

Problems and Prospects of Climate-Smart Agriculture amidst Insecurity in Nigeria

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ABSTRACT

Climate-smart agriculture (CSA) has emerged as a strategic approach for sustaining agricultural productivity, strengthening resilience to climate variability and change, and reducing agricultural greenhouse-gas emissions where feasible. In Nigeria, however, the transition towards climate-smart food systems is taking place within a difficult environment characterised by insecurity, farmer–herder tensions, terrorism and banditry in some locations, displacement, high input costs, weak rural infrastructure, limited extension coverage, market disruption, and recurrent climate shocks such as droughts, floods, heat stress and irregular rainfall. This paper examines the major problems and prospects of CSA amidst insecurity in Nigeria through an integrative review of policy documents, recent empirical studies and authoritative international assessments. The paper argues that insecurity is not simply an external disturbance to agricultural development; it can directly affect the feasibility, affordability, continuity and geographical reach of CSA interventions. Farmers may be unable to cultivate distant plots, extension personnel may avoid high-risk communities, cooperatives may weaken, agricultural finance may become more expensive, and damaged roads and markets may reduce the returns to climate-smart investments. At the same time, climate variability can interact with livelihood pressure and competition over land, pasture and water, thereby complicating conflict-sensitive agricultural development. The paper identifies major CSA opportunities in Nigeria, including improved and stress-tolerant varieties, conservation agriculture, agroforestry, integrated crop–livestock systems, efficient irrigation and water harvesting, climate information services, digital extension, renewable-energy applications, improved livestock management, index-based insurance, diversified livelihoods, and producer organisations. Recent evidence from Nigeria indicates that extension access, education, credit, income, cooperative membership and risk orientation influence CSA adoption, while newer evidence shows that integrated CSA practices can improve productivity and resilience. The paper recommends a conflict-sensitive CSA framework built around security-aware extension delivery, decentralised climate services, affordable finance and insurance, resilient rural infrastructure, farmer organisations, indigenous knowledge, gender- and youth-responsive programmes, early warning and anticipatory action, and stronger coordination between agricultural, environmental, humanitarian and security institutions. The paper concludes that Nigeria's CSA agenda should move beyond technology promotion towards a whole-food-system resilience approach that recognises the combined effects of climate, conflict, markets, institutions and livelihoods.

KEYWORDS

Climate-smart agriculture, climate change; insecurity, food security, resilience, smallholder farmers, Nigeria, agricultural extension

I. INTRODUCTION

Agriculture remains central to Nigeria's food supply, rural employment, household livelihoods and wider economic development. Yet the productive environment in which Nigerian farmers operate is becoming increasingly complex. Climate variability is altering the timing, intensity and distribution of rainfall; episodes of flooding and drought are recurrent; temperatures and heat stress affect crops, livestock and farm labour; and land and water resources are under growing pressure. The Intergovernmental Panel on Climate Change (IPCC) reports that climate change has already contributed to widespread losses and damages in Africa, including reduced food production, water shortages and livelihood disruption, while future warming is projected to increase pressure on food systems. The IPCC also stresses that climate is one of several interacting factors associated with conflict risk and that governance, socioeconomic conditions and previous conflict histories matter substantially.

Nigeria's climate vulnerability is compounded by a range of insecurity conditions. In parts of the country, terrorism, banditry, kidnapping, communal violence and farmer–herder tensions have affected access to farmland, labour mobility, markets and rural services. The consequences are multidimensional. A farmer who cannot safely reach a field cannot reliably implement soil and water management practices; an extension worker who cannot safely travel to a community cannot provide regular technical advice; and a cooperative whose members are displaced cannot easily organise collective purchasing, credit, marketing or equipment sharing. In this context, the question is not simply whether climate-smart technologies exist, but whether farmers and institutions can access, finance, implement and sustain them under conditions of insecurity.

Climate-smart agriculture provides a useful framework because it links three broad objectives: sustainably increasing productivity and incomes, building resilience and adaptation, and reducing or removing greenhouse-gas emissions where possible. Importantly, CSA is context-specific. It is not a single technology or universal package. A practice that is climate-smart in one location may be unsuitable or unaffordable in another. Consequently, Nigerian CSA policy needs to consider agro-ecological differences, farm size, gender, tenure, income, market access, local knowledge, security conditions and institutional capacity.

