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BENUE STATE CLIMATE SMART AGRICULTURE PROFILE

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

Authors

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List of Acronyms and Abbreviations

Acronym/Abbreviation	Description
AFOLU	Agriculture, Forestry and Other Land Use
APS	Agricultural Performance Survey
CCF	Climate Change Fund
CRSA	Climate Resilient Sustainability Agriculture
CSA	Climate-Smart agriculture
BSMANR	Benue State Ministry of Agriculture and Natural Resources
ETS	Emissions Trading Scheme
FAO	Food and Agriculture Organization
FMAFS	Federal Ministry of Agriculture and Food Security
FtFNAPA	Feed the Future Nigeria Agricultural Policy Project
GDP	Gross Domestic Product
Ha	Hectare
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
MDAs	Ministries, Departments, and Agencies
MSMEs	Micro, Small and Medium-Scale Enterprises
MSU	Michigan State University
MT	Metric tons
NAERLS	National Agricultural Extension and Research Liaison Services
NBS	National Bureau of Statistics
NCCP	National Climate Change Policy
NDC	Nationally Determined Contribution
USAID	United States Agency for International Development

Foreward

BENUE STATE GOVERNMENT

OFFICE OF THE SECRETARY TO THE STATE GOVERNMENT

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Climate change is a serious threat to the achievement of the sustainable development goals (SDGs). There is evidence that climate change has accelerated in this century. Its effects include sea level rise, rising temperature, erratic rainfall pattern and distribution, extreme weather/climate events, drought, and flooding. These impacts of climate change affect agriculture and other economic sectors globally.

Benue State is critical to agricultural production in Nigeria. The State is referred to as the "Food Basket of the Nation". The role of agriculture in economic development (especially in providing food, income, and livelihood) in Benue is clear. Agricultural production in Benue State is sensitive to climate and agricultural operations in the State are largely dependent on climate. This makes agricultural production in the State vulnerable to the impacts of climate change. The State economy is dominated by agriculture. Agriculture also contributes to greenhouse gas emissions, which cause climate change. Agriculture is therefore a contributor to climate change and impacted by climate change. It is therefore appropriate to pursue strategies and measures that will simultaneously improve the resilience of the agricultural sector, reduce/remove/avoid carbon emissions and increase agricultural productivity. Climate-smart agriculture is such a strategy.

Unless nations and peoples adopt climate-smart agriculture on a wholesale scale, they will be forced to endure the ravages of climate change with the consequences of food insecurity, increased greenhouse gas emissions, pressure on agricultural resources and land/water scarcity. Given that the foregoing may trigger economic crisis and political upheavals, it is important to aggressively promote the uptake of climate-smart agriculture at all levels in Benue and beyond.

Therefore, a climate-smart agriculture (CSA) profile, which documents the current understanding, practice and dispositions of Benue farmers and other agribusiness owners towards key components of climate-smart agriculture, is needed. Climate-smart agriculture is location-specific, implying that Benue state should pursue interventions that solve the needs of Benue farmers and agribusiness owners. The CSA profile forms the basis for required improvements in thought and practice in climate-smart agriculture, relevant interventions in Benue, what needs to be done to attain the improvements and how it needs to be done, and where necessary, how results may be measured. Essentially, it provides the evidence on which basis the Benue state government and support-institutions can design appropriate climate-smart agriculture, strategies, programs, and performance monitoring. It is the foundation upon which interventions are built. The Benue climate-smart agriculture profile will be helpful to decision-makers for policy planning, programs, investments and practices that are suitable for making agricultural efforts and food systems more climate-smart in Benue State. It will also form the basis for evidence-based monitoring and evaluation of future climate-smart-agriculture-related policies, interventions, and programs.

The Benue State Climate Smart Agriculture Profile is timely as the Government of Rev Fr Hyacinth Alia is committed to ensuring that Benue Walks the Talk in all sectors contributory to the delivery of food security, food safety and sustainable livelihoods. We recognize the support of USAID Nigeria through the Feed the Future Nigeria Agricultural Policy Activity in getting Benue State on track on the support. The role of Michigan State University Team of Researchers and the Collaboration of all Benue State Stakeholders co-led by the Benue State Ministry of Agriculture and Natural Resources and the Benue State Ministry of Water Resources and Environment is well acknowledged. What remains now is to ensure that we move these efforts to next steps. I am pleased to report that the Government of Rev Fr Hyacinth Alia will drive this.

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Prof. Joseph Alakali
Secretary to the State Government
Benue State, Nigeria
October, 3 2023

INTRODUCTION

Agriculture serves as the backbone of Benue State's economy. Benue state, often referred to as the 'Food Basket of the Nation,' boasts the widest array of agricultural produce among all the states in Nigeria, increasing food availability, creating employment opportunities in the form of farm labour and facilitating markets for agricultural products "(Soomiyol & Fadairo, 2020). However, the state faces several challenges such as (i) Climate change: Climate change is a major threat to the agricultural sector in Benue State. The state is already experiencing the effects of climate change such as drought, floods, and pests. These effects are likely to become more severe in the coming years, and they could have a devastating impact on the agricultural sector. (ii) Inadequate access to credit: Farmers in Benue State often face difficulty accessing credit from financial institutions. This is a major challenge for farmers, as it makes it difficult for them to invest in their farms and improve their productivity. (iii) Inadequate infrastructure: The agricultural sector in Benue State suffers from inadequate infrastructure, such as roads, storage facilities, and markets. This makes it difficult for farmers to transport their produce to market and get a fair price for their products.

To address these challenges, particularly relating to climate change, Climate-Smart Agriculture (CSA) offers a holistic approach. Importantly, the state's agricultural policy states that the adoption of Climate-Smart agriculture has become an urgent necessity (Benue State Government, 2020, p. 11). Climate-Smart agriculture (CSA) is an approach to agriculture that sustainably increases productivity and incomes, enhances resilience to climate change, and reduces greenhouse gas emissions. CSA takes into account the interactions between climate change, agriculture, and other sectors. It is designed to be implemented at the field, farm, landscape, and regional levels. CSA has the potential to address the challenges of climate change in the agricultural sector in a number of ways. First, CSA can help increase agricultural productivity by improving the efficiency of water use, reducing soil erosion, and improving nutrient management. Second, CSA can help to build resilience to climate change by making agricultural systems more adaptable to changing weather patterns, pests, and diseases. Third, CSA can help reduce greenhouse gas emissions from agriculture by promoting the use of low-carbon practices, such as cover crops and no-till farming (FAO, 2010; IPCC, 2014).

While CSA is one of the global strategies for tackling climate risks in agriculture, its implementation is location specific. This implies that there is no blanket recommendation for CSA practices. Although CSA is still emerging, there are practices, services, and technologies relevant to this concept being applied across the world. To effectively implement CSA, it is necessary to take stock of already existing and future promising practices, and the existing institutional and financial frameworks that would support large-scale uptake of CSA. This is the core motivation of developing the Benue State CSA Profile. A CSA profile is a document that describes the specific climate challenges facing a particular region or country, as well as the potential CSA practices that could be implemented to address those challenges. The development of a CSA profile is an important step in the implementation of CSA, as it helps to provide baseline information on the current CSA practices in the State as well as an entry point for investment in large-scale CSA implementation in the State.

STATE CONTEXT

Benue State, one of the seven states created on 3rd February 1976, derives its name from the River Benue, the second largest river in Nigeria. The State is located in Nigeria's middle belt zone, between latitudes 6°30'E and 8°10'N and longitudes 8°4'E and 10°0'E. It has

atotal landmass of about 33,955 km^2, with 23 Local Government Areas. The State is politically and agriculturally divided into three zones: A, B, and C with a projected population of 5,741,815 people and more than 413,159 farm families or more than two million people employed in farming (Ani et al., 2014; National Bureau of Statistics, 2018). The State's territorial boundaries connect it to neighboring states, enhancing both its economic and social interactions. The State is bounded by Nasarawa State to the north, Taraba State to the east, Cross-River to the south, Enugu State to the south-west, Ebonyi State to the south central, Kogi State at the west, and at the southeast by Cameroon Republic. These geographical linkages facilitate trade, cultural exchanges, and diplomatic relations, contributing to the overall development and growth of the state. Furthermore, the State is made up of many ethnic groups and diverse cultural backgrounds; however, they share a relatively similar climate. The State's slogan is "Food basket of the nation," owing largely to the endowment of the State with rich fertile land and favorable climatic conditions suitable for agricultural production. (Ani et al., 2014)

Economic Relevance of Agriculture

Benue State boasts the widest array of agricultural produce among all the states in Nigeria. The state is home to a wide variety of crops, including rice, maize, sorghum, millet, and vegetables. It accounts for an impressive 70% of the country's soybean yield and is a leading producer of tree crops like citrus and mangoes, as well as roots and tubers. Benue State is also a major producer of livestock, including cattle, sheep, goats, pigs, and poultry. Agriculture is a major source of employment and income in Benue State, engaging well over 75% of the working population (Terdoo et al., 2016). The agricultural sector also contributes significantly to the state's GDP, accounting for about 23% of total GDP in 2020. The economic relevance of agriculture in Benue State is evident in the state's food security status. Benue State is a net exporter of food, and the state's agricultural sector plays a major role in ensuring food security for the country. The economic relevance of agriculture in Benue State is likely to increase in the coming years. The state's population is growing rapidly, and the demand for food is expected to increase. The state's agricultural sector is also well-positioned to benefit from the growing demand for agricultural products within Nigeria. Agriculture serves as the backbone of the state's economy, and if its potential is effectively harnessed, Benue State could unquestionably become the nation's agro- industrial hub and a regional food supermarket in the near future. However, the current scenario indicates that local market potential remains underexploited, and substantial market opportunities on the international stage have yet to be seized (Benue State Government, 2020, p. 1).

