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Agricultural Technologies, Food Systems and Climate-Resilient Entrepreneurship in Kwara State, Nigeria: Opportunities, Challenges and Policy Imperatives

Idowu Oluwafemi Sunday and Samuel Afuajemi Jonathan

Department of Business Management and Marketing, Faculty of Management and Social Sciences, Baze University, Abuja

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***Corresponding Author:** Idowu Oluwafemi Sunday

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Abstract **Original Research Article**

The agricultural sector which contributes approximately 19-25% of the national GDP is facing increasing challenges from climate changes, food shortages and demographic expansion in Nigeria. The state of Kwara, which is found in Nigeria's North-Central Agro-ecological region, offers a fascinating case study of how Agri-technology, climate-smart methods, and entrepreneurial creativity may interact to change food system. This paper examines the intersection of climate-smart business, food system resilience, and agricultural technology in Kwara State. The study's findings are supported by empirical research, government policy documents and industry reports that Kwara state is endowed with agricultural potential for commercial production of rice, casava, maize, soybeans and yam. It also revealed that climate change has reduced food accessibility for 94.8% of the farming households, increased food prices by 91.8% and limited access to market for 74.7% of the households. The study outlines the emergence of digital agricultural platforms, state-led mechanization programs and climate adaptation partnerships, such as the Kwara ACReSAL-IITA collaboration. Despite these developments, transformative effects are limited by persistent constraints; such as funding gaps, poor extension services, infrastructural deficits, insecurity and low adaptation of climate-smart technologies. The study recommends a wide-ranging policy framework focusing on blended financing, digital infrastructure, youth agripreneurship, and institutional collaboration to fast-track Kwara state's transition into a climate-resilient, technology-led agricultural economy. The findings contribute to the broader discussion on agricultural transformation in sub-Saharan Africa and provide useful guidance for development experts, investors, and decision makers.

Keywords: Agri-Tch, Climate-Smart Agriculture, Food System, Entrepreneurship, Kwara State, Nigeria, Digital Agriculture, Smallholder Farmers.

1. Introduction

Nigeria's economy is still based mostly on agriculture, which employed about 35% of the labour force and contributed between 19% and 25% of the country's GDP between 2023 and the first quatre of 2024 (Nigeria Bureau of Statistics, 2024). However, the industry extreme strain stems under unpredictable rainfall, worsening pest outbreaks,

degraded soil, and insecurity have reduced output and jeopardized food security nationwide. Over 26.5 million Nigerian were at risk of acute food insecurity by the end of 2024, according to a warning from the Food and Agriculture Organization (FAO), a significant increase from the 18.6 million susceptible between October and December 2023 (FAO, 2023). Due to supply constraints, insecurity, and the elimination of fuel subsidies in May 2023, food inflation has risen to 34% (NBS, 2024).

Kwara state, located in the tropical savanna area of Nigeria's North-Central geopolitical zone, provides a microcosm of the prospects and problems facing Nigerian agriculture. As one of the nation's leading producers of rice, the state produces staples such as rice, maize, cassava, yam, sorghum, millet, and soybeans (Vanguard, 2026). It is positioned as a possible agricultural growth pole due to its more stable security environment in contrast to the northeast, which is prone to insurgencies, and the northwest, which is beset by banditry. However, research shows that 41.1% of farming households in the state continue to experience food insecurity, and climate change has been reported to decrease food availability for 94.8% of residents, restrict market access for 74.7%, and raise food prices for 91.8% (Oladimeji, 2025; Adebisi, 2022). Kwara is not exempt from the larger climate and structural shocks affecting Nigerian farming.

This manuscript investigates the common elements of agricultural technology (Agri-tech), food system architecture, and climate-smart entrepreneurship in Kwara state. It asks the following questions: How are digital technologies reshaping agricultural production and market access in Kwara? What climate-smart practices are being adopted, and what barriers impede their diffusion? What institutional and policy arrangements are needed to foster a resilient, entrepreneurial agricultural ecosystem? By addressing these questions, the paper contributes empirical evidence and policy recommendations relevant to Nigeria's agricultural transformation agenda and the broader sub-Saharan African context.