Recent evidence demonstrates both the potential and limitations of CSA in Nigeria. A 2024 study of 270 crop farmers in Southeast Nigeria found that cooperative societies and extension workers were important sources of CSA awareness, while education, farm experience, income, extension exposure, credit access, risk orientation and cooperative membership were associated with adoption. A 2024 multi-zone study involving 1,080 farming households examined climate-risk adaptation and food security, reinforcing the relevance of adaptation strategies to household welfare (Effect of climate risk adaptation on food security among farming households, 2024). More recent evidence from Southwest Nigeria indicates that combinations of CSA practices can improve maize productivity and resilience, although adoption remains constrained by labour and other resource barriers (From vulnerability to viability, 2025). A 2026 study also reports positive associations between producer-organisation membership and adoption and bundling of CSA practices in

Nigeria, highlighting the importance of collective action (Do producer organizations promote climate-smart agriculture? 2026).

At the policy level, Nigeria's climate and agricultural frameworks increasingly recognise resilience and adaptation. Nigeria's 2025 NDC 3.0 identifies agriculture, disaster risk reduction, livelihoods and security among relevant sectors and notes the importance of climate-smart agriculture, watershed management, ecosystem restoration, risk management and early-warning systems. The document also recognises that climate change can contribute to competition over land, pasture and water, while insecurity and low adaptive capacity compound vulnerability (Federal Republic of Nigeria, 2025). These policy directions create an important opportunity to connect agricultural transformation with climate resilience and conflict-sensitive development.

This paper therefore examines the problems and prospects of climate-smart agriculture amidst insecurity in Nigeria. It focuses on the conceptual foundation of CSA; the Nigerian climate and insecurity context; major CSA practices; the pathways through which insecurity constrains adoption; institutional and socioeconomic barriers; prospects for scaling; and practical policy actions. The central argument is that Nigeria needs a conflict-sensitive CSA model in which climate adaptation, food security; rural livelihoods and peace building are considered together rather than addressed through isolated programmes.

II. OBJECTIVES OF THE PAPER

- Explain the concept, principles and major components of climate-smart agriculture in the Nigerian context.
- Examine the interaction between climate change, agricultural vulnerability and insecurity in Nigeria.
- Identify the major problems limiting the adoption, implementation and scaling of CSA practices in insecure and climate-vulnerable communities.
- Discuss the prospects and opportunities for promoting CSA through technology, institutions, finance, extension, producer organisations and climate services.
- Propose policy and programme strategies for conflict-sensitive, inclusive and resilient CSA development in Nigeria.

III. CONCEPTUALIZING CLIMATE-SMART AGRICULTURE

Climate Smart Agriculture (CSA) refers to agricultural practices and systems that aim to increase productivity, enhance resilience to climate change, and reduce greenhouse gas emissions.

Problems: Climate change poses significant challenges to agriculture, including increased temperatures, changing rainfall patterns, and extreme weather events, leading to reduced crop yields and increased vulnerability. Challenges: Implementing CSA faces various challenges, including limited access to finance and technology, lack of knowledge and awareness, and policy and institutional barriers. Climate-smart agriculture: Climate-smart

agriculture refers to the integration of sustainable agricultural practices that enhance productivity, resilience, and adaptation to climate change, while also reducing greenhouse gas emissions. Crop production: Crop production involves the cultivation and management of crops for food, feed, fibre, or fuel production.

Climate-smart crop production refers to the adoption of practices and technologies that enhance agricultural productivity, resilience, and mitigation of greenhouse gas emissions. It involves a combination of climate adaptation and mitigation strategies, such as improved water management, conservation agriculture, agro forestry, and the use of climate-resilient crop varieties. Climate-smart animal production:

Climate-smart animal production refers to the adoption of practices and technologies that enhance livestock production while minimizing the negative impacts of climate change. It involves strategies such as improved animal management, feed efficiency, and adaptation to changing climatic conditions. Animal production: Animal production involves the rearing and management of livestock for meat, milk, eggs, or other animal products.

Problems in climate-smart animal production: Nigeria faces several challenges in implementing climate-smart animal production, including limited access to resources, inadequate knowledge and awareness, poor infrastructure, and lack of policy support.

Climate-smart postharvest agricultural processing, packaging, and storage refer to the adoption of sustainable practices that minimize environmental impact, increase resilience to climate change, and ensure efficient utilization of resources. It involves the use of innovative technologies, improved infrastructure, and appropriate management techniques to reduce postharvest losses and enhance the quality and safety of agricultural products. Postharvest agriculture: Postharvest agriculture encompasses activities such as processing, packaging, and storage of agricultural produce after harvest, aiming to minimize losses and maintain product quality.

Climate-smart agriculture is best understood as an approach to agricultural development rather than a fixed list of technologies. FAO defines CSA around three interconnected pillars: sustainably increasing productivity and incomes; adapting to climate change and building resilience; and reducing or removing greenhouse-gas emissions where possible (FAO, 2010, 2021). The approach therefore asks agricultural planners and farmers to consider what combination of practices can deliver food and livelihood benefits while reducing exposure and sensitivity to climate risks and, where feasible, reducing emissions.