Climate and Vegetation

Benue State exhibits a typical tropical climate characterized by two distinct seasons: the wet or rainy season and the dry season (Terdoo et al., 2016). The rainy season spans from April to October, boasting an annual rainfall ranging from 1,250mm to 1,750mm. Conversely, the dry season commences in November and concludes in March, accompanied by dry North-Easterly winds that are particularly pronounced during the harmattan month of November to February. Additionally, the South-West Monsoon winds prevail in the region from April to October. Throughout the year, temperatures in Benue State undergo significant fluctuations, ranging between 23°C and 38°C. The climate of the State accommodates a wide range of agricultural production such as fruit crops, grain

crops, and tuber crops (Terdoo et al., 2016).
13The vegetation in Benue State is a harmonious blend of semi rainforest and Guinea Savannah grassland, showcasing the diverse ecological characteristics of the region (Terdoo et al., 2016). The topography of the area primarily consists of undulating plains, occasionally interspersed with elevations ranging from 1,500m to 3,000m above sea level. The geological composition of the state is predominantly made up of shale, sand, silt, and clays derived from the basement complex. These geological substrates manifest in the landscape which features a combination of rolling hills, residual mountains, mesas, icebergs, valleys, and plains (Nyagba, 1995).

Benue State offers diverse landscapes and ecological features. From its low-lying plains to the rugged terrains and hills, the state's physical characteristics reflect its location within the middle belt region. The topography and natural resources of the state have played a crucial role in shaping its economy and supporting various sectors such as agriculture, mining, and tourism.

Benue State's geographical location in the transitional belt between the North and South ecologies— semi rainforest and Guinea Savannah grassland— coupled with its favorable rainfall patterns, plays a pivotal role in its ability to sustain a diverse range of crops and thriving livestock. The state's strategic position facilitates the coexistence of agricultural systems from both ecological zones, enabling the cultivation of crops adapted to various climate and soil conditions. Moreover, the region benefits from a well-distributed and substantial amount of rainfall, further augmenting its agricultural potential.

Agricultural Production Systems

A vast majority of Benue State indigenes and residents are agrarian and agriculture employs about 75 per cent of the population (Terdoo et al., 2016). These farmers have made Benue the major source of food production in the Nation. The agricultural systems in Benue are largely traditional, and activities in the agricultural sector are dominated by smallholder farmers whose farmholdings range between 1 hectare to 6 hectares (Omanchi & Abutu, 2014). Most use manual implements such as hoes and cutlasses to eke a living out of the ground. The state is faced with low productivity, mostly due to poor access to production-enhancing inputs; dependency on labour-intensive, low input technologies; considerable post-harvest losses of farm produce (an estimated 20 per cent of grains and over 40 per cent fruits and vegetables are lost to poor post-harvest handling and inadequate agro-processing and rural infrastructure, particularly roads) (Omanchi & Abutu, 2014). Although mechanization and plantation agriculture/agro-forestry are still at its infancy, farm inputs such as fertilizers, improved seed, insecticides and other intensive methods are being increasingly used. However, cost and availability is still a challenge. Important cash crops include Soybeans, rice, peanuts, mango varieties, citrus etc. Other cash crops include palm oil, melon, African pear, chilli pepper, tomatoes etc. Food crops include yam (a staple of local diets), cassava, sweet potato, beans, maize, millet, guinea corn, and vegetables. Animal production includes cattle, piggery, poultry and goat. There is very little irrigation and dairy products are yet to be produced in Benue State(Omanchi & Abutu, 2014).

Agriculture in the state is faced with challenges of low productivity due to poverty, inadequate storage facilities, marketing problems, government policies, environmental factors such as flood and erosion, weak knowledge and information systems, conflicts/crises and inadequate infrastructure. Further, the underdevelopment of the agricultural sector is characterized by dominance of subsistence agriculture over medium

to large scale agribusiness, and minimal use of external farm inputs leading to significant food crop loss both at pre- and post- harvest. Minimal value addition and product differentiation, and inadequate food storage and preservation have resulted in significantcommodity price fluctuation. Climate change has exacerbated natural hazards such as floods and erosion. Whilst these may not necessarily have a considerable impact on State food production, they hit the poorest (mostly rural) communities and those living along the river banks the hardest. Benue State also has a long history of conflicts both internally and across boundaries. These conflicts disrupt agricultural production and marketing systems, and cause mass displacements of rural dwellers who are the major players in the sector.

Due to the poor condition of the roads, the huge farming population living in remote rural areas have very limited access to external markets, and many farmers and agro-pastoralists are therefore isolated from the State's formal economy. The problem is manifold: poor infrastructure and barriers in penetrating the market caused by farmers' limited resources, lack of information, inadequate support institutions in place, among other factors.

Weak knowledge and information systems also contribute to Benue's low production. The services of agricultural extension workers and other mediums are hardly available to inform the rural farmers on new developments in the sector. Even where this is available, these workers lack up-to-date knowledge about appropriate technologies.

Benue State is located in the Benue trough with predominantly rich alluvial soils and favourable climate conditions suitable for the cultivation of virtually all tropical crops. Additionally, 95% of its land is cultivable under rain-fed and irrigation agriculture. The River Benue and its major tributary-River Katsina-Ala are waiting to be exploited for large scale irrigation purposes. The numerous streams and wetlands that dot the landscape as well as the abundant ground water resources provide excellent opportunities for dry season farming and aquaculture. In place of large scale irrigation, individual farm households rely on water harvesting techniques (e.g., rain) for their production activities. Benue has a high youth bulge (median age: 18 years) constituting an affordable labour force that can be trained and employed to accelerate food production, processing and marketing.

Transport systems, particularly the absence of feeder roads into deep farming communities in the State constitute a major constraint to agricultural production. Produce evacuation from the hinterland is difficult. The absence of linkages by rail, air and water transportation also constitute a drawback in market linkages. Inadequate power supply, processing and storage facilities contribute to produce deterioration, poor produce pricing and huge economic losses. The settlement pattern in most parts of the State does not encourage large scale mechanized agriculture. Tractorization of cultivable land is less than 1%, harvest operations and post-harvest handling of produce remains largely manual. Furthermore, the total dependence on rain-fed agriculture limits food production to the rainy season. The knowledge base of Benue Agriculture is also weak. With only 28 Extension Agents (EAs), who are ill-equipped and poorly motivated, the Benue farmer is practically helpless in the acquisition of knowledge for improved practices. Moreover, the state's agricultural policy sets out to establish an Agricultural Extension Fund by Q4 of 2022, attain EA–farmers ratio of 1:1000 by Q4 of 2023, set-up a state wide Extension Demonstration Unit (EDU) by Q4 of 2021, develop a regulatory framework for Agricultural Extension by Q1 of 2021, include private sector and tertiary institutions participation in extension services by Q4 of 2020, and ensure the take-off of extension

services by Q1-2021. Finally, most farmers are not able to access critical inputs.

Crop, livestock, and aquaculture production data for Benue State as of 2021 is reported in Table 1 based on data from the 2021 Agricultural Performance Survey (APS) in Nigeria (NAERLS & FMARD, 2021). Based on data obtained from reports of the 2021 APS in Nigeria (see Table 1), the State cultivates several crops. It is a major cassava-, yam-, rice-, and soybean-producing and supplying State in Nigeria (NAERLS & FMARD, 2021).

Additionally, it produces maize, cocoyam, cowpea, groundnut, among others (Benue State Government, 2020; NAERLS & FMARD, 2021). Traditional livestock rearing (i.e. goat, pig, sheep, cattle, and rabbit farming) is common in the State. Aquaculture is also practiced in the State at different scales by micro, small and medium-scale enterprises (MSMEs).

