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KEBBI STATE CLIMATE SMART AGRICULTURE PROFILE

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Climate-Smart Agriculture (CSA) Profile for Kebbi State, Nigeria

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Table of Contents

List of tables

List of figures

List of Acronyms and Abbreviations

Acronym/Abbreviation	Description
AFOLU	Agriculture, Forestry and Other Land Use
APS	Agricultural Performance Survey
BNRCC	Building Nigeria's Response to Climate Change
CBA	Community-Based Adaptation
CCF	Climate Change Fund
CRSA	Climate Resilient Sustainability Agriculture
CSA	Climate-Smart agriculture
ETS	Emissions Trading Scheme
FAO	Food and Agriculture Organization
FCT	Federal Capital Territory
FGDs	Focus Group Discussions
FMARD	Federal Ministry of Agriculture and Rural Development
FtFNAPA	Feed the Future Nigeria Agricultural Policy Project
GDP	Gross Domestic Product
GtCO2e	Gigatonnes of Equivalent Carbon dioxide
Ha	Hectare
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
IYCF	Infant and Young Child Feeding Practice
LULC	Land Use Land Cover
LULUCF	Land Use, Land-use Change and Forestry
MDAs	Ministries, Departments, and Agencies
MSMEs	Micro, Small and Medium-Scale Enterprises
MSU	Michigan State University
MT	Metric tons
MUAC	Mid-Upper Arm Circumference
NAERLS	National Agricultural Extension and Research Liaison Services
NBS	National Bureau of Statistics
NCCP	National Climate Change Policy
NDC	Nationally Determined Contribution
NNHS	National Nutrition and Health Survey
NPK	Nitrogen, Phosphorus, and Potassium
RFIA	Rapid Flood Impact Assessment
SDP	State Domestic Product
SEMA	State Emergency Management Agency
TNC	Third National Communication
USAID	United States Agency for International Development

Foreward

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Foreword

Agriculture is critical to Kebbi State's overall domestic product, employing a significant part of its population. An important characteristic of the state's agricultural system is its heavy reliance on rain-fed conditions, predominantly led by smallholder farmers. Climate change caused extreme weather conditions including, rising temperatures, unpredictable rainfall patterns, flooding, and droughts. These climate-related threats result in corp failures, lower yields, and more frequent pest and disease outbreaks, therby constituting a serious danger to agricultural productivity, livelihoods, incomes, reduction in fishing activities; and food insecurity. Climate change is one of the major threats to the Agricultural economy of Kebbi State.

We cannot wish away the challenges of climate change. We need to be proactive and work smart. Hence, the Kebbi State Ministry of Agriculture and Natural Resources and the Kebbi State Ministry of Environment partnered with other stakeholders to develop this Climate-Smart Agriculture (CSA) profile. The CSA profile is an approach that integrates climate change adaptation and mitigation strategies to enhance agricultural productivity, build resilience, and reduce greenhouse gas emissions.

The CSA profile provides an in-depth understanding of the specific climate challenges faced by Kebbi State's agricultural sector and identifies appropriate CSA practices that can address these challenges. It serves as a baseline document, outlining the current state of CSA adoption and support sustainable agricultural development in the Kebbi State.

This profile used robust multistakeholder approach and analytical techniques which led to the identification of eighty-eight (88) CSA potential technologies and practices in the sub-sectors of agriculture (crops, livestock, poultry, aquaculture and fisheries, forestry, and cross-cutting issues). It is instructive to note that CSA practices are gender-differentiated, therefore, there is need to consider gender in CSA policies and targetting of interventions. This implies providing both men and women equal access to agricultural advisory services and inputs (improved seeds, fertilizer, and machinery) as well as training on water-efficient farming techniques. Also, initiatives that promote women's participation in decision-making processes at the community level can ensure their unique perspectives on climate change adaptation and resilient strategies.

By implementing CSA in Kebbi State, several benefits can be achieved. Firstly, CSA practices such as improved water management, conservation agriculture, and agroforestry can enhance agricultural productivity and ensure sustainable resource use. Secondly, CSA can increase the resilience of farming systems to climate-related risks, enabling farmers to adapt to changing climatic conditions and reduce vulnerability. Thirdly, CSA practices, such as the use of organic fertilizers and efficient energy systems, can contribute to mitigating greenhouse gas emissions from agricultural activities.

The administration of Governor Nasir Idris is committed to enhancing agriculture productivity to particularly drive food security and sustainability. Thus, the achievement recorded with the development of the Kebbi State Climate Smart Agriculture Profile is well recognized, and in line with the current administration's focus on agriculture. Our commitment to its implementation is certain. I urge all to support us as we move to the next steps, which revolves around implementation.

Finally, the Government of Kebbi State through the Kebbi State Ministry of Agriculture and Natural Resource recognizes with sincere appreciation the support of the United State Agency for International Development (USAID) for graciously supporting the process through the Feed the Future Nigeria Agriculture Policy Activity. We also specially recognize the Research Team led by Faculty from Michigan State University, Kebbi State University of Science and Technology Aliero, University of Ibadan and Alex-Ekwueme Federal University, Ndufu-Alike.

Hon. Commissioner for Agriculture & Natural Resources
Kebbi State Ministry of Agriculture & Natural Resources
Birnin Kebbi, Kebbi State
October, 2, 2023

Introduction

The mainstay of Kebbi State's economy is agriculture. Kebbi State, often known as the "Land of Equity," is home to a wide variety of agricultural products, making it a key contributor to the availability of food, job opportunities, and agricultural markets (Aliero & Ekaette, 2018). However, Kebbi State's agricultural industry has a number of obstacles that prevent it from expanding and improving. These difficulties include: (i) Climate Change: According to Yelwa (2019), Kebbi State is already seeing the negative effects of climate change, which include rising temperatures, unpredictable rainfall patterns, flooding, and drought. These climate-related effects can result in crop failure, lower yields, and more frequent pest and disease outbreaks which constitute a serious danger to agricultural productivity. (ii) Limited Access to Credit: In order to invest in their farms and increase productivity, farmers in Kebbi State frequently struggle to obtain formal financing from financial organizations. Farmers find it difficult to secure the money they need to adopt modern farming practices, buy quality inputs, and upgrade infrastructure due to the absence of suitable financing choices and collateral restrictions (Ahmed, 2020). (iii) Inadequate Infrastructure: The agricultural sector in Kebbi State is hampered by inadequate infrastructure, including shoddy road systems, scanty storage facilities, and weak market connections. Due to inefficient transportation of agricultural products to markets caused by these infrastructure deficiencies, farmers experience post- harvest losses and diminished profitability (Maiyaki & Ibitoye, 2021).

The adverse effects of climate change are expected to worsen in the future and have devastating consequences for agriculture. To address these challenges, Climate-Smart Agriculture (CSA) offers a holistic approach. Adopting Climate-Smart Agriculture (CSA) strategies that are adapted to the unique circumstances of Kebbi State is necessary to address these difficulties. CSA is an approach that integrates climate change adaptation and mitigation strategies to enhance agricultural productivity, build resilience, and reduce greenhouse gas emissions (FAO, 2013).

By implementing CSA in Kebbi State, several benefits can be achieved. Firstly, CSA practices such as improved water management, conservation agriculture, and agroforestry can enhance agricultural productivity and ensure sustainable resource use. Secondly, CSA can increase the resilience of farming systems to climate-related risks, enabling farmers to adapt to changing climatic conditions and reduce vulnerability (Lipper et al., 2014). Thirdly, CSA practices, such as the use of organic fertilizers and efficient energy systems, can contribute to mitigating greenhouse gas emissions from agricultural activities.

To guide the effective implementation of CSA in Kebbi State, the development of a Kebbi State CSA Profile is crucial. Considering that implementation of CSA is location specific, this profile will provide an in-depth understanding of the specific climate challenges faced by the State's agricultural sector and identify appropriate CSA practices that can address these challenges. It will serve as a baseline document, outlining the current state of CSA adoption in Kebbi State and providing recommendations for scaling up CSA practices (FAO, 2016). By developing the Kebbi State CSAProfile, policymakers, stakeholders, and investors will have a solid foundation to design and implement targeted interventions, policies, and investments to promote CSA adoption and support sustainable agricultural development in the State.

STATE CONTEXT

Kebbi State has a very rich historical background. The area became part of northern Nigeria after Nigeria's independence in 1960. Kebbi State was created on 27th August 1991 and Birnin Kebbi serves as the State capital till date. Kebbi State has a population of 3,238,628 comprising 21 Local Government Areas, 4 Emirate Councils, diverse ethnic groups and cultural backgrounds (National Population Commission of Nigeria, 2006). The State's population is primarily engaged in agricultural activities, which form the backbone of its economy. Kebbi State is located in the north western part of Nigeria between latitudes 10°30'N and 13°30'N and longitudes 3°30'E and 6°30'E.

It has a total landmass of about 37,699 square kilometers out of which 36.46% is made up of farmland. However, about one third of the State is situated in a desert-prone environment thus making it one of the front-line States for the menace of drought and desertification. The state shares borders with Niger State to the west, Sokoto State to the north, Zamfara State to the east, and Niger Republic to the north. The landscape of t he State is dominated by extensive flood plains (Fadama) of the inland river valley systems. The largest sources of surface water in Nigeria can be found in the state as the River Niger forms a large body of water several square kilometers in size known as Kainji Lake; which is 80% located in Kebbi State. Kainji Lake has also been experiencing significant fluctuations in hydro-meteorological variables like precipitation, evaporation, temperature, runoff, and water levels (Salami et al., 2015). Kebbi State is renowned for its agricultural productivity, with crops such as rice, wheat, sorghum, millet, maize, cowpea, and cotton being major contributors to its agricultural output.

Economic Relevance of Agriculture

Kebbi State is a major producer of grains, legumes, and cereals while fishing, poultry, and animal husbandry, blacksmithing, weaving, knitting, woodcarving, dyeing, and tannery, are practiced as commercial ventures. The people also practice Fadama (flood plain) farming, cultivating crops like onion, tomatoes, potatoes, and pepper.

The economic relevance of agriculture in Kebbi State is likely to increase in the coming years. Majority of the inhabitants are rural peasant farmers whose major occupation is farming, which is generally of subsistence type, largely due to high level of poverty. The states' population is growing rapidly, and the demand for food is expected to increase. 2The year 2022 budget for agriculture sector performance revealed 93% expenditure performance of the budget. The state is also well-positioned to benefit from the growing demand for agricultural products in the global market. Agriculture serves as the backbone of the state's economy, and if its potential is effectively harnessed, Kebbi State could unquestionably become the nation's agro-industrial hub and a regional food supermarket in the near future.

However, reduction in the ability of the sector to provide for the increasing population size in Kebbi state has been attributed to factors such as low levels of agricultural technology, erratic and intermittent rainfall, fragmentation of farmland, and low levels of soil fertility which in turn have led to a high incidence of poverty in the state. Local market potential remains underexploited, and substantial market opportunities on the international stage have yet to be seized.

Climate and Vegetation

Kebbi State is located in the north western part of Nigeria between latitudes 100 and

130Nand longitudes 30 and 60E. The mean annual rain fall in the state varies significantly from the northern part of the state which stands at 733mm to the southern part at 1045mm. However, the total number of rain days vary. Kebbi State experiences a wet season that spans usually from June to September in the northern parts and April to October in the southern parts, with a characteristically intense local thunderstorms. 2The temperature is generally high in all locations and can be as high as 40°C. However, the temperature can go down to 21°C.

One-third of the state is situated in a desert prone environment, making the state susceptible to drought and desertification. Soil types in Kebbi state are mainly ferrugirious tropical. The main features of the soil are a sandy surface horizon underlain by weakly developed clayey, mottled and sometimes concreting subsoil. The soil is sensitive to erosion, hence, when the vegetation cover is removed, the sandy topsoil is washed away by rain water or wind. The soil also has a low water holding capacity. The Fadama (flood plain) soil is also commonly found in Kebbi state and is very suitable for crop production due to its high moisture content and organic matter even during drought seasons. The natural vegetation of the state consists of Northern Guinea Savannah in the South and South-east and Sudan Savannah in the North, but the vegetation has been altered in many areas by intensive cultivation, grazing, fuel wood harvesting and bush burning.