2. Conceptual and Empirical Framework

2.1 Defining the Core Concepts

The term 'Agri-Tech' described the use of digital and precious technologies in agricultural production, processing, and distribution, such as blockchain, mobile platforms, remote sending, drone monitoring, and artificial intelligence. With around 308 registered companies functioning throughout the value chain, Nigeria's agri-tech ecosystem has grown significantly (Tracxn, 2026). Crowdfunding, mechanization-as-a-service, and farm management software have been shown to be viable in smallholder contexts by platforms like ThriveAgric, Farmcrowdy, and Hello Tractor.

The whole value chain, including input supply, production, processing, storage, transportation, retail, consumption, and waste management, is included in food systems. A sustainable food system is one that provides nutrition and food security while preserving the social, economic, and environmental underpinning for coming generations. High post-harvest losses (over 40%), inadequate cold chain infrastructure, and a strong reliance on rain-fed agriculture more than 60% of staple foods are produced without irrigation and are characteristics of Nigeria's food system (FAO, 2024).

Climate-Smart Entrepreneurship incorporates goals for mitigation and adaptation to climate change into agricultural business models. It entails finding market potential in climate-resilient practices including solar-powered irrigation, agroforestry, dryought-resistant seed varies, and computerized weather forecasting, then scaling them through businesses that can make a profit. The idea is based on the FAO's Climate-Smart Agriculture (CSA) framework, which aims to reduce greenhouse gas emissions wherever feasible, increase productivity sustainably, and adapt to climate change.

2.2 Theoretical Anchors

Two theoretical traditions are used in the analysis. First, according to the Agricultural innovation systems (AIS) idea, technological advancements in agriculture result via networked interactions between farmers, researchers, extension agents, private

companies, and policymakers rather than from isolated studies. This framework is especially useful for comprehending the function of public-private partnerships and digital startups in Kwara's agricultural environment. Second, the ability of socio-ecological systems to absorb disruption, reconfigure, and continue to operate is highlighted by Climate Resilience Theory. When it comes to food systems, resilience relies on diversification, redundancy, adaptation, and connectivity, all of which may be improved through entrepreneurship and technology.

3. Agricultural Profile and Food System Dynamics of Kwara State

3.1 Agro-Ecological Endowments

Kwara state is located in Nigeria's tropical savanna region, which is distinguished by distinct wet and dry seasons and rich soils that support a wide variety of crops. Farm produce such as rice, maize, cassava, yam, sorghum, millet, and soybeans accounts for the majority of the state's agricultural production. Thanks to both natural appropriateness and government intervention programs, Kwara has become one of Nigeria's top rice-producing states (Vanguard, 2026). Additionally, cassava production is an essential part of the agricultural sector, contributing significantly to both economic livelihoods and food security (Kwara State Export Promotion Strategy, 2023). Despite being underrepresented in national statistics, the state's livestock industry has garnered policy attention, as seen by the Kwara state livestock commissioner's engagement in Agri-tech collaborations with academic institutions (Facebook/Thomas Adewumi Uni, 2025).

3.2 Production Trends and Productivity Challenges

Annual yields of maize, sorghum, rice, millet, yam, and cassava have varied around the long-term mean, according to trends study of agricultural production in Kwara state. This suggests systemic volatility rather than steady expansion (Ajadi, 2023). Variability in rainfall, low mechanization rates, insecurity, inadequate market connections, and limited adoption of improved inputs are some of the interrelated elements that cause these changes. In response, the Kwara state government has implemented intervention programs such as the Off-Takers Demand Driven plan for soybeans and Back to Farm initiatives, which have resulted in the cultivation of around 868 hectares (NGFR repository, 2023). However, these programs' limited reach among the state's mostly smallholder farming population and their dispersed implementation have limited their influence.