The productivity pillar is particularly important in Nigeria because low and unstable farm productivity contributes to poverty and food insecurity. Climate-smart productivity improvement may involve improved seed, balanced soil fertility management, integrated pest management, mechanisation appropriate to local conditions, better livestock breeds, improved animal health, efficient water use, post-harvest management and market-oriented production. Productivity, however, should not be pursued through practices that degrade the resource base or create excessive dependence on costly external inputs. The adaptation and resilience pillar focuses on the ability of farmers, households and food systems to absorb shocks, maintain essential functions and recover from disturbances. In Nigeria, resilience can involve drought-tolerant and early-maturing varieties, crop diversification, agroforestry,

water harvesting, irrigation, conservation agriculture, livestock diversification, improved pasture management, insurance, savings, social networks, climate information and access to markets. Resilience also depends on non-farm capacities such as education, health, social protection, secure land tenure and the ability to move goods safely. The mitigation pillar recognises that agriculture is both affected by climate change and contributes to greenhouse-gas emissions. Nigerian mitigation opportunities include improved soil carbon management, agroforestry, efficient fertiliser use, reduced burning, improved livestock feed and manure management, renewable energy for irrigation and processing, and reduced post-harvest losses. However, mitigation should not be pursued in ways that undermine food security or impose unrealistic costs on smallholders.

CSA should also be distinguished from a purely technological interpretation of agricultural modernisation. A farmer may use an improved seed and still remain highly vulnerable if the farmer lacks secure land, climate information, credit, extension, storage, roads and safe access to markets. Conversely, indigenous practices such as adjusted planting dates, mixed cropping, mulching, natural pest control and local water-management knowledge can form part of a climate-smart strategy when they are effective and compatible with local ecological conditions. A recent systematic synthesis of Nigerian CSA research found substantial attention to indigenous knowledge and a broad range of practices, while also noting low awareness and uneven implementation across regions. Climate change is a global phenomenon that poses significant challenges to agricultural systems, including crop production. In Nigeria, a country heavily dependent on agriculture, the impact of climate change on crop production has been increasingly felt. This paper aims to explore the problems faced by Nigerian farmers in adapting to climate change, the potentials for climate-smart crop production, and the prospects for sustainable agricultural practices in the face of a changing climate. Climate change is a challenge that affects various sectors, including agriculture (Ahmed & Adebayo, 2019). Postharvest agricultural processing, packaging, and storage play a crucial role in ensuring food security and reducing postharvest losses. However, in Nigeria, these practices face various challenges that hinder their effectiveness. This paper aims to explore the problems, potentials, and prospects of climate-smart postharvest agricultural processing, packaging, and storage in Nigeria. Climate change poses significant challenges to agricultural production, including crop and animal production, as well as postharvest agriculture, in Nigeria. The changing climate patterns, such as increased temperatures, erratic rainfall, and extreme weather events, have adverse effects on agricultural productivity and food security. This paper aims to explore the challenges of implementing climate-smart practices in crop and animal production, as well as postharvest agriculture, in Nigeria. Additionally, it will discuss the potentials and prospects of adopting climate-smart approaches to mitigate the impacts of climate change on the agricultural sector.

In Nigeria, agriculture is a significant contributor to the economy, with livestock production playing a crucial role. However, the changing climate poses numerous challenges to animal production systems. This paper aims to explore the problems, potentials, and prospects of climate-smart animal production in Nigeria. Climate Smart Agriculture (CSA) is an approach that aims to address the challenges posed by climate change on agriculture while ensuring food security, sustainable development, and resilience. This paper explores the meaning and importance of CSA, the necessity of its implementation, the challenges faced, the successes achieved, and the prospects for its future. Climate Smart Agriculture (CSA) is an

approach that aims to address the challenges of climate change while ensuring sustainable agricultural practices and food security. It involves the integration of climate change adaptation, mitigation, and resilience strategies into agricultural systems. The importance of CSA lies in its potential to enhance the productivity and resilience of agricultural systems, reduce greenhouse gas emissions, and improve the livelihoods of farmers.

Climate Smart Agriculture is to address such agricultural and socioeconomic problems as vulnerability of agriculture to climate change impacts, food insecurity and malnutrition unsustainable agricultural practices and land degradation due to under or over utilization and climate change impacts. It is very significant because it ensures food security in the face of climate change promotes sustainability and resilience of crops and animal production all year round and functions in mitigating greenhouse gas emissions and adapting to changing conditions

CSA is a necessity in any nation's agriculture because of the following justifications:

- Increasing frequency and intensity of extreme weather events
- Declining agricultural productivity and yield losses
- Vulnerability of smallholder farmers and rural communities.

