculture (CSA) (FAO, 2018, IPCC, 2019) as a response for the need to increase food supply without compromising environmental quality and to support the Paris Agreement on climate change.

Studies documenting adoption of CSA practices in Nigeria have found some levels of adoption of early maturing and drought tolerant varieties, changing of planting dates, and diversification of crops (Onoja *et al.,* 2019; Mashi *et al.,* 2022). The problems facing awareness and adoption of CSA practices by small-holder farmers in Nigeria are access to loans and financial incentives, lack of ownership of economic assets, income sources, age and level education of farmers (Mashi *et al.,* 2022). Therefore ensuring improved resilience of farmers to climate change should encompass best strategies that have the capacity to provide "CSA friendly financial incentives", strengthen institutional arrangements and operations of agricultural extension services, provide access to early warning information on climate change, and ensure proper planning for irrigation facilities.

6.0 FINANCING CLIMATE-SMART AGRICULTURE IN NIGERIA

Climate-smart agriculture friendly financial incentives can be achieved through:

Farm credit support: Climate change creates new financing requirements and opportunities in terms of amounts and financial flows associated with needed investments in infrastructure, technology, and innovative institutional solutions. Farm credit support should be provided by the government and relevant financial institutions like development and micro-finance banks to assist them invest in infrastructure and technology related facilities, acquire more land areas and purchase farm inputs required for increased food production and sustainability.

Insurance: Insurance policies on agricultural activities will mitigate climatic impacts and ensures efficient food production systems in Nigeria. Index insurance programme is one latent response to the insurance gap in Nigeria agriculture. Index insurance insures against an objectively-measured index – such as a rainfall deficit. Index based insurance reduces the problems of moral hazard and adverse selection, and fosters lenders willingness to extend credit to farmers. Most important is the degree in which the indicator is correlated with losses and should be careful examined because basis risk may arise where correlations are not well calibrated (Barrett *et al*. 2007). In regions with poor data and changing climates, index insurance may not be viable. Index-insurance programmes can be managed through social safety net programmes or commercial financial institutions, but in either case capacity building is required. Improved use of climate related information is important to increase effectiveness of index-insurance programmes (Hansen *et al.* 2007).

Payments for environmental services: Payments for environmental services are one potential source of alternative financing for agricultural transitions (FAO, 2007). Emerging carbon markets and payments for emissions removal or reduction have attracted much interest and such financing leads to more of productive land systems which encourages maximum food production. However, high transactions costs, and low potential mitigation benefits in many farming systems limit the potential of carbon market offsets to farmers. Payment for environmental services experiences suggest that formal and informal institutional arrangements that can facilitate aggregation amongst large number of smallholders, policies in the agriculture, financial and environmental sectors that encourage the flow of public and private financing to farmers, capacity building, including accessing financing mechanisms, and an agreed system for payments to farmers is imperative (Cacho & Lipper 2006)..

Incentive linkage to farmers: Financing CSA require a better understanding of mitigation and adaptation benefits that can be obtained from different sustainable agricultural strategies, the incentives that may be required to adopt them and the costs implication. Incentives may be monetary in the form of credit or payments but could also be in-kind, including access to land, markets or seeds, organic fertilizers and other production inputs. Experiences with payments for environmental service (PES) and microfinancing could be drawn upon in building incentive systems for the adoption of relevant practices and technologies. Where payments for mitigation and adaptation activities are economically viable, they may provide the stimulus for farmers to adopt sustainable agricultural land management practices. In some cases, payments of limited

duration could provide incentives for soil carbon sequestration and also encourage transition towards productive and resilient production systems, while fitting with the saturation of soil carbon pools. If carbon sequestration incentives lead to more productive and sustainable forms of agriculture, there will be a lower risk of non- permanence compared to baseline conditions.

Develop innovative financing schemes: Strengthening financing opportunities at all levels and for different risks is important, as well as the bundling of insurance and agricultural credits. Development banks and micro-finance banks should gear up support for lending to a partnership-based approach to innovative financing. There is need to develop a programme based investments approach to support climate-smart agriculture, which should be country driven. In assuming a leadership role, governments can better organize resource flows to fill financing gaps, create synergies and avoid duplication. Directing climate finance to support institutional investments that can accelerate adoption of practices for increasing resource use efficiency is an important step towards climate-resilient development in agriculture.