3.3 Food System Architecture

Like much of rural Nigeria, Kwara's food system is based on a pyramid of unofficial vendors, sporadic marketplaces, and a thin layer of official processors. Post-harvest losses are still severe, although producing more than 60% of Nigeria's food, smallholder farmers waste more than 40% of it because of inadequate transportation, processing, and storage facilities. According to reports, 74.74% of farming households in Kwara are unable to access markets due to climate change, which worsen the structural obstacles of poor roads and poor logistics (Oladimeji, 2025). As a result, the food system is both productive and unstable, while it produces enough calories overall, it is unable to provide vulnerable communities with reliably priced, and nourishing food.

4. Climate Change Impacts and Adaptation Responses

4.1 Manifestations of Climate Stress

In kwara state, climate change is a current reality rather than a potential threat. Changes in rainfall patterns in the North-Central zone, such as delayed onset and early cessation of showers, have been reported by the Nigeria Meteorological Agency (NIMET). These changes have resulted in an increase in drought occurrences and a decrease in soil moisture (Ani et al., 2022). As of July 2024, 40% to 85% of cropland in the impacted areas was experiencing drought, according to FAO's Agricultural Stress Index. Kwara's rain-fed crop

calendar, particularly for maize and rice, which are sensitive to planting date timing.

In addition to rainfall, rising temperatures and more humidity have made it easier for pests and diseases to spread. Though more concentrated in various areas, the 2023 outbreaks of Tuta absoluta and ginger fungus indicate the kind of climate driven pest dynamics that could increasingly impact Kwara's vegetable, tomato, and pepper crops. Up to 60% of Nigeria's land area is affected by desertification, and although Kwara is not in the Sahelian core, its northern local government districts are at long-term risk due to the southward spread of arid zones.

4.2 Socio-Economic Impacts

The socio-economic impact of climate change on food systems in Kwara are thoroughly established. Research focusing on residents of Ilorin, the state capital reveals that 94.8% of participants experienced decreased food availability, 91.8% faced rising food costs, and 74.7% encountered restricted market access due to climate change (Oladimeji, 2025). Furthermore, a study of farming households in the region indicated that 41.1% suffer from food insecurity, with only 58.9% being food secure; notably, the implementation of climate-smart agricultural techniques significantly enhances food security (Adebisi, 2022). Logistic regression analyses in these studies demonstrate that climate stress acts as a critical driver of household welfare, nutritional health, and economic stability, extending beyond mere environmental concerns.

4.3 Adaptation and Climate-Smart Practices

Farmers in kwara are not simply suffering from the effects of climate change without taking action. Research on smallholder rice farmers shows that they are adopting various climate-smart agricultural practices to cope with changing conditions. These practices includes using better seed varieties, changing when they plant their crops, saving water through efficient techniques, and improving soil health with organic materials (ResearchGate, 2026). Similar studies on maize farmers indicate they are also using practices like crop rotation, planting cover crops, and reducing soil disturbance through minimum tillage (Olatinwo, 2026). Despite these efforts, the level of adoption is not consistent across all farmers. This is because many face challenges such as difficulty in getting loans, weak support from agricultural advisors, high costs for farming inputs, and a lack of understanding about effective techniques.

The kwara state government, via the agro-climatic resilience in semi-Agrid Landscapes (ACReSAL) program, has strengthened its collaboration with the International Institute of Tropical Agriculture (IITA) to support climate-smart agriculture projects (Facebook/Nigerian Tribune, 2026). This partnership serves as a positive example of how institutions can work together to adapt to climate challenges, but more analysis is needed to fully understand its extent and effects.

5. Agri-Tech Landscape in Kwara State and Nigeria

5.1 National Agri-Tech Ecosystem

Nigeria's agri-tech sector has experienced rapid expansion, increasing from around 23 startups in 2022 to over 308 registered companies by 2026, according to Tracxn. These businesses operate in various areas such as farm crowdfunding through platforms like Farmcrowdy and ThriveAgric, tractor-sharing via Hello Tractor, precision agriculture with Babban Gona, agricultural marketplaces, and digital extension services. Despite this growth, the sector saw a drop in venture capital funding, with African agri-tech startups raising less than $170 million in 2025, the first decline in tracked investment since the industry started monitoring data, as reported by agriculture data in 2025. This reduction in funding presents challenges for companies in the growth stage and highlights the importance of using blended finance solutions.

