UNIVERSIDADE DE BRASÍLIA
FACULDADE DE AGRONOMIA E MEDICINA VETERINÁRIA

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EXPLORATORY ANALYSIS OF NIGERIA'S PUBLIC INVESTMENTS IN AGRICULTURAL RESEARCH AND DEVELOPMENT (R&D)

Brasília-DF
2025

Universidade de Brasília
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Dissertação de Mestrado apresentada ao Programa de Pós-Graduação em Agronegócios (PROPAGA) da Universidade de Brasília, como requisito parcial para a obtenção do título de Mestre em Agronegócios.

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ANÁLISE EXPLORATÓRIA DOS INVESTIMENTOS PÚBLICOS DA NIGÉRIA EM PESQUISA E DESENVOLVIMENTO (P&D) AGRÍCOLA

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Cataloging Data Sheet

O35e OGULEDO, AUSTIN EBERE
EXPLORATORY ANALYSIS OF NIGERIA'S PUBLIC INVESTMENTS IN
AGRICULTURAL RESEARCH AND DEVELOPMENT (R&D) / AUSTIN EBERE OGULEDO; orientador Prof. Dr. Jaim Jose da Silva Junior.
Brasília, 2025.
65 p.

Dissertação(Mestrado em Agronegócios) Universidade de Brasília, 2025.

1. Agronegócio. 2. Public Agricultural Research Organizations. 3. Human Resources. 4. Innovation. 5. Investiments. I. da Silva Junior, Prof. Dr. Jaim Jose , orient. II. Título.

FOLHA DE APROVAÇÃO

Author name: OGULEDO, Austin Ebere

Title: Exploratory analysis of Nigeria's public investments in agricultural research and development (R&D).

Master's thesis submitted to the Postgraduate Program in Agribusiness (PROPAGA) at the University of Brasília, as a partial requirement for obtaining the title of Master in Agribusiness.

Presented on: December 09, 2025

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Judgement :

Result: _____

DEDICATION

I dedicate this work to God Almighty, whose goodness, mercy, and unending grace made this accomplishment possible.

My profound appreciation goes to my supervisor, Prof. Dr. Jaime José da Silva Júnior, for his guidance, patience, and unwavering support. I also dedicate this thesis to the entire FAV and PROPAGA community, and to all the professors whose teachings, encouragement, and openness made me feel truly welcomed despite being a foreigner. I would choose FAV again and again because of their excellence.

Finally, I dedicate this work to my parents and my family, whose love, prayers, and constant support have been my strength throughout this journey.

ACKNOWLEDGEMENTS

My sincere gratitude goes to the entire **FAV–PROPAGA community**, whose warmth, excellence, and support made my academic journey truly remarkable. As a foreigner in Brazil, I was welcomed with kindness, guided with patience, and strengthened by the generosity of everyone in this institution. For this, I remain deeply grateful.

My deepest appreciation goes to my supervisor, **Prof. Dr. Jaim José da Silva Júnior**, for his unwavering guidance, trust, and mentor-ship throughout this work. His dedication, patience, and encouragement were fundamental to my success.

I also express my heartfelt gratitude to the internal and external supervisors who contributed to the evaluation and strengthening of this thesis:
Profa. Mayra Batista Bitencourt Fagundes (UnB) – External to the Program;
Prof. Thales Augusto Medeiros Penha (UFRN) – External to the Institution;
Profa. Dr. Elen Presotto Internal Supervisor University of Brasilia UnB.
Your time, insights, and academic contributions added significant value to this research.

My sincere thanks also extend to all the professors under whose tutelage I had the privilege to learn: **Prof. Dr. Mauro Eduardo Del Grossi**, **Prof. Dr. Gabriel da Silva Medina**, **Prof. Dr. Luiz Honorato da Silva Junior**, **Profa. Ana Maria Resende Junqueira**, **Prof. Dr. Armando Fornazier**, **Profa. Dr. Cristina Schetino Bastos**, **Profa. Dr. Elen Presotto**, **Prof. Dr. Jader Galba Busato**, **Prof. Dr. John Paul Guimarães Soares**, **Profa. Dr. Elisângela Gomes Fidelis**, **Prof. Dr. Fabrício Oliveira Leitão**, **Prof. Dr. Jean Louis Le Guerroué**, **Prof. Dr. José Márcio Carvalho**, **Prof. Dr. Marlon Vinícius Brisola**, **Profa. Dr. Silvia Araújo dos Reis**, and **Profa. Dr. Vânia Ferreira Roque-Specht**, as well as every other professor whose name may not appear here.

Each of you contributed uniquely to my academic and personal growth. Your teachings, patience, and commitment to excellence are truly exceptional. You are **Top Notch**, and I would choose FAV and PROPAGA again and again, any day and any time.

Thank you for believing in me and shaping my journey with your knowledge and humanity. May God bless you all abundantly.

CITATION OF EPIGRAPH

Sustained agricultural growth is not accidental; it is built through long-term investment in research and development (R&D).ALSTON; PARDEY (2014)

ABSTRACT

This article explores the way innovations and investments in the research and development (R&;D)sector are important for the Nigerians transformation in the agriculture industry. Nigeria has consistently allocated insufficient resources to research and development over the years, which results in food insecurity and productivity dormancy even despite the Nation's enormous agricultural potential. This report highlights the need for more investments in agricultural research for the purpose of promoting innovation, to boost the economy output, and as well guarantee food security in the Nation. Inadequate financing, a lack of infrastructure, also a lack of stakeholder participation is among the major issues the paper highlights thereby examining the current status of agricultural R&D in Nigeria. It also emphasizes how important it is to follow the prosperous examples of countries like China, that have successfully used research and development (R&D) to increase agricultural productivity. The findings hereby demonstrate the innovative approaches which are combined focus on deliberate R&D spending which may greatly increase agricultural output, thereby providing employment, and help to lower poverty in Nigeria. In order to go ahead promoting resilience and sustainable growth in the agricultural sector especially Nigeria, the essay ends with the suggestions for policymakers on the way to give agricultural research and development a top priority in the national development plans.

Keywords: Public Agricultural Research Organizations, Human Resources, Innovation, Investments.

RESUMO

Este trabalho analisa a importância das inovações e dos investimentos em pesquisa e desenvolvimento (P&D) para a transformação do setor agrícola na Nigéria. Ao longo dos anos, o país tem destinado recursos insuficientes à pesquisa e ao desenvolvimento agrícola, o que tem contribuído para a persistência da insegurança alimentar e para a estagnação da produtividade, apesar do elevado potencial agrícola nacional. O estudo destaca a necessidade de ampliar os investimentos em pesquisa agrícola como estratégia fundamental para promover a inovação, impulsionar o crescimento econômico e garantir a segurança alimentar no país. Entre os principais desafios identificados estão o financiamento inadequado, a carência de infraestrutura e a limitada participação dos diferentes atores envolvidos no sistema de inovação agrícola, aspectos analisados a partir do panorama atual do P&D agrícola na Nigéria. O trabalho também enfatiza a relevância de experiências bem-sucedidas de países como a China, que utilizaram investimentos consistentes em pesquisa e desenvolvimento para elevar significativamente a produtividade agrícola. Os ensure results demonstram que abordagens inovadoras, associadas a uma alocação deliberada e estratégica de recursos em P&D, podem ampliar a produção agrícola, gerar empregos e contribuir para a redução da pobreza na Nigéria. Por fim, o estudo apresenta recomendações direcionadas aos formuladores de políticas públicas, ressaltando a necessidade de atribuir prioridade à pesquisa e ao desenvolvimento agrícola nos planos nacionais de desenvolvimento, como forma de promover resiliência e crescimento sustentável no setor agrícola.

Palavras chaves: Organizações públicas de pesquisa agrícola; recursos humanos; inovação; investimentos

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LIST OF ACRONYMS AND ABBREVIATIONS

AgGDP	Agricultural Gross Domestic Product
AGRA	Alliance for a Green Revolution in Africa
APP	Agricultural Promotion Policy
ARCN	Agricultural Research Council of Nigeria
ASTI	Agricultural Science and Technology Indicators
ATA	Agricultural Transformation Agenda
BSc	Bachelor of Science
CAADP	Comprehensive Africa Agriculture Development Programme
FAOStat	Food and Agriculture Organization of the United Nations (FAO).
FCT	Federal Capital Territory
FTE	Full-Time Equivalent.
GDP	Gross Domestic Product.
GESS	Growth Enhancement Support Scheme
IFPRI	International Food Policy Research Institute
MSc	Masters of Science
NATIP	National Agricultural Technology and Innovation Policy
NEPAD	New Partnership for Africa's Development
NEP	National Extension Policy
PEA	Public Spending on Agriculture
PhD	Doctor of Philosophy
PPP	Public-Private Partnerships/Purchasing Power Parity
R&D	Research and Development
SMEs	Small and Medium Enterprises

SUMMARY

1 INTRODUCTION

A significant portion of Nigeria's population lives in rural areas and most of the country's workforce derives their primary source of income and employment from agriculture, which serves as the backbone of the nation's economy. According to the World bank 2024 about 47% of Nigeria's population lives in rural areas and agriculture represents around approximately 24% of the Nations GDP.

The transition to a petroleum-based economy in subsequent decades, however, resulted in the neglect of agricultural research, extension, and infrastructure. Despite abundant arable land and ecological diversity ranging from semi-arid Sahel in the north to humid rainforest in the south, the sector’s productivity has been constrained by low R&D investment, averaging only 0.4% of AgGDP (ASTI, 2023).

Recent national and international initiatives — such as the Agricultural Transformation Agenda (ATA), the IITA-led research networks, and collaborative programs between Nigeria and Brazil have aimed to revitalize R&D systems, promote innovation and technology adoption, and expand agribusiness linkages. These partnerships are strategically important: Brazil’s technological expertise in tropical agriculture and Nigeria’s vast agricultural potential offer mutual opportunities for sustainable development and food security (IFPRI, 2023).

Despite the importance of agriculture for the country economy and population, the sector has faced numerous challenges, which includes low productivity, inadequate infrastructure, and the lack of R&D investments. The comparison between Nigerian and Brazilian numbers of agricultural productivity in crops with significant cultivated area in both countries such as maize and cassava, reveals the magnitude of the challenges which Nigeria is facing. While Brazil mean productivity is around 6 tons per hectare in maize and 5 tons in cassava, Nigeria productivity is close to 2 tons per hectare in maize and 1 ton per hectare in cassava (FAOStat, 2025).

Indeed, Nigeria agriculture as whole would benefit from increasing public investments in agricultural R&D. Many studies have identified the importance of R&D investments in rural population welfare and agricultural productivity. Specifically in the Nigerian case, which register year by year a significant amount of agricultural products importation, the increasing of agricultural R&D investments will reduce the country´s external dependence and wean itself off of its dependency on oil. (Daniel; Maiwada 2015). Also, investing in research and

development is essential to foster food security and achieve national development goals, which includes eradicating hunger (Gbadamosi; Oniku, 2015; Khalid *et al.*, 2021).

Nigeria could thereby learn a lot from Brazil's agricultural development experience, especially on how to use R&D to increase agricultural output and food security. Millions of people have been able to leave poverty because of the spectacular growth of Brazilian agricultural production and productivity, which is based on the integration of technology, research, and farmer education (Buainain *et al.*, 2014). In this sense, Nigeria could benefit from Brazilian experience, and avoid some mistakes regarding the incentives and public investments for agriculture development. It is intended that this research helps to improve Nigeria socioeconomic growth by revealing possible avenues for raising agricultural output and guaranteeing food security in the country.

1.1 Justification of the study

Nigeria has enormous potential to boost agricultural productivity and output. Nigeria is a country that has a large labor force because the Nigerian population is almost equal to that of Brazil with a lot of mineral resources, water resources and arable land for agricultural productions. If these resources are used effectively, agriculture might thereby become a major factor in the economic growth and development in the Nigerian Nation.

Investments in agricultural research and development (R&D) are essential to bringing about this change. That is why the dissertation dives into this sector to make improvements. R&D acts as a stimulant for agricultural innovations, productivity, sustainable agriculture, encouraging the creation of durable and high-yielding crop varieties, contemporary farming methods, etc. Even though agricultural research and development is widely recognized as a critical tool of productivity and growth, food system resilience, and rural economic transformation there is still a great noticeable scarcity of academic studies which focus specifically on R&D investment in Nigerian agriculture (Akinbode; Adebayo, 2020). The Nigerian case will always show a significant academic and institutional gap. Also, international organizations such as IFPRI and the World Bank periodically report that African countries, especially Nigeria, under invest in agricultural research when compared to global averages; however, Nigeria receives far less dedicated scholarly attention than other nations of similar size and agricultural dependence (IFPRI, 2022; World Bank, 2023). This gap in scientific production also makes it very difficult for policymakers, development agencies,

agribusiness investors, and public institutions to rely on the solid, data-driven evidence when designing policies for innovation, technology development, and the sector modernization.

Therefore, the limited number of scientific studies that examine how agricultural R&D is funded, implemented, and translated into measurable outcomes represent an important gap in both academic literature and national planning priorities. For this reason, this dissertation is justified not only by the socioeconomic relevance of the theme but also by the special need to contribute to an under-exploited field of research, thereby providing updated and evidence-based analysis of agricultural R&D investment in Nigeria. The study adds new knowledge to a field where consistent inquiry is still lacking, supporting the development of policies rooted in statistical evidence, economic reasoning, and agricultural innovation frameworks.

1.2 Main goal of the study

The primary aim of this study is to investigate the dynamics and as well the structure of public agricultural research and development (R&D) investments in Nigeria. By delving into these mechanisms of R&D funding and allocations, the study will seek these specific objectives as follows:

- **Assess the Allocation of R&D Investments,**

Evaluate how agricultural R&D funds will be allocated to various sub-sectors of the agribusiness, such as crop production, livestock development, fisheries, aggro-processing, etc. The analysis will help to determine whether the current investment priorities effectively address the specific needs and challenges of Nigeria's agricultural sector

- **Evaluate Structures and Capacities**,

Examine various aspects of Nigerian public agricultural research organizations, which includes capacities, staff and human resources

- **Investigate Regional Disparities**

Another critical area of focus in this study will be regional disparities in agricultural R&D investments. The study will assess how the funding is distributed across Nigeria's geopolitical zones and areas, providing insights into the regional challenges and the opportunities in agricultural innovation.

The findings will aim to inform the policies and strategies to optimize funding, strengthen institutional capacities, and promote sustainable growth and innovation in Nigeria's agricultural sector.

2 LITERATURE REVIEW

2.1 Nigeria history and society

Archaeological and historical evidence indicates that the territory now called Nigeria hosted ancient civilizations such as the Nok Culture (500 BCE–200 CE), renowned for early iron-smelting and terracotta art (Britannica, 2024). Successive empires, notably the Kanem-Bornu, Oyo, and Benin Kingdoms, established complex trade and governance systems long before European contact.