Agricultural Production Systems

The agricultural landscape of Kebbi State, Nigeria is shaped by both rainfed and irrigation agriculture (Olayide et al., 2016). Rainfed agriculture produces a wide variety of crops like millet, sorghum, rice, maize, cowpea, groundnut, and vegetables (IITA, 2018), and is dependent on seasonal rainfall. Contrarily, the Hadejia-Jama'are River Basin supports the state's irrigation agriculture, which raises agricultural productivity significantly (Yahaya et al., 2020). Rice output in the state has increased because of the Kebbi Irrigation Project's Argungu Rice Scheme (Ojo, 2019).

In Kebbi State, rice farming stands out as a key agricultural endeavour. According to Abdulrahman (2019), Kebbi State is a significant rice-producing region in Nigeria. Agriculture serves as a major employer in Kebbi State, supporting the livelihoods of a significant portion of the population. Farming activities, agro-processing, marketing, and trading of agricultural produce create employment opportunities and income for farmers, processors, traders, and other actors along the agricultural value chain (Ahmed et al., 2018).

The combination of rainfed and irrigation agriculture, coupled with livestock farming, has contributed to food security, employment generation, and economic development. According to the 1Kebbi state Government official website, the State Government laments the rudimentary level of the sector in Kebbi State despite concerted efforts to enhance and modernize agriculture, with many farming communities engaged in subsistence-level production. Several factors contribute to the challenges faced in agriculture, including limited agricultural technological advancements, inadequate access to credit on favorable terms, unpredictable and insufficient rainfall patterns, land fragmentation due to inheritance and population growth, which has reduced individual farm sizes, difficulties in obtaining timely farm inputs, and the unavailability of improved varieties.

Furthermore, the absence of processing and storage facilities capable of absorbing agricultural surpluses exacerbates the situation. While the production of staple crops such as rice, millet, and sorghum has shown an upward trend, the production of cash crops has declined.

Food Security and Nutrition in Kebbi State, Nigeria

Food security and nutrition are critical components of sustainable development, ensuring the well-being and livelihoods of individuals and communities. Kebbi State, like many regions in Nigeria, faces challenges in achieving food security. Factors such as climate variability, limited access to productive resources, and low agricultural productivity contribute to the vulnerability of households in the state (Oladele et al., 2019). Low-income levels, inadequate infrastructure, and poor market access further exacerbate food security concerns (Adeoti et al., 2018).

In Kebbi State, agriculture is essential for the production and accessibility of food. Efforts to address food security and nutrition in Kebbi State include various interventions and programs. These initiatives aim to improve agricultural productivity, enhance value chains, promote nutrition education, and increase access to nutritious foods. Examples include the Anchor Borrowers' Program, which supports smallholder farmers with inputs and credit facilities (CBN, 2015), and nutrition-sensitive agriculture programs that integrate nutrition considerations into agricultural practices (Adekanmbi et al., 2017).

In Kebbi State, interventions aimed at improving food security have had a positive effect. Food availability and access have improved as a result of better agricultural productivity and diverse food production (Yahaya et al., 2020). Additionally, feeding practices have improved as a result of behaviour modification and nutrition education programs (Adeoti et al., 2018). The need for multisectoral coordination to solve complex nutrition concerns, however, as well as budget constraints and inadequate infrastructure, continue to be problems (Okafor et al., 2019).

CLIMATE CHANGEAND IMPLICATIONS FORAGRICULTURE

Climate change is the phrase used to describe long-term changes in Earth's temperature patterns and weather brought on by human activity, particularly the atmospheric release of greenhouse gases (GHGs) including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). The greenhouse effect, which is a result of these GHGs trapping solar heat, raises the planet's average temperature, a phenomenon known as global warming.

The Intergovernmental Panel on Climate Change (IPCC), a leading international scientific body, defines climate change as follows: "Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC, 2014. Africa will be seriously impacted by the effects of climate change and as a result of this, Nigeria is vulnerable to the effects of climate change. Available evidence shows that the effect of climate change will be felt more by the developing countries (IPCC, 2014).

Agriculture, water resources, and ways of life are significantly impacted by climatechange. Like many other parts of Nigeria, the North-West region of Kebbi State is susceptible to the effects of climate change. According to Bose et al (2015), rainfall variability in northern Nigeria has increased compared with historical levels which signifies a clear evidence of

climate change in the region. Other observed trends include rising temperatures, altered rainfall patterns, and an increase in the frequency and severity of extreme weather events including droughts and floods (Adams et al., 2019). These have a severe negative impact on the state's socioeconomic, agricultural, and environmental systems.

Key Trends in Kebbi State

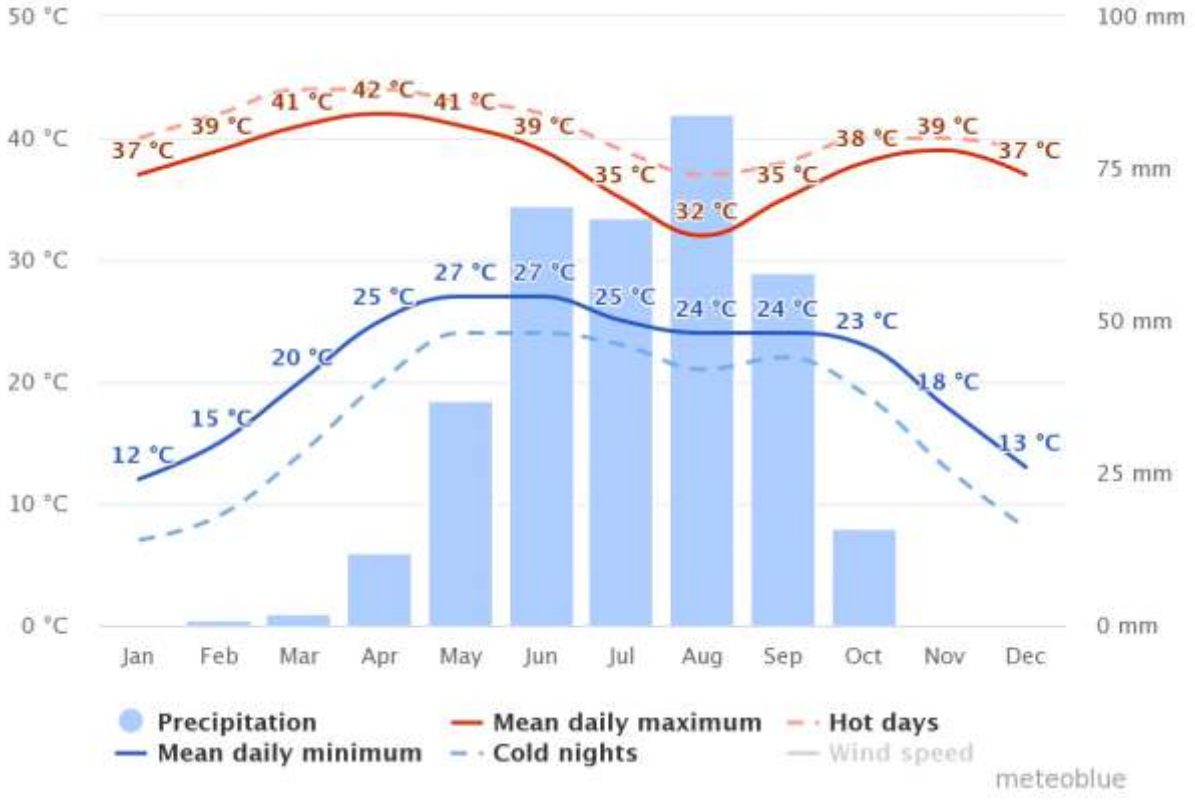

Figure 1: Average temperature and precipitation in Kebbi state over the last 30 years. (Source: meteoblue)

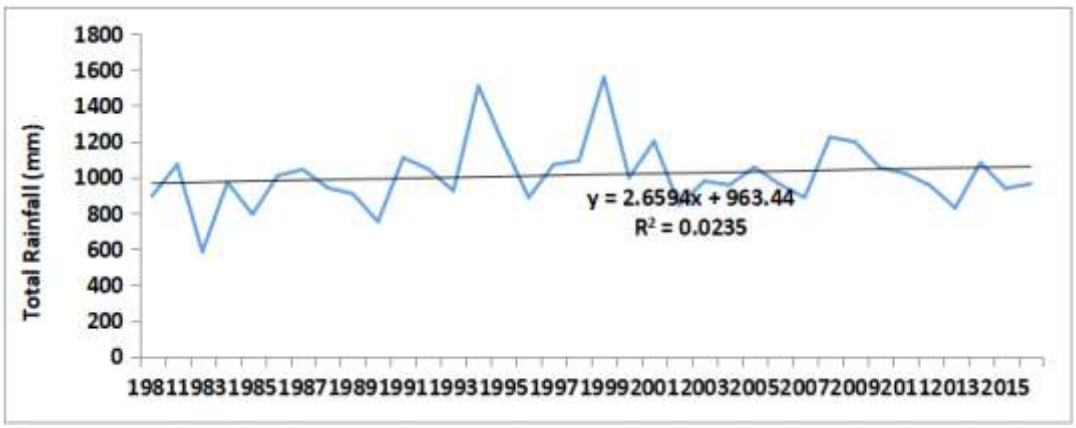

Figure 2: Trend of total volume of rainfall between 1981 and 2016 in Yelwa, Kebbi State Data Source: Nigerian Meteorological Agency in Central Bank of Nigeria, 2021)

Impacts of Climate Change and Implications for Agriculture

1. **Changing Rainfall Patterns:** Climate change is altering rainfall patterns, leading to increased variability and unpredictability of rainfall in Kebbi State. This can result in droughts, floods, and irregular growing seasons, all of which pose challenges for agricultural production (Olayemi et al. (2018).

2. **Water Availability:** Climate change affects the availability of water resources, including rivers, lakes, and groundwater. Changes in precipitation patterns and increased evaporation rates can lead to water scarcity, making irrigation more difficult and reducing crop yields (Ibe et al., 2020).

3. **Crop Yield Reduction:** Rising temperatures and changes in rainfall patterns can negatively impact crop yields. Extreme heat can damage crops and reduce their productivity. Droughts can lead to crop failure, while heavy rainfall and flooding can damage crops and cause soil erosion (IPCC., 2014).

4. **Pests and Diseases:** Climate change can influence the distribution and abundance of pests and diseases. Rising temperatures and changing rainfall patterns create more favorable conditions for certain pests and diseases, leading to increased infestations and crop damage (Okonkwo et al., 2020).

5. **Decline in Livestock Productivity:** Climate change affects not only crops but also livestock. Increased temperatures and water scarcity can reduce the availability and quality of grazing lands, leading to a decline in livestock productivity. Heat stress can also negatively impact animal health and reproduction (Adeoye, et al., 2017).

6. **Food Security and Rural Livelihoods:** The implications of climate change on agriculture can have severe consequences for food security and rural livelihoods in Kebbi State. Reduced crop yields and livestock productivity can lead to food shortages, increased food prices, and income losses for farmers and rural communities (Abaje et al., 2019).

Farmers can no longer rely on their old understanding of the seasonality of climatic elements as rainfall becomes more unpredictable. According to the FAO, climate change will harm 11% of the world's arable land, resulting in a subsequent decline in cereal production and a 16% decline in agricultural GDP. As a result of the lower performance of rain-fed agricultural production systems, this may translate into a significant increase in poverty, hunger, and overall food security concerns. In order to increase crop production in the area, it is advised that farmers be equipped with the most recent information on climate-smart crop production techniques, such as the use of early maturing seeds, drought-tolerant varieties, and more specifically, the use of irrigation, especially for cereals. Farmers should have access to weather forecast information through all appropriate sources, such as radio broadcasts, TVs, and SMS on mobile phones.

Agricultural Greenhouse Gas emissions

Global emissions of Greenhouse Gases (GHGs) due to Agriculture, Forestry and other Land use is on the increase. The main Greenhouse Gases attributed to Agriculture include methane (Ch4), nitrous oxide (N2O), and carbon dioxide (Co2).In Africa, emissions due to agriculture have experienced an upward trend and in Nigeria, the level of GHG emissions is relatively substantial compared to other African countries as 51.2% of Nigerian GHG

emissions are from agriculture, forestry, and land use activities (Okorie and Lin, 2022).

