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ASSESSING THE ROLES OF MODERN AGRICULTURAL INNOVATIONS IN COMBATTING INSECURITY CHALLENGES IN NIGERIAN AGRICULTURAL SECTOR

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Abstract

This paper examines the roles of modern agricultural innovations in addressing insecurity in Nigeria primarily in the agricultural sector that comprises crops and animal production. This paper looks at the bedevilled clashes that have been occurring between farmers and herders in Nigerian rural areas over the accessibility of land and water resources. Among other things, the clashes exacerbate food insecurity and socio-economic instability in the country. Therefore, this study explores several innovative approaches in crop cultivation and animal husbandry. The paper demonstrated the how use of these technologies can enhance productivity and resilience among farmers and herders. In addition, the paper discusses the major challenges and barriers to the adoption of these innovative approaches that also involve the utilisation of Information and Communication Technologies (ICT). The challenges identified included limited access to finance by the farmers and herders, inadequate infrastructure for adopting the innovative approaches, and socio-cultural factors of the farmers and herders that prevent the adoption of the approaches. The study also looks at the recommendations to strengthen agricultural innovations in Nigeria such as improving access to finance, infrastructure development, capacity building, supportive policies, and public-private partnerships.

Keywords: Agriculture, Agricultural innovation, modern approaches, insecurity

INTRODUCTION

Agriculture that includes crop and animal production is the backbone of the Nigerian economy. Agriculture does not only provides food and job opportunities to Nigerians but it also contributes substantially to revenue and the gross domestic product (GDP) (National Bureau of Statistics, 2020). Nigeria is endowed with arable land that it could produce various crops such as cereals, roots and tubers, legumes. The country also has lands that support large-scale livestock management that support the lives of millions of Nigeria (Food and Agriculture Organization,

2019). The agricultural sector in the country has been increasingly threatened by immense insecurity, chiefly through violent clashes between farmers and herders that have recently resorted to armed banditry and kidnapping. These conflicts, often over access to arable land and water resources, lead to disruptions of food supply chains in the country (Adelakun et al., 2015; International Crisis Group, 2017).

However, the root causes of the clashes are complex in nature. They include the socio-economic decadence of the country, environmental degradation factors, and political factors. Climate change that has manifested in every part of the country and population growth have increased competition over limited resources such as land and water. These have exacerbated tensions between sedentary farmer communities and Fulani nomadic pastoralists who live on grazing the animals (Olaniyan et al., 2015). Furthermore, other factors that are exacerbating the clashes include the lack of a robust framework policy for land and resource management in the country, together with insufficient conflict resolution mechanisms. These neglects leave rural communities prone to frequent and unending disputes between the farmers and herders (Benjaminsen et al., 2012).

The full adoption of modern agricultural innovations and information and communication technologies (CT) in crop and animal production in Nigeria could provide a potential solution to mitigate the incessant conflicts that divested not only the rural economy but also the entire economy of the country. These agricultural innovations comprise climate-smart practices, improved irrigation techniques, and sustainable grazing management, they provide new ways to optimise resource use and reduce the risk of conflict (World Bank, 2021). Moreover, ICT solutions such as mobile applications for real-time data sharing and digital platforms for market access have shown promise in improving communication and resource management among farmers and herders in the country (Aker & Mbiti, 2010; Okello et al., 2020).

The objective of this paper is to explore the role of these modern agricultural innovations and ICT gadgets in combating insecurity within the Nigerian agricultural sector. The paper examines how these modern technologies can improve resource allocation, foster collaboration, and enhance productivity. Among other things, this paper seeks to primarily contribute to an in-depth understanding of how innovative technological advancements can transform the agricultural landscape in Nigeria. Finally, this study hopes that the insights provided here will assist policymakers, agricultural practitioners, and community leaders in developing strategies

that promote sustainable agricultural practices and peaceful coexistence among rural populations.