European contact with the territory now known as Nigeria began in the late 15th century when Portuguese explorers arrived along the West African coast around 1472 (Davidson, 1991). Until before this period, the region already hosted well-established states and civilizations such as the Benin Kingdom, Oyo Empire, and Hausa city-states, known for advanced political and economic systems (Falola; Heaton, 2008). Early interaction with Europeans began through coastal trade involving ivory, spices, and eventually the transatlantic slave trade (Rodney, 1972). Over time, British economic and military interests expanded inland as commerce increased (Law, 1991). By the 19th century, missionary activity and treaties strengthened European influence across different regions (Falola; Heaton, 2008). These developments laid the foundation for the gradual consolidation of diverse societies into a single colonial state under British rule in the early 20th century (Crowder, 1978).

The arrival of the Portuguese in 1472 marked the beginning of external interaction, followed by centuries of the trans-Atlantic slave trade that deeply affected the region's socio-economic structures (History of Nigeria, 2024). In 1914, the British colonial administration merged the Northern and Southern Protectorates into a single entity named *Nigeria. The* division into Northern and Southern Protectorates was established by the British to administer territories acquired through treaties, military conquest, and commercial expansion, each governed separately according to local political and economic conditions. The North was administered indirectly through traditional rulers, while the South was controlled more directly due to greater European presence and commercial activity

Thus, laying the foundation for the modern state (Britannica, 2024). The drive toward independence accelerated through a series of constitutional reforms and expanding regional self-government in the 1940s–1950s, which gradually transferred administrative responsibilities to Nigerian leaders and strengthened nationalist parties (Falola; Heaton, 2008). Political mobilization by figures such as Nnamdi Azikiwe, Obafemi Awolowo and Ahmadu Bello, together with the outcome of the 1959 federal elections and subsequent

coalition arrangements, created the political conditions that allowed Britain to grant full sovereignty; the Nigerian Independence Act was passed in July 1960 and formal independence was proclaimed on 1 October 1960. (Britannica, 2024; Falola; Heaton, 2008).

Independence was achieved on 1 October 1960, followed by the declaration of a Federal Republic in 1963. Post-independence Nigeria experienced alternating periods of civilian and military rule, with critical events such as the 1967–1970 Civil War (Biafran War) shaping the national consciousness. Democratic governance was permanently restored in 1999, and since then the country has consolidated its federal structure with executive, legislative, and judicial powers constitutionally separated (Nigerian Government, 2024).

The Nigerian Civil War (1967–1970) began when the Eastern Region, predominantly inhabited by the Igbo population, declared independence as the Republic of Biafra after political unrest and ethnic killings, leading to armed conflict with the Nigerian Federal Government (Falola; Heaton, 2008). International involvement was decisive: Britain, the Soviet Union, and the United States offered diplomatic and military support to the federal government for strategic and economic interests, while France and a few African nations provided limited backing to Biafra (Nnoli, 2003). The conflict caused severe humanitarian disasters, including mass starvation and significant loss of life, reducing the labor force and deeply damaging agricultural and industrial production capacities (Okeke, 2010). The war ended with the defeat of Biafra and the Nigerian government's policy of "No victor, no vanquished," intended to promote reconciliation and national unity (Falola; Heaton, 2008). Postwar reconstruction included rebuilding infrastructure, reintegrating displaced civilians, and restoring economic activities, which supported Nigeria's gradual recovery from the extensive devastation (Okeke, 2010).

Linguistic and cultural diversity define the nation, with over 250 ethnic groups and more than 500 languages. The three major groups are the Hausa-Fulani in the north, Yoruba in the southwest, and Igbo in the southeast, alongside numerous minority groups contributing to Nigeria's cultural mosaic (FAO, 2023).

Figure 1 – Nigeria ethnic groups

Sources: Anthro Addis, based on data from the World Fact book (2018).

2.2 Nigeria territory, economic activity and climate

The Federal Republic of Nigeria is located in West Africa, bordered by Benin to the west, Niger to the north, Chad to the northeast, and Cameroon to the east, with an extensive southern coastline along the Gulf of Guinea. Its territorial extension is approximately 923,768 km², making it one of the largest countries on the African continent (Britannica, 2024). The nation is divided into 36 states and a Federal Capital Territory (FCT), whose capital, Abuja, was established in 1991 to promote national integration.

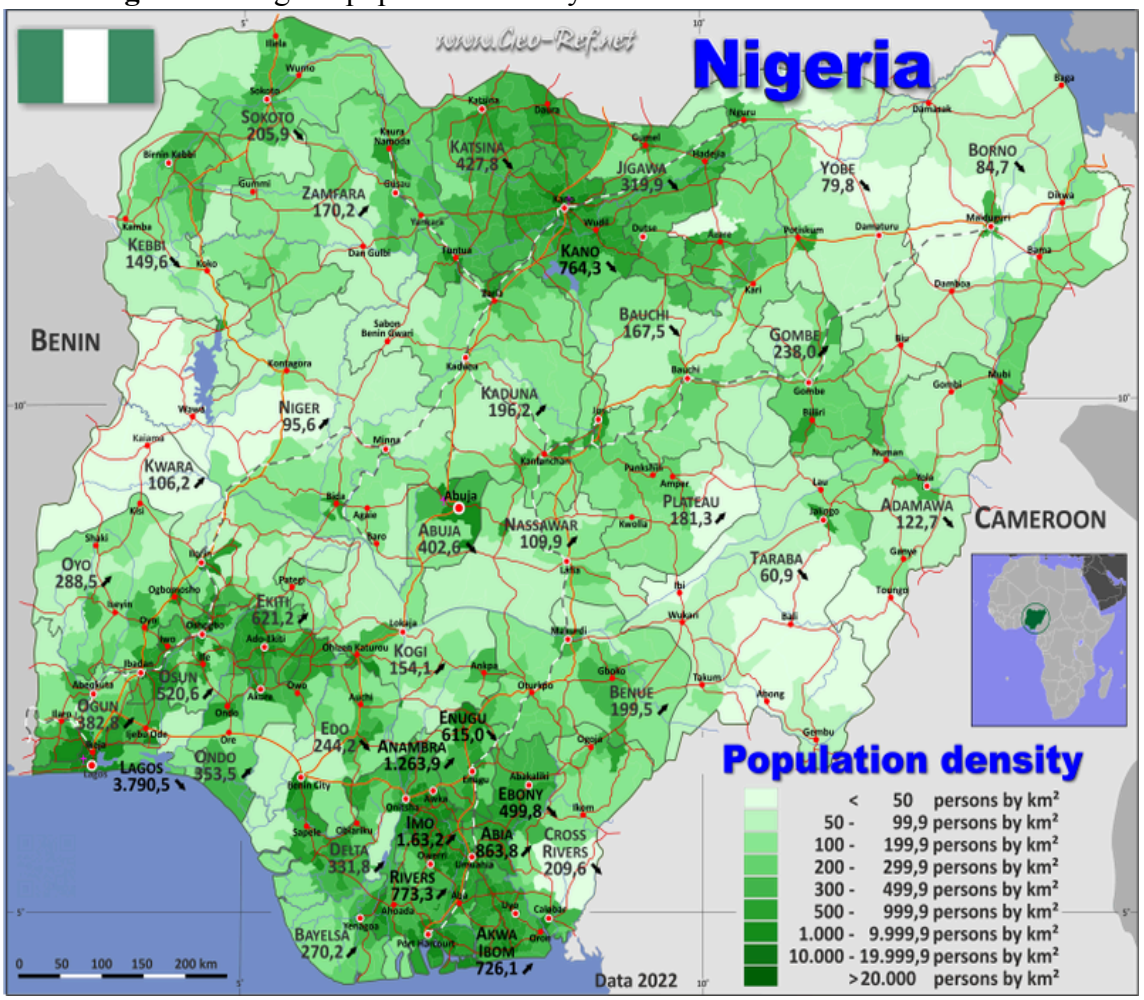
Nigeria, which is Africa's most populous nation, has over 220 million people living in the country, with nearly 47% of these people are living in the rural areas, like in the northwest, which is considered to have the highest rural population density (World Bank, 2024).

In these rural areas agriculture majorly sustains their livelihoods. Nigeria was once heavily dependent on agriculture before oil was discovered in the 1950s. Nigeria became a crude oil exporter, but yet agriculture still contributes about 24% of the nation's GDP and also

employs the majority of the labor force (World Bank 2023). Nigeria's population density map shows a highly uneven distribution of people across the country, with the highest concentrations located in the southern and north-central regions. Areas such as Lagos, Anambra, Imo, Enugu, and Rivers have very high population densities, in some cases exceeding 1,000 persons per square kilometer. This is mainly due to greater urbanization, industrialization, economic activity, and better access to social services, which attract internal migration. The federal capital territory, Abuja, also shows significant density growth due to rapid urban expansion and administrative importance.

In contrast, the northern regions, especially states such as Borno, Yobe, Taraba, and Niger, display much lower population densities. These areas have larger landmass, fewer large urban centers, lower rainfall, and in some cases, security challenges and desert-prone landscapes that reduce intensive settlement. The map highlights how Nigeria's demographic distribution is strongly influenced by economic opportunities, geography, and infrastructure development. This imbalance creates pressure on services in densely populated southern cities, while sparsely populated northern states face challenges such as limited labor availability, slower market development, and higher cost of public service delivery per capital.

Figure 2 – Nigeria population density



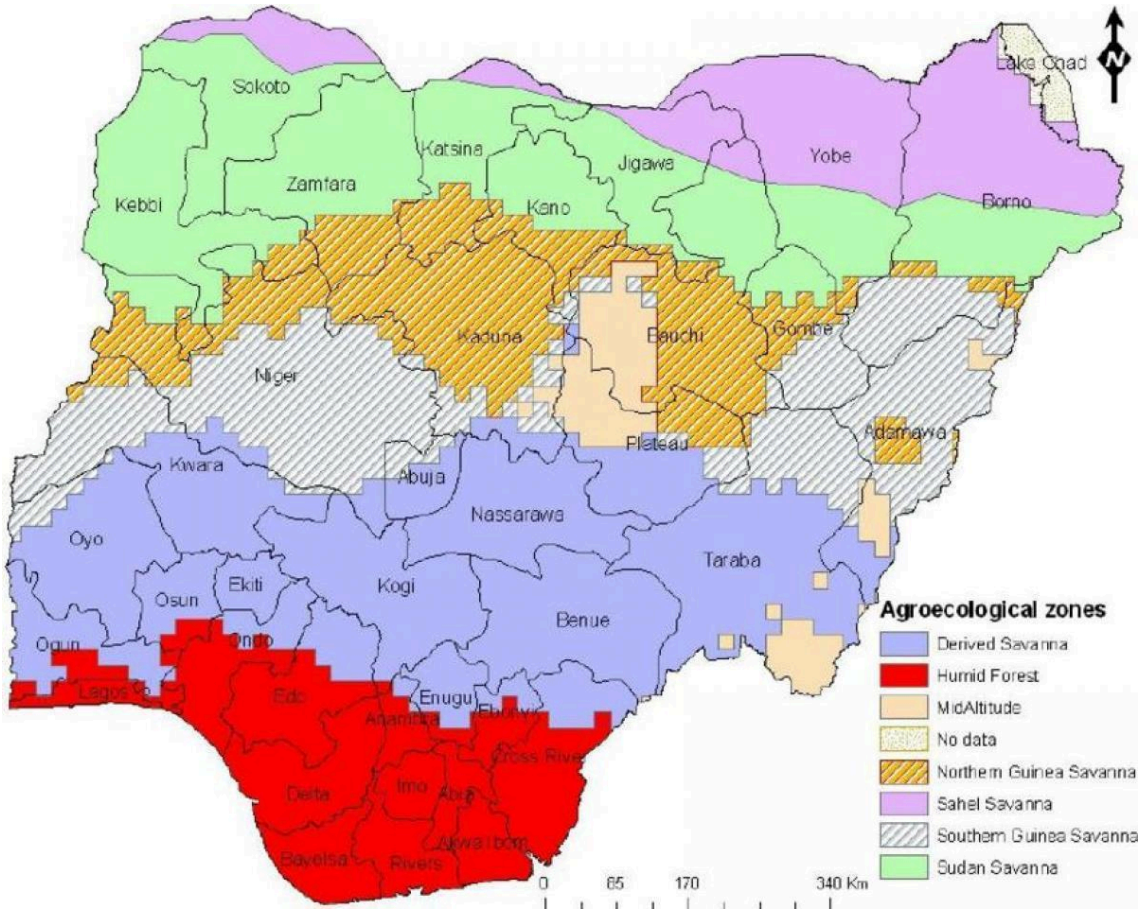
Sources: GEO-REF.NET. *Nigeria – Population Density Map*. 2022.

Nigeria is divided into distinct agroecological zones shaped by rainfall patterns, temperature, soil characteristics, and vegetation. In the northern part of the country, the **Sahel, Sudan, and Northern Guinea savannas** dominate, characterized by lower rainfall, open grassland vegetation, and sandy loam soils. These zones support cereal crops such as millet, sorghum, and maize, as well as legumes like cowpea and groundnut. The long sunshine hours also make them suitable for cotton, sesame, and livestock rearing, particularly cattle and goats. However, limited rainfall and advancing desertification present challenges for sustainable agricultural productivity, increasing dependence on irrigation infrastructure and drought-resistant crop varieties.

Moving southward, rainfall increases and the environment shifts from the Southern Guinea savannah to the rainforest and mangrove coastal zones, which possess deeper, more fertile soils and dense vegetation. These humid regions are well-suited for root and tuber cultivation, including cassava, yam, and cocoyam, and support major perennial cash crops

such as cocoa, oil palm, rubber, kola nut, and plantain. The Niger Delta and coastal zones also provide extensive conditions for aquaculture and inland fisheries. Overall, Nigeria's agri ecological diversity enables a broad agricultural portfolio, but each zone requires tailored policies, adaptive technologies, and investment in climate-resilient practices to fully realize its production potential.

Figure 3 – Nigeria Agroecological Zones



Sources: InMAP (2025).