The necessity of CSA arises from the urgent need to mitigate and adapt to the impacts of climate change on agriculture. Rising temperatures, changing rainfall patterns, and increased frequency of extreme weather events pose significant challenges to food production. CSA provides framework to enhance the resilience of agricultural systems, reduce vulnerability to climate-related risks, and ensure sustainable food production in the face of climate change.

IV. CLIMATE CHANGE, AGRICULTURE AND INSECURITY IN NIGERIA

A. Climate risks confronting Nigerian agriculture

Nigeria's agricultural systems are exposed to rainfall variability, drought, flooding, heat stress, land degradation, pest and disease pressures and changing growing seasons. These risks differ across ecological zones. The northern dry lands face water scarcity and drought-related pressures, the Middle Belt experiences variable rainfall and competing land uses, while southern areas face flooding, erosion, coastal and high-rainfall hazards.

The IPCC concludes that climate change is already reducing food security in Africa through impacts on crop yields, rangelands, livestock and fisheries, as well as through food access, distribution and price effects. It also reports that agricultural diversification, conservation agriculture, agroforestry, aquaculture, on-farm engineering and climate information can strengthen resilience when supported by appropriate institutions and finance (IPCC, 2022).

Recent Nigerian evidence indicates that CSA adoption can have measurable productivity and resilience benefits. In Southwest Nigeria, a 2025 study of 480 maize farmers found that drought-tolerant varieties were widely used and that integrated CSA strategies were associated with higher maize yields and reduced climate vulnerability. The same study identified extension access and socioeconomic characteristics as important drivers, while

labour constraints and household pressures could limit implementation (From vulnerability to viability, 2025).

B. The insecurity dimension

Insecurity affects agriculture through direct and indirect pathways. Direct effects include destruction or abandonment of farms, theft of crops and livestock, injury and death, displacement, restricted movement and reduced labour availability. Indirect effects include higher transport costs, reduced market participation, increased input prices, and reduced access to credit, disrupted extension services and greater uncertainty about investment returns.

Food and Agriculture Organization assessments have highlighted the connection between conflict, high input prices, restricted productive capacity and food insecurity in Nigeria. A 2025 FAO country brief reported that conflict in northern areas was expected to continue undermining farmers' productive capacity and that high input prices and difficulty accessing loans were constraining agricultural activities. FAO also reported that about 25.1 million people experienced acute food insecurity in the final quarter of 2024, while a subsequent Cadre Harmonisé assessment projected 33.1 million people to face high levels of food insecurity during the 2025 lean season.

IFAD's country strategy documentation similarly describes Nigeria's agrifood system as affected by climate shocks, land and resource conflicts, farmer–herder tensions, insecurity and terrorism, with these pressures placing farming activities at risk and forcing some farmers away from their land (IFAD, 2024). The interaction is therefore systemic: insecurity reduces production and market access, while climate shocks and livelihood scarcity can intensify competition over natural resources.

V. ANALYTICAL FRAMEWORK: A CLIMATE–CONFLICT–LIVELIHOOD NEXUS

This paper adopts a climate–conflict–livelihood nexus to explain why CSA adoption in Nigeria cannot be separated from the wider conditions in which farmers operate. The framework assumes four interacting domains: climate exposure, insecurity exposure, household adaptive capacity, and institutional support. Climate exposure includes drought, flood, and heat and rainfall variability. Insecurity exposure includes violence, displacement, restricted mobility, and theft and market disruption. Adaptive capacity includes assets, education, income, labour, land, social networks, technology and knowledge. Institutional support includes extension, finance, insurance, early warning, infrastructure, research, producer organisations and public policy. Where climate exposure is high and insecurity is also high, farmers tend to prioritise immediate survival and risk reduction. Long-term investments whose benefits are delayed may become less attractive. This helps explain why a technically appropriate CSA practice may have low adoption in a conflict-affected community. The adoption decision is shaped not only by awareness but also by whether the farmer expects to remain on the farm, whether inputs can be purchased, whether outputs can reach markets, whether the technology can be maintained, and whether public institutions can provide support. Conversely, producer organisations, secure land arrangements, accessible finance, reliable climate information, extension and social protection can reduce vulnerability and make CSA investment more feasible. Recent Nigerian evidence on producer organisations suggests that collective membership can promote both adoption and the

bundling of CSA practices, including observable low-cost strategies such as intercropping and crop rotation (Do producer organizations promote climate-smart agriculture?, 2026).