Table 1. Crop and livestock production in Benue State, 2021

Crop	Land area (Ha)	Production (MT)	Yield (Ton/Ha)	Animal	Number
Cassava	407.01	3,731.87	9.17	Goats	4,779,686
Yam	210.61	3,158.30	15.00	Pig	1,243,916
Rice	272.29	517.65	1.90	Sheep	879,946
Maize	163.59	386.33	2.36	Cattle	132,513
Groundnut	270.73	307.80	1.03	Rabbit	75,886
Soybean	100.35	247.87	2.47		
Sorghum	196.1	204.8	1.04	**Poultry**	**Number**
Cowpea	126.45	138.51	1.10	Chicken	3,796,510
Cocoyam	30.04	127.76	4.25	Guinea Fowl	67,416
Benniseed	119.38	96.58	0.81	Turkey	13,985
Millet	112.31	86.94	0.77		
Tomato	21.18	75.95	3.59	**Aquaculture***	**MT**
Ginger	10.47	65.95	6.30	Clarias sp	3,000
Okra	37.35	56.11	1.50	Heterobranchus sp	1,500
Onion	27.67	51.22	1.85	Tilapia sp	1,000

Note: *Aquaculture production: No data was reported for the State in 2021, so 2020 values were reported here. Source: Authors' table based on data from the 2021 and 2020 Agricultural Performance Survey in Nigeria (NAERLS & FMARD, 2020, 2021).

By harvested area and production quantity, Benue State's cassava production constitutes the largest share of crop production in 2021, with about 3,731.87 metric tons (MT). The State's cassava production also accounted for a significant share of the country's total cassava production. The State also contributed a significant share of overall yam and rice production. Notably, the State was the largest producer of soybean in Nigeria in 2021 with a production value of 247.87MT. The total number of goats, pig, sheep, cattle, and rabbit reared were 4,779,686, 1,243,916, 879,946, 132,513, and 75,886, respectively. On the other hand, the aquaculture production was 5,500 metric tons (Clarias sp – 3,000 MT; Heterobranchus sp – 1,500 MT; and Tilapia sp – 1,000 MT) in 2020 (NAERLS & FMARD, 2020).

CLIMATE CHANGE AND IMPLICATIONS FOR AGRICULTURE

Key Trends in Benue State

This section presents the trends in key climate variables, namely temperature and precipitation in Benue State. The data used for this analysis was sourced from the World

Bank Climate Change Knowledge Portal (CCKP) (World Bank, 2020).

Historical temperature trend

Analysis of data from the CCKP showed that, for Benue State, mean annual temperature increase of 0.02°C was observed between 1990–2021, with stronger increases occurring during the 2000-2009 decade (see Figure 3).

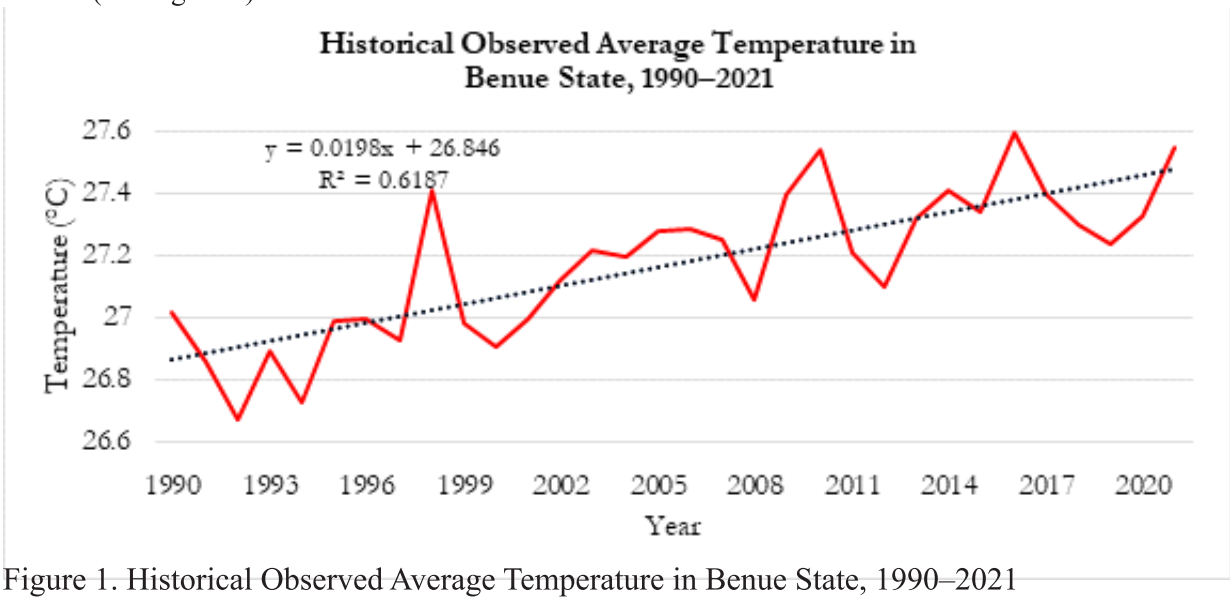

Figure 1. Historical Observed Average Temperature in Benue State, 1990–2021
Source: Authors' diagram based on data from the World Bank Climate Change Knowledge Portal (CCKP)

Historical rainfall trend

In Nigeria (and Benue State), rainfall trends have a high degree of variability and the last several decades have observed a decrease in the predictability for seasonal rains across the country. Overall, rainfall during the 1990 to 2021 period averaged 1,532 mm (see Figure 4). At the same time, it decreased marginally from 1569.31 mm in 1990 to 1510.64 mm in 2021. Over the period between 1990 and 2021, average precipitation was 1,532 mm. The annual variation of rainfall is large. This has resulted in climatic hazards, especially floods and droughts. Observed rainfall patterns indicate that rainfall for the State during the considered period declined by approximately 59 millimeteres (mm).

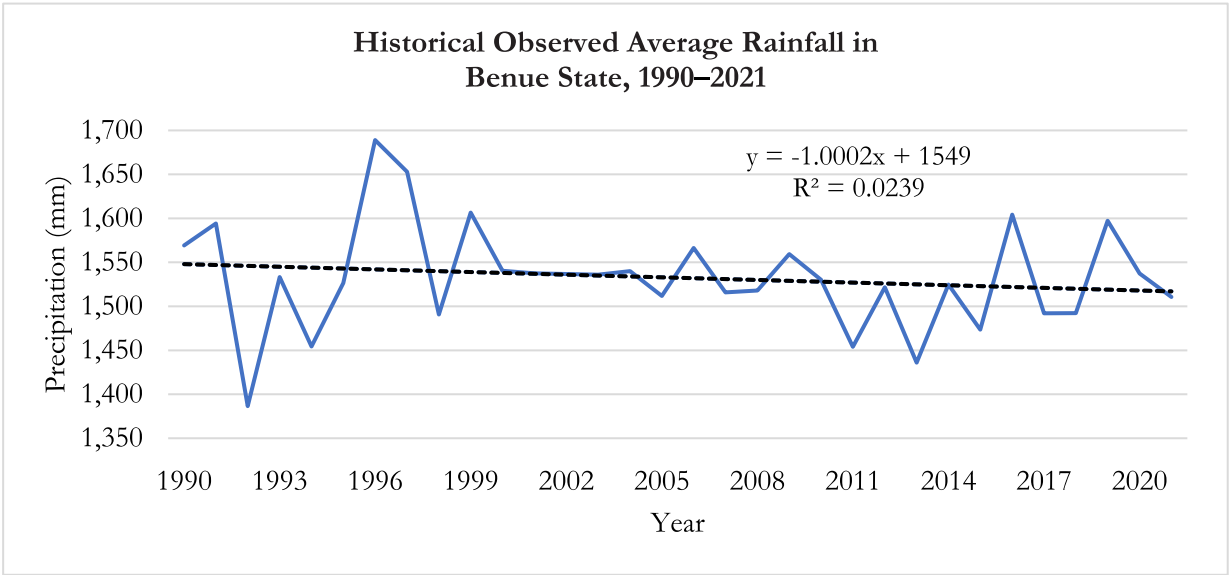

Figure 2. Historical Observed Average Precipitation in Benue State, 1990–2021
Source: Authors' diagram based on data from the World Bank Climate Change Knowledge Portal (CCKP)

Climate Future

To provide a picture of the potential climate future and trends in the key variables considered above, we rely on projections from climate models provided by the World Bank's Climate Change Knowledge Portal (CCKP). Specifically, we use data from the latest CMIP6 (Coupled Model Intercomparison Project Phase 6) data ensemble, which were the basis for the 2021 Intergovernmental Panel on Climate Change (IPCC) sixth assessment report (AR6). These projections are part of the outcome of modeling work assessing how socioeconomic factors may change over the next century—known as the "Shared Socioeconomic Pathways" (SSPs) (Riahi et al., 2017). Five SSPs (i.e. SSP1, SSP2, SSP3, SSP4, and SSP5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100 (Riahi et al., 2017). For brevity, only the multi-model (CMIP6) ensemble of 32 Global Circulation Models (GCMs) showing the projected annual temperature and rainfall for the SSP1, SSP2 and SSP5 are presented here for the 2015–2050 period based on a 1995–2014 historical period.