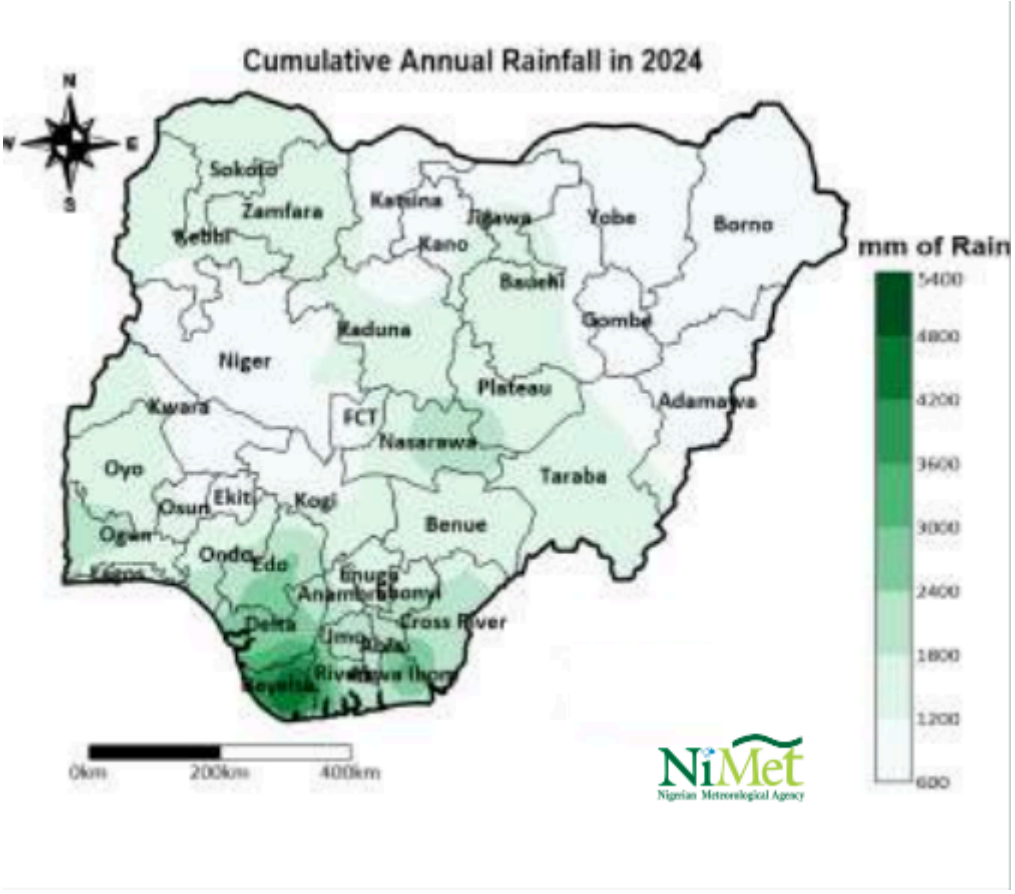
Nigeria presents diverse climatic zones ranging from the semi-arid Sahel in the far north to humid rainforest and mangrove belts in the south, with a clear gradient of decreasing rainfall from coast to inland. Southern regions receive more than 1,200 mm of annual precipitation, the middle belt records between 800 and 1,200 mm, while the far north experiences short rainy seasons with totals below 600 mm per year (FAO, 2024). These variations determine agricultural calendars, crop suitability, and resource management strategies across ecological zones.

The country's natural resources include extensive river systems such as the Niger and Benue, fertile soils across the savannas and middle belt, and mineral deposits including oil,

tin, limestone, and coal (Nigerian Government, 2024). However, dependence on petroleum exports has historically reduced investments in agricultural infrastructure and research systems, limiting productivity gains despite abundant arable land and favorable agroecological potential (FAO, 2024).

Studies show that Nigeria has significant potential for irrigated agriculture, estimated between 1.5 and 3.2 million hectares, but only a small portion is developed due to financing, maintenance, and institutional constraints (World Bank, 2024). Small-scale irrigation systems—such as groundwater pumping, small reservoirs, and river diversions—are technically viable and offer a realistic solution for improving dry-season food production, especially in the northern regions where rainfall is limited and highly seasonal (World Bank, 2024)

Figure 4 – Cumulative Rainfall in Nigeria – 2024



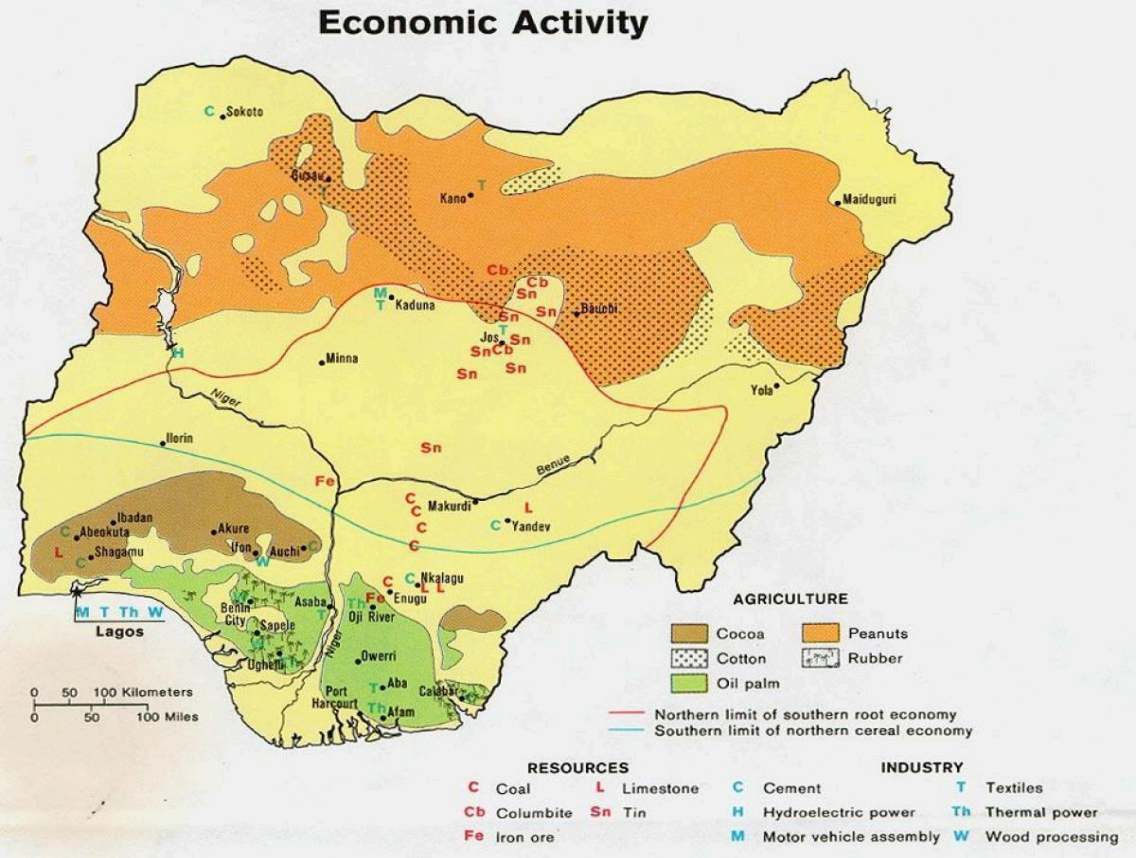
Sources: Nimet (2025).

The Nigeria agricultural map illustrates the spatial distribution of Nigeria's major agricultural production zones, highlighting how climatic conditions, soil types, and ecological

variations shape the country's farming systems. The northern regions—particularly states such as Kano, Kaduna, Jigawa, Borno, and Katsina—are dominated by Savannah and semi-arid climates, which favor the large-scale cultivation of sorghum, millet, maize, groundnuts (peanuts), sesame, cowpea, and cotton. This region also hosts significant irrigation schemes along the Hadejia-Jama'are and Sokoto River basins, allowing dry-season farming through systems such as the Kano River Irrigation Project. Livestock, including cattle, goats, and sheep, is also heavily concentrated in northern Nigeria due to expansive grazing reserves and nomadic pastoral routes.

In contrast, the central and southern zones of Nigeria benefit from higher rainfall and more fertile soils, supporting tree crops and root-based agricultural systems. The Middle Belt—covering states such as Benue, Kogi, Plateau, and Niger—is recognized as the country's "food basket," producing large quantities of yam, cassava, soybeans, rice, sweet potatoes, and oil seeds. Moving further south into humid rainforest regions like Edo, Ondo, Cross River, Abia, and Delta, the map shows concentrations of major cash crops, including cocoa, rubber, palm oil, plantain, banana, and kola nut. Coastal areas also support extensive fisheries and aquaculture, especially in the Niger Delta river network. Overall, the agricultural map demonstrates Nigeria's ecological diversity and how production is spatially aligned with climate patterns—from dry northern cereal systems to southern perennial crop economies—reflecting the country's significant potential for diversified agricultural development and agro-industry expansion.

Figure 5 – Nigeria Agriculture Map



Sources: Maps-Nigeria (2025).

2.3 Nigeria Agricultural Sector

Historically, Nigeria was a global exporter of cocoa, groundnuts, and palm oil before oil discovery shifted focus in the 1970s (FAO, 2023). Despite its rich agro-ecological zones, the sector still faces low productivity, weak R&D funding, and limited mechanization (ASTI, 2023).

Nigeria's agricultural sector presents a persistent imbalance between high production volumes and low productivity, a pattern widely documented in FAO and national assessments. Root and tuber crops such as cassava and yam exceed 60 million tonnes annually, consolidating Nigeria as the world's largest producer of these commodities (Otekunrin *et al.*, 2024; FAO, 2023). Despite these impressive totals, average yields remain well below potential because production is dominated by low input, rain-fed smallholder systems with limited access to improved seeds, fertilizers, mechanization, and irrigation (Wossen *et al.*, 2023). Similar productivity gaps affect cereals: maize, rice, and sorghum occupy millions of hectares, yet average yields remain modest compared with global benchmarks, even though rice production has increased in recent years (USDA, 2024). As a result, Nigeria continues to

rely on substantial imports of milled rice, revealing the structural tension between domestic supply and consumption needs (USDA, 2024; FAO, 2022).

Trade and spatial distribution of production further shape Nigeria's agricultural performance. The country imports large quantities of high-value staples, including rice and wheat, while exporting relatively smaller but expanding volumes of value-added products such as cocoa, cashew, sesame, and processed palm oil derivatives (FAO, 2023; USDA, 2024). Spatial disparities remain pronounced: the northern states dominate in grains (maize, sorghum, millet), whereas the southern and Middle Belt regions lead in tubers and oil crops (Wossen *et al.*, 2023). These regional dynamics interact with infrastructure deficits, insecurity, climate shocks, and limited access to processing facilities, creating uneven agricultural outcomes. Consequently, improving productivity and reducing dependence on food imports requires targeted policies—including investment in irrigation, seed systems, extension services, rural roads, and agro-processing—designed according to the specific needs of each production zone (FAO, 2023; Otekunrin *et al.*, 2024).

Going forward, Gidanmana (2020) emphasized that Nigeria's agriculture, which once contributed 57% of GDP and 64.5% of export earnings, is now contributing only 23.5% of GDP and 5.1% of exports, which is due to neglect and weak value-chain development in the sector. The study highlighted that inadequate access to improved seeds, fertilizers, and processing infrastructure has limited productivity, while cocoa and dairy case studies show that targeted investments and research partnerships could boost yields by up to 70% and reduce import dependence. The author also concluded that transforming Nigeria's agricultural value chain requires massive R&D investment, extension support, and policy reforms to promote innovation-driven growth.

2.4 Nigeria Agricultural Policies

The Nigerian government has recognized the importance of R&D in agriculture and has introduced various policies and programs to support it. The Agricultural Transformation Agenda (ATA) and the more recent Agricultural Promotion Policy (APP) aim to create an enabling environment for research and innovation (FMARD, 2016).

The Agricultural Transformation Agenda (ATA) was launched in 2011 to shift Nigerian agriculture from a subsistence system to a market-oriented and private-sector-driven sector (FMARD, 2014). Its main goals included improving productivity, reducing food imports, expanding commercial agriculture, and increasing farmer access to improved seeds,

fertilizers, credit, and extension services. ATA introduced programs such as the Growth Enhancement Support Scheme (GESS), which used a digital input system to provide subsidized farm inputs directly to farmers, reducing corruption in fertilizer distribution (World Bank, 2017). Funding under ATA came from a mix of federal budget allocations, collaboration with development partners, and initiatives that encouraged private investment in value chains. The policy did not focus on tax exemptions but instead emphasized public spending, institutional reforms, and new governance frameworks to stimulate agricultural technology adoption and efficiency (FMARD, 2014).

The Agricultural Promotion Policy (APP), implemented from 2016 to 2020, continued the transformation strategy but shifted focus toward improving the business environment for agricultural investment and tackling persistent supply-chain constraints such as logistics, market access, storage, and commodity pricing (FMARD, 2016). APP aimed to ensure food security, expand aggro-processing, and enhance competitiveness through policy incentives, partnerships with local and international investors, and targeted public spending in agricultural research and infrastructure. Although the APP also did not primarily rely on tax exemption programs, it promoted government spending in areas such as irrigation, research and development, seed quality regulation, and farmer support services to stimulate private sector participation (AFDB, 2018). In both ATA and APP, the federal government positioned itself as a facilitator, creating an enabling environment and directing public investment to mobilize private capital and support technological modernization of agriculture (FMARD, 2016). These policies focus on enhancing funding mechanisms, improving infrastructure, and promoting public-private partnerships (PPPs) to drive research initiatives.

Hatzenbuehler and Mavrotas (2024) examined whether Nigeria's Agricultural Transformation Agenda (ATA, 2011–2015) produced lasting impacts on farm input markets after its implementation. Using trade data (1996–2021) and LSMS-ISA household surveys, they found that imports of maize and vegetable seeds increased by over 50%**,** and herbicide and pesticide imports became more stable in the post-ATA years**.** Farm-level evidence showed higher adoption: fertilizer purchases rose from 42% in 2012–2013 to 56% in 2018–2019, seed purchases from 28% to 49**%**, and herbicide use from 28% to 57%**.** These results indicate that despite fluctuating public funding, short-term policies with strong private-sector participation can generate persistent positive effects on agricultural modernization and input use in Nigeria.

By increasing the government spending on the subsidized seeds and fertilizers, Nigeria's 2011–2015 Agricultural Transformation Agenda (ATA) aimed for the increase in farm productivity (Hatzenbuehler *et al.*, 2023). When it was put into practice, the receivers of

subsidies produced large and gained a good understanding of agricultural endeavors. However, Hatzenbuehler *et al.* (2023) assert that the benefits of these products vary, with the peri-urban farmers reaping more benefits from the enhancement of market accessibility and infrastructure. Despite these differences, ATA has marked a significant shift in Nigeria's agricultural landscape, especially for farmers close to the urban areas. Nigeria and other African countries have realized how important it is to improve their agricultural extension curricula to enhance the agricultural production and food security in Africa.

Dimelu *et al.* (2023) emphasize the significance of addressing the competency gaps in the curriculum to adequately prepare the extension agents for the challenges faced in the agricultural sector in the African nations. The authors also argue that integrating experiential learning and practical skills in the curriculum is necessary to promote effective farming practices and community involvement. Additionally, Babu *et al.*(2020) explains in details how the National Extension Policy (NEP) is essential to changing Nigeria's agricultural sector through the increase of smallholder farmers' productivity for efficient knowledge sharing and agricultural extension service, the difficulties we encounter while implementing the NEP at the state level and the necessity of a pluralistic and the demand-driven extension system which is the importance of incorporating good governance principles into agricultural interventions to achieve sustainable service delivery and the findings that will support a multi-stakeholder approach in addressing the specific issues impeding policy implementation especially in Niger State Nigeria. The NEP also supports the transition from subsistence to agribusiness for the purpose of improving household welfare and contributing to the GDP of the country.