The National Agricultural Technology and Innovation Policy (NATIP) 2022-2027 establishes a federal framework for e-agriculture. It acknowledges that digital tools help promote climate-smart agricultural practices, which can boost biodiversity, improve soil quality, enhance water resources, and

strengthen the resilience of agricultural systems (Federal Ministry of Agriculture, 2024). The policy focuses on providing technical support, enhancing skills, and forming strategic partnerships to effectively use digital tools for improving agriculture.

5.2 Agri-Tech Presence in Kwara

While Lagos and Abuja continue to be the main centers for Agri-tech startups in Nigeria, kwara state is becoming more involved in the digital agriculture environment. The National Centre for Agricultural Mechanization (NCAM), based in Ilorin, acts as a national center for research and development in agricultural engineering, offering essential technical support for the creation of mechanization and precision agriculture tools. Additionally, kwara state university (KWASU) and other universities are conducting research on climate-smart agricultural practices and digital extension methods, as noted in the KWASU Space Repository (2024).

Government efforts have also included the use of digital tools. The Kwara State Agricultural Development Program, working with federal departments and international groups such as the International Fund for Agricultural Development (IFAD), has brought in technology-based farming methods for small scale farmers. The IFAD supported Community-Based Agricultural and Rural Development Programme (CBARDP) has been active in Kwara, introducing better farming technologies and evaluating how widely they are being adopted by smallholder communities (Adesoji, 2020). The federal government project in kwara, along with IFAD's plan to support 450,000 rural families by 2029, shows ongoing support from institutions for transforming agriculture in the state (SAPZ, 2025/ AIT, 2026).

5.3 Digital Tools and Their Applications

In the context of Kwara, various types of digital tools play an important role. Mobile based extension services provide farmers with weather forecasts, agricultural advice, and market price updates through SMS and voice messages. Studies on how maize farmers in kwara use weather forecasts show that having access to climate predictions is a key part of climate-smart agriculture and adaptation efforts (Abdulrahman, 2025). Digital financial services offer savings, credit, and insurance options that match the financial needs of farmer s based on the seasonal flow of income from agriculture. E-commerce platforms help producers in kwara reach buyers in cities like Lagos, Ibadan, and Abuja, helping to overcome the market access challenges forced by 74.7% of farming households. Precision agriculture tools such as drone mapping, soil sensors, and satellite monitoring are still in early stages but are becoming more available through service provider models, which remove the need for individual farmers to own these technologies.

6. Climate-Smart Entrepreneurship: Models and Opportunities

6.1 Define Climate-Smart Entrepreneurship in Context

Climate-smart entrepreneurship in kwara state focuses on building business that are both profitable and effective in dealing with climate challenges. These enterprises aim to reduce the impact of climate risks while also making money. Unlike traditional farming business, climate -smart enterprises actively include strategies to adapt to climate change, such as producing seeds that can withstand dry conditions or offering irrigation services that use water more efficiently. They also work towards reducing the effects of climate change by creating products like biofuels or setting up nurseries for trees that can be planned alongside crops. Additionally, these businesses help improve food security by processing crops that are rich in nutrients and by reducing the amount of food that is lost after harvest. All these efforts are built into the main way these businesses operate.

6.2 Emerging Entrepreneurial Models

Several entrepreneurial models are developing in and around kwara state that support the need to adapt to climate change:

Mechanization and Equipment Leasing: The rice sector in the state has expanded with the help of government reforms, leading to more jobs and better value for local production (Vanguard, 2026). Entrepreneurs are investing in mobile processing units and shared machinery services, which helps reduce hard labour and improve the timing of farming operations, key strategies for adapting to climate change.