Agriculture, Forestry and Other Land Use (AFOLU) is the second largest contributor to total GHG in Nigeria (after the energy sub sector). The AFOLU contributed 25% of the country's total GHG emissions in 2018 (FME, 2021). Apart from being the second largest source of GHG emissions in Nigeria, the AFOLU is also very important for climate-smart-agriculture in terms of productivity, adaptation and mitigation. Of the total 87 MtCO2eq of GHG emissions from AFOLU in 2018, agriculture contributed 54.46 MtCO2eq of GHG emissions (representing 62.6%), while Forestry and Other Land Use contributed 32.54 MtCO2eq of GHG emissions (representing 37.4%). See Figure 3.

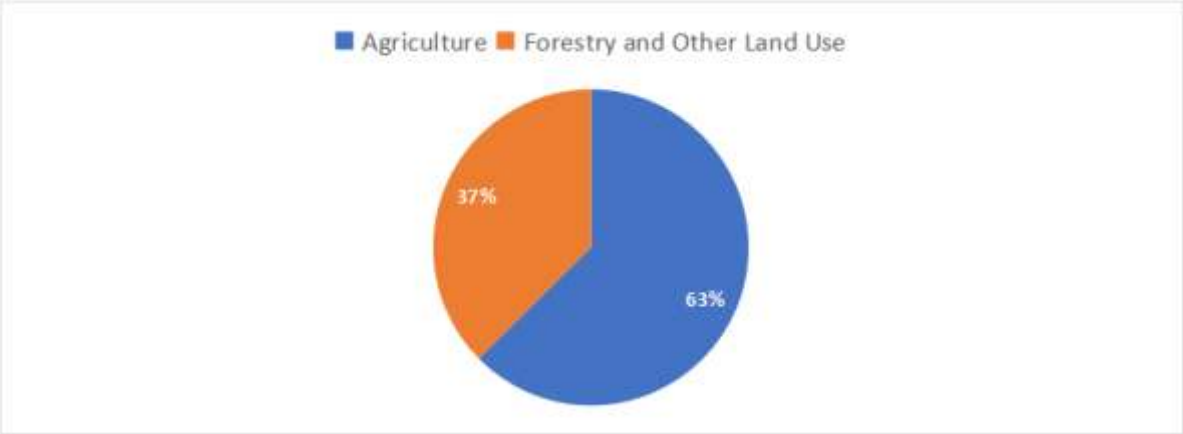

Figure 3. AFOLU greenhouse gas emissions by sub sector (2018). Source: Federal Ministry of Environment, 2021.

CONCEPTUALIZING CLIMATE SMART AGRICULTURE (CSA) IN KEBBI STATE

Climate Smart Agriculture (CSA) is recognized broadly by the concurrent increase in resource use efficiency and livelihood productivity, climate change adaptation, and GHG reduction (FAO, 2010; Olayide et al., 2016). The conceptual framework for CSA is given in Figure 4.

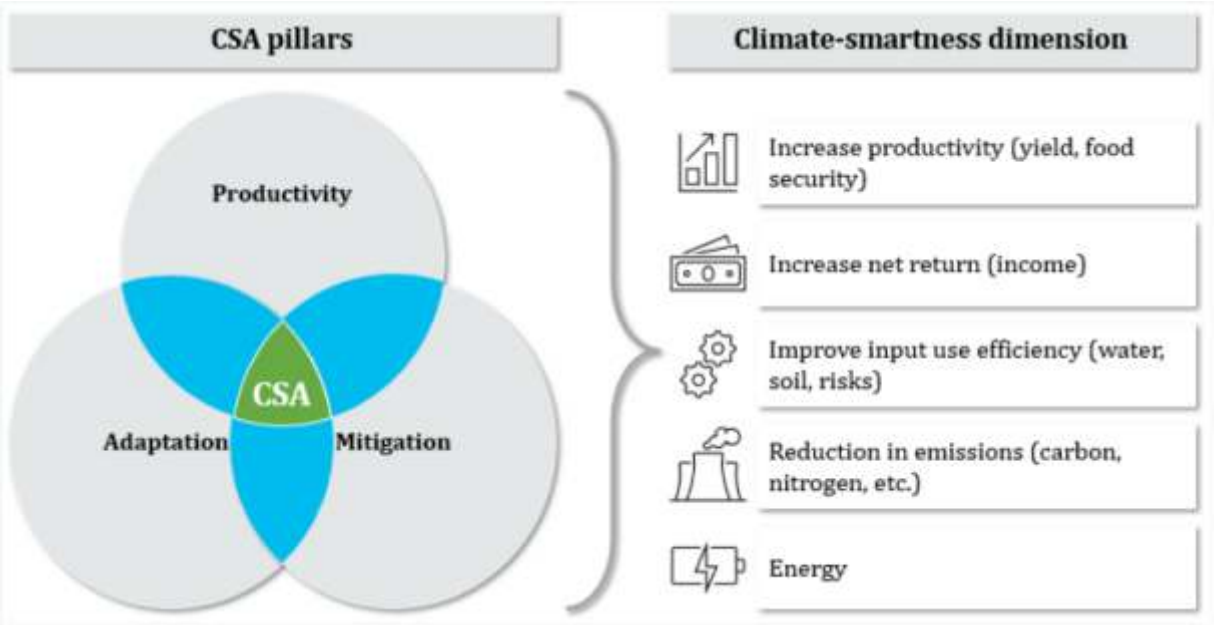

Figure 4. Conceptual Framework for Climate-Smart Agriculture and Expected Outputs
Source: Authors' diagram based on insights from FAO and Nwajiuba et al (2015).

There has been increasing awareness at both local and international levels on the need to commit financial resources into activities on productivity, adaptation and mitigation. As an example, the World Bank committed to working with countries to deliver climate-smart agriculture that achieves the triple win of increased productivity, enhanced resilience, and reduced emissions. In 2020, 52 percent of World Bank financing in agriculture also targeted climate adaption and mitigation. 2The West Africa Agricultural Productivity Program (WAAP) involves 13 countries and multiple partners, helping develop climate-smart varieties of staple crops, such as rice, plantain, and maize. Farmers also gain access to technologies such as efficient water-harvesting systems. As of July 2019, the project had directly helped more than 9.6 million people and more than 7.6 million hectares of land be more productive, resilient, and sustainable. Beneficiary yields and incomes have grown by an average of about 30%, improving food security for about 50 million people in the region.

CSA TECHNOLOGIES, PRACTICES AND EFFECTIVENESS IN KEBBI STATE

Technologies and practices associated with CSA offer prospects for addressing the problems caused by climate change as well as for the expansion of the agricultural industry and for economic prosperity. For the purposes of this profile, a practice is CSA if it advances food security and at least one of the other CSA goals (mitigation and/or adaptation). The term "CSA" refers to thousands of methods and technologies used all over the world. According to evidence from the literature, farmers are utilizing a number of agricultural innovations derived from both local knowledge and new technologies to increase their capacity for climate change and variability adaptation. Ex-ante practices are those based on anticipated climatic events, while ex-post practices are those that are implemented after a climatic event has already occurred. Here we explore various agricultural technologies and practices in Kebbi state that have shown promise in accomplishing one or more of the three pillars of CSA: productivity, mitigation, and adaptation. We did this by using data from the literature.

a. Conservation agriculture (CA): a popular technique with benefits for soil and water conservation, is prevalent in Kebbi State, as it is in the majority of farming areas in Nigeria. The following CA tactics are based on traditional slash-and-burn farming methods: (i) minimal or zero tillage; (ii) preservation of soil cover through cover crops or mulching; and (iii) crop rotation (Giller et.al, 2009). One or more of the three pillars of climate-smart agriculture are met by CA. Empirical research demonstrates that CA boosts the biological production of important food crops like maize, sorghum, and millet even on poor soils and gives economic benefits from diversified crop rotation systems in terms of productivity and adaptation (Giller et.al, 2009). Mulching the soil regularly has many advantages for the farmer when managing hazards associated with the climate. These include less runoff, more infiltration of water, higher soil organic matter, and better soil moisture retention. The promotion of zero or minimal tillage in CA also reduces labor expenses associated with field preparation and permits early planting to coincide with the start of rains.

b. Intercropping/crop diversity: In Conservation Agriculture, crop failure risks are significantly reduced through crop diversification and the use of various intercropping techniques supplying farmers with crucial safety nets in the event that a crop doesn't perform as anticipated. Groundnuts and cowpeas are two legumes that are frequently produced in annual double- cropping systems along with cereals, maize and millet.

c. Improved seeds: Due to rising temperatures and more rains over the past few decades, many farmers now employ seed kinds that are resistant to extreme weather. Some adopted seeds that mature early in order to avoid the effects of reduced rainfall brought on by a changing and variable climate.

d. Integrated soil fertility management: Here, farmers apply animal manure, compost, crop leftovers, and other soil fertility improvement techniques in addition to chemical fertilizers. Organic manures must be added to the soil to increase soil aggregate stability and to improve soil nutrition through decomposition and nitrogen mineralization.

Identification of CSA Options

In addition to the technologies already being practiced in Kebbi state, there is an opportunity to implement other CSA practices which have been identified in the literature.

These include different CSA options that have existed for long in agricultural practices and should be adopted as strategies to mitigate the tides of a changing climate. These practices computed from Anuga et al., 2019; Kombat et al., 2021 are:

- **Energy smart:** Compost residue after harvesting; convert residue into bioenergy; and use solar equipment in farming.

- **Weather smart:** Use personal experience to predict weather events (this will become increasingly more difficult as the climate shifts, because past trends are not an indicator of future patterns); usage information from radio/TV for weather events; received training/education from an extension worker/agent on weather; Use a mobile phone to access weather information; and access to weather information on the internet.

- **Water smart:** Plant early during the rainy season to make use of rainwater; plant cover crops to maintain soil moisture; and harvest and store rainwater for future use in watering crops and feeding animals.

- **Carbon and nitrogen smart:** Use organic manuring; practice mixed cropping; use trees as farm boundaries (afforestation); practice crop rotation; plant legumes among crops; estimate the amount of fertilizer/manure needed at a time (precision fertilization); and use specific fertilizer/manure based on the type of soil (site-specific nutrient application)

- **Knowledge smart:** Farmer-to-farmer knowledge sharing; belonging to a farmer association; store seeds for next season/emergency (seed banking); and get access to market information on prices of outputs and input

Further, CSA could be broadly applied to encompass various technologies and practices. To compile this Profile, examples of agricultural technologies and practices in Kebbi State that have shown promise in contributing to one or more CSA pillars were compiled from the literature (See Table 1).