Aremu and Reynolds (2024) analyzed 9,815 panel observations from 5,781 rural Nigerian households across three waves (2012/13–2018/19) to measure the welfare effects of agricultural extension. Only 18.25 % of households had ever received extension, yet participation reduced food insecurity by 1.26 FIES points (=15.75%) and increased household assets by 0.493 log points (= 64%)**.** Access to seed-related advice cut food insecurity by 12–13% and boosted assets by 113%, while fertilizer guidance reduced food insecurity by 15% and raised assets by 92%. The study concludes that improving both the coverage and quality of extension services is crucial for achieving equitable rural welfare gains in Nigeria.

Also, the study of Olomola (2014) provides valuable insight into the financial and operational challenges faced by agrodealers in Nigeria. It shows that many agrodealers struggle with limited access to credit due to high interest rates, insufficient assets, and weak organizational structures. Participation in trade associations and improved business training

are identified as key factors in enhancing their creditworthiness. Strengthening agro dealers financing mechanisms is essential for effective agricultural input distribution and sectoral growth in Nigeria.

Building on this, AGRA (2015) emphasizes that access to quality agricultural inputs remains a foundational barrier to productivity in sub-Saharan Africa. The report highlights that rural agrodealer networks are still weak, with many farmers traveling over 20 kilometers to access basic inputs. Financial constraints, limited awareness, and poor infrastructure continue to hinder agro dealers' growth and effectiveness. AGRA's investments in training over 25,000 agro dealers across 18 countries demonstrate promising strategies for enhancing input delivery systems.

Continuing this trajectory, AGRA (2020) expanded its agro dealer support by building networks and training over 6,500 retail agro dealers across six African countries, supplying 61,000 metric tons of seed and nearly 1 million metric tons of fertilizer to over 4.8 million smallholder farmers. These interventions improved input access, technical capacity, and market linkages in under served rural areas. Despite this progress challenges such as weak business ethics, limited outreach in remote zones, and underdeveloped agri dealers associations persist. The study emphasizes the need for further investment in training, infrastructure, and policy to sustain agrodealer-led transformation in seed systems.

Adding to the policy dimension, Balana and Fasoranti (2022) trace over five decades of fertilizer policy shifts in Nigeria, highlighting inconsistency and weak implementation as recurring setbacks. Despite being one of the top fertilizer producers in sub-Saharan Africa, Nigeria's average application remains around 20 kg far below the global average. The study underscores how poorly structured subsidy programs and weak infrastructure limit access for smallholders. The recent NATIP policy offers a promising shift toward private investment and long-term sector reform.

Further emphasizing the financing gap, Watse (2017) found that 96% of Nigerian small and medium enterprises (SMEs), many operating in agriculture and aggro-related sectors, are struggling to access credit due to poor financial records, lack of collateral, and institutional weaknesses. The study highlighted that while internal funding and informal sources remain dominant, bank loans are often inaccessible. Key findings revealed that only well-structured SMEs with sound record keeping accessed formal credit. Watse (2017) concludes that policy reforms and capacity building are essential to improving financial inclusion for Nigerian SMEs. Moving forward, Takeshima, H. *et al.* (2020) provides comprehensive research on public spending on agriculture in Nigeria and the relationship to

the outcome's agriculture. Its emphasis is the historically little amount of government spending on agriculture even though the sector contributes significantly to employment. The authors in their research intend to fill in the existing evidence gaps about public expenditures on agriculture (PEA) and their effects on agricultural productivity by integrating sub-national expenditure data with the nationally representative household-level data. The research in this study adds to their understanding of how public investment impacts rural welfare and development while providing a critical evaluation of urban bias in agricultural policy.

While using a range of statistics, it also offers stakeholders the practical policy implications for enhancing Nigeria's agricultural performance highlighted on sustainable farming techniques which are crucial for enhancing food security and minimizing environmental degradation (Rumpel *et al.*,2020). The authors emphasize the 4 per 1000 initiative, which aims to improve soil organic carbon sequestration as an approach in mitigating climate change. In keeping with the global sustainability goals, the initiative emphasizes sustainability of land management practices in the effort to integrate ecological restoration with agricultural output. Furthermore, in order to promote the sustainability of agricultural practices globally, (Pawlak; Kołodziejczak, 2020) reviews emphasizes the link between agriculture and food security in developing countries, a case study of Nigerian Nation and offers strategies to boost food access, rural household purchasing power, and agricultural infrastructure. The idea of a circular economy in the bibliometric analysis of R&D investments is becoming more popular as a sustainable agricultural strategy. (Zucchella et al.,2019) as well investigate how circular business models might support sustainability, more especially when it comes to agricultural waste. They contend that the development of successful circular ecosystems in agriculture depends on the innovation and cooperation between suppliers, consumers, and government agencies. This viewpoint is especially pertinent as the agriculture industry works to minimize it. Governance and policy frameworks are central to promoting innovation and investment in agricultural R&D.

2.5 Contemporary Challenges and Opportunities

Nigeria faces persistent challenges, including infrastructure deficits, climate variability, and policy in consistency (World Bank 2023). Nigeria continues to grapple with the deep-rooted infrastructural challenges which hinders national development, especially in agriculture and industry. Although the country has a widespread road network, the majority of these roads suffer from poor maintenance, erosion, and inadequate investment in repairs.

Rural feeder roads that link farming communities to markets are often unpaved and become unusable during the rainy season, causing high transportation costs and worsening post-harvest losses. For example, agricultural zones in states such as Benue, Kaduna, and Niger face serious difficulties transporting fresh produce to major consumption centers like Lagos and Abuja due to deteriorated highways marked by large potholes and limited alternative logistics support. Rail transport also remains weak. Despite having one of Africa's longest historical rail networks, most tracks are obsolete, single-lane, and fail to reach key farming and industrial areas. Recent projects such as the Abuja–Kaduna and Lagos–Ibadan lines show progress, but they remain insufficient to meaningfully address nationwide connectivity gaps needed for a competitive supply chain.

Export and maritime logistics also pose significant obstacles. Nigeria has several major seaports, for example, Lagos (Apapa and Tin Can), Port Harcourt, Calabar, and Warri but they are frequently congested, slow-moving, and burdened by inefficient customs processes, inadequate cargo-handling equipment, and limited integration with inland transport systems. As a result, container dwell time can reach up to 15–20 days (about 3 weeks) in Lagos ports, compared with only a few days in more efficient ports around the world, according to World Bank assessments (World Bank, 2021)

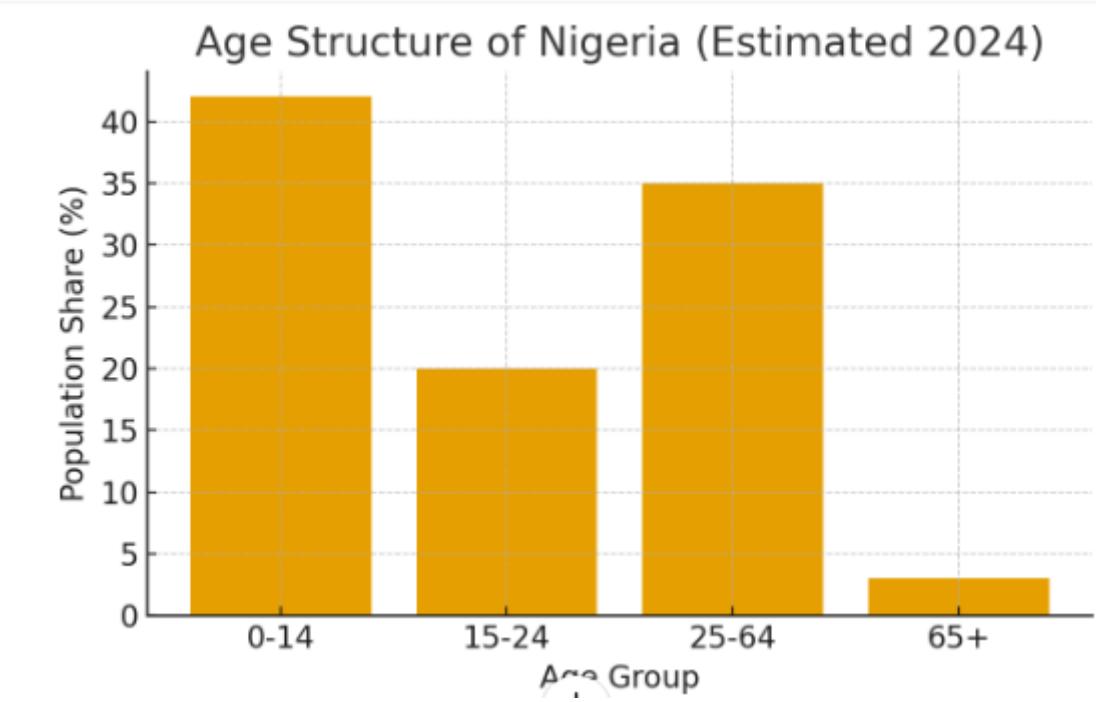
Inland waterways, which could serve as a cheaper and more sustainable mode of moving bulk agricultural goods, remain largely underdeveloped due to insufficient dredging, maintenance challenges, and security risks along some routes. For a company producing goods in Nigeria and seeking to export processed agricultural products or manufactured goods, these challenges translate into higher production and logistical costs, weaker global competitiveness, and reduced investor confidence. Addressing these infrastructural constraints is therefore essential but not only to lower business costs, but also to support innovation, strengthen agricultural value chains, and stimulate sustainable economic development

Yet, the country's youthful population, expanding middle class, and strong entrepreneurial culture create a promising environment for agricultural modernization. Government efforts to diversify the economy through agro-industrial parks, agricultural research funding, and international cooperation demonstrate a renewed commitment to innovation-driven rural development (African Development Bank *et al.*, 2022).

Nigeria presents a predominantly youthful demographic profile, with approximately 70% of its population under the age of 30 and around 42% below 15 years of age, reflecting sustained high fertility rates and a very low median age of 17.2 years (DRPC, 2024). This

population configuration forms a classic expansive age pyramid, showing a large concentration of children and adolescents at the base, and a narrowing shape at older ages. Such a structure indicates the presence of a substantial young population that has the potential to drive economic growth in the long term, as the country could benefit from a demographic dividend if adequate investments are made in education, skills development, healthcare, and employment opportunities.

Figure 6 – Nigeria population´s age



Sources:United Nations, *World Population Prospects 2024*

Nigeria's age structure in 2024 reveals a distinctly youthful population profile. The graph shows that approximately 42% of Nigerians are aged 0–14, indicating a rapidly growing young population and a high dependency ratio. The next age bracket, 15–24 years, accounts for about 20%, reinforcing the demographic reality that more than 60% of Nigerians are below 25 years. This structure suggests strong future labor force potential but also highlights the need for massive investment in education, skills development, and social services to prepare this young population for productive employment.

The working-age population (25–64 years) represents around 35%, forming the main economic backbone of the country. In contrast, only about 3% of the population is aged 65 or older, reflecting high birth rates and relatively low life expectancy. For policymakers, this age distribution presents both challenges and opportunities: while the youthful population can drive economic growth and innovation, failure to create jobs, ensure infrastructure

development, and promote inclusive economic opportunities could lead to unemployment, poverty, and increased social instability.

However, the same demographic structure also represents significant short-term socioeconomic challenges. With only 3–4% of the population aged 65 or more and a large proportion of economically dependent children and youth, Nigeria faces heavy pressure on public services, especially schooling, job creation, and basic social infrastructure (CIA, 2021). If the country fails to expand its social and economic systems to meet this rising demand, the growing youth population could lead to higher unemployment, under-utilization of human capital, and increased social vulnerability, rather than becoming a source of long-term economic competitiveness. Therefore, demographic change in Nigeria presents both opportunity and urgency for strategic public policy action.

2.6 Literature review on agriculture research and development investments

Agriculture is one of the most significant ways to promote growth and sustainability in the world. To visualize R&D investments and its breakthroughs the economy of the world focuses heavily on agriculture, which helps a sizable section of the population. However, Nigeria agriculture has always had problems with lower production, outdated technology, and access restriction to cutting-edge farming methods. The landscape of agriculture has changed throughout time as a result of ongoing research and development investments, which opens doors for innovations that tackle these issues and advance sustainable farming systems which will combine research innovations and developments. R&D in agriculture has been crucial for addressing concerns about global food security, economic growth and sustainability.

According to Pardey and Chan-Kang (2016), significant shifts in agricultural research and development funding emphasizes the disparity between the high-income and low-income countries. Rich countries have traditionally dominated Agricultural R&D spending, while lower-income regions are lacking, posing challenges for enhancing agricultural productivity. This divide is particularly useful for Nigeria where increased investments are essential to meet the food demands of the people amid a growing urban population in the Nation. The analysis thereby emphasizes the need for collaboration between public and private sectors to address both market opportunities and the long-term challenges in the sector such as pest resistance and climate change. Furthermore, countries experiencing rapid population growth require the targeted investment strategies that will boost local agricultural innovation. Hereby improve urgent government funding and institutional support which are necessary to promote

sustainable agricultural practices. The future of food security hinges on aligning investments with both economic viability and ecological sustainability.The Nigerian government has recognized the importance of R&D in agriculture and has introduced various policies and programs to support it. The Agricultural Transformation Agenda (ATA) and the more recent Agricultural Promotion Policy (APP) aim to create an enabling environment for research and innovation (FMARD, 2016).

Beintema (2020) explains that countries allocate research and development (R&D) resources strongly in agriculture to influence their productivity growth and the innovation outcomes. Data from the Agricultural Science and Technology Indicators (ASTI) show that, in the past two decades, most developing nations dedicate about half of their agricultural researchers' time to crops and related studies, while livestock, forestry, and natural resources receive comparatively less attention. (Oliveira *et al.*, 2021) helps to discuss the key access to technologies such as sensors, computer vision algorithms as well locomotion systems in their in-depth examination of agricultural robots(Malik *et al.*, 2023). Highlights another significant topic which is the revolutionary potential of nanotechnology in agriculture, The study indicated agriculture is one of the many industries that make extensive use of nanotechnology, according to the authors, collaboration between academic institutions and commercial stakeholders will be highly crucial for agricultural sustainability as nanotechnology will transform industries by boosting productions and efficiency. In terms of agricultural robots and precision farming which is another important area of this analysis.

These innovations have the energy to alter planting, harvesting, as well as land preparation techniques which are used in agricultural systems. In this regard there are still barriers to the commercial development and widespread application of agricultural robots, and the significant infrastructure and study expenditures are needed to advance the field of Agricultural robotics and precision farming. In terms of ecological and sustainable agricultural practices in the bibliometric analysis R&D in investments and innovations in agriculture.

Beintema (2020) also went ahead to emphasize that many developing countries still invest far below their potential in agricultural research and development (R&D), despite global growth in funding. Using ASTI's intensity index, the study found that in 2016, the global gap between actual and attainable investment was 34%, which is equal to about US$24 billion (about $74 per person in the US). Most low- and middle-income nations, particularly in Africa, invested less than 1% of their agricultural GDP in R&D, which reveals chronic underfunding in this area. The research thereby shows that small and medium agricultural

systems face the greatest difficulties in achieving critical research capacity in research and development. The author concludes that it is realistic and country specific.