Climate-Resilient Seed Enterprises: There is increasing demand for better, drought resistant seed varieties of maize, rice, and soybean. Local seed entrepreneurs with support from research organizations can gain value by producing certified seeds suited to the specific environmental conditions of kwara.

Digital Advisory and Input Distribution: Young entrepreneurs are starting to act as last-mile distributors of agricultural supplies such as fertilizer pesticides, and improved seeds, often combined with digital advisory services. These models help reduce the gap in information between farmers and supplies, ensuring efficient use of inputs which lowers costs and environmental impact.

Agro-Processing and Cold Chain Logistics: with a 40% loss of crops after harvest in Nigeria, businesses offering, packaging, and cold storage services present significant opportunities in climate-smart agriculture. These services are especially relevant for crops like cassava and soybean, which are common in kwara and meet the growing needs of urban areas.

Renewable Energy for Agriculture: Solar-powered irrigation and milling systems are becoming more popular as the cost of diesel and petrol rises after the removal of subsidies. Entrepreneurs who provide financing, installation, and maintenance for solar irrigation systems can earn regular income while helping farmers avoid the risks of fluctuating fossil fuel prices and reducing carbon emissions.

6.3 Youth and Women in Agripreneurship

Nigeria's policy discussions have been placing more focus on initiatives led by young people and women in the agricultural sector. The federal government's ten-year agricultural action plan clearly highlights the need to involve youth and adopt climate-smart practices with the goal of supporting the coming generation of agripreneurs (Arise TV, 2025). In kwara state, the government is making greater efforts to boost mechanized farming and increase woman's involvement in agriculture which aligns with the national direction (kwara Govt, 2026). The 'Youth and Women Climate-Smart Agripreneurship (YaWoCA)' program, supported by federal and state agencies specifically targets the youth and women in the context of agricultural transformation (YouTube, 2026).

7. Policy Framework and Institutional Architecture

7.1 Federal Policy Landscape

Nigeria's agriculture and climate policy landscape has evolved significantly at the federal level. The foundation for digital and climate-smart agriculture is established under the National Agricultural Technology and Innovation Policy (NATIP) 2022-2027. The funding for agriculture rose from N1.01 trillion in 2024 to N2.27 trillion in 2025, and the National Agricultural Development Fund has helped flood-affected farmers and other value chains (Lagos Chamber of Commerce, 2025). The Federal Ministry of Agriculture has registered thousands of farmers for input support programs and set aside 40,000 hectares for the production of wheat during the 2025-2026 dry season (FMAFS, 2025).

Although there is still some connection with agricultural planning, climate policy has also made progress. The Rural Electrification Agency (REA) and the National Climate Change Council (NCCC) have mandates related to climate-smart agriculture, but their cooperation with the Ministry of Agriculture has been deemed inadequate (APRI, 2025). This gap is a significant obstacle to the successful implementation of climate-smart policies, according to the Africa Policy Research Institute's Policy Brief.

7.2 Kwara State Government Initiatives

The Kwara State Government has actively sought to promote agricultural growth. Under previous

administrations, the "Back to Farm" initiative added hundreds of hectares under cultivation for vegetables, rice, and sugarcane among other cash crops (Ngfrrepository, 2023). Effort to improve mechanized agriculture, climate resilience, and women's involvement in agriculture have been accelerated under the current administration (Kwara Govt, 2026). Though adoption studies show that continuous extension and input support are required for long-term influence (Adesoji, 2020). The Kwara State Agricultural Development Program (KWADP) and its collaboration with IFAD via CBARDP have brough innovative agricultural technologies to smallholder farmers.

The Kwara State Investment and Support Program (KWASSIP) prioritises agriculture and agribusiness, emphasising the state's expansive, fertile land ideal for large scale crop production and livestock farming and strategic location for market access (KWASSIP, 2024). The Export Promotion Strategy of the state gives priority to rice, soybeans, and cassava as major commodities for the growth of value-added exports.