OVERVIEW OF INSECURITY IN NIGERIAN AGRICULTURAL SECTORS

Agriculture is the main economic stay of the Nigerian teeming population. The sector accounted for 70% of job provision in the country. Moreover, it contributes significantly to the national Gross Domestic Product (GDP) (National Bureau of Statistics, 2020). Despite its importance, the sector has been facing mounting challenges such as conflicts over natural resources, particularly between sedentary farming communities and Fulani nomadic pastoralists. These conflicts usually referred to as farmer-herder clashes have intensified in recent years and they threaten agricultural productivity and stability in rural among the rural dwellers (Adisa, 2012; Olaniyan et al., 2015).

i. Nature and Causes of Farmer-Herder Conflicts

The clashes between the sedentary farming communities and nomadic pastoralists in Nigeria are centred on economic, social and environmental causes that are usually interwoven complex phenomena. However, all the issues revolve around land hunger which creates too much competition. In Nigeria traditionally, the Fulani monads are involved in seasonal migrations looking for good pasture and water for their livestock. These movements happen in a given area and also in long-distance places. Therefore, the nomadic have contact with farmlands throughout their daily and long-distance grazing. As a result of desert encroachment in the Northern part of the country, land degradation, and climate changes in Nigeria, the competition over resources is heightened (Benjaminsen et al 2012). Rising temperatures and erratic rainfall patterns have exacerbated desertification in northern Nigeria, forcing herders to migrate southward in search of greener pastures. These movements often bring Fulani nomadic pastoralists into direct conflict with farmers in many states in the country (Abbas, 2009; Fiki & Lee, 2004).

In addition, the expansions of agricultural land and urbanisation have led to a significant reduction in grazing lands and traditional livestock routes. Many herders who previously had access to grazing are now blocked as the grazing areas have been converted into farmland or restricted through policies that fail to consider the needs of nomadic communities, which led to clashes (Okello et al., 2020). There haven conflicts between the farmers and herders due to intense competitions over the land for farming and grazing which have recently developed to

arm banditry and incensed killings (Adelakun et al., 2015). One of the factors that have exacerbated communal clashes in Nigeria is lack of effective institutions committed to shared resource management and conflict resolution (Benjaminsen et al., 2012).

ii. Impact on Agricultural Productivity and Rural Communities

Violent clashes between farmers and herders primarily lead to the destruction of crops, loss of livestock, and the abandonment of farming activities, which resulted in the reduction of agricultural yields and income (Blench, 2010; International Crisis Group, 2017). These conflicts led to many households that live in conflict-prone areas report to have significant income losses. The herders also suffer losses in terms of livestock mortality and restricted access to grazing lands (Olaniyan et al., 2015).

Conflicts, therefore, have forced thousands of Nigerian farmers to abandon their homes and farmlands and to relocate to safer areas. Henceforth, the conflicts lead to the disintegration of rural communities and it leads to an increase in internally displaced persons (IDPs) (International Crisis Group, 2017). This displacement, as mentioned earlier, disrupts social structures, strains community resources, and hinders educational and health services in many rural and suburban communities. These conflicts also exacerbate existing ethnic and religious tensions. It leads to clear divisions between farmers and herders that frequently align with ethnic and cultural identities (Higazi, 2016). Consequently, insecurity not only undermines the agricultural sector but also destabilises rural communities impeding development efforts and hindering Nigerian socio-economic growth.

MODERN AGRICULTURAL INNOVATIONS IN CROP CULTIVATION AND ANIMAL HUSBANDRY

As Nigeria as a country with vast resources have been struggling with the increased demands of food crops to sustain its teeming population. At the same time, the country requires enough livestock products. These could be achieved through modern agricultural inventions despite the escalating conflicts over land and water in the country. Modern Agricultural inventions have been the most reliable fostering sustainable practices for both crop cultivation and animal husbandry in the country. The modern innovations that are proven to be reliable and adaptable to the country are climate-smart agricultural inventions, improved irrigation schemes, advanced livestock management schemes as well as modern and sustainable grazing methods. The innovations first facilitate productivity, lessen the effects of climate change, and reduce conflicts among the farmers and herders through the promotion of efficient resource utilisation (World Bank, 2021; FAO, 2019). This section demonstrates the innovations that could transform

Agriculture in Nigeria, bring food security, and resolve classes among the farmers. In the country:

i. Innovations in Crop Cultivation

Climate Smart Agriculture: According to the World Bank (2021) climate smart agriculture (CSA) is one of the most promising modern agricultural practices in developing countries. The system forces improving resilience to environmental challenges. At the same time, the scheme develops enhances yielding and maintains sustainability (World Bank, 2021). This type of agriculture deals with the varieties of crops that are developed through genetic research and selective breeding. The varieties can survive longer dry spells. This reduces the crops' failures and it ensures food security in drought-prone areas mostly in Northern Nigeria (AGRA, 2019). The most suitable climate-smart programmes in Nigeria are drought-resistant crop varieties, conservation agriculture, and improved water management practices. The drought-resistant crop varieties that are identified which they produce imperative results are drought-tolerant maize. These varieties of maize are introduced in different parts of the country. The farmers can maintain bumper harvests despite the weather uncertainty as the climate in the country has become unpredictable (Olagunju, 2015).