Moving forward, comparing Brazil's agriculture to that of Nigeria. Silva Junior *et al.*, (2019) states that because of the significant R&D investments, Brazil's agricultural sector has thereby emerged as a global leader. Brazil's great participation in the international trade of agricultural products and also the strengthening of intellectual property rights has given the Brazilian agricultural input markets few of the most - transformed by R&D.

Adamu (2018) is optimistic about the prospects of R&D in the agricultural sector of the Nigerian economy. He posits that several strategies can be adopted to bolster R&D in Nigeria's agricultural sector. Increasing investment in agricultural research is crucial to ensuring sustained progress and innovation. In order to raise financing and develop results in Nigeria's agricultural sector, this literature emphasizes the immediate need for evidence-based policies in agricultural research and development (R&D).

At the same time in order to promote sustainable agriculture practices and close financing shortages(Carden *et al.* 2019), stress the importance of national leadership and ownership of research programs in the sector. The report also goes by to emphasize how crucial it is for the stakeholders to continue talking to be able to formalize debates about supporting agricultural research to be able to guarantee that evidence is used effectively when formulating policies in the sector.

Flaherty and Abdullahi (2014) went ahead to reveal that even though Nigeria leads sub-Saharan Africa in agricultural research spending and staffing, Nigerian investment intensity still remains low at only 0.33% of agricultural GDP. Research capacity expanded between 2000 and 2011, but growth was mainly among MSc and BSc holders, while PhD qualified researchers increased slowly and are nearing retirement. Most funding came from government sources with salaries consuming two thirds of total expenditure which leaves little for infrastructure or programs. The authors emphasize the urgent need for stronger funding mechanisms, postgraduate training, and institutional reforms to enhance Nigeria's agricultural R&D performance. Growth in researcher numbers was strongest at the BSc and MSc levels, while PhD-level growth lagged behind, creating a gap in senior scientific leadership and mentoring capacity within Nigeria's agricultural R&D system.

Beintema, Nasir, and Gao (2017) went ahead to report that Nigeria remains the leader in sub-Saharan Africa in total agricultural research investment but yet Nigeria's R&D intensity fell sharply from 0.39% of AgGDP in 2008 to 0.22% in 2014. Public agricultural research spending reached ₦32.2 billion (₦433.5 million PPP) in 2014, but over 98% of

funding came from the government with its donor contributions averaging only 1.2%. The national research workforce comprised 2,975 FTEs, but only 33% held MSc or PhD degrees, and more than 60% of PhD researchers were aged 50 or older which signals an impending capacity crisis. Salary expenditures consumed roughly two-thirds of ARCN's budget which leaves inadequate funds for equipment and field programs. The authors hereby emphasize the urgent need for reforms to strengthen ARCN's governance and thereby diversifying funding to expand postgraduate training to sustain Nigeria's agricultural innovation system.

Despite having the largest agricultural R&D system in Africa, Nigeria's research intensity and training pipeline remain weak due to over-reliance on government funds and limited PhD-level capacity. Stads, Nin-Pratt, and Beintema (2021) provides the most recent continental assessment of agricultural R&D investments in Africa which highlights both progress and persistent funding shortfalls. The study found that the total public agricultural research spending in Africa increased from US $ 2.9 billion in 2011 to US $ 3.4 billion in 2016**,** marking a growth of 18 percent. Yet, average research intensity declined from 0.42 percent to 0.39 percent of agricultural GDP**,** remaining well below the 1 percent target adopted by African Union members. The report shows that Nigeria, South Africa, and Kenya together accounted for roughly 40 percent of the continent's total investment, while more than half of African countries still spent less than 0.5 percent of AgGDP on research. Furthermore, about 40 percent of the region's researchers were over 50 years old. The modest rise in funding coupled with falling intensity shows that Africa's and by extension Nigeria's agricultural R&D systems are growing in volume but not in efficiency, demanding renewed policy action to expand sustainable, diversified investment.

3 MATERIALS AND METHODS

This dissertation is characterized as exploratory and descriptive research, according to the classification proposed by Gil (2008), as it seeks to deepen understanding of public investment in agricultural research and development (R&D) in Nigeria, as well as to describe the institutional functioning of public organizations involved in these activities. Primary and secondary data were used to achieve this objective.

The primary data were obtained from Nigerian public agricultural research organizations through the application of a structured questionnaire. The choice of this instrument is justified by its ability to standardize the collection of information, ensuring comparability between the responding organizations and allowing the collection of quantitative and qualitative data relevant to the activities, expenses and resources allocated to R&D. In addition, structured questionnaires have been widely used in international studies on R&D investment, as demonstrated by Da Silva Junior *et al.* (2019), reinforcing their methodological suitability for surveys of this nature.

The instrument was developed taking into account models already consolidated in research on R&D financing in the public and private sectors. The questionnaire included open and closed questions related to institutional activities, operating expenses, workforce composition, and investments in research infrastructure. The complete questionnaire is available in Appendix 1 of this dissertation.

The questionnaires were sent by email between January and February 2025 to the selected organizations. The sample was defined based on the official list of public agricultural research institutions available on the Agricultural Science and Technology Indicators (ASTI) platform. This database was chosen due to its comprehensiveness and international credibility, ensuring the representatives of the main institutions responsible for agricultural R&D in the country. Table XX presents the complete list of organizations that responded to the questionnaire and participated in the survey.

Secondary data, in turn, were used to complement and contextualize the primary information, allowing for methodological triangulation and strengthening analytical robustness, as recommended by Flick (2009). These data include institutional information, annual reports, and official indicators made available by international organizations and specialized statistical databases.

Despite the procedures adopted to enable the collection of primary data, none of the organizations contacted returned the questionnaire within the deadline required for the

completion of this dissertation. The lack of responses made it impossible to execute the originally conceived methodological strategy, since it would not be possible to guarantee the consistency, representatives, and internal validity of the intended analyses (Lakatos; Marconi, 2017). Given this empirical limitation, it became necessary to proceed with a methodological readjustment, a practice recognized in the literature as legitimate and essential when field conditions prove restrictive or incompatible with the initial research design (Creswell, 2014; Flick, 2009). Thus, in accordance with the principle of methodological flexibility advocated by Gil (2008), we opted to adopt an alternative approach based predominantly on secondary data, ensuring the continuity of the investigation and the possibility of responding to the central objectives of the study without compromising analytical rigour(Maarsingh *et al.*, 2023). Also contribute to previous efforts going ahead analyzing the dynamics of innovation in ICT4D schedules and emphasizing the functions that inclusive development plays in promoting agricultural innovation in developing nations such as Nigeria. Going forward (Tyagi *et al.*, 2024), for instance, goes ahead to highlight how green nanotechnology may be integrated with the Sustainable Development Goals and as well demonstrate how it will transform agricultural methods through creative and sustainable solutions. Similarly, Zambon *et al.* (2019) discusses the slow adoption of Industry 4.0 technologies in the agricultural sector and as well suggests SMEs to face significant barriers in implementing these recent advancements. Going forward , Obe *et al.*, (2024) gives empirical support for the solution that investment in agriculture is a main factor in determining its success. They also argue that policymakers need to create favorable conditions for the use of SMEs to adopt new technologies in order for this tool to stay competitive in a market that is changing rapidly.

Data from the Agricultural Science and Technology Indicators (ASTI) database was used to analyse public investment in agricultural R&D in Nigeria. This source was chosen due to the identification of significant gaps in recent literature on the subject, especially with regard to the availability of up-to-date and systematized information on the distribution of R&D resources by research area, gender, region of the country and other relevant institutional characteristics. Given the scarcity of studies that address these specialties in a comprehensive and comparable manner, the use of the ASTI database proved to be methodologically appropriate, as it brings together standardized, internationally recognized data produced according to consistent protocols for collection, systematization and validation (ASTI, 2024). Moving forward Yurui *et al.* (2021) examines the relationship that exists between ecological restoration and economic development, which centers on China's Loess Plateau. Reading the bibliometrics of R&D investments and innovations. According to the result, sustainable

agricultural expansion needs strength at many levels of governance and involvement of stakeholders, starting from local communities to national governments

In addition, we opted to adopt these data due to the need to examine, on a regional basis, the relationship between the intensity of public investment in agricultural R&D and agricultural production levels in different regions of Nigeria. Leo *et al.* (2022) concluded that various combinations of innovative capacities enhance agribusiness performance filling a gap in the literature on the specific innovation capabilities required in the sector. The literature points out that analyses linking R&D investments with production indicators allow for a better understanding of the effectiveness of public policies and the impact of national efforts on agricultural innovation (Alston; Pardey; Ruttan, 2008). Thus, the use of the ASTI database made it possible to explore spatial and thematic patterns of investment, helping to fill empirical gaps and provide a systematic assessment of Nigeria's national agricultural research system.

Data processing followed cleaning, standardization and organization procedures to ensure internal consistency and comparability of information throughout the period analyzed. Initially, missing values, inconsistencies in data entry and duplication's were checked, in accordance with the methodological recommendations of Creswell (2014) and Hair *et al.* (2019). For variables with missing data, the possibility of reconstruction from complementary reports provided by ASTI itself was verified; in cases where this reconstruction was not possible, the missing values were kept as gaps, with due indication in the interpretation of the results.

The original variables were then grouped, aggregated, or reclassified according to analytical needs. Financial investment values were harmonized in constant prices, using international deflectors when necessary, in order to allow for appropriate temporal comparisons. Data on the research workforce such as distribution by gender, qualifications, and area of activity—were reorganized into analytical categories compatible with Nigeria's agronomic and institutional structure.

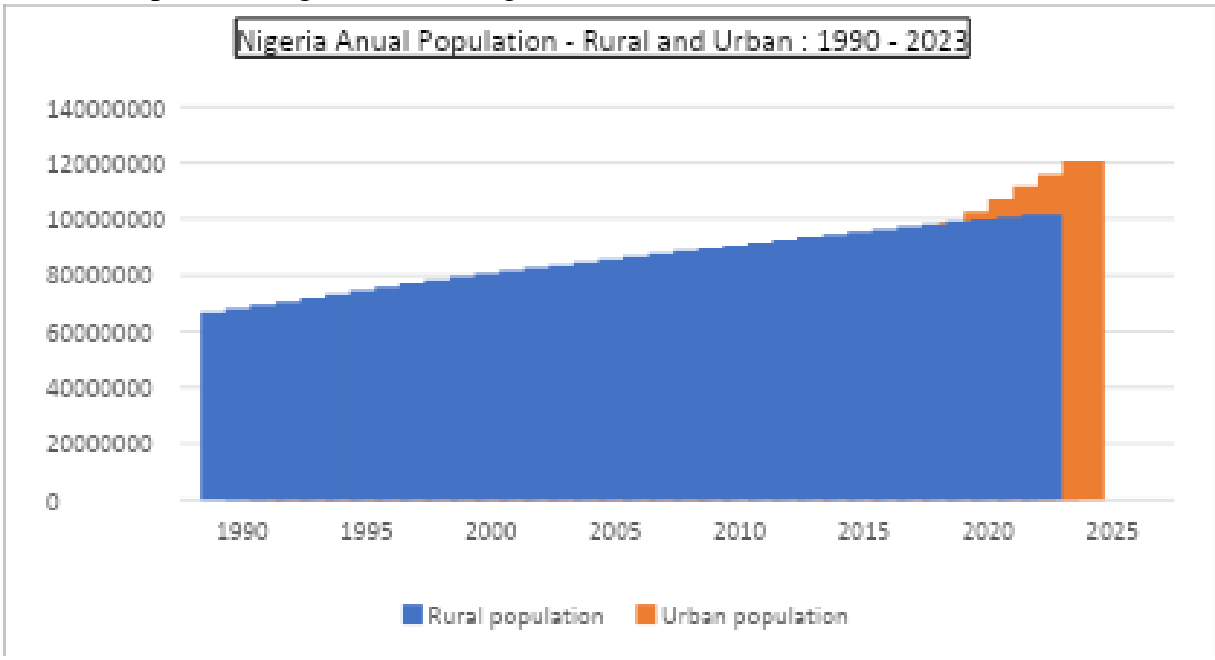
Finally, the data were integrated with regional agricultural production indicators, enabling comparative analyses between R&D investment intensity and productive performance by region. This step involved the construction of derived metrics, such as investment per researcher, investment per research area, and investment relative to volume produced, in line with the recommendations of Alston and Pardey (2014) for studies on the efficiency and impacts of agricultural R&D.

4 RESULTS AND DISCUSSIONS

4.1 Nigeria Agricultural Sector: Structure and Dynamics

In my results and discussions, the graph of Nigeria's annual rural and urban population from 1990 to 2023 comes first which shows a clear demographic transition, with urban growth accelerating rapidly while the rural population increases more slowly. In 1990, the rural population was significantly higher, but by 2023 the gap had narrowed sharply as millions of Nigerians migrated toward cities in search of employment, education, and better services. Urban population growth reflects structural economic changes, industrial expansion, and urban-driven development policies, while the slower rise in rural population highlights persistent challenges such as limited job creation, weak infrastructure, and agricultural productivity constraints. The result is a country that is becoming increasingly urban, creating both opportunities such as a growing consumer market and potential innovation hubs and serious pressures, including overcrowding, housing shortages, and rising demand for food and public services. This demographic shift underscores the urgent need for balanced development strategies that strengthen rural economies while managing sustainable urban growth to ensure that population dynamics translate into national development gains.

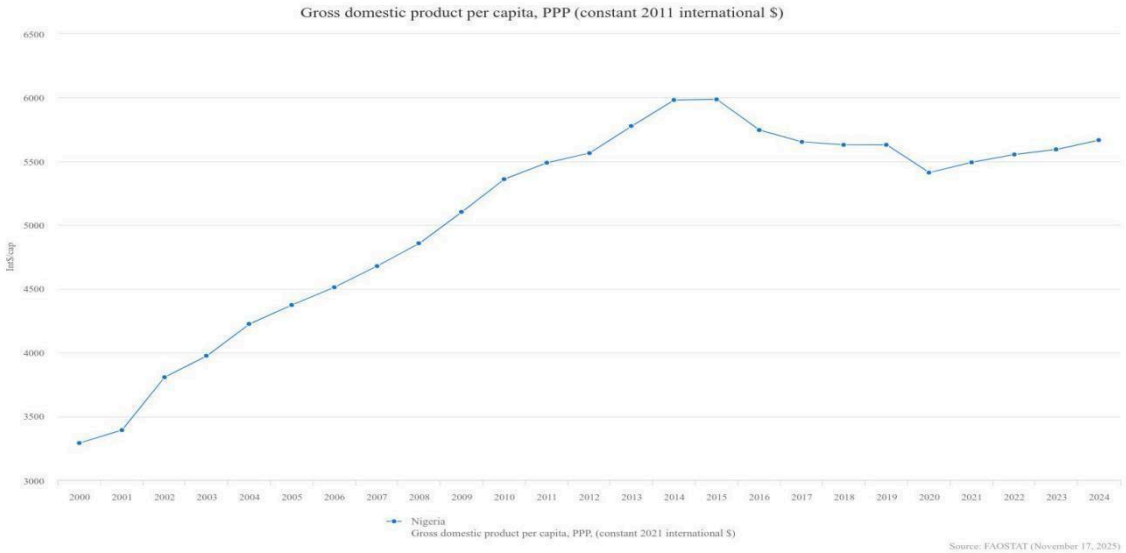
Graphic 1 – Nigeria Annual Population



Sources: FAOStat (2025).