Short-medium-and long-term financing mechanisms: Proposals for financing mechanisms are capable of addressing needs depending on the time window of the climate-smart actions at hand. Different private sector financing mechanisms that target different areas such as large agri-business value chains, sustainability standards, and national/regional suppliers are needed. Concessionary mechanisms have been instrumental to build, operate and transfer schemes, and could be used to drive climate-related investment where concessionary agreements can be successfully negotiated. Development banks can provide grants, loans and other monetary instruments. The AfDB Global adaptation funds have specific windows to provide support for countries and other relevant entities, e.g. Green Climate Fund and the Adaptation Funds (AfDB, 2020). Emerging markets and other investment funds provide potential funding streams for innovative start-up ventures, e.g. renewable energy projects. Other monetary instruments include the NEPAD climate change fund, in addition to other mechanisms under consideration by regional economic commission (UNFCCC, 2011).

Social Safety Nets: Safety nets are a form of social incentives or insurance made up of programmes sponsored by the public sector or NGOs that provide transfers to prevent the poor from falling below a certain poverty level. These programmes include cash transfers, food distribution, seeds and tools distributions, conditional cash transfers (Devereaux, 2002). Several new initiatives for safety net programmes have recently emerged, including the Nigeria's ₦8000 cash transfer programme, the

Ethiopia's productive safety net programme and the Kenya hunger safety net programme. There has been a continuing debate about the role of such programmes in development activities. Recent evidence indicates tradeoffs between protection and development are not pronounced (Ravallion, 2006). Safety net programmes can actually be a form of social investment into human capital (e.g. nutrition, education) and productive capital, allowing households to adopt higher risk and higher productivity strategies.

Other measures of financing climate-smart agriculture in Nigeria: Many improved farm management practices have long term maturity. This can be a hindrance to small-holder farmers because investing in innovative practices requires labour and huge financial outlay that must be borne before the benefits can be reaped (IFAD, 2010). There is need to provide an enabling legal and political environment with appropriate institutions, effective and transparent governance structures that can coordinate sectoral responsibilities across national to local institutions. This will help to overcome the barriers of high opportunity costs to land so that smallholder farmers can increase their farm planning. This is a key requirement for successful implementation of climate-smart agriculture friendly financial incentive in developing countries because of the problems of land tenure system, and to-date it has been given little attention especially in Nigeria.

7.0 POLICY DIRECTION FOR EFFECTIVE CLIMATE-SMART AGRICULTURE FINANCING IN NIGERIA

Key requirements for an enabling policy environment to promote the adoption of climate-smart agricultural practices will involve greater coherence, coordination and integration between climate change, agricultural development and food security policy processes and programmes. Lack of coherence can prevent synergy capture and prevent the achievement of climate-smart agriculture policy objectives. Nigeria recognizes the huge opportunity it has to build a more robust climate finance mechanism, taking advantage of its global networks and linkages. Thus, the main policy direction is to mobilize and align national climate financial mechanism with global ones, including the Green Climate Fund and others available through national, regional and international financial institutions. The policy directions needed to ensure effective financing of climate-smart agriculture include:

- **Mobilization of social protection funds:** Social protection covers a wide range of instruments and objectives, encompassing both safety nets and "safety ropes", i.e., mechanisms that enhance income-generating abilities and opportunities for the poor and vulnerable. Adequate, well-

designed social protection policy would tackle some of the main vulnerabilities of households to climate change shocks. These actions will need to be supplemented by disaster risk reduction and management (DRR/DRM) strategies to address the risks of extreme weather events. Disaster risk reduction should be prioritized in any social protection policy financing to ensure reduction and proactive management of risks rather than reacting to events.

- **Build resilience of agricultural systems:** Agricultural systems can be made more resilient, by implementing policy measures that are can be domesticated locally. Individual farmers, forest dwellers, fisher-folk and those along the supply chain will need to adopt a set of measures that should be implemented contingent on individual environmental conditions and circumstances.
- **Policies focused on healthy, diversified forest ecosystems:** Healthy ecosystems are more resilient to negative biotic and abiotic influences than are ecosystems under stress whose ecological processes are impaired. Best policies to ensure healthy, diversified forest ecosystems should focus on integrated pest management, disease control, forest fire management, employment of reduced impact logging in production forests, limitation of gathering of non-wood forest products or livestock grazing in forests at sustainable levels, and forest law enforcement.
- **Hybrid fish species:** Adaptation options to declining or variable yields in terms of fisheries technologies and management will need to be carefully assessed, to avoid exacerbating the overexploitation of fisheries or impacting habitats. For aquaculture, a set of adaptive practices has been identified, such as diversified and integrated aquaculture systems, water quality monitoring, species selection, selective breeding, genetic improvement, site selection, and improved cage and pond construction.
- **Resilient agricultural development policies:** Policies geared towards the prevention and management of specific risks and vulnerabilities such as water scarcity, plant pests, animal diseases, invasive species and wild fires that can be modified by variability in climate are needed.