Table 1. CSA Technologies and Practices in Kebbi State

Production Activity	Broad Category	Specific strategies / technologies	Reference
Crop		Improved crop varieties (higher-yielding)	(Ezihe et al., 2019; Mbah & Ezeano, 2016; Onyemma et al., 2019; Shomkegh, 2019) UNDP Nigeria (2022) [1]
		Planting of climate-tolerant varieties (drought-, pest-, flood-resistant)	(Akinnagbe & Irohibe, 2014; Ezihe et al., 2019; Kim et al., 2017; Mbah & Ezeano, 2016; Okpe & Aye, 2015) UNDP Nigeria (2022)
		Planting of weed-tolerant crop varieties	(Mbah & Ezeano, 2016)
		Use of early maturing / high-yielding variety	(Ezihe et al., 2019; Kim et al., 2017; Mbah & Ezeano, 2016)
		Crop diversification	(Akinnagbe & Irohibe, 2014; Okpe & Aye, 2015)
		Change in cropping pattern and planting calendar	(Akinnagbe & Irohibe, 2014; Ezihe et al., 2019; Kim et al., 2017; Mbah & Ezeano, 2016; Okpe & Aye, 2015; Tyubee et al., 2020)
		Early harvesting of crops	(Mbah & Ezeano, 2016)
		Mixed cropping	(Akinnagbe & Irohibe, 2014; Mbah & Ezeano, 2016; Tyubee et al., 2020)
		Intercropping	(Shomkegh, 2019)
		Varying (increasing/reducing) area under cultivation	(Kim et al., 2017; Okpe & Aye, 2015; Terdoo et al., 2016)
	Soil conservation	Use of zero tillage / alternative tillage practices	(Akinnagbe & Irohibe, 2014; Ezihe et al., 2019; Kim et al., 2017; Mbah & Ezeano, 2016; Shomkegh, 2019)
	Soil conservation	Mulching	(Kim et al., 2017; Mbah & Ezeano, 2016; Okpe & Aye, 2015) (Shittu, 2017) [1]
	Soil conservation	Cover cropping	(Mbah & Ezeano, 2016; Okpe & Aye, 2015)
	Soil conservation	Application of organic fertilizers	(Kim et al., 2017; Mbah & Ezeano, 2016)

		Crop rotation	(Mbah & Ezeano, 2016)
		Bush fallowing to increase soil fertility	(Mbah & Ezeano, 2016)
		Improved access to credit services and inputs	(Kim et al., 2017)
		Inorganicfertilizer	(Ezihe et al., 2019; Okpe & Aye, 2015)
		Contour Bunding and Contour Ploughing	(Ezihe et al., 2019) UNDP Nigeria (2022)
		Bonding practices in rice field	UNDP Nigeria (2022)
		Change of farming location	(Tyubee et al., 2020)
	Traditional parklands	Plant high economic value and open canopies indigenous trees on crop lands	(Akinnagbe & Irohibe, 2014; Ezihe et al., 2019; Mbah & Ezeano, 2016; Shomkegh, 2019) UNDP Nigeria (2022) Shittu (2017)
		Citrus orchards	(Shomkegh, 2019)
		Streamlined planting techniques (leaving less space between crops)	UNDP Nigeria (2022)
		Dry season farming	UNDP Nigeria (2022)
		high-quality bio-fertilizers (compost production)	UNDP Nigeria (2022)
		Use of fungicides (e.g., Aflasafe to control aflatoxin infestation)	UNDP Nigeria (2022)
		Use of bio-pesticides	UNDP Nigeria (2022)
		Use of microbial Inoculants	UNDP Nigeria (2022)
	Integrated Pest Management	Integrated Pest Management	Shittu (2017)
	Improved water management	Water harvesting	Shittu (2017)
	Improved water management	Use of alternate wet and dry flooding system in low land rice production	Shittu (2017)
	Improved water management	Improved irrigation efficiency	(Akinnagbe & Irohibe, 2014)

	Improved water management	Use of drainage system	(Okpe & Aye, 2015)
	Improved water management	Erection of dams for storing water	Mbah & Ezeano, 2016)
	Mixed farming	Integrated crop - livestock production	(Mbah & Ezeano, 2016)
Livestock	Production adjustments	Livestock diversification	(Akinnagbe & Irohibe, 2014)
	Production adjustments	Integration of pasture management	(Akinnagbe & Irohibe, 2014)
	Production adjustments	Livestock and crop production	(Akinnagbe & Irohibe, 2014; Iyiola-Tunji, 2021)
	Production adjustments	Altering the timing of operations	(Akinnagbe & Irohibe, 2014)
	Production adjustments	Conservation of nature and ecosystems	(Akinnagbe & Irohibe, 2014)
	Production adjustments	Modifying stock routings and distance	(Akinnagbe & Irohibe, 2014)
	Production adjustments	Mixed livestock farming (e.g., stall-fed systems and pasture grazing)	(Akinnagbe & Irohibe, 2014)
	Breeding strategies	Raise local breeds adapted to local climatic stress and feed source	(Akinnagbe & Irohibe, 2014)
	Breeding strategies	Improve local genetics through crossbreeding with heat & disease-tolerant breed	(Akinnagbe & Irohibe, 2014; Iyiola-Tunji, 2021)
	Livestock mgt. systems	Provision of shade and water to reduce heat stress from increased temperature	(Akinnagbe & Irohibe, 2014)
	Livestock mgt. systems	Reduction of livestock numbers	(Akinnagbe & Irohibe, 2014)
	Livestock mgt. systems	Changes in livestock/herd composition (selection of large animals rather than small	(Akinnagbe & Irohibe, 2014)

	Livestock mgt. systems	Improved management of water resources through the introduction of simple techniques for localized irrigation	(Akinnagbe & Irohibe, 2014)
	Livestock mgt. systems	Proper livestock health management and welfare	(Iyiola-Tunji, 2021)
	Capacity building for livestock keepers	Training of livestock producers and herders / awareness creation	(Akinnagbe & Irohibe, 2014)
			(Iyiola-Tunji, 2021)
	Improved feed mgt.	Use of methane reducing feed additives	(Iyiola-Tunji, 2021)
		Ranching	(Iyiola-Tunji, 2021)
		Adequate waste management and utilization	(Iyiola-Tunji, 2021)
Poultry		Keeping of climate tolerant breeds (e.g., heat-resistant)	(Ezihe et al., 2020)
		Keeping of early maturing birds	(Ezihe et al., 2020)
		Installed cooling equipment	(Ezihe et al., 2020)
		Tree planting around poultry house	(Ezihe et al., 2020)
		Improved hygiene	(Ezihe et al., 2020)
		More space per bird	(Ezihe et al., 2020)
		More water served	(Ezihe et al., 2020)
		Prompt and extra vaccination of birds	(Ezihe et al., 2020)
Aquaculture and Fisheries		Transition from capture fisheries to aquaculture	Expert suggestion
	Aquaculture	Plastic/concrete ponds	Expert suggestion
	Aquaculture	Adopting improved aquaculture management	Expert suggestion
	Aquaculture	Reuse waste and integrate resources to reduce input costs	Expert suggestion

	Capture fisheries	Increasing fishing efforts	Expert suggestion
	Capture fisheries	Fishing further away or deeper inside water	Expert suggestion
	Capture fisheries	Change fishing time	Expert suggestion
	Capture fisheries	Migrate to other fishing areas	Expert suggestion
	Livelihood diversification	Engage in alternative livelihood means	Expert suggestion
Agroforestry, afforestation, reforestation	Agroforestry	Tree planting with crop production	(Akinnagbe & Irohibe, 2014; Ezihe et al., 2019) UNDP Nigeria (2022) Shittu (2017)
	Reforestation	Reforestation	(Okon & Usman, 2022)
	Afforestation	Afforestation	(Mbah & Ezeano, 2016)
Cross-cutting	Livelihood diversification into non-farm activities		(Akinnagbe & Irohibe, 2014; Ezihe et al., 2019; Kim et al., 2017; Tyubee et al., 2020)
	Labour migration (temporary)		(Akinnagbe & Irohibe, 2014)
	Extension Agents and Agricultural centres help community members	Improved extension service delivery	UNDP Nigeria (2022)
	Climate awareness	Creating rural awareness campaigns	(Adamgbe et al., 2022; Okon & Usman, 2022)
	Climate awareness	Weather Information Dissemination	(Adamgbe et al., 2022)
	Disaster risk management	Setup disaster plan	(Okon & Usman, 2022)

Measuring Climate-smartness

Measuring the "climate smartness" of agricultural practices involves assessing their ability to enhance productivity, increase resilience to climate change, and reduce greenhouse gas emissions. Several indicators and frameworks can be used to evaluate the climate smartness of agricultural systems. Here are a few commonly employed approaches:

1. **Productivity:** Climate-smart practices should aim to improve agricultural productivity while minimizing negative environmental impacts. Key indicators include crop yields, livestock productivity, and overall farm profitability.

2. **Adaptation:** Assessing the adaptive capacity of agricultural practices involves evaluating their ability to cope with and adjust to changing climate conditions. Adaptation actions can include the adoption of drought-tolerant crops, improved water management techniques, and diversification of farming systems.

3. **Mitigation:** Climate-smart agriculture aims to reduce greenhouse gas emissions from agricultural activities. Mitigation actions may include the use of low-carbon practices such as conservation agriculture, agroforestry, and improved livestock management to minimize emissions.

To measure the climate smartness of agricultural systems, a combination of quantitative data, such as yield measurements and emission levels, and qualitative assessments, such as interviews and surveys, are often utilized.

Methodology for Establishing Climate-smartness

To establish the climate smartness for the identified CSA technologies and practices, this Profile uses expert evaluation from critical stakeholders in the agricultural and CSA space through surveys and expert consultations. These stakeholders, from various Agricultural zones of the state, are knowledgeable about agricultural practices in Kebbi State. They include mainly researchers and agricultural development programme workers in the State. Kebbi State has 21 Local Government Area with four agricultural zones: Zone I (Birnin Kebbi), Zone II (Argungu) , Zone III (Bunza) and Zone IV (Zuru).

The data for the analysis and scores were generated from expert stakeholders from the Ministries of agriculture, environment, energy, youth and women as well as farmers' groups. Overall, the study identified 88 CSA practices in the five subsectors of agriculture (crop, livestock, fisheries and aquaculture, forestry, and crosscutting issues). The total of 39 fully completed survey forms were administered and retrieved at a stakeholder workshop that was held in Benin Kebbi, Kebbi State in June 2023. In the current analysis, each CSA practice was ranked on a scale of 1 to 10 points by the eight dimensions of climate smartness (that is, yield, income, water, soil, risk reduction, carbon, nitrogen, and energy) and the average was computed for each CSA dimensions, and aggregate as the climate smartness score. The result of the ranking of the climate smartness score was later categorised as low (1 to 4 points), moderate (5 to 7 points), and high (8 to 10 points). The expert rankings are determined based on the merits and effectiveness of the CSA technologies/practices. Detailed outcomes of the climate smartness score are presented in Table 2.

Result of Climate Smartness Score

The CSA profile presents the result of the assessment of climate smartness of the identified CSA technologies and practices based on expert evaluation, and by subsector of agriculture. Crop production sub-sector

1. **Moderate Climate Smartness Score:** Several CSA technologies and practices received a moderate climate smartness score of 5 to 7 points, indicating their potential to contribute positively to climate resilience and sustainability in crop production. These practices include:

   Improved crop varieties: The use of improved crop varieties demonstrates the potential to enhance productivity and adaptation to climate change.

   Planting of climate-tolerant varieties: Planting crops that are resistant to drought, pests, and floods can help mitigate the negative impacts of extreme weather events.

   Planting of weed-tolerant crop varieties: Weed-tolerant varieties can reduce the need for excessive herbicide use, contributing to environmental sustainability.

   Use of early maturing/high-yielding variety: Early maturing and high-yielding crop varieties can improve food security by reducing the risk of crop failure and increasing productivity.

   Crop diversification: Diversifying crops can enhance resilience against climate variability and pests, while also providing economic benefits.

2. **Importance of Crop Management Practices:** Several crop management practices also scored moderately in terms of climate smartness. These practices include: Change in cropping pattern and planting calendar: Adjusting cropping patterns and planting calendars can optimize resource utilization and adapt to changing climate conditions.

   Early harvesting of crops: Early harvesting helps minimize crop losses due to climate-related risks such as floods, pests, or diseases.

   Mulching: Mulching is effective in conserving soil moisture, reducing erosion, and improving soil health, contributing to both adaptation and mitigation efforts.

   Cover cropping: Cover crops help improve soil fertility, reduce erosion, and enhance carbon sequestration, thus providing multiple climate-smart benefits.

3. **Potential for Further Improvement:** While many CSA technologies and practices received moderate scores, some practices scored lower, indicating areas for improvement and additional attention. For example:

   Contour Bunding and Contour Ploughing, Bonding practices in rice fields, Change of farming location, and Sunken beds and/or raised beds scored relatively low in terms of climate smartness. These practices may require further evaluation and refinement to enhance their climate-smart potential.

   The Half moon and Zai pit (planting pit) received low scores, suggesting that they may have limited climate-smart benefits in the specific context of Kebbi

State.Further investigation may be needed to determine their suitability or explore alternative practices.

4. Integration of Livestock in Crop Production: Integrated crop-livestock production scored moderately, highlighting the potential benefits of combining crop and livestock activities. This integrated approach can enhance nutrient cycling, diversify income sources, and improve overall farm resilience.

Livestock and poultry production sub-sector

One key finding from the results is that several CSA technologies and practices in the livestock sector received moderate to high Climate Smartness Scores, indicating their potential to contribute to climate-smart agriculture. These technologies and practices include:

1. **Integration of pasture management:** This practice received a moderate Climate Smartness Score of 8, suggesting its positive impact on productivity, adaptation, and mitigation. By effectively managing pastures, livestock producers can optimize grazing resources, enhance animal nutrition, and improve soil health.