In the second graph of my results , Nigeria's GDP per capita (PPP) rose steadily from the early 2000s to a peak around 2014 and then stalled and contracted in the years that followed, a pattern consistent with rising oil-driven incomes before the fall in oil prices and subsequent macroeconomic shocks (World Bank, 2024). The post-2014 slowdown and weak recovery—documented by the IMF and the African Development Bank—reflects currency pressures, fiscal constraints, and limited structural diversification, which together constrain public and private budgets available for long-term investments such as agricultural R&D (IMF, 2024; African Development Bank, 2023). Because agriculture remains a major employer and contributor to national output, stagnant per-capita incomes increase the urgency of productivity-raising investments; FAO notes persistent sector constraints (low mechanization, poor irrigation, and market access) that reduce farm incomes and resilience (FAO, 2022). At the same time, ASTI data show that Nigeria's public agricultural R&D spending and researcher capacity have been uneven and underfunded relative to the scale of the challenge, limiting the development and diffusion of the technologies needed to raise yields and rural incomes (ASTI, 2019). Taken together, the GDP-per-capital trajectory underscores that without deliberate reallocation of fiscal space and targeted R&D financing, Nigeria will struggle to translate demographic and market opportunities into sustained agricultural transformation and pro-poor growth (World Bank, 2024; FAO, 2022; ASTI, 2019).

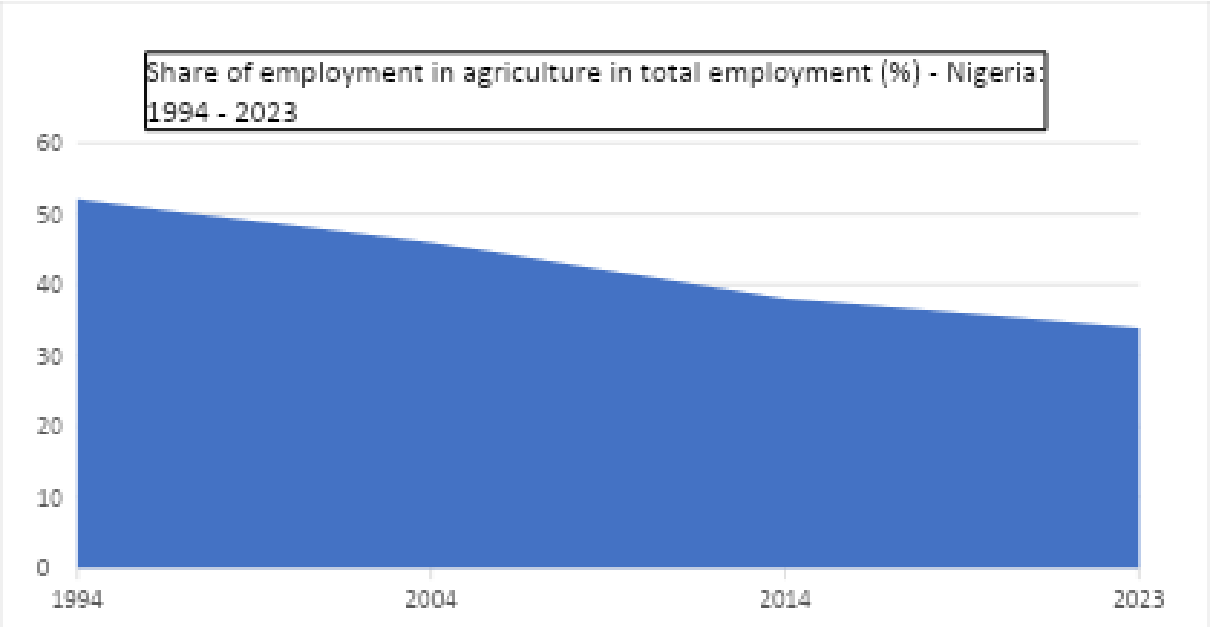
Graphic 2 – Nigeria gross domestic product per capita



Sources: FAOStat (2025).

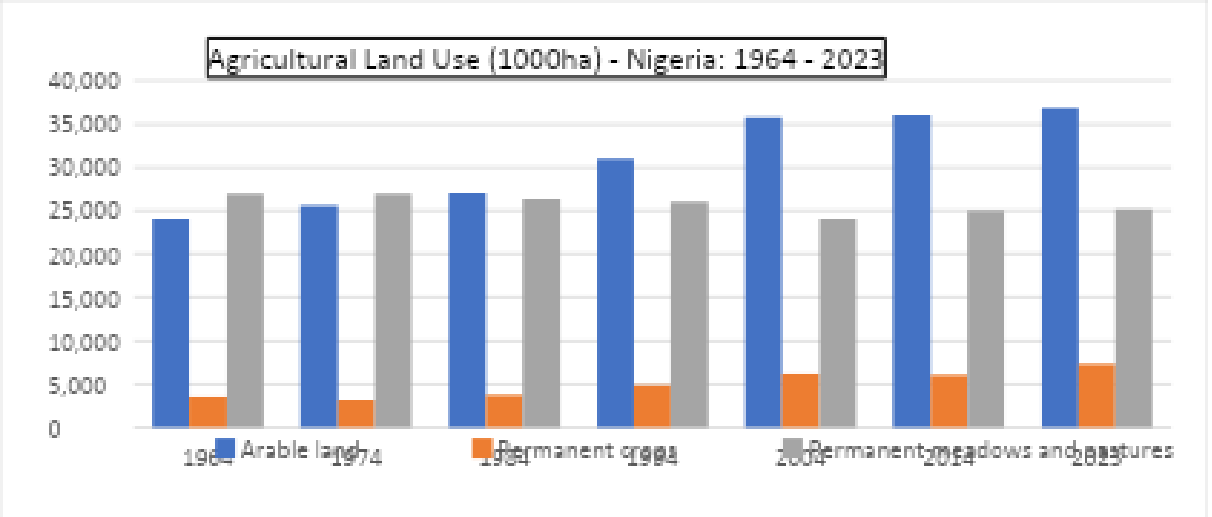
Nigeria's share of employment in agriculture has steadily declined from over 50% in 1994 to about 35% by 2023, reflecting a gradual structural shift away from farming toward non-agricultural sectors (FAOSTAT, 2025). This trend indicates increasing urbanization and diversification of the Nigerian economy, although agriculture still remains a major employer nationally (FAOSTAT, 2025).

Graphic 3 – Nigeria employment share in agriculture



Sources: FAOStat (2025)

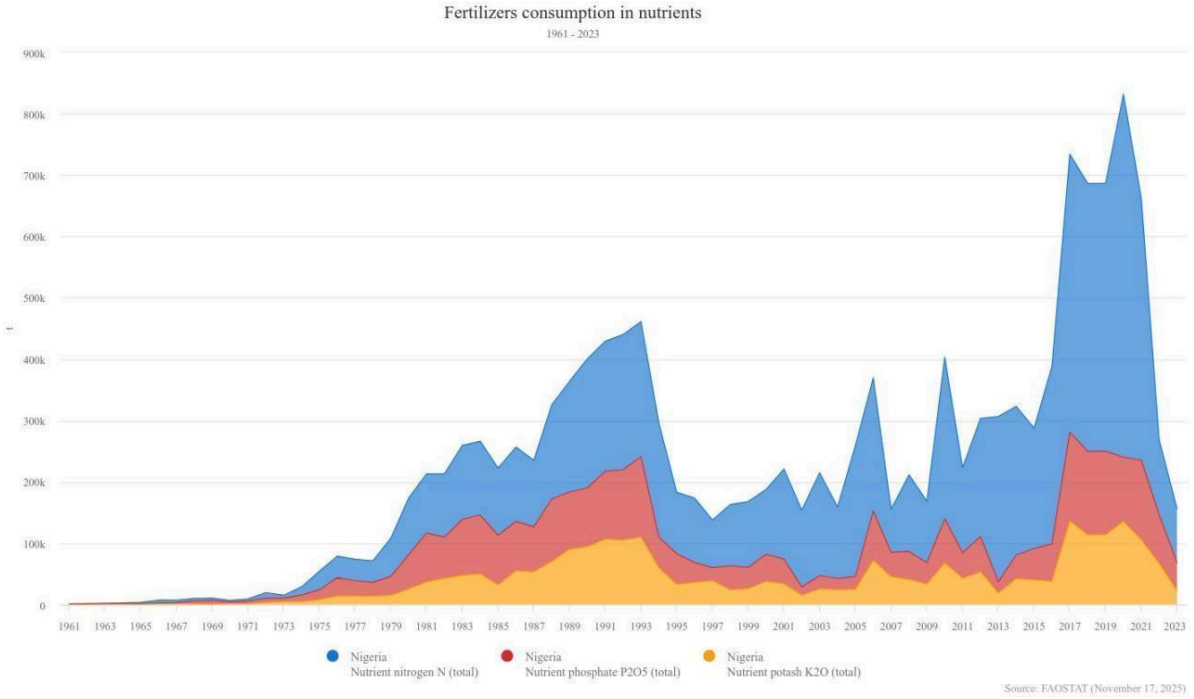
Graphic 4 – Agricultural land use



Sources: FAOStat (2025)

Nigeria's agricultural land use has expanded over the past decades, with more than 70% of total land now dedicated to agriculture, driven by population growth and dependence on farming for livelihoods (FAO, 2024). However, productivity remains low due to limited mechanization, soil degradation, and inadequate investment in modern inputs (World Bank, 2023). This reflects a system where land use is extensive rather than efficient, highlighting the need for stronger R&D and policy support to improve yields and sustainability.

Graphic 5 – Fertilizers consumption

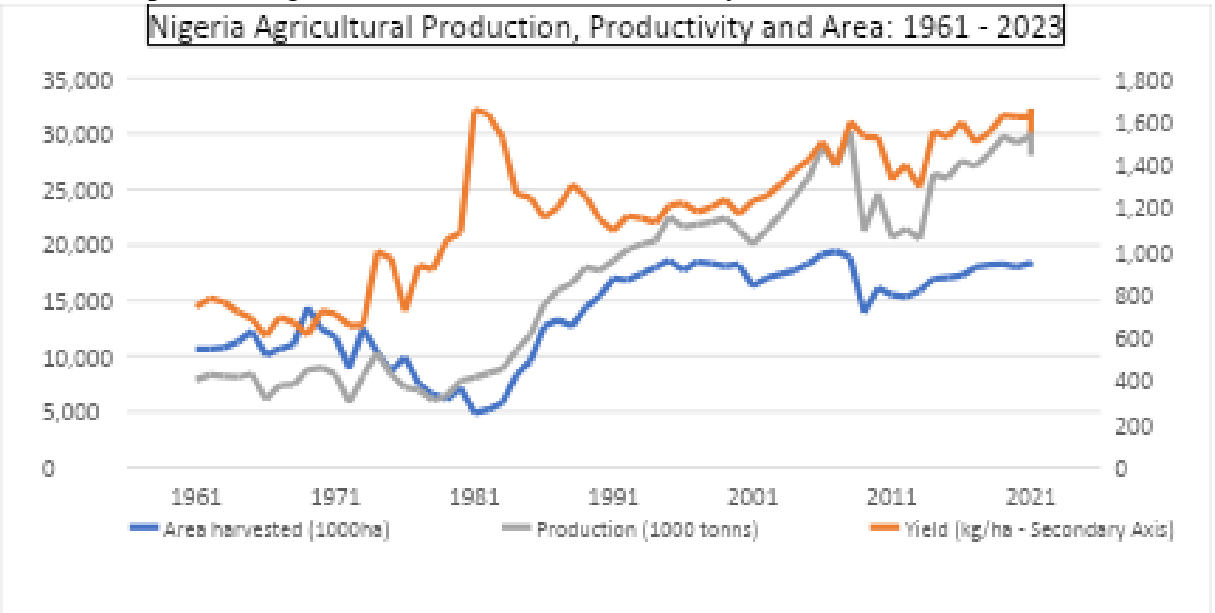


Sources: FAOStat (2025).

Fertilizer consumption in Nigeria has expanded sharply since the early 2000s, with nitrogen use rising the fastest, reflecting growing intensification of agricultural production. However, the large fluctuations especially after 2010 indicate instability linked to policy changes, import dependence, and inconsistent subsidy programs, which continue to affect farmers' access to agricultural inputs.

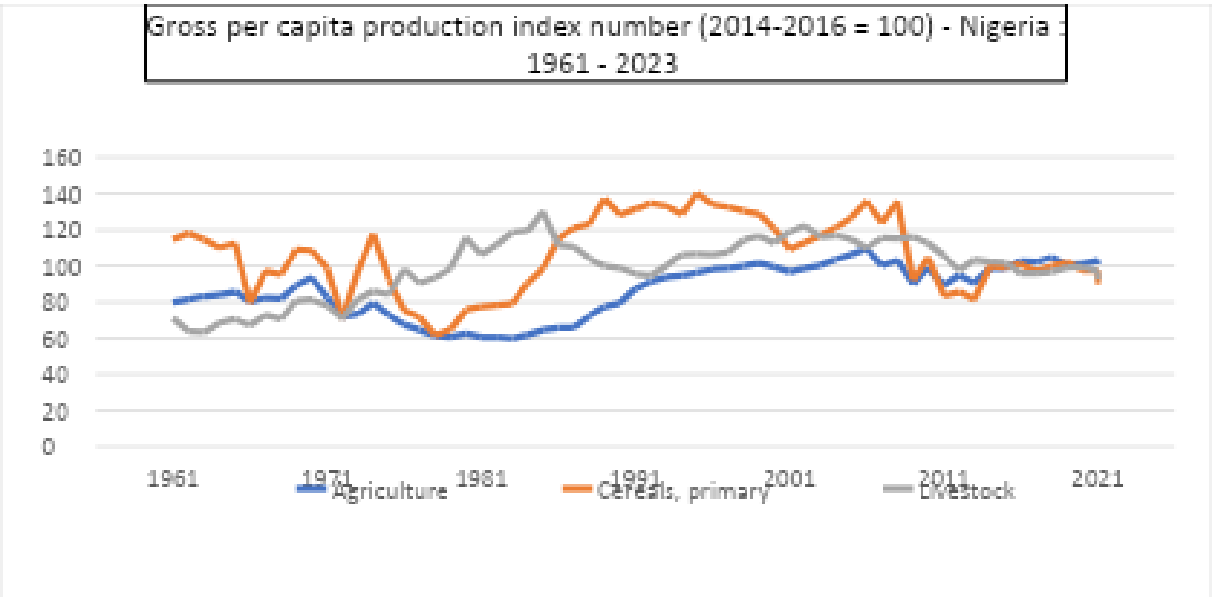
Nigeria's agricultural production has expanded over time as cultivated area increased, but productivity gains have remained modest, showing that growth is driven more by land expansion than efficiency improvements. This highlights the need for stronger R&D investments, technology adoption, and input efficiency to shift the sector from extensive farming to higher productivity and sustainable output.