Farmers, fisher-folks and forest dwellers need financial support from governments and from the private sector, and there is also an important role for civil society organizations.

- **Policies on managing genetic resources:** This requires policies that will preserve, characterize and improve genetic resources to valorize the goals of breeding programmes. There may be need to introduce new varieties and breeds. Improvements to *in-situ* and *ex-situ* conservation programmes for domesticated species, their wild relatives and other wild genetic resources are imperative for ecosystem sustainability, along with policies that promote their proper use and management.

- **Enable adaptation through policies and institutions:** Appropriate policies and institutions at national and international levels are needed to enable, support and complement the economic and technical options, to enable adaptation of food producers, and especially to support small-scale food producers in their efforts to adapt to climate change. Institutions that generate and manage public goods are key, as well as those that generate and channel public funds to specific investments.
- **Policy on land ownership system:** Securing land rights and equitable access to land is paramount to enable farmers to benefit from the value added on the land and to encourage them in adopting a long-term perspective. The Voluntary guidelines on the responsible governance of tenure of land, fisheries and forests in the context of national food security adopted in 2012 by the Committee on World Food Security promote tenure rights and equitable access to land, fisheries and forests as a means of eradicating hunger and poverty, supporting sustainable development and enhancing the environment.

◆ **Policies that will ensure market linkages:** Market development and establishment of better linkages of farmers to domestic, national and regional markets are needed to support adaptation actions, to enable farmers to get the inputs needed to adapt, and to sell new products from a diversification of activities. Developing these market linkages requires financing of the market linkage chain including investment in small- and medium- size food processors, and small-scale traders at the retail and wholesale levels.

Policies that strengthen regional and international cooperation: Climate change will lead to production systems mobility across national borders. Regional and international cooperation will be needed to enhance exchange of production systems techniques. Government policy directions on agriculture and international cooperation should inculcate adaptation options, vulnerability assessments, genetic material mobility, fish stocks, and management of trans-boundary risks emanating from pests and diseases. Policies on gender-specific support services are essential, recognizing the differentiated roles of household members in ecosystem activities, production processes, consumption, value addition and distribution chain.

8.0 CONCLUSION

Vulnerability to climate change creates a sequence of risks and shocks. The farming populations whose livelihoods depend on agriculture are the most vulnerable. Understanding the series of risks, as well as the vulnerabilities to these risks, is essential in developing resilience to variability in climate. Reducing vulnerabilities is the key to reducing the net effects on food security. Increasing food security in the face of climate change calls for multiple interventions, from social protection to climate-smart agricultural practices and risk management. The changes needed for adaptation to climate change in agriculture and food systems for food security will need to be enabled by financing climate-smart agriculture, and implementation of appropriate policies and efficient institutional framework. To be effective such interventions have to integrate different strategies and plans that are gender-sensitive, multi-scales, multi-sectors and multi-stakeholders, while at the same time consider issues on the different dimensions of development (social, economic, environmental) and climate-smart agriculture

(intensification, adaptation, and mitigation), and different time scales by which the changes will need to be implemented and supported. Actions by different stakeholders are needed in the short term to enable responses in the short, medium and long term. Some medium and long-term responses will need immediate enabling action and planning, and immediate implementation of policies and programmes, especially those policies and programmes in forestry, livestock breeding, aquatic ecosystem, seed multiplication, R&D, innovation and knowledge transfer that require longer time frames to be developed to enable adaptation.

The adoption of climate-smart agricultural practices and ensuring food security go hand in hand. Nigeria therefore needs a paradigm shift towards Climate-Smart Agriculture to ensure food security for her teaming population. It is therefore recommended that farmers in Nigeria should adopt CSA for increased food productivity in the face of climate change. The key problems facing awareness and adoption of CSA practices by farmers in Nigeria are access to loans and financial incentives, land tenure system, income sources, age and level of education of farmers. Ensuring improved resilience of farmers to climate change should encompass best policies and strategies, that have the potential and capacity to finance climate-smart agriculture, strengthen institutional arrangement and operations of agricultural extension services, provide access to early warning information on climate change, and ensure proper planning for irrigation facilities. Climate-Smart agriculture friendly financial incentives which are payments to farmers on conditions that relates to the circumstances and challenges confronting them has the potential of generating revenues and the flexibility to include series of activities that can be implemented locally and timing that addresses the costs and risks faced by farmers. Climate-Smart agriculture friendly financial incentives can therefore foster intensification, adaptation and mitigation, and safeguard everyone's food security.

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