2. **Livestock and crop production (mixed farming):** This approach, which involves integrating crop production with livestock rearing, received a moderate Climate Smartness Score of 7. Mixed farming systems can enhance resource utilization, such as utilizing crop residues as feed, and provide additional income streams for farmers.

3. **Conservation of nature and ecosystems:** The high Climate Smartness Score of 8 highlights the importance of preserving natural habitats and ecosystems. Protecting biodiversity and ecosystem services can contribute to climate resilience, sustainable livestock production, and the preservation of ecosystem functions.

4. **Mixed livestock farming:** This practice, which combines stall-fed systems and pasture grazing, received a moderate Climate Smartness Score of 7. Mixed livestock farming systems offer flexibility in feed management and can optimize resource utilization while reducing environmental impacts.

5. **Raise local breeds adapted to local climatic stress and feed sources:** This practice acknowledges the importance of using locally adapted livestock breeds and scored a moderate Climate Smartness Score of 7. Local breeds are often better adapted to the local environment, including climatic stressors, and can contribute to climate resilience in livestock production systems.

6. **Improved management of water resources through the introduction of simple techniques for localized irrigation:** This practice received a moderate Climate Smartness Score of 7. Efficient water management and localized irrigation techniques can help mitigate the impacts of water scarcity and variability, enhancing livestock productivity and resilience.

7. For poultry production, tree planting around poultry house scored a high Climate Smartness Score of above 5 points, while installed cooling equipment, improved hygiene, and more space per bird, more water served, and low vaccination of birds indicate low smartness (less than 5 points), and low poultry production in

KebbiState. This measure offers potential benefits that contribute to climate-smart agriculture in poultry production. For example, in terms of temperature regulation and energy savings, trees provide natural shade and help regulate temperatures around the poultry house. By reducing solar radiation and providing cooler microclimates, tree planting can lower heat stress on poultry, thus improving their well-being and productivity. In terms of carbon sequestration and air quality, trees play a crucial role in sequestering carbon dioxide from the atmosphere, mitigating climate change. By planting trees around poultry houses, carbon dioxide emissions from the facility can be offset, contributing to carbon reduction.

Additionally, several practices in the livestock sector received low Climate Smartness Scores, indicating limited climate-smartness potential. These include altering the timing of operations, modifying stock routings and distances, improving local genetics through crossbreeding, and reducing livestock numbers. These practices may require further evaluation or refinement to enhance their effectiveness and climate-smartness in Kebbi State.

Aquaculture and Fisheries

The transition from capture fisheries to aquaculture and adopting improved aquaculture management have moderate Climate Smartness Score. These technologies indicate a significant potential for sustainable fish production, contributing to increased productivity, food security, and reduced pressure on wild fish populations.

Similarly, increasing fishing efforts, and migrating to other fishing areas have moderate scores. These practices also demonstrate the potential for improving productivity and adapting to changing environmental conditions or market demands. Careful monitoring and regulation are necessary to prevent overfishing and negative ecological impacts.

The technologies and practices in the low climate smartness category encompass reusing waste and integrating resources to reduce input costs, changing fishing time, and fishing further away or deeper inside water. While these practices may offer some benefits, they exhibit relatively lower impact levels in terms of climate smartness. Policymakers should focus on enhancing the sustainability and environmental performance of these practices to maximize their potential contributions to climate-smart agriculture.

Agroforestry, afforestation, and reforestation

1. **Agroforestry:** Tree with crop production has moderate climate smartness score. More specifically, the planting of high economic value and open canopies indigenous trees on crop lands. By integrating high-value indigenous trees with open canopies into crop lands, farmers can enhance the productivity and sustainability of their agricultural systems. These trees offer multiple benefits, including providing shade, improving soil fertility, reducing water evaporation, promoting biodiversity, and sequestering carbon dioxide. Policymakers should encourage and support the adoption of this practice by providing incentives, technical assistance, and access to suitable tree species.

2. **Afforestation and reforestation:** Tree planting (new forests) and replanting of trees (restoration of old forests) have moderate climate smartness score. Afforestation and reforestation underscore the potential to mitigate climate change and restore ecosystems. Reforestation involves establishing forests on lands

thatwere previously forested but have been cleared or degraded. Trees help sequester carbon, conserve water, enhance biodiversity, and provide valuable ecosystem services. Policymakers should prioritize reforestation initiatives by developing appropriate frameworks, engaging local communities, and collaborating with relevant stakeholders to ensure successful implementation.

3. **Natural tree regeneration:** Natural tree regeneration refers to the spontaneous regrowth of trees in areas where forests have been disturbed or cleared. This practice is low on climate smartness score in Kebbi state. However, the practice should be encouraged since it allows native tree species to naturally recolonize and restore ecosystems over time. It also contributes to carbon sequestration and supports biodiversity conservation and ecosystem resilience. Policymakers should recognize the value of natural tree regeneration and incorporate it into land-use planning and restoration strategies.

Cross-cutting Issues

The cross-cutting issues in climate smart agriculture are livelihood diversification into non-farm activities, labour migration (temporary), improved extension service delivery, creating rural awareness campaigns, weather information dissemination, and setup disaster management plan. While the average CSA score was moderate for each of the cross-cutting issues, they vary by categories of productivity, adaptation and mitigation. The lowest score was in mitigation (energy savings/conservation) perhaps due to insufficient energy. The highest was productivity because of increased yield/food security due to improved extension service delivery.

Gender Issues

The CSA practices were further categorised based on three categories: (a) gender- sensitive (male and female); (b) gender-specific (male or female); and (c) gender-neutral (neither male nor female). These three categories (see Table 2) were jointly identified by stakeholders, and the classification into the three categories was validated during the stakeholders' validation exercise. The results showed that only the crop sub-sector has five CSA practices that are gender-sensitive (planting of climate-tolerant varieties (drought-, pest-, flood-resistant), planting of weed-tolerant crop varieties, mixed cropping, intercropping, and varying (increasing/reducing) area under cultivation. The other sub-sectors have predominately a mixture of gender-specific and gender-neutral CSA practices. Overall, more than half, representing 51 percent (45 out of 88) CSA practices are gender- neutral. The implication is that there are gender issues around CSA practices in Kebbi State. Therefore, policy targeting any of the CSA practices and sub-sector should ensure gender considerations and mainstreaming.

Table 2. Result of Climate Smartness Score

Sub-sector	Broad category	Specific technologies & practices	Gender Issue	Productivity	Adaptation				Mitigation			CSS
				Incremental Yield / Food security	Increased Income	Conserves / saves water	Soil fertility	Risk reduction	Carbon emission reduction	Nitrogen emission reduction	Energy savings or conservation	
Crop	Crop management	Improved crop varieties	c	7.07	7.10	5.79	5.45	6.52	5.04	5.56	5.54	6.01
		Planting of climate-tolerant varieties (drought-, pest-, flood-resistant)	a	7.26	7.00	5.79	5.51	6.68	4.27	4.44	5.00	5.75
		Planting of weed-tolerant crop varieties	a	7.03	6.95	5.78	5.78	6.11	4.25	4.22	5.09	5.65
		Use of early maturing / high-yielding variety	c	7.92	7.58	6.00	5.68	6.32	4.51	4.51	5.29	5.98
		Crop diversification	b	7.60	7.52	5.30	5.45	6.66	4.54	4.34	4.44	5.73
		Change in cropping pattern and planting calendar	b	6.85	6.55	5.36	5.19	6.03	4.52	3.90	4.59	5.37
		Early harvesting of crops	c	6.88	6.66	6.03	5.67	6.28	4.61	4.87	4.81	5.73
		Mixed cropping	a	7.67	7.17	5.61	5.83	6.26	4.12	4.58	4.48	5.71
		Intercropping	a	7.15	7.09	5.53	5.80	6.27	4.28	4.86	4.69	5.71
		Varying (increasing/reducing) area under cultivation	a	7.55	7.41	5.76	5.55	5.91	4.35	4.42	4.64	5.70
		Spacing as a planting technique	c	7.29	6.88	5.41	5.66	5.84	4.40	4.00	4.13	5.45
		Number of seeds per hole	c	7.10	6.77	5.07	5.50	5.52	4.57	4.48	4.32	5.42
		Broadcasting and/or transplanting (especially rice)	c	7.12	7.03	5.88	5.84	6.13	4.97	4.84	4.68	5.81
	Soil conservation	Use of zero tillage / alternative tillage practices	b	6.33	6.30	5.97	5.97	5.85	4.72	4.50	4.72	5.55
	Soil conservation	Mulching	c	7.38	6.97	6.91	7.06	6.33	5.00	4.94	4.80	6.17
	Soil conservation	Cover cropping	c	7.18	7.12	6.85	6.76	6.41	5.34	4.84	4.84	6.17
	Soil conservation	Application of organic fertilizers	b	8.20	7.86	6.51	7.46	6.26	4.47	4.67	4.18	6.20
		Crop rotation	b	7.81	7.41	5.74	7.23	6.26	3.78	4.06	4.50	5.85
		Bush fallowing to increase soil fertility	b	7.66	7.29	6.58	6.70	6.22	5.77	4.97	4.93	6.26
		Improved access to credit services and inputs	c	7.69	7.17	5.83	5.57	5.09	3.86	3.86	4.03	5.39
		Inorganic fertilizer	c	7.53	7.21	5.55	6.64	6.30	4.55	4.30	3.78	5.73
		Contour Bunding and Contour Ploughing	b	6.53	6.06	6.88	6.78	6.23	4.66	4.48	4.41	5.75
		Bonding practices in rice field	b	7.69	7.24	7.28	6.24	6.41	4.85	4.30	5.04	6.13

Sub-sector	Broad category	Specific technologies & practices	Gender Issue	Productivity	Adaptation				Mitigation			CSS
				Incremental Yield / Food security	Increased Income	Conserves / saves water	Soil fertility	Risk reduction	Carbon emission reduction	Nitrogen emission reduction	Energy savings or conservation	
		Change of farming location	b	7.44	7.11	6.62	6.74	6.08	5.17	4.74	4.82	6.09
	Traditional parklands	Plant high economic value and open canopies indigenous trees on crop lands	c	7.40	7.10	6.87	6.87	6.37	5.76	5.07	5.52	6.37
		Citrus orchards	b	7.61	7.30	6.30	6.04	6.22	5.09	5.05	4.50	6.01
		Streamlined planting techniques (leaving less space between crops)	b	6.93	6.53	6.38	6.07	5.72	4.96	4.86	5.26	5.84
		Dry season farming	c	8.34	8.26	6.49	6.31	6.91	5.34	4.85	4.63	6.39
		High-quality bio-fertilizers (compost production)	b	7.24	6.84	6.22	6.67	6.39	4.94	4.81	4.83	5.99
		Use of fungicides (e.g., Aflasafe to control aflatoxin infestation)	c	7.03	6.69	5.10	5.68	6.38	4.19	4.10	3.67	5.35
		Use of bio-pesticides	c	6.82	6.82	5.43	5.50	6.04	4.92	4.23	4.44	5.53
		Use of microbial Inoculants	c	6.52	6.74	5.22	6.04	6.19	4.40	4.42	4.88	5.55
	Integrated Pest Management	Integrated Pest Management	c	7.82	7.29	5.56	4.86	6.19	4.56	4.23	3.82	5.54
	Improved water management	Water harvesting	c	8.13	7.81	7.63	5.94	6.97	5.16	5.00	5.32	6.49
	Improved water management	Use of alternate wet and dry flooding system in low land rice production	c	7.28	6.97	6.59	5.75	6.50	4.74	4.90	4.89	5.95
	Improved water management	Improved irrigation efficiency	c	7.89	7.80	7.23	6.59	6.50	5.12	4.73	4.36	6.28
	Improved water management	Use of drainage system	c	6.97	6.39	6.48	5.78	6.42	4.90	5.00	4.61	5.82
	Improved water management	Mounting of dams for storing water	b	7.45	7.07	6.71	5.40	6.29	4.14	4.79	4.83	5.83
	Water Harvesting	Half moon	b	6.70	6.27	6.73	6.03	6.45	3.82	4.14	3.89	5.50
		Zai pit (planting pit)	b	6.76	6.62	6.62	5.72	5.76	4.04	4.07	4.33	5.49
		Contour bond	b	6.86	6.29	6.68	6.52	6.26	4.29	4.46	4.88	5.78
		Sunken beds and/or raised beds	c	7.10	6.90	6.80	6.17	5.90	3.84	3.96	3.92	5.57
	Mixed farming	Integrated crop - livestock production	c	7.79	7.79	6.09	7.32	6.74	3.41	3.81	4.13	5.88
Livestock	Production adjustments	Livestock diversification	b	7.46	7.37	5.91	6.38	6.50	3.97	3.97	4.17	5.71
	Production adjustments	Integration of pasture management	b	6.90	6.76	4.78	6.46	6.11	4.28	4.16	4.21	5.46
	Production adjustments	Livestock and crop production (mixed farming)	c	8.14	7.75	5.94	6.91	6.47	4.84	4.77	4.65	6.18