7.3 International and Development Partner Engagement

International partners play a major role in Kwara's agricultural scene. Under IFAD's Community-Based Agricultural and Rural Development Programme, kwara's rural population, particularly women and small-scam farmers, has been targeted for technology introduction and capacity building. The new IFAD cooperation with the Federal Government seeks to change 450,000 rural households by 2029 with kwara becoming a beneficiary state. The IITA-ACReSAL cooperation is a modern example of climate-smart research to practice cooperation that applies global agricultural research to regional adaptation issues.

8. Systemic Challenges and Constraints

Several structural limitations prohibit radical transformation in kwara state notwithstanding the possibilities of Agri-tech, climate-smart agriculture, and entrepreneurial innovation.

8.1 Financing and Investment Gaps

The most mentioned obstacle for smallholder farmers and agripreneurs in kwara is still availability of reasonably priced finance. Commercial banks see farming as risky, and their collateral rules exclude most smallholders. Even if Agri-tech platforms have introduced digital lending and crowdfunding, the general funding environment has tightened, African Agri-tech startups raised less than $170 million in 2025, a decrease that endanger the expansion of early-stage businesses. Although they are still underdeveloped in the kwara context, blended finance models integrating public grants, development finance, and private equity are needed.

8.2 Infrastructure Deficits

Poor road networks, erratic power supply, and limited irrigation infrastructure limit agricultural production and market access. Poor infrastructure not only raises post-harvest losses but also boosts the cost of digital services delivery as cold chain logistics, internet connection, and equipment maintenance all rely on operational infrastructure. The removal of fuel subsidies in 2023 has raised transportation costs, hence increasing the distance between rural farming towns and city markets.

8.3 Weak Extension and Advisory Services

Effective extension networks that convert research into practical knowledge will help to determine the uptake of climate-smart approaches and digital tools. Public extension services in kwara, like in other parts of Nigeria, suffer from a shortage of funds, staff, and proper equipment. The ratio of extension agents to farmers is significantly lower than global standards. While digital extension platforms show potential, they need ongoing investment in content development, farmer education, and feedback mechanisms.

8.4 Low Technology Adoption and Awareness

Research on adoption of climate-smart agriculture techniques among smallholder rice farmers in kwara expose major disconnects between knowledge and application. Farmers might be aware that better seeds or changed planting dates would increase resiliency, but they lack the inputs, money, or confidence to use them. Digital literacy is also a constraint as older farmers who constitute a larger share of the smallholder population, may struggle to navigate mobile applications or interpret digital weather forecasts without support.

8.5 Climate Finance and Institutional Coordination

Climate finance for agriculture in Nigeria is inadequate and badly monitored. The Africa policy Research Institute observes that although solar-powered irrigation, drought-resistant seeds, and better processing have clear advantage, these climate-smart approaches are not widely used because of funding gaps, lack of knowledge, inadequate extension services, and limited infrastructure (APRI, 2025). Furthermore, the lack of coordination between the Ministry of Agriculture and climate agencies (NCCC, REA) limits the successful execution of integrated climate-agriculture initiative at the state level.

8.6 Security and Conflict

While Kwara state enjoys greater security than the insurgency-affected Northeast or banditry-plagued Northwest, it is not immune to larger national trends. Violent conflict, farmer-herder clashes, and communal disputes over land and water resources can impede farming, displace families, and discourage investment. According to the Global Report on internal Displacement (GRID, 2024) documented 457,000 people internally displaced in Nigeria in 2023, of whom 291,000 were displaced by violet conflict. Such dynamics directly lower the market stability and agricultural labour supply.

9. Strategic Recommendations

The following strategic recommendations are put forth for speeding up kwara state's move to a technology-enabled, climate-resilient agricultural economy based on the evidence examined.

9.1 Scale Blended Finance for Climate-Smart Enterprises

In collaboration with federal organizations and development finance institutions, the kwara state government ought to set up a specialized Climate-Smart Agripreneurship Fund. To de-risk investments in solar irrigation, climate-resilient seed production, digital advising services, and Agro-processing, this fund should combine public subsidies, concessional loans and private capital. Simplified application processes and technical support should be included with capital for special windows aimed at young people and woman entrepreneurs.