Temperature

Across all SSPs (emission scenarios), temperature increases for Benue State are projected throughout the end of the century. Under a sustainability scenario (SSP1), (middle of the road scenario (SSP2), and a high-emission scenario (SSP5), average temperatures are expected to increase by 0.9°C, 1.2°C, and 1.7°C, respectively, by mid-century (2050) compared to historical levels. Increased heat and extreme heat conditions from high average temperatures will result in significant implications for human and animal health, agriculture, and ecosystems.

Precipitation

Projected rainfall for Benue State is highly variable and analysis indicates no clear trend in precipitation. Under the middle of the road scenario (SSP2), annual average rainfall is expected to remain similar to historical observations, but under the lowest emission scenario, annual average rainfall is expected to decrease drastically compared to historical observations. On the other hand, under the highest emissions scenario (SSP5), rainfall may increase significantly compared to historical observations. Further, heavy rainfall is projected to result in extreme flooding. It is also expected to impact rivers and surface water runoff during the summer rainy seasons. Natural disasters due to the increase in the frequency and intensity of floods and droughts are also expected to increase.

Impacts of climate change and implications for agriculture

Climate change is a major threat to agriculture in Benue State. The state is already experiencing the effects of climate change, such as rising temperatures, erratic rainfall, and more frequent droughts. These effects are likely to become more severe in the coming years, and they could have a devastating impact on agriculture in the state. Between July and October 2012, most parts of Benue State were submerged, with floods ravaging farmlands and farmsteads, leaving many farmers homeless (Obiora, 2014).

Climate change trends in Benue are expected to increase the risk and intensity of flooding through increased frequency and intensity of heavy rainfall events. Additionally, parts of the state are expected to experience increased aridity and drought, with significant impact on livelihoods. Droughts have already resulted in famine, population displacement, conflicts, and biodiversity loss '(Amonum, 2023; Olagunju et al., 2021). Seasonal droughts

are expected to be prolonged which will cause problems for the state. Benue hasexperienced major flooding events, with the most significant occurring between July and October 2012 (Obiora, 2014) and the most recent occurring in 2022. Severe flooding in 2012 and 2022 affected many households and resulted in damages worth several billions both in Benue and other Nigerian states (NAERLS & FMARD, 2022; Obiora, 2014). The 2022 Agricultural Performance Survey (APS) (NAERLS & FMARD, 2022) reports that the discharge of water from the Ladgo dam in Cameroon into the rivers in Nigeria, together with the impacts of global warming and considerable increases in rainfall compared to 2021, were mostly responsible for floods in 2022, and these caused several rivers (including Benue River) to overflow their banks, thereby washing away many farmlands and killing off many animals. Across the country, around 500 individuals lost their lives and 1,411,051 were displaced when floodwaters affected 34 Nigerian states in 2022; also, 37,633 houses were destroyed, livestock and crops in flooded farms were lost, and there were 1,546 recorded injuries. Benue State was one of the hardest hit states in the country during the 2022 floods (NAERLS & FMARD, 2022).

Projected climate variability and change trends for Benue such as rising temperatures, an increase in frequency and intensity of heavy rain events, and increased aridity and drought threaten the State's agricultural sector. The sector is already challenged by seasonal changes and increasingly variable rainfall, limited infrastructure, substantial post-harvest losses, and lack of access to inputs and finance (Benue State Government, 2020). Benue State is the fifth largest producer in Nigeria, with about 1.5 Million MT. Studies show that increased levels of CO_2 will lead to nutrient declines in rice of up to 17% ——(Ujiie et al., 2019), with increased rainfall variability and higher temperatures likely to also further reduce rice yields. Cassava is relatively well adapted to hot and dry conditions; however, it is susceptible to water logging and production yields could be impacted from heavy rainfall events. It is estimated that just 1% of Benue State agriculture is irrigated, with the vast majority of the country's agriculture reliant upon rainfed agriculture and smallholder farmers using traditional methods (Benue State Government, 2020; Omanchi & Abutu, 2014). Future flooding, erosion and soil loss are of concern for the sector. For the traditional livestock production system, decreasing precipitation and increased temperatures are of significant concern. Trends are likely to adversely impact livestock productivity and affect ecosystems due to over-stressed grazing lands and the direct impact of heat on livestock. Due to changes in seasonal rainfall patterns, shortened growing seasons are also a likely scenario. Higher temperatures are expected to further impact rice production.

Several studies have established one mechanism through which climate change can lead to more conflict in agro-pastoral zones ——'(McGuirk & Nunn, 2020). They have determined climate change-induced desertification, drought, and decreasing average annual rainfall as the major factors that forced Fulani herdsmen from the Lake Chad Basin to migrate southward to Benue State, thereby causing resource competition with Tiv farmers """(Ekanem, 2022; Lanshima, 2020). In summary, future climate change could impact Benue State's agricultural sector through the following: Rising temperatures can lead to heat stress on crops and livestock which can reduce yields. Erratic rainfall can lead to droughts and floods which can damage crops and livestock. More frequent droughts can lead to crop failure, which can reduce food availability and increase food prices. More frequent floods can damage crops and livestock and they can also displace people.

Gender Differentiated Impacts of Climate Change

Climate change has far-reaching impact on various aspects of human life, particularly in the agricultural sector. However, these impacts are not uniformly distributed among genders. Women, especially in rural areas often bear a disproportionate burden of

theeffects of climate change due to their socially constructed roles and responsibilities.

In regions like Benue State, Nigeria, women play a significant role in agriculture. They are involved in various farming activities, from planting and harvesting to selling produce in the markets. However, they are also tasked with fetching water for household use, a task that is becoming increasingly difficult due to the changing climate. As the availability of surface water decreases due to climate change, women have to travel further, increasing their workload and exposing them to additional risks.

Moreover, women often have fewer rights, less mobility and less access to resources, information, and decision-making authority than men. This makes them more vulnerable to the impacts of climate change and limits their capacity to adapt and diversify their livelihood options. The Intergovernmental Panel on Climate Change (IPCC) states that climate change hazards exacerbate existing gender inequalities, making many women more vulnerable to climate change.

CONCEPTUALIZING CLIMATE SMART AGRICULTURE (CSA) IN THE BENUE CONTEXT

Climate Smart Agriculture (CSA) is recognized broadly as the concurrent increase in resource use efficiency and productivity, climate change adaptation, and GHG reduction (FAO, 2010) (see Figure 3).

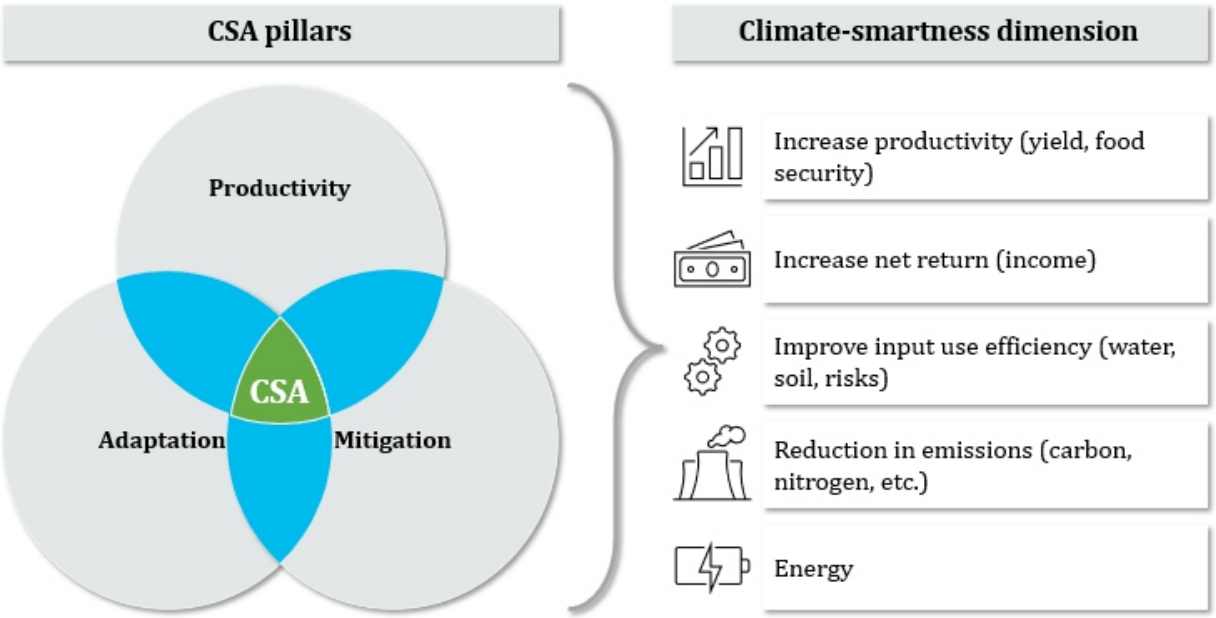

Figure 3. Conceptual Framework for Climate-Smart Agriculture and Expected Outputs
Source: Authors' diagram based on insights from FAO (2010) and Nwajiuba et al. (2015)

The identification and promotion of technologies and techniques that simultaneously address all three objectives presents a significant challenge. However, it is crucial to bridge the gap between this international understanding of Climate-Smart Agriculture (CSA) and the unique characteristics of farming systems in Benue State. The first notable characteristic of Benue is the low resource productivity prevailing in the State. Inadequate utilization of available resources hampers the commercial viability of agriculture, which may explain the predominance of subsistence smallholder farmers while large-scale commercial agriculture remains uncommon. Consequently, the introduction of novel ideas, technologies, and management practices becomes imperative to enhance productivity within the agricultural sector.