Sub-sector	Broad category	Specific technologies & practices	Gender Issue	Productivity	Adaptation				Mitigation			CSS
				Incremental Yield / Food security	Increased Income	Conserves / saves water	Soil fertility	Risk reduction	Carbon emission reduction	Nitrogen emission reduction	Energy savings or conservation	
	Production adjustments	Altering the timing of operations	c	6.47	6.53	5.15	5.32	5.86	4.38	4.35	4.91	5.37
	Production adjustments	Conservation of nature and ecosystems	b	6.88	6.50	5.23	5.62	4.79	4.92	5.46	5.38	5.60
	Production adjustments	Modifying stock routings and distance	b	5.71	5.77	4.67	4.25	5.38	3.92	5.58	4.00	4.91
	Production adjustments	Mixed livestock farming (e.g., stall-fed systems and pasture grazing)	c	7.37	6.85	5.16	5.71	5.91	3.94	4.17	3.75	5.36
	Breeding strategies	Raise local breeds adapted to local climatic stress and feed source	c	6.80	6.66	4.68	5.31	6.03	3.94	3.94	3.75	5.14
	Breeding strategies	Improve local genetics through crossbreeding with heat & disease-tolerant breed	c	7.44	7.03	4.64	5.44	5.77	3.61	3.96	3.77	5.21
	Livestock mgt. systems	Provision of shade and water to reduce heat stress from increased temperature	b	7.23	7.03	5.58	5.81	6.23	3.75	3.75	3.83	5.40
	Livestock mgt. systems	Reduction of livestock numbers	c	5.00	4.76	4.00	4.38	5.08	3.50	3.75	3.77	4.28
	Livestock mgt. systems	Changes in livestock/herd composition (selection of large animals rather than small	b	6.53	6.34	4.54	5.12	5.44	3.09	3.64	3.74	4.80
	Livestock mgt. systems	Improved management of water resources through the introduction of simple techniques for localized irrigation	b	6.30	6.15	5.67	5.65	5.44	4.38	3.55	4.20	5.17
	Livestock mgt. systems	Proper livestock health management and welfare	b	7.68	7.65	5.00	5.50	6.32	3.26	3.44	3.62	5.31
	Capacity building for livestock keepers	Training of livestock producers and herders / awareness creation	c	7.23	6.86	5.12	4.90	6.12	3.54	3.56	3.80	5.14
	Improved feed mgt.	Use of methane reducing feed additives	c	6.62	5.77	5.00	5.13	5.09	3.13	3.86	4.38	4.87
		Ranching	b	7.16	6.73	5.00	5.23	5.44	3.82	3.28	4.28	5.12
		Adequate waste management and utilization	c	7.43	7.03	6.11	6.08	5.71	4.10	3.29	4.10	5.48
		Keeping of climate tolerant breeds (e.g., heat-resistant)	c	7.00	7.03	4.67	6.00	6.09	3.57	3.60	4.17	5.27
Poultry		Keeping of early maturing birds	c	7.47	7.34	5.05	5.73	6.07	3.72	3.79	3.82	5.37
		Installed cooling equipment	c	5.81	5.59	4.16	4.45	5.67	3.85	3.38	3.76	4.58
		Tree planting around poultry house	c	6.57	6.27	4.96	5.33	5.39	4.30	4.26	4.10	5.15
		Improved hygiene	c	6.91	6.85	4.56	4.92	6.06	3.58	3.23	3.22	4.92
		More space per bird	c	6.21	5.79	4.53	4.33	5.46	3.22	3.38	3.23	4.52
		More water served	c	6.41	6.14	6.05	4.47	5.19	3.68	3.79	3.72	4.93

Sub-sector	Broad category	Specific technologies & practices	Gender Issue	Productivity	Adaptation				Mitigation			CSS
				Incremental Yield / Food security	Increased Income	Conserves / saves water	Soil fertility	Risk reduction	Carbon emission reduction	Nitrogen emission reduction	Energy savings or conservation	
		Prompt and extra vaccination of birds	b	6.97	6.48	4.64	4.48	6.07	3.48	3.96	3.48	4.94
Aquaculture and Fisheries		Transition from capture fisheries to aquaculture	b	6.93	6.79	5.91	4.92	5.89	3.83	3.92	4.00	5.27
	Aquaculture	Plastic/concrete ponds	c	6.42	6.19	6.04	4.89	5.50	3.13	3.29	3.60	4.88
	Aquaculture	Adopting improved aquaculture management	c	7.80	7.73	6.24	5.38	6.07	3.87	4.09	3.39	5.57
	Aquaculture	Reuse waste and integrate resources to reduce input costs	c	6.48	6.53	5.54	5.74	4.93	3.58	3.17	3.71	4.96
	Capture fisheries	Increasing fishing efforts	b	7.14	7.07	5.47	5.58	4.63	4.05	4.00	4.21	5.27
	Capture fisheries	Fishing further away or deeper inside water	b	6.17	6.07	5.27	5.29	5.04	3.75	3.45	3.50	4.82
	Capture fisheries	Change fishing time	b	6.43	6.00	5.55	5.13	4.96	4.35	3.80	3.30	4.94
	Capture fisheries	Migrate to other fishing areas	b	6.87	6.84	5.26	5.00	5.17	3.90	3.57	4.24	5.11
	Livelihood diversification	Engage in alternative livelihood means	c	9.93	6.81	4.67	4.73	5.80	3.50	3.43	4.45	5.41
Agroforestry, afforestation, reforestation	Agroforestry	Tree planting with crop production	b	7.16	7.00	5.57	6.30	6.19	4.70	4.07	4.46	5.68
	Reforestation	Reforestation	b	6.31	6.62	5.46	6.13	5.84	4.91	5.17	4.59	5.63
	Afforestation	Afforestation	b	6.96	6.88	6.04	6.95	6.76	4.87	4.83	4.48	5.97
	Regeneration	Natural tree regeneration	b	6.19	6.08	4.79	5.74	5.33	4.24	3.74	3.65	4.97
Cross-cutting	Livelihood diversification into non-farm activities	Livelihood diversification into non-farm activities	c	7.35	7.17	4.78	5.10	6.09	4.37	4.05	4.26	5.40
	Labour migration (temporary)	Labour migration (temporary)	b	6.46	6.15	5.50	4.82	5.00	4.00	4.00	4.25	5.02
	Extension Agents and Agricultural centres help community members	Improved extension service delivery	c	7.59	7.29	5.41	6.04	6.77	4.21	4.22	4.76	5.78
	Climate awareness	Creating rural awareness campaigns	c	7.32	6.85	5.38	5.15	6.23	4.14	4.42	4.32	5.48
	Climate awareness	Weather Information Dissemination	b	6.80	6.25	5.22	4.93	6.07	4.43	4.14	3.60	5.18
	Disaster risk management	Setup disaster management plan	b	6.10	6.03	5.08	5.43	5.96	4.75	5.09	4.91	5.42

Note: CSS (Climate Smartness Score); Gender Issue: a = gender-sensitive (male and female); b = gender-specific (male or female); and c = gender-neutral (neither male nor female).

INSTITUTIONSAND POLICIES FOR CSA

Institutions

Kebbi State has several important institutions and regulations designed to encourage and boost agricultural productivity and advance CSA techniques. Numerous organizations that engage on CSA-related projects are active at both the federal and state levels. The Kebbi State Ministry of Agriculture and Natural Resources is charged with developing agricultural policies and implementing climate-resilient projects and activities. The Federal Ministry of Agriculture and Rural Development (FMARD), Nigeria's leading institution for rural development, stands out among the institutions because it is primarily in charge of developing the country's agricultural policies. Except for agricultural research, which is also funded by the federal government, state ministries of agriculture oversee implementing agricultural policy in their individual states. The formulation, development, and implementation of policies, programs, and strategies for combating climate change activities are the responsibilities of the Federal Ministry of Agriculture and Rural Development (FMARD), other sectoral ministries, such as the Federal Ministry of Environment, and their state counterparts.

As a venue for climate resilience in Nigeria, the Advisory Committee on Agricultural Resilience in Nigeria (ACARN) was established. To inform policies that will strengthen the capacity of small- and large-scale agricultural producers to increase productivity, grow wealth, and thrive in the face of mounting challenges from numerous environmental stressors and changing climate, the committees make recommendations based on well-informed expertise and research. International research and development organizations also have a footprint in CSA research activities in the State. As a venue for climate resilience in Nigeria, the Advisory Committee on Agricultural Resilience in Nigeria (ACARN) was established.

Universities, colleges, and various agricultural research institutions are all engaged in CSA. The National Agricultural Research System (NARS), which is made up of several institutions and organizations, is owned by the federal government. They include 3 specialist universities of agriculture, over 50 faculties of agriculture at normal federal universities, 15 Commodity-based Research Institutes, 11 Federal colleges of agriculture, and a specialized National Agricultural Extension Institute. The Agricultural Research Council of Nigeria (ARCN), which oversees these institutions' operations, is responsible for their activities. The International Agricultural Research Centre (IARC), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the Food and Agriculture Organization of the United Nations (FAO), and the International Institute of Tropical Agriculture (IITA), among others, are all located in Nigeria and conduct important international research and development projects there.

CSA priorities, strategies, policies, plans, goals, and actions

1. Climate Smart Agriculture (CSA) is context specific and interventions are determined through social, economic and environmental conditions where it will be applied. Scaling CSA requires knowledge, an enabling policy environment, and accountability for impact. Putting all these elements in place requires the engagement and commitment of all key stakeholders, including governments, farmers' organizations, national and international civil society organizations, the private sector, research institutions, and international and inter-governmental bodies. Most of the policy frameworks for the Kebbi CSA will cover both mitigation and adaptation strategies and plans.