Precision Agriculture: Precision Agriculture is another agricultural innovations critical that innovation is the adoption of precision agriculture. This approach involves using technology to manage crops with high precision, allowing farmers to apply inputs like water, fertilisers, and pesticides exactly where they are needed. Technologies such as GPS, remote sensing, and data analytics enable farmers to monitor crop health and soil conditions, leading to more efficient resource use and higher yields (Mandal & Maity, 2013). In Nigeria, several initiatives have introduced precision farming practices, with mobile applications providing farmers with timely weather forecasts, soil quality updates, and pest management tips (Abubakar et al., 2017). These practices not only improve productivity but also reduce environmental impact by minimising chemical use.

Improved irrigation schemes: Irrigation innovation has also become a focus in Nigeria, where unreliable rainfall patterns threaten crop cultivation. Technologies like drip irrigation and sprinkler systems allow farmers to maximise water efficiency, especially in arid and semi-arid regions. Drip irrigation, which delivers water directly to the root zones of plants, conserves water and reduces evaporation loss. Studies have shown that implementing drip irrigation in Nigerian farms has resulted in up to a 40% increase in water efficiency and crop yield (Adeniji

et al., 2020). By improving water use efficiency, these irrigation systems can help reduce competition for water resources between farmers and pastoralists, thereby mitigating one of the major sources of conflict in rural areas.

ii. Innovations in Animal Husbandry

In animal husbandry, innovations are focused on improving livestock productivity, enhancing disease management, and promoting sustainable grazing practices. One of the key advancements is the use of selective breeding techniques to produce livestock that are more resilient to Nigeria's climatic conditions and disease challenges. Through genetic improvements, livestock breeds such as cattle, goats, and poultry can be bred for specific traits, such as increased milk production, resistance to disease, or adaptability to warmer climates (FAO, 2019). These genetic enhancements enable livestock to thrive under local conditions, increasing productivity and reducing losses due to diseases and harsh weather (Dossa et al., 2015).

Another vital innovation is the adoption of advanced veterinary care and disease control systems. Livestock diseases like foot-and-mouth disease and avian influenza are significant threats to animal husbandry in Nigeria, often leading to considerable economic losses and food shortages (Obi et al., 2018). The establishment of mobile veterinary clinics and digital health tracking systems has made veterinary care more accessible in rural areas. Mobile apps now allow herders to record livestock health data, access information on disease outbreaks, and receive vaccination reminders, which have helped reduce disease spread and mortality (Onono et al., 2013).

Sustainable grazing management has also been promoted as a key innovation in Nigeria to address the farmer-herder conflicts over land. Rotational grazing, a method where herders rotate livestock across different grazing areas, allows land to recover between grazing periods, preserving vegetation and preventing overgrazing (Agyemang et al., 2020). This practice helps to maintain soil health and reduces the likelihood of desertification, which is a critical concern in northern Nigeria. Furthermore, the implementation of agro-pastoral systems, where livestock rearing is integrated with crop farming, has enabled pastoralists to access feed crops, reducing their reliance on natural grazing lands and minimising clashes with farmers (Blench, 2010).

iii. Benefits of Agricultural Innovations for Reducing Conflict

The adoption of these innovations in crop cultivation and animal husbandry offers several benefits that can help mitigate resource-based conflicts. By improving water and land use efficiency, these innovations reduce the need for large tracts of land and extensive water sources,

thus lessening the competition between farmers and herders (FAO, 2019). Furthermore, higher crop yields and increased livestock productivity help improve food security and provide a stable income for rural populations, making them less vulnerable to the economic pressures that often fuel conflicts (Adelakun et al., 2015).

In conclusion, the integration of modern agricultural innovations holds immense potential for transforming Nigerian agriculture and reducing resource-based conflicts. By adopting climate-smart practices, precision agriculture, improved livestock breeds, and sustainable grazing systems, Nigeria can enhance its agricultural resilience, foster economic stability, and promote peaceful coexistence between farmers and herders. However, the widespread adoption of these innovations will require concerted efforts from policymakers, agricultural extension services, and rural communities to address financial, infrastructural, and educational barriers.