Secondly, Benue State exhibits a low adaptive capacity to climate change. Although Nigeria's carbon footprint is relatively small compared to other nations, the country is still highly vulnerable to the adverse impacts of climate change. Ensuring food security necessitates providing access to technology and innovations that safeguard biodiversity, manage the environment and natural resources, and generate new livelihood opportunities (Nwajiuba et al., 2015).

The third distinctive characteristic pertains to the role of current agricultural systems in mitigating the effects of climate change. This involves the adoption of carbon-neutral or emission-reducing techniques. One significant contributor to carbon emissions in farming systems is the widespread use of tillage and other forms of soil disturbance, as well as the extensive deforestation practices. Balancing the pressing need to increase production, address food insecurity, and alleviate poverty presents a challenge in research and policy formulation, particularly in developing regions like Benue State.

Addressing these three factors requires a comprehensive understanding of the local context and the development of context-specific strategies that align with the principles of Climate- Smart Agriculture.

CSA TECHNOLOGIES, PRACTICES AND CLIMATE SMARTNESS IN BENUE STATE

Identification of CSA Options

CSA could be broadly applied to encompass various technologies and practices. To compile this Profile, examples of agricultural technologies and practices in Benue State that have shown promise in contributing to one or more CSA pillars were compiled from the literature (See Table 2 below).

Table 2. CSA technologies and practices in Benue State

Production Activity	Broad Category	Specific strategies/ technologies	Reference
Crop		Improved crop varieties	(Ezihe et al., 2019; Mbah & Ezeano, 2016; Onyemma et al., 2019; Shomkegh, 2019) UNDP Nigeria (2022) UNDP Nigeria (2022).
		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)
	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)

		Inorganic fertilizer	(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	Installation of efficient irrigation systems	(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 grazing land management	(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 breeds	(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	Change fishing time	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 on climate impacts and possible adaptation measures	(Adamgbe et al., 2022; Okon & Usman, 2022)
	Climate awareness	Weather Information Dissemination	(Adamgbe et al., 2022
	Disaster risk management	Setup disaster management plan	(Okon & Usman, 2022)

Measuring Climate-Smartness Methodology for establishing climate-smartness

To ascertain the climate smartness of the identified Climate-Smart Agriculture (CSA) technologies and practices, this Profile relies on expert evaluations provided by key stakeholders within the agricultural and CSA domains. These evaluations are obtainedthrough comprehensive surveys and expert consultations conducted with

individuals who possess substantial knowledge of agricultural practices specific to Benue State. The primary participants in these surveys and consultations consist of farmers, staff of MDAs, researchers and agricultural development program professionals operating within the State.

Moreover, this Profile employs a climate-smartness score that corresponds to the various dimensions associated with the CSA pillars depicted in Figure 4. These dimensions encompass incremental yield/food security (productivity), increased income, water conservation, soil fertility, risk reduction (adaptation), as well as carbon reduction, nitrogen reduction, and energy savings or conservation (mitigation). A questionnaire encompassing a comprehensive list of the CSA technologies and practices outlined in Table 3 was distributed to the aforementioned experts, requesting them to assess the climate-smartness of each CSA option using the designated climate smartness score. This score is based on a scale ranging from 0 to 10, where 0 signifies no impact, 1 signifies the lowest impact, and 10 signifies the highest impact across the aforementioned smartness dimensions. The average of the total ranking for each practice was used as the climate-smartness score for Benue state. This score was further classified into three broad categories – low (with climate-smartness score of 0-4.0), moderate (with climate-smartness score of 4.1-7.0), and high (with climate-smartness score of 7.1-10.0). The expert rankings are determined based on the merits and effectiveness of the CSA technologies/practices. Figure 4 presents the respondents' characteristics. There were a total of 35 distinct respondents. Eighty percent were male while 20 percent were female.

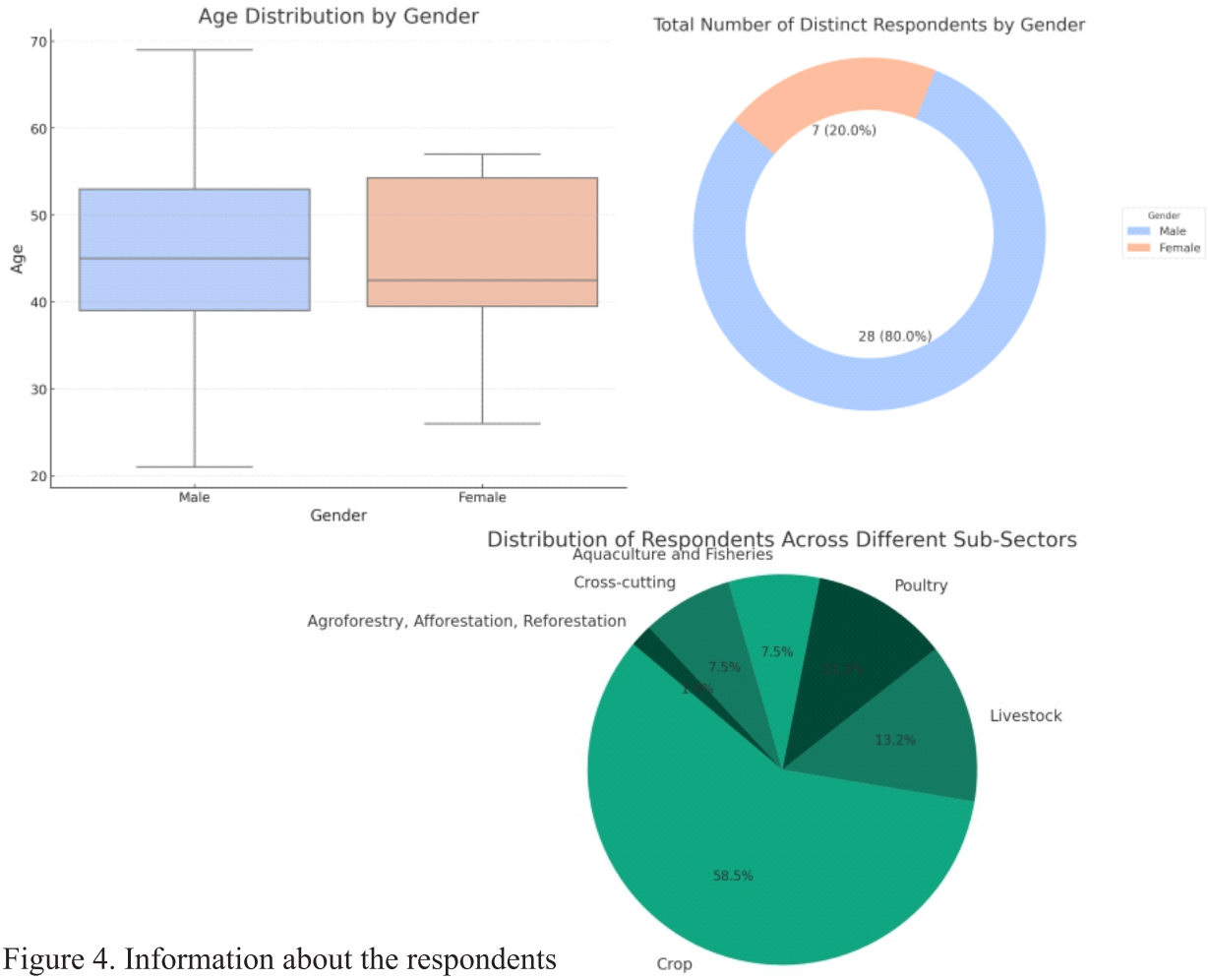

Figure 4. Information about the respondents
Source: Authors' compilation of survey respondents

Detailed outcomes of the climate-smartness score are presented in Table 3

Result of Climate Smartness score

Here, this Profile presents the result of the assessment of climate-smartness of the identified CSA technologies and practices based on expert evaluation.

Crop production sub-sector

One key finding from the results is that several CSA technologies and practices received a moderate climate-smartness Score of 6 or 7, indicating their potential to contribute to climate-smart agriculture. 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.

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.

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

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:

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.

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.

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.

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.

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.

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.