Policy / Strategy / Action / Plan / Priorities / Goal Period Active		Selected CSA-related elements relevant to the State	CSA pillar active			Status	
			P	A	M	In formulation	Currently implemented
Panel A: State Level							
Kebbi State Policies on Agriculture, Environment and Solid Minerals (Taungya Farming Scheme)	2003 – current	▪ Crop ➢ To strengthen the engagement of agro-vendors for adequate distribution of inputs to farmers across the 21 Local Government Areas of the State and facilitate their access to certified seeds and seedlings, fertilizers, and agro-chemicals ➢ To establish three pilot irrigation schemes for training purposes ➢ To ensure increase in irrigable land is under irrigation ▪ Livestock and fisheries ➢ To actively promote pasture agronomy by the private sector and to facilitate the business of fodder and silage production, targeting ranchers as off-takers ➢ To promote the establishment of feed mills and fish hatcheries across the State ➢ Recycling of livestock and fisheries waste ▪ Cross-cutting ➢ Establishment of 21 forest reserves covering 481,590.5 hectares ➢ Ensure quality supply of inputs to farmers ➢ To put in place a risk sharing framework in agriculture ➢ To establish Agricultural Extension Fund ➢ To attain better Extension Agent – farmers ratio ➢ Cooperatives establishment for easy access to credit, grants, training and expanded production	✓	✓	✓	✓	✓
Kebbi State Policy on Agriculture	2013 – current	▪ Agriculture ➢ Commitment of 100% of agriculture budget to agriculture ➢ Implementation of Anchor Borrower Scheme ➢ Promote appropriate, effective and efficient management techniques to maintain soil quality and enhance land capability ➢ Encouraging and supporting the use of sustainable agroindustry and alley-cropping techniques for the preservation and remediation of erosion and to improve agricultural productivity ➢ Promote dry season irrigation-based farming practices ➢ Promote research and monitoring of soil for over-fertilization and over-cultivation ➢ Encourage and support ecologically appropriate livestock and poultry production ➢ Promote efficient use of crop and livestock waste products as organic manure and other soil conditioners for sustainable agriculture ➢ Promote the adoption of efficient agro-processing techniques to minimize losses ➢ Facilitate improved storage of agricultural produces ➢ Improve farmers' access to high yield, early maturing crop varieties ➢ Promote integrated pest management ➢ Strengthen agricultural extension service delivery	✓	✓	✓	✓	✓
Kebbi State policy on Forestry (Kebbi State Official Gazette, 2020	Forest Edict, 1997 2020 – current	▪ Forestry ➢ Provide conservation, management, and development of forest ➢ Establishment of 21 forest reserves covering 481,590.5 hectares ➢ Prepare and implement forest resources conservation plan, individual forests management plan ➢ Control the cutting, harvesting, milling and sale of timber and other forest products ➢ Protect and preserve water resources in forest reserves ➢ Afforestation programme, including the planting of one million assorted trees in 2020/2021 ➢ The afforestation programmes include shelter belts to checkmate wind and gully erosion, orchard establishment and water shade planting to control siltation into streams and rivers ➢ Control and regulate fires in forest reserve and conservation reserve ➢ Promote the practice of forestry and agro-forestry in agricultural, pastoral and other areas ➢ Promote proper soil and forest conservation practice ➢ Promote and supervise forestry research ➢ Ensure the maintenance of biological diversity ➢ Provide training for forestry officers and other staff ➢ Promote and implement educational programs to improve understanding of the forestry to economic well-being and development ➢ Provide compensation of N8,000 to N25,000 depending on variety of tree species (improved or local) and number of years	✓	✓	✓	✓	✓
Panel B: National level							
2050 Long-Term Vision for Nigeria (LTV-2050) (Federal Ministry of Environment, 2021b)	2021 – current	▪ Conservation of water in irrigated rice farms ▪ Reduced methane fodders for livestock ▪ Low-input agriculture ▪ Introduction of carbon sequestration techniques and management ▪ R&D on carbon-efficient agricultural practices ▪ Utilization of solar, wind, and other eco-friendly energy sources in agricultural and fishing operations	✓	✓	✓		✓
National Development Plan (NDP) (Federal Ministry of Finance Budget and National Planning, 2021)	2021 – current	▪ Enhance national agricultural output and decrease post-harvest losses ▪ Major programs on animal breeding and conservation,	✓	✓	✓		✓
Nigeria Economic Sustainability Plan (Budget Office of the Federation, 2020)	2020 – current	▪ Guarantee market and mitigate post-harvest losses ▪ Interest-free credit financing options for small holder farmers ▪ Implement strategies to increase yield per hectare	✓	✓	✓		✓
Updated Nationally Determined Contribution (Federal Ministry of Environment, 2021a)	2021 – current	▪ Support for climate-smart agriculture ▪ Half of the farmland uses rice paddy fields with intermittent aeration. ▪ A 50% drop in the amount of crop waste that is burned by 2030 ▪ Better care for natural forests ▪ Increased forest protection ▪ Forest restoration	✓	✓	✓		✓

National Climate Change Policy (Federal Ministry of Environment, 2021c)	2021 – current	▪ Reduce the destruction and loss of forests. ▪ Use fuels other than wood for homes in rural areas. ▪ Increase the amount of carbon that is stored in agricultural soils. ▪ Promote agroforestry, reforestation, and afforestation.	✓	✓	✓		✓
National Rice Development Strategy II (Federal Ministry of Agriculture and Rural Development, 2020)	2020 – current	▪ Sustained production and improved access to quality seeds of improved rice varieties ▪ Sustainable increase in paddy production and storage ▪ Improve irrigation use ▪ Increase access and use of mechanization equipment and tools in rice production and processing ▪ Improve access to credit and use of financial services	✓	✓	✓		✓
National Action Plan on Gender and Climate Change for Nigeria (Federal Ministry of Environment, 2020b)	2020 – current	▪ Build and strengthen institutional understanding of gender and climate change ▪ Erect climate-resilient infrastructure ▪ Enhance local communities' participation in the forestry and agricultural sector	✓	✓	✓		✓
National Agricultural Resilience Framework (FMARD, 2015)	2014 – current	▪ Expand access to drought-tolerant crops and livestock varieties ▪ Improve soil quality management system. ▪ Strengthen climate information systems. ▪ Develop enhanced resource management practices. ▪ Use irrigation and water collection systems more frequently. ▪ Develop efficient water management systems ▪ Increase planting of native vegetation cover ▪ Strengthen the capacity of federal institutions by designing and implementing climate-resilient development activities ▪ Promote climate-smart agricultural practices country-wide	✓	✓	✓		✓
National Agricultural Technology and Innovation Policy (FMARD, 2022)	2022 – 2027	▪ Encourage the application of on-farm digital technologies ▪ Providing digital capabilities to all agriculture initiatives to establish sustainable business models and possibilities ▪ Improved agricultural output ▪ Allowing farmers to access financial services, register land and cattle online, access detailed geographic and soil-related information ▪ Collating and digitizing relevant agricultural research content and carrying out joint research on agricultural productivity and exportation needs ▪ Promotion of sustainable land and water management practices ▪ Ensuring the timely provision of weather and climate information to farmers for crops, fisheries, and livestock production ▪ Building farmers' capacity on sustainable methods of water harvesting techniques for supplementary irrigation ▪ Promotion of greenhouse crops and vegetable production ▪ Setting up minimum standards for organic crops, fisheries, and livestock production in the country ▪ Promotion of organic crops, fisheries, and livestock production, and ▪ Supporting the establishment of Meteorological Stations in all FMARD State offices to have adequate and reliable data for forecasting purposes.	✓	✓	✓		✓
National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (BNRCC and Federal Ministry of Environment, 2011)	2011 – current	▪ Adopt improved crops and livestock systems ▪ Improve climate information systems ▪ Strengthen financing and insurance services ▪ Strengthen extension services ▪ Enlarge food storage capacity ▪ Strengthen the capacity of federal institutions by designing and implementing climate-resilient development activities ▪ Promote climate-smart agricultural practices country-wide	✓	✓	✓		✓
National Policy on Drought and Desertification (Federal Ministry of Environment, 2018b)	2018 – current	▪ Improvements to current early warning systems ▪ Creating adequate awareness programs to increase understanding of climate and environmental issues ▪ Encourage appropriate land use practices that improve carbon dioxide sequestration		✓	✓		✓
National Clean Cooking Stoves (NCCS) Initiative (Federal Ministry of Environment & Kebbi Sate Ministry of Environment and Solid Minerals)	Ongoing	▪ Distribution Of Gas Cylinders, Save 80 Stoves, Environ Fit Charcoal, And Improved Firewood Stoves Within The 21 Local Government Areas of Kebbi State	✓	✓	✓		✓
National Agency for the Great Green Wall (NAGGW)	2007 – current	The National Agency for the Great Green Wall (NAGGW) is at the forefront of combating desertification and land degradation in line with the United Nation Convention on Combating Desertification (UNCCD). ▪ The programme involves among others, the establishment of a Green wall or shelterbelt from the Kebbi State in Northwest to Borno State in Northeast.	✓	✓	✓		✓

Scaling up ongoing community CSA actions

A lot of attention has been drawn to the need to ensure effective implementation of community-level climate change adaptation efforts in Kebbi State. However, it is worth noting that communities within the State have long engaged in adaptive agricultural practices to confront climate change challenges. These strategies and actions can be broadly categorized as absorptive capacity, referring to a community's ability to cope with anticipated shocks, such as through informal safety nets (Olabisi et al., 2020). However, the State exhibits low and moderate levels of both adaptive and transformative capacities as presented in the climate smartness scores for the various CSA practices. Hence, the need for adequate preparedness to face future shocks by implementing measures like diversified cropping systems and livelihood strategies. Similarly, there is need to develop innovative systems with the potential to mitigate risks and exposure, such as institutional reforms in land tenure, financial markets, or cropping practices. Overall, successful adaptation in Kebbi State tend to favour a combination of adaptive and transformative actions. For example, if flood patterns become increasingly unpredictable, a community may choose to transition from cultivating in floodplains to alternative cultivation methods (Olabisi et al., 2020).

Furthermore, achieving the goal of upscaling community-driven adaptation initiatives requires focused attention on four key factors related to the adaptation process. These factors encompass institutional arrangements, information and knowledge sharing, capacity development, and financial considerations. Mfitumukiza et al. (2020) elaborate on the relevant approaches for scaling up localized, community-based adaptation efforts. It also underscores the significance of learning opportunities through effective monitoring and evaluation mechanisms.

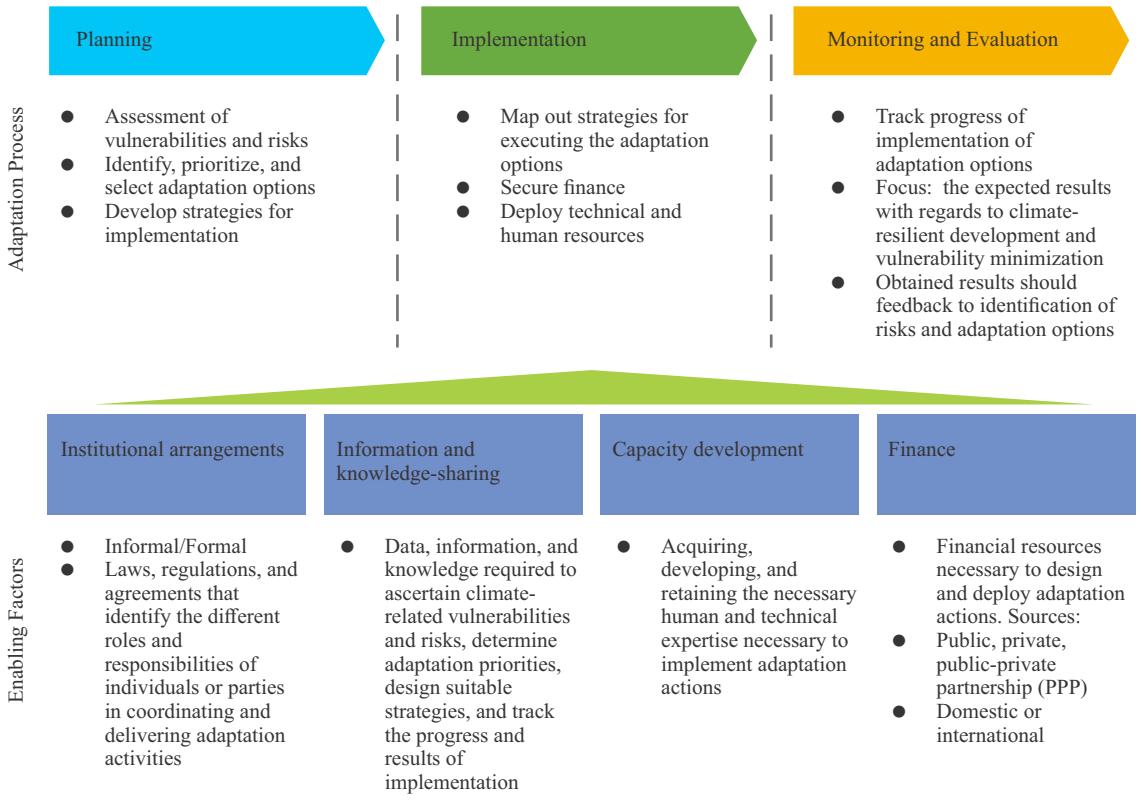

Figure 5. The adaptation process and its enabling factors
Source: Authors' diagram based on information from Mfitumukiza et al.

Financing CSA

According to the Climate Policy Initiative (CPI), the Nigerian public and private money invested in climate-related projects at a rate of USD 1.9 billion a year in 2019/2020. In order to fulfill the conditional Nationally Determined Contribution (NDC) objective of decreasing emissions 47% below business-as- usual by 2030, this amount represents only 11% of the estimated USD 17.7 billion needed annually. More particularly: The monitored USD 1.9 billion of climate money flowing to and within Nigeria is negligible compared to the prospects for low-carbon development and the size of the country's economy, with a GDP of USD 432 billion (WB, 2020).