9.2 Investment in Digital Infrastructure and Literacy

Reliable internet connection and affordable smartphones are requirements for agri-tech adoption. The state government should partner with telecom providers and the Universal Service Provide Fund (USPF) to expand broadband coverage in rural agricultural zones. Simultaneously, digital literacy initiatives should be included into extension services, using local languages and community-based trainers to guarantee inclusive access.

9.3 Strengthen Climate Information Services

Based on studies indicating that weather prediction data is vital for climate-smart adaptation, Kwara State ought to provide a local farmer-friendly climate information service. This would combine NIMET predictions, satellite imagery, and ground-level readings into SMS, voice, and WhatsAPP channels supplied by agricultural co-ops and extension networks.

9.4 Deepen Public-Private Research Partnerships

The ACReSAL-IITA model ought to be developed and replicated. Every three months, the state government ought to establish and Agricultural innovation platform that brings together universities i.e. KWASU, NCAM and other research institutes, private agricultural technology companies, farmer cooperatives, and financial institutions. This platform would help coordinate research priorities with market needs, enable technology transfer and support the development of new climate-friendly businesses.

9.5 Integrate Climate Goals into Agricultural Policy

Kwara state ought to create a climate-smart agriculture action plan that clearly connects agricultural development goals with those for climate change mitigation and adaptation. This strategy should set objectives for increasing solar irrigation, lowering post-harvest losses, adopting drought-resistant cultivars and sequestering carbon via agroforestry. It should also require climate impact evaluation for every state funded agricultural project.

9.6 Address Structural Infrastructure Gaps

Technology and entrepreneurship cannot thrive without infrastructure such as roads, electricity and irrigation. They should give rural road repair, small grid electrification for agricultural clusters and renovation of old irrigation systems top priority. Public-private partnerships should be employed wherever possible to fund and upkeep infrastructure assets.

9.7 Reform Extension Services for Digital and Climate Integration

The complexity of digital climate-smart agriculture goes beyond what the traditional extension model handle. Kwara state ought to hire and teach a fresh group of digital extension experts ready to provide advice on both technology use and agricultural techniques. These agents should work using a hybrid approach that incorporates in-person consultations, mobile advising platforms and farmer-to-farmer video sharing.

10. Conclusion

Kwara State is at a crucial turning point in its path of agricultural growth. With rich soil, strategic position, and a relatively secure environment, it has the foundations to be a role model for tech-enabled agricultural change that is resilient to climate change in Nigeria. The convergence of federal policy support through NATIP, state-level activities like the ACReSAL-IITA cooperation, and national Agri-tech development produces a favourable policy window for fast change.

But it is clear from the available data that potential alone won't bring about change. For most farming families in kwara, climate change is already lowering food availability, limiting market access, and pushing up food prices. Food insecurity impacts 41.1% of farming households; awareness, extension, infrastructure, and financial gaps limit adoption of proven climate-smart practices. Although energetic across the country, the agri-tech ecosystem is just starting to significantly reach kwara's rural farming populations.

The way ahead calls for a deliberate, multifarious approach combining finance, development of digital infrastructure, enhancement of institutional cooperation, and placement of young people and woman agripreneurs at the forefront of young people and women agripreneurs at the forefront of implementation. When these aspects are in sync, Kwara State can move from being an agricultural sensitive area to a centre of climate-smart innovation, providing lessons not only for Nigeria but also for the greater sub-Sahara African area facing the existential issue of feeding a growing population in a changing environment.

The study has shown that for Kwara State, the intersection of agri-tech, food systems, and climate-smart entrepreneurship is not merely an aspirational

policy ideal but rather a real pressing necessity. The recommendations on blended finance, digital infrastructure, climate information services, public-private partnerships, and extension reform are practical and based on the actual situation of the agricultural landscape of the state. Their execution will call for political will, ongoing investment and engaged participation of farmers, businesses, scientists, and politicians. The stakes are as high as they can get; the future of food security, rural livelihoods, and climate resilience in kwara depends on decisions taken today.

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