Table 1. Major pathways through which insecurity affects CSA

Insecurity pathway	Effect on agriculture	Implication for CSA
Restricted mobility	Farmers and extension personnel cannot safely reach fields/communities.	Reduces implementation, monitoring and technical support.
Displacement	Farmers abandon land, livestock and productive assets.	Discourages long-term investments such as agroforestry and soil restoration.
Input and credit disruption	Higher prices and reduced access to loans.	Makes improved seed, irrigation, machinery and soil management less affordable.
Market disruption	Road closures, insecurity and higher transport costs.	Reduces expected returns from climate-smart production.
Loss of labour/assets	Death, migration, injury and asset loss reduce household capacity.	Limits labour-intensive CSA such as conservation agriculture and water harvesting.
Institutional disruption	Extension, research and cooperative activities may be interrupted.	Weakens awareness, training, collective action and technology diffusion.

VI. MAJOR CLIMATE-SMART AGRICULTURE PRACTICES RELEVANT TO NIGERIA

A. Climate-resilient crop varieties

Stress-tolerant, early-maturing, disease-resistant and locally adapted varieties can reduce production losses associated with drought, heat and shortened or irregular growing seasons. Their effectiveness depends on seed quality, availability, affordability, farmer knowledge and compatibility with local markets. Seed systems should therefore combine formal breeding with community-based seed systems and local adaptation testing.

B. Soil and water management

Conservation agriculture, mulching, minimum or reduced tillage where appropriate, cover crops, crop rotation, contour measures, organic amendments and integrated soil fertility management can improve soil structure and water retention. Water harvesting, small-scale irrigation, efficient water application and drainage can reduce exposure to rainfall variability. In insecure areas, low-cost and labour-efficient options may be more feasible than capital-intensive technologies that require regular maintenance.

C. Agroforestry

Agroforestry integrates trees with crops and/or livestock to provide shade, soil protection, biomass, fodder, fruit, and fuel wood and income diversification. It can reduce erosion and contribute to carbon sequestration. However, successful agroforestry requires secure enough land tenure for farmers to capture long-term benefits and locally suitable species.

D. Integrated crop–livestock systems

Crop residues can provide livestock feed while manure can contribute to soil fertility. Integrated systems can diversify income and spread climate risk. Their success depends on animal health, pasture and feed availability, land-use arrangements and conflict-sensitive mechanisms for managing interactions between crop farmers and livestock keepers.

E. Climate-smart livestock management

Livestock adaptation can include heat-tolerant breeds, improved animal nutrition, water provision, vaccination, improved housing and shade, fodder banks, pasture restoration and strategic mobility. In areas affected by farmer–herder tensions, livestock interventions should be linked to negotiated grazing arrangements, water-point governance and community conflict-resolution structures rather than treated solely as technical livestock projects.

F. Climate information and early-warning services

Timely information about rainfall onset, dry spells, floods, pests and extreme heat can help farmers adjust planting dates, select varieties, plan irrigation and protect livestock. Nigeria can expand weather and climate services through mobile phones, radio, extension agents, community organisations and local-language communication. In insecure areas, remote and digital channels are especially important because they can reduce dependence on frequent physical gatherings.

G. Renewable energy and efficient mechanisation

Solar-powered irrigation, solar cold storage, energy-efficient processing equipment and appropriate mechanisation can reduce dependence on unreliable energy systems and labour shortages. Such technologies require viable financing models, local repair services, spare parts and technical training.

H. Post-harvest management

Climate-smart agriculture should extend beyond the farm gate. Improved drying, hermetic storage, cold chains, processing and aggregation reduce food losses and increase the return to production. In insecure communities, decentralised storage and processing can reduce the need to transport produce over long distances immediately after harvest.

I. Insurance and risk-financing mechanisms

Weather-index insurance, agricultural insurance, savings groups and emergency finance can help households recover from shocks and protect productive assets. The IPCC notes that innovative index-based insurance can support recovery in African food systems but that affordability, awareness and product diversity constrain uptake (IPCC, 2022). Nigerian programmes therefore need simple products, trusted providers, transparent claims procedures and premium support for vulnerable farmers.

J. Diversification and livelihood resilience

Crop diversification, livestock, aquaculture, agro-processing, beekeeping, horticulture, off-farm employment and other livelihood options can spread risk. Diversification should be designed around local markets and ecological suitability and should avoid creating new environmental pressures.

VII. MAJOR PROBLEMS OF CSA AMIDST INSECURITY IN NIGERIA

A. Physical insecurity and restricted access to farms

The first and most immediate problem is physical access. CSA requires repeated activities—land preparation, planting, weeding, soil management, irrigation maintenance, livestock management, monitoring and harvesting. Insecurity can make these activities dangerous or impossible. Farmers may shorten the time spent on farms, cultivate only plots close to settlements, or abandon distant fields. Such responses can reduce production and discourage practices whose benefits accumulate over several seasons.

B. Displacement and loss of productive assets

Displacement can separate households from land, livestock, tools, seed stocks, trees and social networks. Climate-smart practices often require continuity, yet displaced households may prioritise immediate food and shelter. Long-term investments such as tree planting, soil restoration and irrigation may appear too risky when tenure or residence is uncertain.