Graphic 6 – Agricultural Production, Productivity and area



Sources: FAOStat (2025).

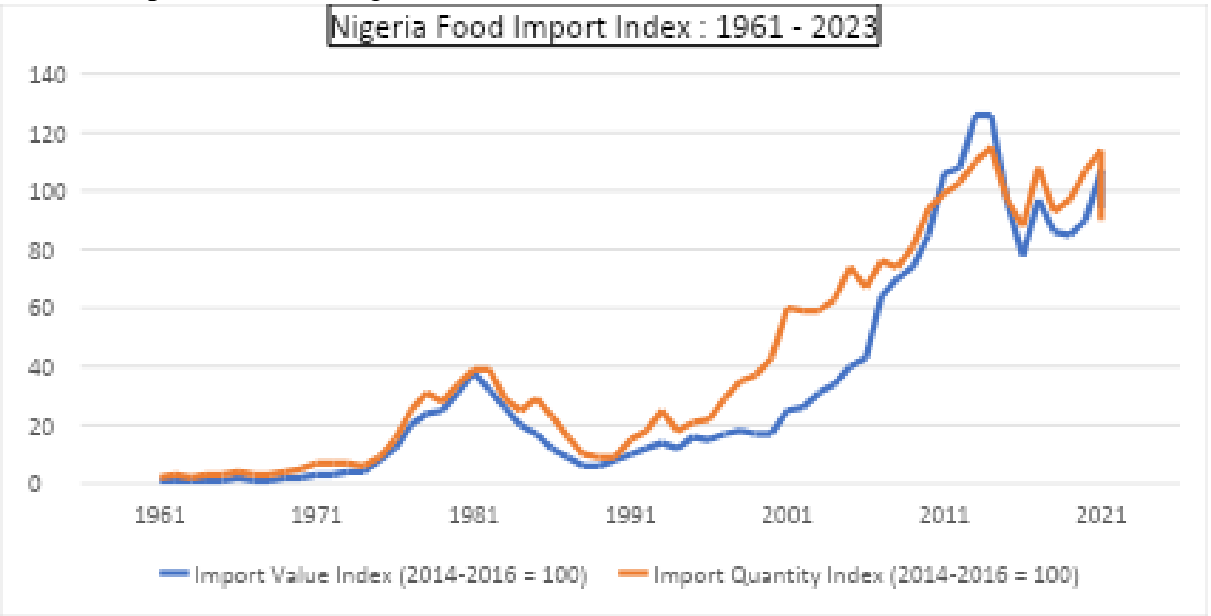
Graphic 7 – Gross per capita production



Sources: FAOStat (2025).

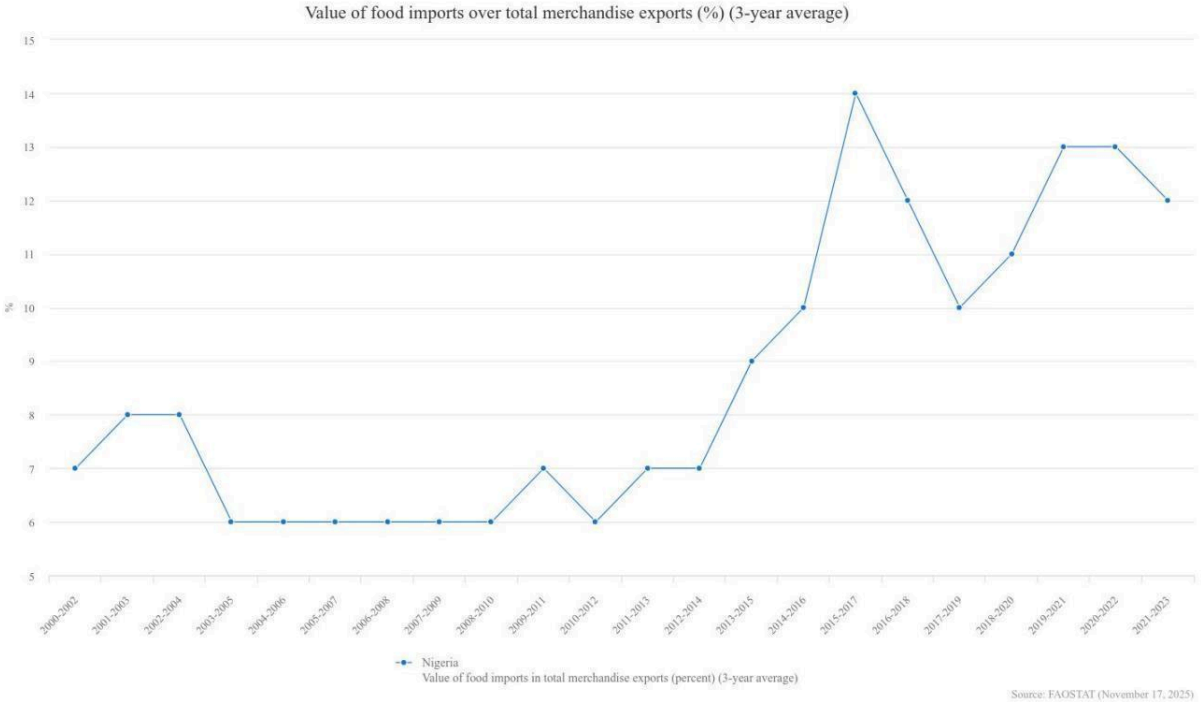
Nigeria's gross per capita agricultural production shows steady long-term growth from the 1960s to the mid-2010s, driven mainly by increases in both cereals and livestock output. However, the slight decline and stagnation after 2015 reflect production challenges such as climate shocks, structural inefficiencies, and limited investment in agricultural modernization (Fao Stat, 2025).

Graphic 8 – Food Import Index



Sources: FAOStat (2025).

Graphic 9 – Nigeria food imports value over total exports

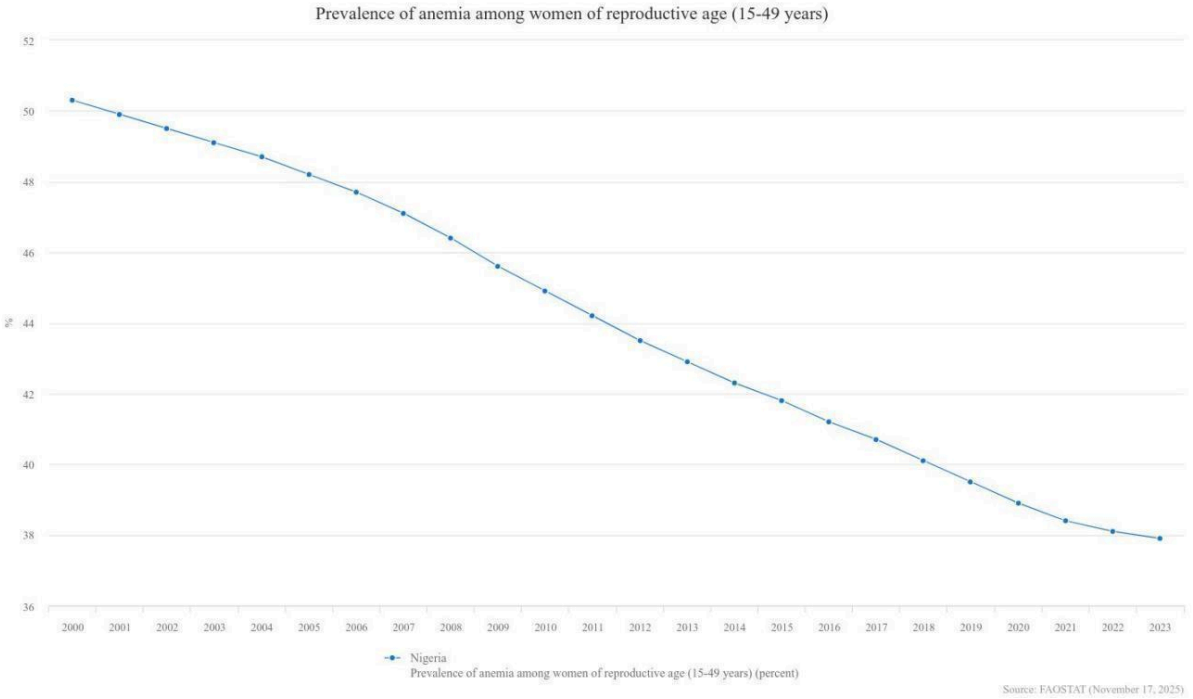


Sources: FAOStat (2025)

Nigeria's food import index increased notably from the early 2000s, with a sharp surge after 2010, showing that the country has become progressively more reliant on imported food.

This upward trend reflects persistent challenges in local agricultural production, where domestic output has not kept pace with population growth and rising food demand.

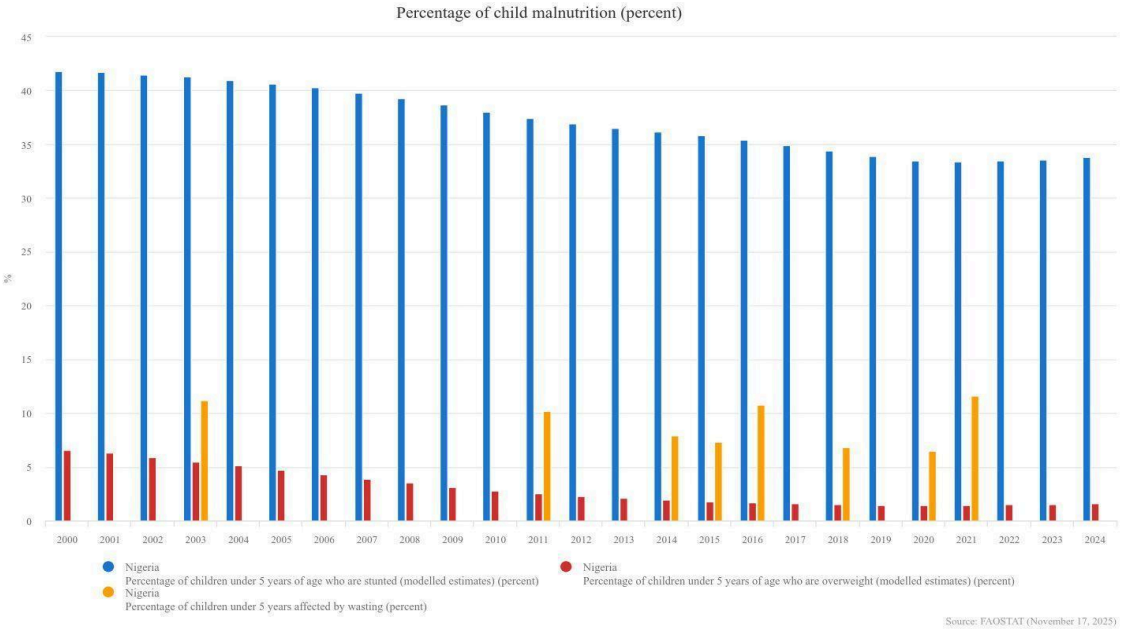
Graphic 10 – Anemia among women of reproductive age



Sources: FAOStat (2025).

The graph indicates a steady decline in anemia among Nigerian women of reproductive age from 2000 to 2023, showing gradual improvements in nutrition and health access. This downward trend reflects enhanced public health interventions and increased awareness of maternal nutrition in the country.

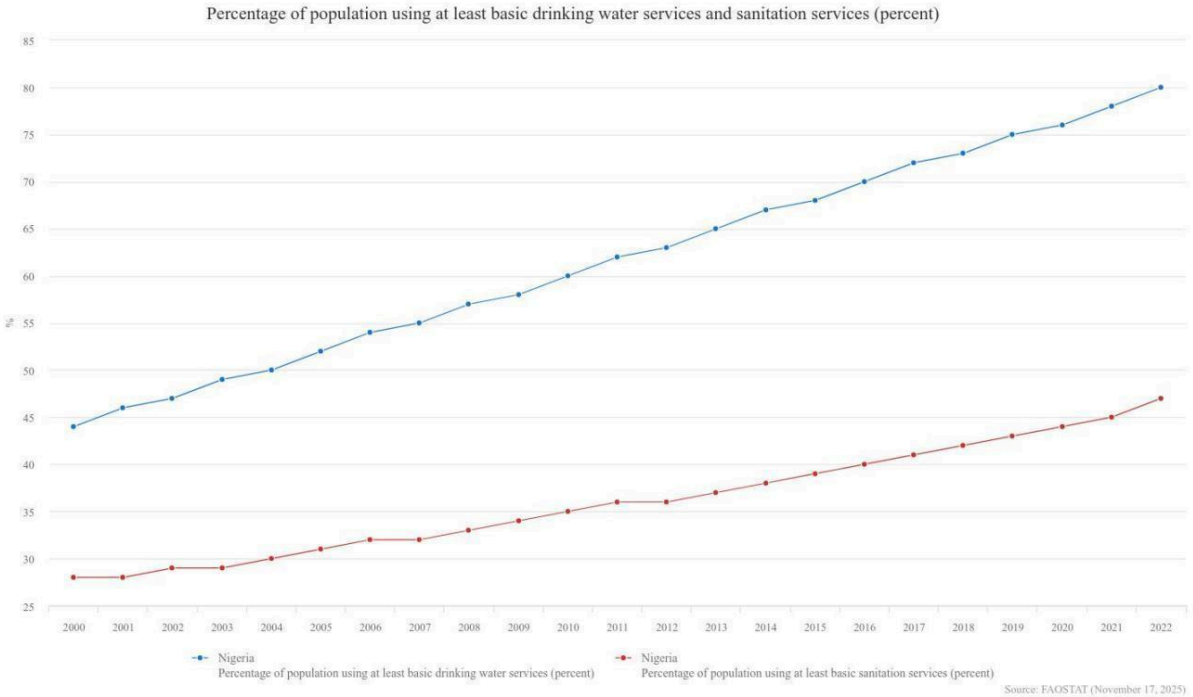
Graphic 11 – Child Malnutrition



Sources: FAOStat (2025)

The graph shows that although child malnutrition in Nigeria has declined slightly over the years, the percentage of children under five who are stunted remains consistently high, indicating persistent nutritional challenges. Rates of wasting and overweight remain much lower but fluctuate over time, showing ongoing vulnerability in child health and nutrition.