CASE STUDIES AND EXAMPLES

The implementation of modern agricultural innovations in Nigeria has yielded significant results in enhancing productivity, promoting sustainability, and reducing conflicts between farmers and herders. This section presents case studies and examples that illustrate successful applications of these innovations in both crop cultivation and animal husbandry, highlighting their impacts on agricultural practices and community resilience.

i. Case Study: The Drought-Tolerant Maize Project

The Drought-Tolerant Maize for Africa (DTMA) project is a prime example of successful agricultural innovation aimed at improving food security in Nigeria. Launched in 2007, the project was initiated by the International Maize and Wheat Improvement Center (CIMMYT) in collaboration with various partners, including the African Development Bank and national agricultural research institutions (Bänziger et al., 2011). The DTMA project focused on developing and distributing maize varieties that are resilient to drought, which is a significant challenge for farmers in northern Nigeria due to climate variability.

By 2020, the project had reached over 2 million farmers across Nigeria, providing them with access to drought-tolerant maize seeds, training in agronomic practices, and information on weather patterns (Kibata et al., 2020). Farmers who adopted these new varieties reported an average yield increase of 30% during drought conditions compared to traditional maize varieties. The adoption of drought-tolerant maize has helped improve food security and household incomes in vulnerable farming communities, reducing their reliance on food aid and enabling them to invest in other livelihood activities (Bänziger et al., 2011).

ii. Case Study: The Adoption of Drip Irrigation in Northern Nigeria

In response to the challenges posed by erratic rainfall patterns and water scarcity, several initiatives have promoted the adoption of drip irrigation systems among farmers in northern Nigeria. One notable initiative is the Irrigation for Climate Resilience project implemented by the International Institute of Tropical Agriculture (IITA) in collaboration with the Nigerian government and various NGOs. The project aimed to increase agricultural productivity and improve water management practices in arid and semi-arid regions (IITA, 2020).

The introduction of drip irrigation technology has enabled farmers to optimise water usage, leading to significant increases in crop yields. For example, farmers in the Sokoto State who adopted drip irrigation reported yield increases of up to 50% for tomatoes and vegetables, compared to conventional irrigation methods (Olorunfemi et al., 2021). Moreover, by reducing water consumption by 40-60%, drip irrigation has alleviated competition for water resources between agricultural and pastoral activities, thereby contributing to conflict reduction (IITA, 2020).

iii. Case Study: Mobile Veterinary Clinics for Livestock Health Management

In Nigeria's livestock sector, mobile veterinary clinics have emerged as an effective solution for improving animal health and productivity. One successful programme is the Mobile Veterinary Clinics Initiative, established by the Nigerian Veterinary Medical Association (NVMA) in collaboration with local governments and international partners. The initiative aims to provide veterinary services to pastoralist communities, particularly in remote areas where access to healthcare is limited (Obi et al., 2018).

Mobile clinics have provided essential services such as vaccinations, disease diagnosis, and treatment to over 100,000 livestock in northern Nigeria since their inception in 2016. Farmers have reported a substantial decrease in livestock mortality rates due to improved access to veterinary care (Obi et al., 2018). Additionally, the initiative has integrated digital platforms to track livestock health records, enabling herders to monitor their animals' health more effectively. This approach not only enhances livestock productivity but also fosters better relationships between herders and farmers, reducing tensions over shared resources.

iv. Case Study: The Agro-Pastoral System in Kaduna State

The integration of crop and livestock farming through agro-pastoral systems has shown promise in reducing conflicts and enhancing food security in Nigeria. In Kaduna State, an initiative led by

the Agricultural Transformation Agenda (ATA) has promoted agro-pastoralism by encouraging herders to cultivate fodder crops alongside traditional livestock farming practices (Federal Ministry of Agriculture and Rural Development, 2017).

By planting crops such as legumes and grasses, herders can provide their livestock with high-quality feed while simultaneously producing food for their households. This system not only improves the nutritional status of the livestock but also generates additional income for pastoral families (Blench, 2010). Farmers participating in this programme reported a 40% increase in livestock productivity and reduced conflicts with crop farmers, as agro-pastoralists became less reliant on communal grazing lands (Federal Ministry of Agriculture and Rural Development, 2017).

v. Case Study: ICT in Agriculture—Farmers' Mobile Applications

The use of Information and Communication Technology (ICT) in agriculture has revolutionised farming practices in Nigeria. One noteworthy example is the Farmers' Friend mobile application, developed by a consortium of agricultural NGOs and tech startups. This application provides farmers with critical information on weather forecasts, market prices, pest management, and best agricultural practices (Sani et al., 2018).