C. High cost of climate-smart technologies

Many CSA options require initial investment. Improved seed, irrigation equipment, water pumps, solar systems, farm machinery, organic inputs, fencing, storage and insurance premiums can be expensive. Insecurity raises these costs through transport risks, informal charges, supply disruptions and market uncertainty. The result is a gap between technical availability and practical affordability.

D. Weak and uneven agricultural extension services

Extension is critical for explaining unfamiliar practices, demonstrating technologies and helping farmers combine practices. Yet Nigeria faces shortages in extension personnel, mobility and operational resources. A Nigerian CSA synthesis identified inadequate extension, limited awareness, funding constraints and policy implementation problems among major barriers (Promoting uptake and integration of climate smart agriculture technologies, 2022). Insecurity can intensify these weaknesses by restricting field visits.

E. Limited access to agricultural finance

Climate-smart investment can require upfront expenditure while returns may be delayed. Smallholders with limited collateral may struggle to obtain credit. Insecurity increases perceived lender risk and may reduce the willingness of financial institutions to lend in some rural areas. High interest rates can further weaken the business case for technology adoption.

F. Poor rural infrastructure

Roads, electricity, irrigation, storage, processing facilities, telecommunications and market infrastructure are essential to CSA. Poor roads increase transport costs and post-harvest losses. Weak electricity limits cold storage and processing. Poor telecommunications reduce access to digital climate information. Insecurity can further damage or disrupt infrastructure.

G. Land tenure and land-use uncertainty

Secure land rights encourage investments whose benefits take time to materialise. Where land is contested or access is uncertain, farmers may favour short-term production over long-term soil and tree management. Land-use conflicts between farming and pastoral activities can also reduce willingness to adopt practices that require fixed infrastructure.

H. Market volatility and weak incentives

CSA adoption is influenced by expected returns. If improved production does not translate into reliable market income because of insecurity, price volatility or transport barriers, farmers may have little incentive to invest. Climate-smart production must therefore be connected to aggregation, storage, and processing and market information.

I. Gender and youth constraints

Women and young people often face unequal access to land, finance, extension, machinery and digital resources. In insecure environments, women may also experience increased care responsibilities when household members migrate. Youth may leave rural areas because of insecurity or limited employment. CSA programmes that ignore these differences can reproduce unequal access to innovation.

J. Weak coordination among institutions

Agriculture, environment, water, disaster management, humanitarian response and security institutions often operate through separate programmes. CSA amidst insecurity requires coordination because the same community may simultaneously need seeds, extension, early warning, livelihood support, conflict mediation and infrastructure rehabilitation.\

K. Information and awareness gaps

Farmers cannot adopt technologies they do not know about or understand. Awareness alone is insufficient, but it is a necessary condition. Evidence from Southeast Nigeria shows that extension workers and cooperatives are important CSA information channels, reinforcing the importance of trusted local institutions.

L. Risk of maladaptation

Not every intervention labelled climate-smart will produce positive outcomes in every context. A technology can increase debt, groundwater pressure, labour burdens or inequality if poorly designed. CSA should therefore be assessed for trade-offs, distributional effects and long-term sustainability rather than judged solely by short-term yield gains.

VIII. PROSPECTS FOR CLIMATE-SMART AGRICULTURE IN NIGERIA

A. *Stronger policy recognition*

Nigeria's climate policy architecture increasingly recognises adaptation, resilience, climate-smart agriculture, early warning and disaster risk management. The 2025 NDC 3.0 explicitly identifies agriculture and livestock, livelihoods, disaster reduction and security among relevant sectors and recognises climate-related resource competition and vulnerability (Federal Republic of Nigeria, 2025). This creates a policy basis for integrated programming.

B. *Growing empirical evidence from Nigeria*

The evidence base is expanding. Studies now examine CSA adoption, food security, productivity, producer organisations and social networks. This creates an opportunity to move from generic advocacy to evidence-based, location-specific interventions. A 2025 scoping review of social networks among Nigerian smallholders emphasised the role of social relationships in adaptation and mitigation, suggesting that technology diffusion should not rely exclusively on formal extension.

C. *Digital agriculture and remote extension*

Mobile phones, radio, digital platforms and remote sensing can extend climate information and advisory services to farmers who cannot be reached frequently by physical visits. Local-language voice messages, interactive radio, SMS alerts and digital farmer groups can complement conventional extension, particularly in insecure communities.

D. *Producer organisations and cooperatives*

Producer organizations can reduce transaction costs, facilitate input purchase, provide peer learning, support aggregation and improve bargaining power. Recent Nigerian evidence associates producer-organisation membership with greater CSA adoption and bundling (Do producer organizations promote climate-smart agriculture?, 2026). Strengthening such organisations can therefore produce both economic and knowledge benefits.