For poultry production, tree planting around poultry house scored a high Climate Smartness Score of 10. This measure offers several benefits that contribute to climate-smart agriculture. 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 throughcrossbreeding, and reducing livestock numbers. These practices may require

further evaluation or refinement to enhance their effectiveness and climate-smartness.

Furthermore, the results highlight specific technologies and practices that possess high Climate Smartness Scores and can significantly contribute to climate-smart agriculture in the livestock sector. These include ranching, adequate waste management and utilization, and training of livestock producers and herders/awareness creation. These practices demonstrate the potential for improving livestock management, reducing environmental impacts, and enhancing climate resilience.

Aquaculture and Fisheries

Moderate Climate Smartness Score Class: The transition from capture fisheries to aquaculture stands out with a Climate Smartness Score of 6, placing it in the high climate smartness category. This technology indicates a significant potential for sustainable fish production, contributing to increased productivity, food security, and reduced pressure on wild fish populations.

The technologies and practices in the low climate smartness category encompass reusing waste and integrating resources to reduce input costs (Score: 5), changing fishing time (Score: 5), and engaging in alternative livelihood means (Score: 5). 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, reforestation

The results of the survey in the Agroforestry, afforestation, and reforestation sector reveal highly promising outcomes in terms of climate smartness. The specific CSA technologies and practices, namely "Plant high economic value and open canopies indigenous trees on crop lands," "Reforestation," and "Natural tree regeneration," have all received perfect Climate Smartness Scores of 10 each, placing them in the high climate smartness category. More specifically, Plant 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.

Reforestation: The high climate smartness score of reforestation emphasizes its potential to mitigate climate change and restore ecosystems. Reforestation involves establishing forests on lands that were previously forested but have been cleared or degraded. It helps 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.

Natural tree regeneration: Natural tree regeneration refers to the spontaneous regrowth of trees in areas where forests have been disturbed or cleared. This process allows native tree species to naturally recolonize and restore ecosystems over time. It not only contributes tocarbon sequestration but also 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.

Gender Issues

The CSA practices were further categorized 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 3) were jointly identified by stakeholders, and the classification into the three categories was validated during the stakeholders' validation exercise. The results showed that the crop sub-sector has two CSA practices that are gender-sensitive - mounting of dams for storing water, and bonding practices in rice field; ten CSA practices that are gender-specific - contour bunding and contour ploughing, plant high economic value and open canopies indigenous trees on crop lands, citrus orchards, water harvesting, use of alternate wet and dry flooding system in low land rice production, improved irrigation efficiency, use of drainage system, half-moon, Zai pit (planting pit), and contour bond; and thirty-one CSA practices that are gender-neutral. All the CSA practices under the livestock sub-sector except ranching (which is gender-specific) are gender-neutral. Also, all the CSA practices under the aquaculture and cross-cutting sub-sectors are gender-neutral. Plant high economic value and open canopies indigenous trees on crop lands, and natural tree regeneration under the agroforestry, afforestation, and reforestation sub-sector are gender-neutral while reforestation is gender-specific. Overall, more than half, representing 80.5 percent (62 out of 77) CSA practices are gender-neutral. The implication is that there are gender issues around CSA practices in Benue State. Therefore, policy targeting any of the CSA practices and sub-sector should ensure gender considerations and mainstreaming.

				Productivity		Adaptation					Mitigation					
Sub-sector	Broad category	Specific technologies & practices	Gender Issue	Incremental Yield / Food security		Increased Income	Conserves / saves water	Soil fertility	Risk reduction		Carbon reduction	Nitrogen reduction	Energy savings or conservation		CSS	CSS Class
	Crop management	Improved crop varieties	C	8		8	6	7	7		6	5	7		7	Mod.
		Planting of climate-tolerant varieties (drought-, pest-, flood-resistant)	C	7		8	7	7	6		5	5	7		7	Mod.
		Planting of weed-tolerant crop varieties	C	7		7	6	7	7		4	5	7		6	Mod.
		Use of early maturing / high-yielding variety	C	8		8	6	7	5		5	5	7		6	Mod.
		Crop diversification	C	6		7	6	6	6		4	5	6		6	Mod.
		Change in cropping pattern and planting calendar	C	7		7	5	6	6		4	5	6		6	Mod.
		Early harvesting of crops	C	7		8	6	6	7		5	5	6		6	Mod.
		Mixed cropping	C	6		6	7	7	7		5	6	7		6	Mod.
		Intercropping	C	7		7	7	7	6		5	6	6		6	Mod.
		Varying (increasing/reducing) area under cultivation	C	6		6	6	5	5		5	4	6		5	Mod.
		Spacing as a planting technique	C	8		7	6	7	6		6	5	6		6	Mod.
		Number of seeds per hole	C	6		6	6	6	6		5	5	6		6	Mod.
		Broadcasting and/or transplanting (especially rice)	C	7		7	6	6	5		5	4	7		6	Mod.
	Soil conservation	Use of zero tillage / alternative tillage practices	C	6		6	6	6	5		3	3	6		5	Mod.
	Soil conservation	Mulching	C	8		7	7	7	6		5	6	6		7	Mod.
	Soil conservation	Cover cropping	C	7		7	6	7	6		5	5	6		6	Mod.
	Soil conservation	Application of organic fertilizers	C	8		9	7	7	6		5	5	6		7	Mod.
		Crop rotation	C	8		7	6	7	6		5	4	6		6	Mod.
		Bush fallowing to increase soil fertility	C	8		8	6	7	7		5	5	6		6	Mod.
		Improved access to credit services and inputs	C	8		8	6	5	6		4	4	5		6	Mod.
		Inorganic fertilizer	C	7		7	6	7	6		5	4	6		6	Mod.
		Contour Bunding and Contour Ploughing	B	6		6	6	6	5		4	4	6		5	Mod.
		Bonding practices in rice field	A	5		5	6	5	4		3	4	5		5	Low
		Change of farming location	C	6		6	5	6	5		4	4	6		5	Mod.
	Traditional Parklands	Plant high economic value and open canopies indigenous trees on crop lands	B	7		6	6	7	6		5	5	6		6	Mod.
		Citrus orchards	B	6		7	6	6	5		5	5	6		6	Mod.
		Streamlined planting techniques (leaving less space between crops)	C	6		5	5	6	5		5	5	6		5	Mod.
		Dry season farming	C	6		6	6	5	6		5	4	6		5	Mod.
		High-quality bio-fertilizers (compost production)	C	7		8	7	7	6		5	5	7		7	Mod.
		Use of fungicides (e.g., Aflasafe to control aflatoxin infestation)	C	8		7	6	6	6		4	5	6		6	Mod.

		Use of bio-pesticides	C	7		7	6	6	6		6	5	6		6	Mod.
		Use of microbial Inoculants	C	7		7	6	7	5		5	4	6		6	Mod.
	Integrated Pest Management	Integrated Pest Management	C	8		7	6	7	6		5	5	7		6	Mod.
	Improved water management	Water harvesting	B	7		7	8	6	6		6	7	6		6	Mod.
	Improved water management	Use of alternate wet and dry flooding system in low land rice production	B	6		7	6	5	5		4	4	6		5	Mod.
	Improved water management	Improved irrigation efficiency	B	7		7	7	6	6		5	5	5		6	Mod.
	Improved water management	Use of drainage system	B	6		6	6	6	5		4	4	5		5	Mod.
	Improved water management	Mounting of dams for storing water	A	7		6	6	5	5		4	5	6		5	Mod.
	Water harvesting	Half moon	B	5		5	5	5	5		4	4	6		5	Low
		Zai pit (planting pit)	B	5		4	5	5	5		5	5	5		5	Low
		Contour bond	B	5		5	5	4	3		3	4	4		4	Low
		Sunken beds and/or raised beds	C	6		5	4	5	4		4	3	5		4	Low
	Mixed farming	Integrated crop - livestock production	C	8		7	6	6	6		5	5	6		6	Mod.
Livestock	Production adjustments	Livestock diversification	C	5		8	6	8	2		2	2	3		5	Low
	Production adjustments	Integration of pasture management	C	8		9	9	8	8		7	7	7		8	Mod.
	Production adjustments	Livestock and crop production (mixed farming)	C	9		8	8	8	8		5	5	8		7	Mod.
	Production adjustments	Altering the timing of operations	C	9		9	5	0	2		0	0	8		4	Low
	Production adjustments	Conservation of nature and ecosystems	C	9		10	8	7	8		5	6	8		8	Mod.
	Production adjustments	Modifying stock routings and distance	C	6		8	6	0	3		0	0	8		4	Low
	Production adjustments	Mixed livestock farming (e.g., stall-fed systems and pasture grazing)	C	9		9	8	5	7		5	5	9		7	Mod.
	Breeding strategies	Raise local breeds adapted to local climatic stress and feed source	C	8		9	9	5	7		5	5	9		7	Mod.
	Breeding strategies	Improve local genetics through crossbreeding with heat & disease-tolerant breed	C	9		9	6	0	3		0	0	8		4	Low
	Livestock mgt. systems	Provision of shade and water to reduce heat stress from increased temperature	C	9		9	7	0	3		0	0	8		5	Low
	Livestock mgt. systems	Reduction of livestock numbers	C	4		5	4	1	2		1	1	5		3	Low
	Livestock mgt. systems	Changes in livestock/herd composition (selection of large animals rather than small	C	6		8	4	0	3		0	0	8		4	Low
	Livestock mgt. systems	Improved management of water resources through the introduction of simple techniques for localized irrigation	C	8		9	7	5	7		5	5	8		7	Mod.
	Livestock mgt. systems	Proper livestock health management and welfare	C	9		9	6	0	3		0	0	8		4	Low