By using the app, farmers can make informed decisions about planting times, crop selection, and resource allocation. A study conducted in the Benue State indicated that farmers using the app experienced a 25% increase in yields compared to those who relied solely on traditional farming methods (Sani et al., 2018). The integration of ICT has also facilitated better communication between farmers and pastoralists, enabling them to share information on resource availability and reducing misunderstandings that could lead to conflict.

CHALLENGES AND BARRIERS TO THE ADOPTION OF INNOVATIONS AND ICT IN NIGERIAN AGRICULTURE

While modern agricultural innovations and Information and Communication Technology (ICT) present significant opportunities for enhancing productivity and sustainability in Nigerian agriculture, their adoption is often hindered by various challenges and barriers. Understanding these obstacles is crucial for developing effective strategies to promote the widespread implementation of innovative agricultural practices and ICT solutions. This section outlines key challenges, including limited access to financing, inadequate infrastructure, lack of technical knowledge, and socio-cultural factors.

i. Limited Access to Financing

Access to finance remains one of the most significant barriers to adopting agricultural innovations in Nigeria. Many smallholder farmers lack the necessary capital to invest in modern technologies, improved seeds, and irrigation systems. The World Bank (2020) estimates that over 80% of smallholder farmers in Nigeria do not have access to formal credit, relying instead on informal loans with high interest rates, which can be unsustainable (World Bank, 2020). Without financial support, farmers are often unable to invest in the necessary tools and resources to adopt innovations, limiting their productivity and income potential.

Moreover, financial institutions often view agriculture as a high-risk sector, leading to stringent lending criteria that many farmers cannot meet. This lack of access to credit stifles the potential for innovation adoption, as farmers may be hesitant to take risks associated with new technologies when they lack the financial safety net to support potential failures (Adebayo & Daramola, 2020).

ii. Inadequate Infrastructure

Inadequate infrastructure poses a significant challenge to the adoption of agricultural innovations and ICT in Nigeria. Many rural areas lack essential facilities such as reliable roads, storage facilities, and electricity, which are crucial for implementing modern agricultural practices and using ICT effectively (Adeniyi et al., 2019). Poor road networks hinder farmers' ability to access markets, reducing their motivation to invest in new technologies that require transport to and from agricultural sites.

Additionally, the lack of a consistent electricity supply makes it challenging to use technology-dependent tools, such as irrigation systems and mobile applications. For instance, a study by Tologbonse et al. (2018) found that farmers in rural Nigeria often face difficulties in charging devices necessary for accessing ICT solutions due to unreliable power supply. This infrastructural deficit limits the potential of ICT to enhance agricultural productivity and farmers' engagement with new practices.

iii. Lack of Technical Knowledge and Skills

The successful adoption of modern agricultural innovations and ICT requires a certain level of technical knowledge and skills. Unfortunately, many farmers in Nigeria lack the training needed to implement and maintain these technologies effectively. A survey conducted by Abdu et al. (2017) revealed that a significant percentage of farmers reported insufficient understanding of how to use ICT tools, such as mobile applications for market information and weather forecasts.

Furthermore, agricultural extension services in Nigeria are often underfunded and cannot reach a large number of farmers effectively. According to the Food and Agriculture Organization (FAO, 2020), there are approximately 2,500 agricultural extension agents serving over 35 million farmers in Nigeria, leading to a significant gap in the dissemination of knowledge about innovations and ICT. Without adequate training and support, farmers may be reluctant to adopt new practices, fearing the associated risks and uncertainties.

iv. Socio-Cultural Factors

Socio-cultural factors also play a crucial role in shaping farmers' attitudes toward adopting innovations and ICT. Traditional farming practices are deeply rooted in Nigerian agriculture, and many farmers may be hesitant to change their methods due to a lack of trust in new technologies or scepticism about their benefits (Okunlola et al., 2020). Cultural beliefs and norms can influence farmers' decision-making processes, leading to resistance against innovations perceived as foreign or incompatible with local practices.

Additionally, gender dynamics in rural areas can impact the adoption of innovations. Women, who make up a significant portion of the agricultural workforce, often face barriers related to access to resources, information, and training (World Bank, 2020). Societal norms that restrict women's mobility and decision-making authority can hinder their ability to engage with modern agricultural practices and ICT solutions, further exacerbating gender disparities in agricultural productivity.

v. Poor Policy Framework

The lack of coherent agricultural policies and regulations also hampers the adoption of innovations and ICT in Nigerian agriculture. Inconsistent government support and a lack of coordination among various agricultural agencies can create uncertainty for farmers regarding the availability of resources and assistance for adopting new technologies (Nigerian Economic Summit Group, 2021). Furthermore, the absence of clear policies supporting research and development in agriculture limits the creation of context-specific innovations that address the unique challenges faced by Nigerian farmers.