E. *Indigenous and local knowledge*

Local knowledge can provide low-cost adaptation options, including planting calendars, crop mixtures, seed selection, soil conservation and natural pest management. Integrating local knowledge with scientific climate information can improve relevance and community ownership. It should, however, be evaluated rather than romanticised, because local practices vary in effectiveness under changing climate conditions.

F. *Climate-smart finance*

Blended finance involving government, development partners, commercial banks, microfinance institutions, cooperatives and insurance providers can reduce the initial cost barrier. Credit guarantees, concessional loans, input financing, matching grants and premium subsidies can improve access while protecting lenders and farmers from excessive risk.

G. *Early warning and anticipatory action*

Early-warning systems can help communities prepare before droughts, floods and other hazards occur. Linking warnings to pre-agreed actions—such as seed distribution, livestock

vaccination, evacuation, water provision, cash assistance or market support—can reduce losses and protect productive assets.

H. Resilient infrastructure

Investment in rural roads, bridges, irrigation, drainage, storage, renewable energy and telecommunications can simultaneously support productivity, adaptation and security. Infrastructure should be designed with climate risks in mind and maintained through local institutions.

I. Conflict-sensitive agricultural development

CSA offers an opportunity to strengthen social cooperation when programmes are designed to reduce competition over scarce resources. Shared water infrastructure, negotiated grazing arrangements, joint producer groups and inclusive value chains can create incentives for cooperation. Such interventions must be locally grounded and should not assume that every climate problem is a conflict problem.

J. Education and agricultural teacher preparation

Agricultural education institutions have a major role in preparing extension workers, teachers, farmers and young professionals for climate-smart production. Curricula should integrate climate science, risk management, digital agriculture, conservation practices, conflict sensitivity, entrepreneurship and local adaptation. This is particularly relevant to colleges of education and agricultural training institutions.

IX. POLICY AND PRACTICE FRAMEWORK FOR SCALING CSA UNDER INSECURITY

A workable Nigerian strategy should not attempt to solve climate change, insecurity and agricultural underdevelopment through one programme. Instead, it should create a coordinated framework in which agricultural and climate interventions are designed with explicit risk and conflict considerations. The following policy actions are proposed.

- Develop state- and local-government-level conflict-sensitive CSA plans that identify climate hazards, insecurity risks, vulnerable groups, major crops/livestock systems, market constraints and locally feasible CSA options.
- Create security-aware extension systems using a combination of community-based extension agents, farmer field schools, radio, mobile messaging and digital advisory services so that agricultural advice can continue when routine travel is constrained.
- Expand climate information services and translate forecasts into actionable farm advice. Information should be timely, location-specific, understandable and available in relevant local languages.
- Strengthen producer organisations and cooperatives as platforms for input procurement, technology demonstrations, savings, credit linkage, aggregation, insurance and collective marketing.
- Establish dedicated CSA financing windows with credit guarantees, concessional finance, matching grants and appropriate insurance products for smallholders, women, youth and displaced or returning farming households.
- Invest in resilient rural infrastructure—roads, bridges, drainage, irrigation, water harvesting, storage, processing, renewable energy and telecommunications—with climate and security risk assessments incorporated into project design.

- Integrate early warning with anticipatory action. Forecasts should trigger pre-agreed agricultural and humanitarian responses before climate shocks become emergencies.
- Promote integrated crop–livestock and land-use planning in areas affected by farmer–herder tensions. Water-point governance, negotiated access arrangements and community mediation should accompany technical livestock and crop interventions.
- Protect and improve land-tenure security, especially for smallholders making long-term investments in trees, soil restoration, and irrigation and conservation infrastructure.
- Mainstream gender and youth considerations into CSA programmes. Women and young farmers should have direct access to land, finance, training, digital tools, equipment and leadership opportunities.
- Strengthen agricultural research on locally adapted CSA packages rather than isolated technologies. Research should measure yield, income, resilience, food security, labour demand, environmental effects and distributional outcomes.
- Develop monitoring systems that distinguish adoption from sustained use. Programmes should track whether farmers continue practices after subsidies or projects end.
- Improve coordination among ministries and agencies responsible for agriculture, environment, water, disaster management, humanitarian affairs, rural development and security, while engaging universities, colleges of education, farmer organisations, private firms and development partners.
- Support post-harvest and value-chain interventions so that climate-smart production generates dependable income. Storage, processing and aggregation can reduce losses and make adoption economically attractive.
- Use conflict-sensitive procurement and implementation arrangements. Projects should avoid unintentionally concentrating benefits in one group, should consult affected communities and should establish transparent grievance mechanisms.