	Capacity building for livestock keepers	Training of livestock producers and herders / awareness creation	C	10		10	9	7	8		7	7	9		8	High
	Improved feed mgt.	Use of methane reducing feed additives	C	8		9	7	0	3		0	0	8		4	Low
		Ranching	B	10		10	9	7	8		7	7	9		8	High
		Adequate waste management and utilization	C	8		9	7	5	7		5	5	9		7	Mod.
Poultry		Tree planting around poultry house	B	10		10	10	10	10		10	10	10		10	High
Aquaculture and Fisheries		Transition from capture fisheries to aquaculture	C	0		8	7	0	6		7	8	9		6	Mod.
	Aquaculture	Plastic/concrete ponds	C	8		NR	NR	NR	NR		NR	NR	NR		1	Low
	Aquaculture	Adopting improved aquaculture management	C	9		8	8	9	3		7	5	8		7	Mod.
	Aquaculture	Reuse waste and integrate resources to reduce input costs	C	2		2	2	9	3		7	6	7		5	Low
	Capture fisheries	Change fishing time	C	6		5	5	5	4		4	4	3		5	Low
	Livelihood diversification	Engage in alternative livelihood means	C	3		3	9	7	8		4	2	3		5	Low
Agroforestry, afforestation, reforestation	Agroforestry	Plant high economic value and open canopies indigenous trees on crop lands	C	10		10	10	10	10		10	10	10		10	High
	Reforestation	Reforestation	B	10		10	10	10	10		10	10	10		10	High
	Regeneration	Natural tree regeneration	C	10		10	10	10	10		10	10	10		10	High
Cross-cutting	Livelihood Diversification into non-farm activities		C	8		9	7	9	9		6	6	6		7	Mod.
	Labor migration	Temporary labor migration	C	8		8	7	8	9		8	7	7		8	Mod.
	Extension service	Improved extension service delivery; Agents and Agricultural centers help community to help members	C	9		9	8	9	9		7	7	7		8	High
	Climate awareness	Creating rural awareness campaigns	C	10		10	8	9	9		7	7	8		8	High
	Climate awareness	Weather Information Dissemination	C	9		10	8	9	9		7	7	8		8	High
	Disaster risk management	Setup disaster management plan	C	9		9	9	9	9		7	7	8		8	High

Note: CSS (Climate Smartness Score); Mod. is a short form for "Moderate". 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

Various entities at both the state and federal levels are presently engaged in a range of initiatives pertaining to Climate Smart Agriculture (CSA) within Benue State. Moreover, there exist development partners actively involved in fostering CSA-related activities. Assuming responsibility for the formulation and implementation of agricultural policies alongside the coordination of climate-resilient projects and undertakings, is the Benue State Ministry of Agriculture and Natural Resources (BSMANR). Furthermore, the BSMANR provides support to the Federal Ministry of Agriculture and Food Security (FMAFS) in the delivery of federal assistance at the state level.

Furthermore, the agricultural research faculties within the institutions of higher education, including universities and colleges, as well as international research and development organizations, make substantial contributions to CSA research activities within the State. Among the notable institutions with a significant presence in various CSA pillars, either directly within Benue State or at the federal level with implications for the state, are the Federal University of Agriculture, Makurdi (FUAM) (currently recognized as Joseph Sarwuan Tarka University, Makurdi), the Akperan Orshi College of Agriculture, Yandev (AOCAY), Michigan State University, USAID-funded Feed the Future Activities/Projects, World Bank-assisted projects, IFAD-supported projects, and others.

CSApriorities, strategies, policies, plans, goals, and actions

A formal climate change policy and action plan for the agricultural sector have not been developed in Benue State. However, the State has relevant policies both in the agricultural and non-agriculturual sectors that contain attributes relevant to CSA, as well as federal presence in the agricultural sector in the State with relevance to CSA. Table 4 presents selected State- and National-level policies related to CSA activities.

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							
Benue State Policy on Agriculture (Benue State Government, 2020)	2020 – current	▪ Crop ➢ To strengthen the engagement of agro-vendors for adequate distribution of inputs to farmers across the 23 Local Government Areas of the State and facilitate their access to certified seeds and seedlings, fertilizers, and agro-chemicals by Q1-2022 ➢ To conduct a Statewide soil survey by Q1-2021 (Reports and Maps) Q4-2021 ➢ To establish three pilot irrigation schemes for training purposes by 2021 ➢ To ensure that 25% of irrigable land is under irrigation by 2023 ▪ 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 by 2021. ➢ To promote the establishment of feed mills and fish hatcheries across the State by 2022 ➢ Recycling of livestock and fisheries waste ▪ Cross-cutting ➢ To reduce post-harvest losses by 50% by the year 2025 at the rate of 25% by 2020 and 40% by 2023 ➢ Ensure quality supply of inputs to farmers ➢ To put in place a risk sharing framework in agriculture by 2021 ➢ To establish Agricultural Extension Fund by Q4 – 2022 ➢ To attain Extension Agent – farmers ratio of 1:1000 by Q4-2023 ➢ Cooperatives establishment for easy access to credit, grants, training and expanded production	✓	✓	✓	✓	✓
Benue State Policy on Environment	2013 – current	▪ Agriculture ➢ 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	✓	✓	✓	✓	✓
Benue State of Nigeria Gazette No. 45 Vol. 35 Law to make Provisions for the Conservation, Management, and Declaration of Forest Reserves, Preservation, and Control of Forests and for the purposes connected therewith	2010 – current	▪ Forestry ➢ Provide conservation, management, and development of forest ➢ 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 ➢ 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	✓	✓	✓	✓	✓
Panel B: National level							
2050 Long-Term Vision for Nigeria (LTV-2050) (Federal	2021 – current	▪ Conservation of water in irrigated rice farms ▪ Reduced methane fodders for livestock ▪ Low-input agriculture					
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 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 ▪ 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 ▪ Decreasing food waste ▪ 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	✓ ✓	✓ ✓	✓ ✓		✓ ✓
National Agricultural Technology and Innovation Policy (FMARD, 2022)	2022 – 2027	▪ 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 ▪ Supporting the establishment of Meteorological Stations in all State offices of the Ministry 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) National Policy on Drought and Desertification (Federal Ministry of Environment, 2018b)	2011 – current 2018 – 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 ▪ 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	✓	✓ ✓	✓ ✓		✓ ✓

Scaling up ongoing community CSA actions

Insufficient emphasis has been placed on the practical implementation and scholarly discourse surrounding community-level climate change adaptation efforts, as highlighted by the State's Agricultural Policy (Benue State Government, 2020). 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 levels of both adaptive and transformative capacities (Benue State Government, 2020). The former necessitates preparedness to face future shocks by implementing measures like diversified cropping systems and livelihood strategies. In contrast, the latter involves the development of innovative systems with the potential to mitigate risks and exposure, such as institutional reforms in land tenure, financial markets, or cropping practices. Successful adaptation is likely to involve 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. Figure 5 provides a comprehensive overview of the crucial enabling factors essential for the adaptation process, thereby facilitating the expansion of local or community-based adaptation actions. It also underscores the significance of learning opportunities through effective monitoring and evaluation mechanisms.