RECOMMENDATIONS FOR STRENGTHENING AGRICULTURAL INNOVATION AND ICT IN NIGERIA

To effectively enhance agricultural innovation and the adoption of Information and Communication Technology (ICT) in Nigeria, several strategic recommendations can be

implemented. These recommendations aim to address the challenges identified in previous sections and create an enabling environment for farmers to embrace modern agricultural practices. The following strategies encompass financial support, infrastructure development, capacity building, policy formulation, and promoting public-private partnerships.

i. Enhancing Access to Finance

Improving access to financial services for smallholder farmers is critical for enabling the adoption of agricultural innovations and ICT. Financial institutions, including microfinance banks and cooperatives, should develop tailored financial products that cater specifically to the agricultural sector. These products could include:

- Low-Interest Loans: Offer low-interest loans with flexible repayment terms to reduce the financial burden on farmers, allowing them to invest in modern technologies (Adebayo & Daramola, 2020).
- Grant Programs: Establish grant programs aimed at providing non-repayable funds to farmers adopting specific innovations or ICT solutions, thus reducing their financial risk (Ogundipe et al., 2021).
- Insurance Schemes: Develop agricultural insurance products to mitigate the risks associated with climate change and other uncertainties, encouraging farmers to invest in innovations without the fear of total loss (World Bank, 2020).

ii. Improving Infrastructure

Infrastructure plays a crucial role in the successful adoption of agricultural innovations and ICT. The Nigerian government, in collaboration with private sector stakeholders, should prioritize the following:

- Road Networks: Invest in rural road construction and maintenance to ensure farmers can easily access markets, inputs, and services (Adeniyi et al., 2019). Improved road networks will facilitate timely access to agricultural innovations and information.
- Electricity Supply: Increase investments in rural electrification projects to provide a reliable power supply, which is essential for the operation of ICT tools and modern agricultural equipment (Tologbonse et al., 2018).
- Storage Facilities: Establish adequate storage facilities to reduce post-harvest losses and ensure that farmers can store their produce until they secure favourable market prices (Ogundipe et al., 2021).

iii. Capacity Building and Training

To enhance farmers' ability to adopt and utilize modern agricultural innovations and ICT, it is essential to invest in capacity building and training programs. Key initiatives could include:

- Extension Services: Strengthen agricultural extension services by training more extension agents and providing them with the necessary resources to deliver effective training to farmers (FAO, 2020).
- Workshops and Training Programs: Organize regular workshops and training sessions focused on the use of modern technologies and ICT tools. Such programs should target both male and female farmers to ensure inclusivity (Okunlola et al., 2020).
- Peer Learning Platforms: Establish peer learning networks where farmers can share experiences and knowledge regarding the adoption of innovations and ICT, fostering a culture of learning and collaboration (Blench, 2010).

iv. Formulating Supportive Policies

A coherent and supportive policy framework is essential for promoting agricultural innovation and ICT in Nigeria. Policymakers should consider the following:

- National Agricultural Policy Review: Review and update the national agricultural policy to incorporate modern agricultural innovations and ICT as central components of agricultural development strategies (Nigerian Economic Summit Group, 2021).
- Incentives for Innovation Adoption: Develop policies that provide incentives for farmers and agribusinesses to adopt innovations, such as tax breaks or subsidies for purchasing modern equipment (Adebayo & Daramola, 2020).
- Collaboration with Research Institutions: Foster partnerships between government agencies, research institutions, and agricultural stakeholders to drive research and development efforts focused on context-specific agricultural solutions (FAO, 2020).

v. Promoting Public-Private Partnerships

Public-private partnerships (PPPs) can play a vital role in driving innovation in Nigerian agriculture. The government should facilitate collaborations between public institutions and private sector players by:

- Encouraging Investment: Create a conducive environment for private sector investment in agricultural innovation and ICT by reducing bureaucratic hurdles and offering incentives (Ogundipe et al., 2021).

- Leveraging Technology Providers: Collaborate with technology companies to develop affordable and accessible ICT solutions tailored to the needs of Nigerian farmers (Sani et al., 2018).
- Supporting Agribusiness Startups: Encourage the emergence of agribusiness startups that focus on innovative solutions and services for farmers. Providing mentorship, funding, and networking opportunities will stimulate entrepreneurship in the agricultural sector (World Bank, 2020).

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