X. ROLES OF KEY STAKEHOLDERS

Stakeholder	Priority role
Federal and State Governments	Set coherent policy, fund extension and research, improve infrastructure, create financing mechanisms, strengthen early warning, support insurance and coordinate cross-sectorial action.
Local Governments and Community Institutions	Identify local hazards, support community extension, maintain small infrastructure, coordinate local adaptation plans and facilitate inclusive dialogue.
Research Institutes and Universities	Develop locally appropriate technologies, evaluate CSA packages, conduct impact assessments and generate evidence for policy.

Colleges of Education and Agricultural Training Institutions	Prepare teachers and extension personnel in climate science, CSA technologies, digital extension, entrepreneurship and conflict-sensitive agricultural education.
Extension Services	Provide demonstrations, farm-level diagnosis, climate advisories, follow-up and feedback to researchers and policymakers.
Farmer Organisations and Cooperatives	Facilitate collective learning, input access, finance, marketing, insurance and peer-to-peer diffusion.
Financial Institutions and Insurers	Develop accessible credit, savings and insurance products suited to smallholders and climate risk.
Private Sector	Supply quality seed, equipment, renewable energy, digital services, and storage, processing and market solutions.
Civil Society and Development Partners	Support vulnerable communities, strengthen institutions, provide technical assistance and finance, and test scalable innovations.
Traditional and Community Leaders	Support inclusive resource governance, local dispute resolution, community mobilisation and acceptance of adaptation programmes.
Farmers and Livestock Keepers	Participate in technology selection, experimentation, collective action, monitoring and feedback while adapting practices to local ecological and economic conditions.

XI. CONCLUSION

Climate-smart agriculture presents Nigeria with an important pathway for improving agricultural resilience, food security and livelihood sustainability under a changing climate. However, the prospects of CSA cannot be assessed solely from the technical effectiveness of individual practices. Insecurity changes the conditions under which agricultural innovation is adopted and sustained. Violence, displacement, restricted mobility, asset loss, market disruption, high input prices, weak finance and reduced extension access can turn technically feasible CSA options into practically inaccessible ones. At the same time, climate variability can interact with competition over land, pasture and water and with pre-existing socioeconomic vulnerabilities. The relationship should not be simplified into a claim that climate change automatically causes insecurity; rather, climate, institutions, livelihoods and conflict interact in context-specific ways.

Evidence from Nigeria shows that CSA adoption is influenced by education, extension, income, credit, cooperative membership and risk orientation, while newer studies indicate benefits from integrated CSA strategies and producer organisations. These findings imply

that scaling CSA requires more than distributing improved seed or promoting a single conservation technique. It requires an enabling system of knowledge, finance, infrastructure, climate information, secure land access, producer organisation, insurance and markets.

Nigeria's policy direction provides a foundation for this transition. The country can strengthen implementation by making CSA explicitly conflict-sensitive, decentralised and inclusive. Programmes should be designed around local climate and security conditions, with flexible delivery mechanisms that can continue during periods of restricted movement. Agricultural colleges, universities, extension services, farmer organisations, private firms, local institutions and government agencies should be connected through a common resilience agenda.

Ultimately, the goal should be a resilient Nigerian food system capable of producing nutritious food, sustaining rural incomes and protecting natural resources despite climatic and security shocks. Climate-smart agriculture can contribute substantially to this goal, but its success will depend on institutional quality, farmer participation, accessible finance, secure livelihoods, effective climate information and the capacity to deliver services safely and consistently.

RECOMMENDATIONS

- Adopt a national conflict-sensitive CSA implementation framework with state-specific operational plans.
- Increase funding for agricultural extension and combine physical extension with digital, radio and community-based channels.
- Expand affordable climate-smart finance, including credit guarantees, concessional loans, savings mechanisms and insurance.
- Prioritise resilient rural infrastructure, especially roads, irrigation, water harvesting, drainage, storage, processing and renewable energy.
- Strengthen early-warning and anticipatory-action systems and connect them directly to farmer decision-making.
- Support farmer cooperatives and producer organisations as vehicles for technology diffusion, collective finance and market access.
- Integrate indigenous knowledge with scientific climate information through participatory research and farmer field schools.
- Develop gender- and youth-responsive CSA programmes with measurable targets for access to land, finance, training and technology.
- Promote conflict-sensitive crop–livestock and water-resource management, including locally negotiated resource-sharing arrangements.
- Strengthen monitoring and evaluation to measure sustained adoption, productivity, household food security, resilience, environmental outcomes and equity.
- Embed CSA, climate-risk management, digital agriculture and conflict sensitivity into agricultural education and teacher-training curricula.
- Promote interdisciplinary research linking climate science, agriculture, economics, peace and security, sociology, education and rural development.

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