Current Financing Landscape

The responsibility of funding CSA operations in Kebbi state currently rests with the state's implementing organizations. At the bilateral and multilateral levels, there aren't many actual connections with financing organizations to assist CSA. However, there are federal climate change projects financed by donors that are advantageous to the state. Currently, CSA-related initiatives and agricultural development projects that are focused on improving rural livelihoods and food security in Kebbi state are supported by the United Nations Development Programme, United Nations Environment Programme, Food and Agriculture Organization of the United Nations, the World Bank, and the African Development Bank.

Funding for CSA is limited in the state and Nigeria in general, however there are opportunities to access and utilize international climate finance from sources such as the Green Climate Fund and Global Environment Facility and through readiness and capacity building programmes. At the national level, the National Agricultural Resilience in Nigeria, an arm of the Federal Ministry of Agriculture and Rural Development which targets reforestation, agriculture and livestock, is a useful mechanism for directing climate finance to CSA-related activities. Others are the fund set aside for the National Climate Change Adaptation Strategy and Action Plan for Climate Change in Nigeria (NASPA-CCN) which can benefit CSA-related activities in Kebbi state.

Kebbi State Government

Oxfam had noted that the “Kebbi government has been consistently committing over 10 per cent of its annual budget to the agriculture sector, from 2016 to 2018. The state government voted N12.5 billion out of a budget of N109.7 billion to agriculture in 2018. In 2017, it voted over N14 billion out of the budget of N139.3 billion to the same sector. Budgetary allocation to the agriculture and rural development sector for 2015 represents 11.4 per cent while that of 2016 represents 10.1 per cent. In 2015, the Anchor Borrowers scheme of the Federal Government was first launched in the state, while in 2017, the largest rice mill in Africa, WACOT Rice Mill, was commissioned in the state.

Complementary efforts

Enhancing rural livelihoods and ensuring food security constitute the central objectives driving a multitude of contemporary agricultural assistance and Climate-Smart Agriculture (CSA) initiatives in Kebbi State. These endeavors have garnered substantial backing from esteemed entities such as the World Bank, the United States Agency for International Development (USAID) funded Feed the Future Activities, the

InternationalFund for Agricultural Development (IFAD), and Lagos State Government. To gain further clarity, presents an overview of select donors and their respective donor-assisted projects, highlighting their profound engagement and financial support towards agricultural and CSA-related undertakings within the boundaries of Kebbi State. Table 4 provides information on selected donor/donor-assisted climate change-related response efforts in Kebbi State.

		CSA pillar		
Entity	Projects financed	P	A	M
World Bank assisted projects	▪ Climate-smart rainfed agriculture ▪ Support to farmers at the household level to optimize climate-smart rainfed agriculture practices, particularly relating to crops. ▪ Investments could include water and soil conservation, optimizing farm management (improved crop varieties, ▪ Integrated Pest Management; soil and water testing technologies), controlling invasive species, and supporting value chains. ▪ Provide loans from community revolving funds (CRF) to registered community/farmer groups and cooperatives. ▪ Address gender inequalities in access to funding for enterprises by prioritizing subproject proposals from groups/cooperatives that have women beneficiaries as members and/or leaders ▪ Farmer-led irrigation development (FLID) ▪ Support farmers at the household level to increase irrigation, including small-scale solar-powered irrigation	✓	✓	✓
International Fund for Agricultural Development (IFAD) (VCDP) and Lagos State Government	▪ Financing of rice and cassava crop post-harvest handing technology ▪ Provision of productivity-enhancing inputs for smallholder farmers engaged in rice and cassava production ▪ Infrastructure investment for increased market access for smallholder farmers ▪ Support for farmers' organizations (FOS) in the State ▪ Investment in value chain development program	✓	✓	
Feed the Future Nigeria Agribusiness Investment Activity	The Activity operates within Kebbi State, Nigeria, with the primary objective of fortifying the conducive framework for agribusiness finance and investment. Through the enhancement of the enabling environment for the growth of the agricultural sector, the expansion of financial accessibility, the facilitation of investment prospects, and the sustainable enhancement of performance among agribusiness micro, small, and medium enterprises, this Activity endeavors to bolster the depth, scope, vibrancy, and competitiveness of Nigeria's agribusiness sector. Such efforts are aimed at fostering improved investment opportunities and advancing food security within the region.	✓	✓	
Feed the Future Nigeria Agricultural Policy Project	▪ Support for research and policy efforts in Kebbi State ▪ Research on community-scale climate change adaptation research	✓	✓	

Furthermore, the Nigerian Federal Government has intensified its efforts to provide financial support for climate change mitigation and adaptation initiatives across the country, with particular focus on sectors that are susceptible to climate impacts, such as agriculture. These efforts are channeled through the respective Ministries, Departments, and Agencies (MDAs) of the federal government. Moreover, the federal government has the capacity to access crucial global funding mechanisms dedicated to climate change action, including the Adaptation Fund, Global Environment Facility, and Green Climate Fund. In addition to these avenues, the federal government has successfully mobilized capital for climate change mitigation and adaptation through the utilization of the Green Bond facility as highlighted by Moody's (2019). Furthermore, the federal government possesses the capability to raise significant financial resources for large-scale climate action in multiple states. This situation presents a unique opportunity for Kebbi State to capitalize on potential global funding opportunities that have hitherto remained unexplored.

Potential finance

There may not have been much financing for Kebbi State coming from programs like the Green Climate Fund and the Global Environment Facility. However, programs aiming to promote climate change adaptation and rural livelihoods are attractive to donors due to

theregion's sensitivity to climate change and the growing need for the adoption of innovative agricultural technology that mitigate its hazards. Currently, the federal government's contributions are insufficient, forcing the state to rely heavily on regionally based local and international development organizations.

Unfortunately, both local and federal financing for these CSA technologies and practices remain inadequate. Consequently, there is a pressing need to explore external financial support, including resources from the organized private sector and local/international development partners operating within Nigeria. Recognizing the urgent requirement for collective action to combat climate change, the private sector has already commenced financing mitigation efforts, as highlighted by the Federal Ministry of Environment (2018a). By regarding agriculture as a business endeavor, a greater influx of private investment can be facilitated, leading to the development of resilient agricultural systems capable of withstanding extreme climate change impacts. The private sector possesses several inherent advantages, including organized structures, expertise, capital, and skilled human resources. It acknowledges the value of agricultural systems that can effectively cope with extreme climate change impacts and is thus willing to invest accordingly.

In line with these developments, the federal government, as represented by the Federal Ministry of Environment (2021b), recently launched the National Climate Change Policy (NCCP) for the period 2021-2030. This policy document outlines Nigeria's stance on climate change, delineates the necessary steps to transform the nation into a climate-resilient economy, and elucidates sector-specific actions that can be undertaken to mitigate the impact of climate change. Furthermore, the Climate Change Act of 2021 establishes the Climate Change Fund (CCF) as a dedicated financing mechanism for climate actions within Nigeria.

Mitigation efforts which constitute a co-benefit of the identified CSA technologies and practices have not been actively pursued by farmers within the State when compared to the need for enhanced productivity and yields, with adaptation efforts also receiving marginal attention. However, there exists an opportunity to formalize and promote this particular pillar of CSA within the State. In August 2022, the Nigerian Federal Government initiated its inaugural Emissions Trading Scheme (ETS) as confirmed by the Department of Climate Change (2022). Under this incentivized framework, the government has established an upper limit on emission levels and grants permits or allowances that can be traded among individuals and businesses (UNFCCC, 2022). Thus, in this scheme, emissions can be treated as tradable commodities (PWC, 2022). This development presents a promising opportunity to expand mitigation activities within the agricultural sector and increase farmers' income by incentivizing the adoption of mitigation technologies and practices. Additionally, farmers can augment their earnings through participation in emissions trading and subsequently invest in resilient technologies while simultaneously reducing carbon emissions. Furthermore, the State government can intensify its efforts to enhance technical capacity, thereby enabling the development of bankable projects that can attract funding from global financing initiatives.

SUMMARY

This profile has identified the existing climate-smart agriculture (CSA) technologies and practices that are applicable within the agricultural system of Kebbi State. It has also presented a comprehensive overview of the prevailing adverse impacts of climate

changeexperienced within the State. Given the pivotal role played by the agricultural sector in ensuring food security, employment opportunities, and overall domestic value added within Kebbi State, coupled with its heightened vulnerability to climate change, it is imperative to promote technologies and practices that enhance resilience and foster rural livelihoods.

Agriculture plays a substantial role in contributing to Kebbi State's overall domestic product, employing a significant part of its population. Acritical characteristic of the state's agricultural system is its heavy reliance on rainfed conditions, predominantly led by smallholder farmers. However, farming systems face constraints due to limited input usage, including inadequate access to seedlings, fertilizers, and essential agrochemicals. Kebbi State is renowned for its cultivation of diverse crops, notably being a major producer and supplier of rice and yam in Nigeria. Additionally, it cultivates crops such as maize, sorghum, potatoes, beans, cowpea, groundnut, date palm as well as various vegetables like okra, peppers, tomatoes, eggplant, and green leafy vegetables. Livestock rearing comprises cattle, sheep, goats, pigs, poultry, and rabbits, while aquaculture is also practiced by micro, small, and medium enterprises (MSMEs) at varying scales.

Nevertheless, there exists a considerable gap between food demand and supply, as the agricultural systems struggle to meet the increasing food demands resulting from population growth, compounded by heightened climate variability and change. Key challenges faced by the agricultural sector include low soil fertility, limited access to finance, inadequate infrastructure, and poor market access. Despite these challenges, the State government has undertaken efforts to enhance the sector's resilience to climate change. Notably, the development of a draft climate change policy at the State level provides significant policy directions to foster Climate-Smart Agriculture (CSA) across various sub-sectors, encompassing crops, livestock, forestry, and fisheries. These state-level initiatives align with national-level policies, plans, and strategies that hold substantial implications for CSA activities within the State, especially under the complex dynamics of a changing and variable climate.

This profile identified and assessed 88 CSA potential technologies and practices, including conservation agriculture, crop diversification, and organic fertilizers.
The climate-smartness of various agricultural practices and technologies in Kebbi State was assessed through expert evaluations and surveys. The evaluation considered dimensions such as productivity, income, water conservation, soil fertility, adaptation, and mitigation. Several practices in crop production, including improved crop varieties, crop diversification, and changes in cropping patterns, showed moderate climate smartness. In livestock production, integrated pasture management, mixed farming, and conservation of nature and ecosystems were found to be climate-smart. Agroforestry, afforestation, and reforestation practices such as planting high-value indigenous trees, reforestation, and natural tree regeneration have climate smartness scores.

The CSA practices are gender-differentiated, therefore, there is need to consider gender in CSA policies and targeting of interventions. In the context of Kebbi State, this means providing both men and women equal access to agricultural advisory services and inputs (improved seeds, fertilizer, machinery. Training on water-efficient farming techniques, soil conservation, soil conservation methods, or the use of drought-resistant crop varieties can help women adapt to changing climatic conditions and maintain agricultural productivity and livelihoods. Similarly, initiatives that promote women's participation in decision-

making processes at the community level can ensure that their unique perspectives and needs are considered in climate change adaptation strategies.

Adoption of CSA practices is primarily influenced by factors such as ease of implementation and associated co-benefits, which encompass increased yield, enhanced food security, diversified income streams, and improved adaptive capacity. Additionally, there is a pressing need to intensify mitigation efforts. Although finance remains a challenge at both local and national levels, the recent establishment of the Nigeria Emissions Trading Scheme (ETS) presents significant potential for stakeholders across the agricultural value chains, including farmers, firms, and the State government, to bolster mitigation activities and generate income through carbon trading. Furthermore, the Federal Government's Green Bond program offers opportunities for the State to develop viable CSA projects that can augment its financing endeavors. Leveraging the expertise and capital of the private sector through the creation of an enabling environment can further enhance the State's agricultural pursuits and a green economy.

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KEBBI STATE CLIMATE SMART AGRICULTURE STAKEHOLDERS MEETINGS

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