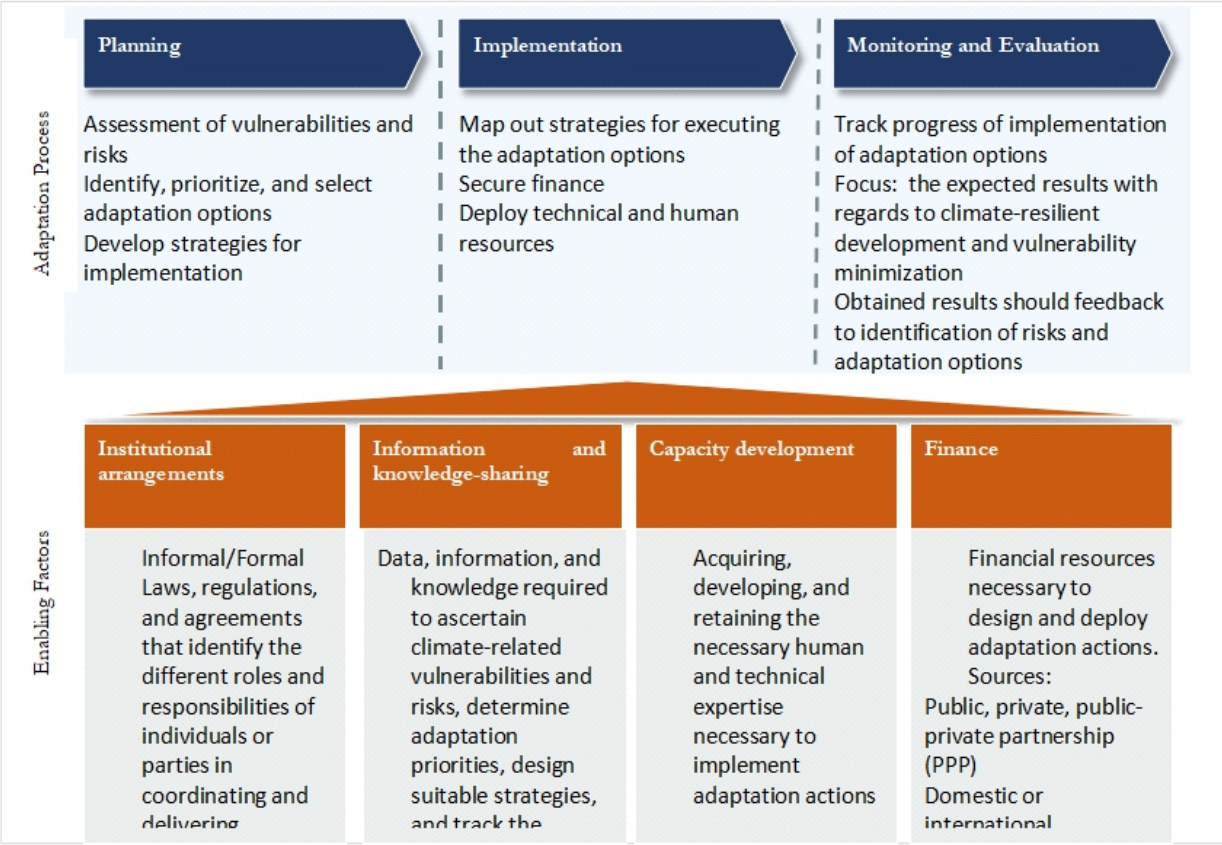

Figure 5. The adaptation process and its enabling factors
Source: Authors' diagram based on information from Mfitumukiza et al. (2020)

Financing CSA in Benue State

Current financing landscape

At present, an all-encompassing evaluation or supportive documentation required for the implementation of identified Climate-Smart Agriculture (CSA) technologies and practices within the State is lacking. Consequently, this Profile serves as an informational resource, presenting details on the latest climate change-related financial transactions within Benue State, obtained through meticulous desktop reviews. The financial flows are classified into domestic and external categories. Domestic flows primarily emanate from the budgetary allocations of the Benue State government, while external flows encompass funds acquired through collaborations with both domestic and international counterparts.

State Government

The State government has exhibited commendable dedication to climate change mitigation and adaptation through its annual budgetary framework. Notably, an approximate allocation of ₦657 million was designated in 2022 towards projects and programs pertaining to Climate-Smart Agriculture (CSA) within the agricultural sector of the State. Table 5 provides an overview of the State's 2022 agriculture sector budget allocation to CSA-related projects and programs.

Table 5. Agriculture sector 2022 budget allocation to projects and programs related to CSA in Benue State

Expenditure Group	Item of Expenditure	Total Expenditure (?)
Rehabilitation/Repairs - Agricultural Facilities	Renovation of ponds & fingerlings production	15,600,000
	Swine/Crops improvement project, Yandev	
Purchase of Agricultural Inputs	Purchase of 200Nos cattle & feeds. RAAV	2,120,000
Construction/Provision of Agricultural Facilities	Cattle Ranch Dev. for implementation of the Open Grazing Prohibition & Establishment of Ranches Law	2,050,000
	Greenhouse production, Gaadi	
	Animal feed production	
Purchase of Agricultural Chemicals	Fertilizer Procurement & Distribution	500,000,000
Construction/Provision of Water Facilities	Sprinkling & dripping irrigation – Katsina-Ala	5,000,000
	Sprinkling & dripping irrigation – Guma	
	Earth dam at Konishisha	
	Earth Dams at GlEast (Aliade)	
Other Storage Facilities	Ukum (Mbayenge)	1,500,000
	Katsina-Ala Gwor	
	Guma	
Construction/Provision of Infrastructure	Weather data station, Makurdi (Central)	15,000,000
	Weather data station, Gboko (Central)	
	Weather data station, Otukpo	
Research and Development	Land classification & soil mapping	5,000,000
Implementation of National Livestock Transformation		100,000,000
Grand Total		656,772,000

While direct linkages between the State and bilateral or multilateral financing agencies specifically focused on supporting CSA initiatives may be limited, it is essential to highlight the influential role played by donor-sponsored climate change response endeavors in bolstering the State's overall endeavors to combat and address the challenges posed by climate change. These initiatives serve as a crucial means of support, reinforcing the State's efforts in mitigating and adapting to the impacts of climate change.

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 Benue 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, and the International Fund for Agricultural Development (IFAD). To gain further clarity, Table 6 presents an overview of select donors and their respective donor-assisted projects, highlighting their profound engagement and financial support.

Table 6. Selected donor/donor-assisted climate change-related response efforts in Benue State

Entity	Projects financed	CSA pillar		
		P	A	M
World Bank's Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) Project	▪ Landscape restoration in community-selected degraded areas ➢ Promote hybrid agroforestry models on communal lands, using plant species chosen by the communities. These investments produce non-timber forestry products, such as: fodder, acacia (gum Arabic), balanitis, beekeeping, nuts, mushrooms, and grains such as millet and sorghum. ➢ Improved pasture and rangeland management and restoration. ➢ Prioritized community infrastructure investments. ▪ 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)	▪ 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 Benue 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 Benue 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 a 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 Benue State to capitalize on potential global funding opportunities that have hitherto remained unexplored.

Potential finance

This Profile has identified the existing climate-smart agriculture (CSA) technologies and practices that are applicable within the agricultural system of Benue State. It has also presented a comprehensive overview of the prevailing adverse impacts of climate change experienced within the State. Given the pivotal role played by the agricultural sector in ensuring food security, employment opportunities, and overall domestic value added within Benue State, coupled with its heightened vulnerability to climate change, it is imperative to promote technologies and practices that enhance resilience and foster rural livelihoods.

While the State may not have yet fully accessed crucial global climate change action financing initiatives such as the Adaptation Fund, Global Environment Facility, and Green Climate Fund, there exists considerable potential to secure such financial support, along with other forms of donor assistance, by effectively packaging individual or a combination of CSA technologies and practices in a manner that renders them sufficiently attractive for financing support.

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, while constituting 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 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.

Gender Consideration in Upscaling Successful CSA Practices

The gender-differentiated impacts of climate change underscore the need for climate-smart agriculture (CSA) practices that consider gender differences. Recognizing the unique challenges faced by women farmers is crucial in building a more resilient agricultural sector.

In the context of Benue State, this means providing women farmers with equal access to agricultural advisory services. This can empower them with knowledge about sustainable farming practices and coping strategies in the face of climate change. Training on water-efficient farming techniques, soil conservation methods, or the use of drought-resistant crop varieties can help women adapt to changing climatic conditions and maintain their agricultural productivity.

Furthermore, enhancing women's access to resources such as seeds, fertilizers, and farming equipment can help them adapt to changing climatic conditions. 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.

SUMMARY

Agriculture plays a substantial role in contributing to Benue State's overall domestic product, employing a significant part of its population. A critical 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. Benue 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, cocoyam, potatoes, beans, cassava, cowpea, groundnut, and oil palm, as well as various

vegetables like okra, peppers, tomatoes, eggplant, and green leafy vegetables. Livestock rearing is comprised of 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.

Numerous CSA technologies and practices are prevalent in the State, including conservation agriculture, crop diversification, and organic fertilizers.

The climate-smartness of various agricultural practices and technologies in Benue 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. Aquaculture practices had a high climate smartness score, particularly the transition to aquaculture from capture fisheries. Agroforestry, afforestation, and reforestation practices such as planting high-value indigenous trees, reforestation, and natural tree regeneration received perfect climate smartness scores. These practices contribute significantly to climate-smart agriculture and should be prioritized in policy and implementation efforts.

Adoption of these 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.

Additionally, the transition to climate-smart agriculture in Benue State, Nigeria, requires a gender-responsive approach. Recognizing the crucial role of women in agriculture and addressing the gender-differentiated impacts of climate change can help build a more resilient and inclusive agricultural sector. This approach aligns with the broader goals of sustainable development, ensuring food security, and promoting gender equality in the face of a changing climate.

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BENUE STATE CLIMATE SMART AGRICULTURE STAKEHOLDERS MEETINGS

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