Graphic 12 – Drinking water and sanitation services

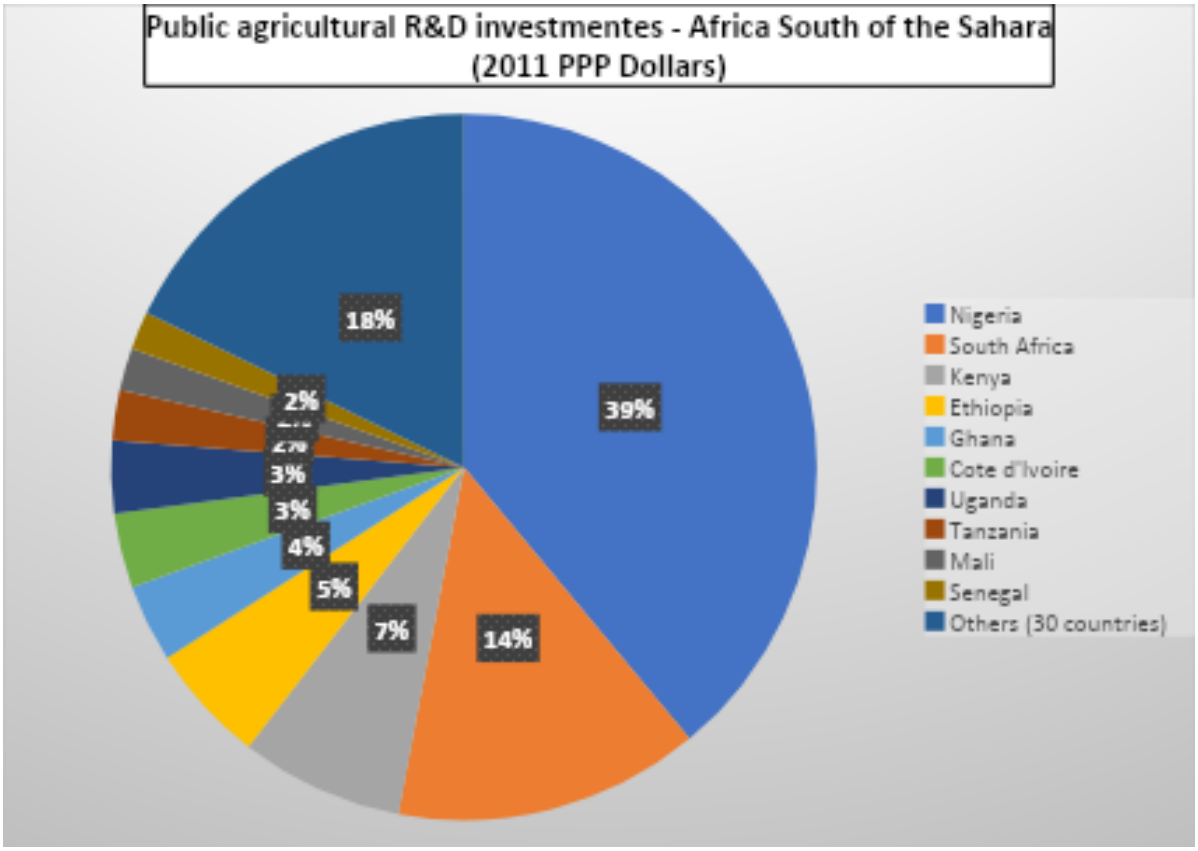


Sources: FAOStat (2025).

The graph in my results shows a steady improvement in access to basic drinking water and sanitation in Nigeria from 2000 to 2022, with water coverage rising from about 45% to nearly 90% while sanitation access increased from around 30% to just over 45%. This upward trend reflects gradual progress in public infrastructure and service delivery, although the gap between water and sanitation access highlights the need for stronger investment in hygiene and waste management systems to support long-term health outcomes.

4.2. Africa South of the Sahara public agriculture research and development investments

Graphic 13 – Countries public agricultural R&D investments

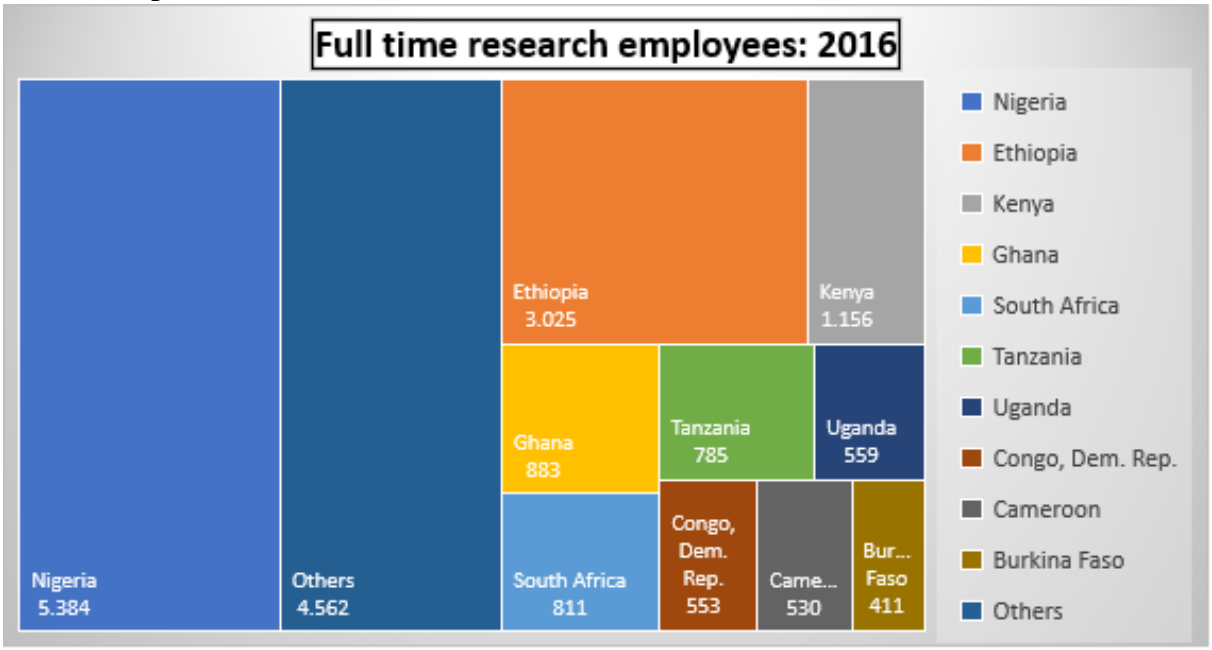


Sources: ASTI (2025).

This chart in my results and discussion shows that Nigeria accounts for the largest share of public agricultural R&D investment in Sub-Saharan Africa, contributing 39% of the

region's total spending. South Africa follows with 14%, while Kenya, Ethiopia and Ghana make much smaller individual contributions. Overall, the distribution reveals a highly uneven investment pattern, where a few countries drive most of the region's research capacity, leaving many others underfunded and less able to support agricultural innovation

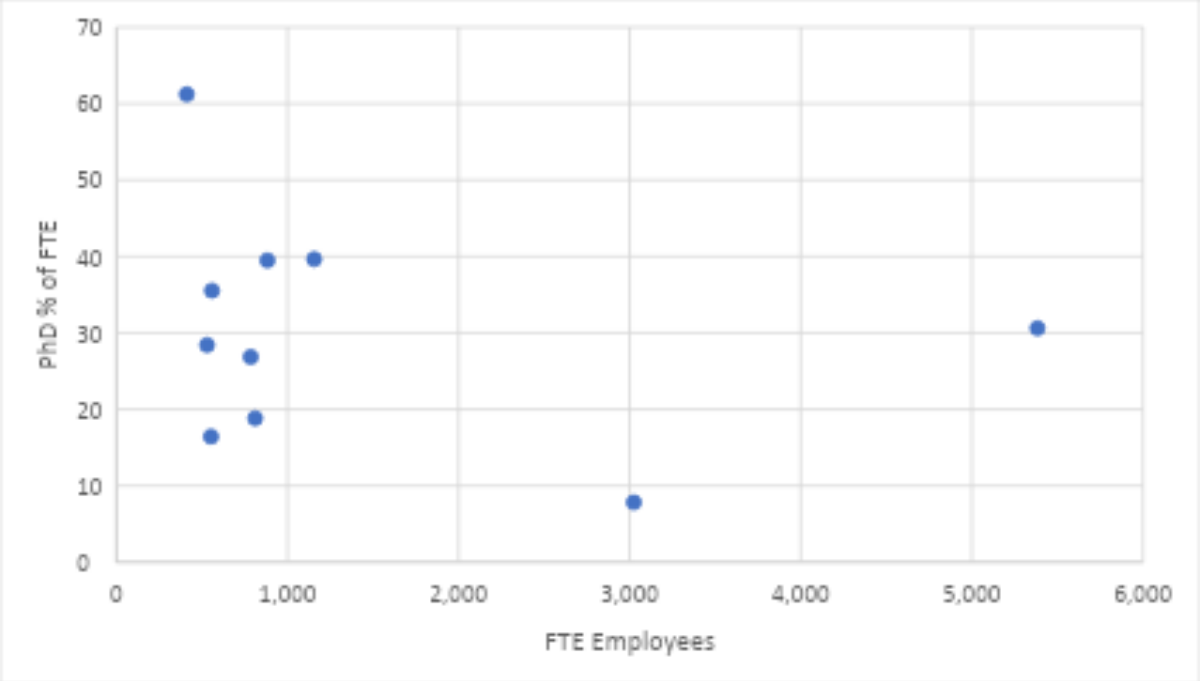
Graphic 14 – FTE in 2016



Sources: ASTI (2025).

As my results continue this chart of full time research employees shows that Nigeria had the highest number of full-time agricultural research employees in 2016 which reflects its larger research system compared to other countries. Ethiopia, Kenya, Ghana, and Tanzania also maintained substantial research capacity, though at significantly lower levels than Nigeria. Overall, the distribution highlights major disparities in research staffing across Sub-Saharan Africa, which directly influence each country's ability to generate and sustain agricultural innovation.

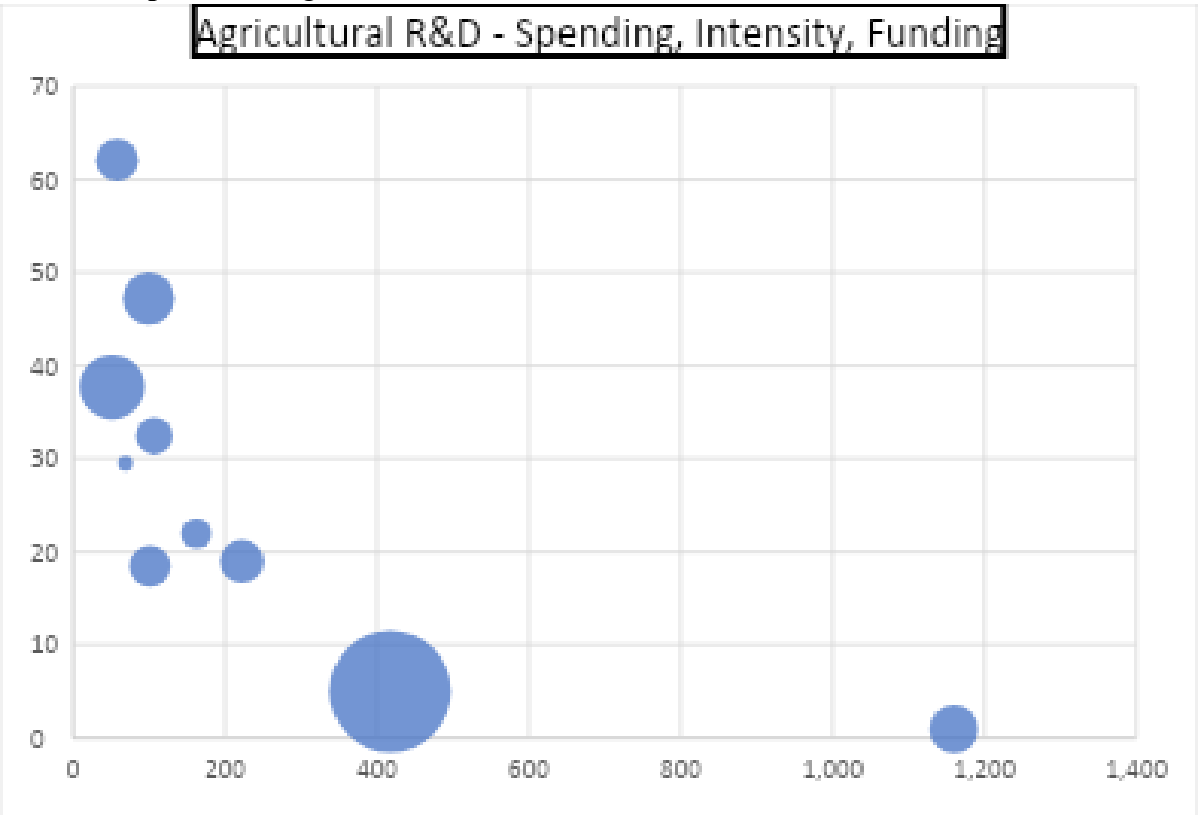
Graphic 15 – FTE and share of PhD in agricultural R&D



Sources: ASTI (2025).

The chart below of the FTE and share of PhD in agricultural R&D shows wide variation in the share of PhD-qualified researchers across countries, with Burkina Faso, Kenya, and Uganda having the highest proportions despite having relatively small research systems. In contrast, Ethiopia and the Democratic Republic of Congo have large research workforce but very low PhD representation, indicating limited advanced research capacity. Nigeria combines a large number of full-time employees with a moderate share of PhD holders, reflecting both its scale and the need for continued investment in high-level training

Graphic 16 – Agricultural R&D – Selected countries



Sources: ASTI (2025).

The results from this graph shows that Nigeria and South Africa recorded the highest levels of agricultural R&D spending, although Nigeria displayed a noticeably low R&D intensity relative to the size of its agricultural sector. Smaller countries such as Mali, Uganda, and Senegal achieved much higher intensity levels despite limited total spending, indicating stronger proportional investment efforts. These patterns reveal significant variation in how countries allocate resources to agricultural research, reflecting differences in national priorities and economic capacity

4.3. Nigeria public agriculture research and development investments

Public agricultural research and development (R&D) investments in Nigeria are central to raising productivity, strengthening food security and promoting structural transformation. Agriculture still contributes around one quarter of national GDP and employs more than one-third of the labour force, yet most producers remain poor and vulnerable, indicating that technological progress has been slow and uneven (Alabi, 2020; Nigeria, 2022). In principle, public R&D should generate location-specific technologies and knowledge that

private actors are unlikely to finance, such as improved varieties for smallholders, sustainable soil and water management, and innovations suited to risk-prone environments (Benin *et al.*, 2016).

Despite this strategic role, agriculture receives a very small share of the federal budget. Less than 2 % of total federal expenditure went to agriculture in the early 2000s, and agricultural spending as a share of the budget remained below 5 % during 2008–2012, far short of the 10 % target adopted under the Maputo/CAADP commitments (Mogues *et al.*, 2008; Olomola, 2014). Recent estimates suggest that agriculture's share in total public expenditure is around 1.5 %, confirming persistent under investment (Alabi, 2020). Within this already limited envelope, only a very small portion is allocated to research: detailed budget analysis shows that fertilizer subsidies and project coordination units absorb close to 80 % of capital expenditure, while R&D receives roughly 3 % and irrigation about 1 % (Alabi, 2020). This pattern favors short-term, politically visible programmes over long-term productivity-enhancing public goods.

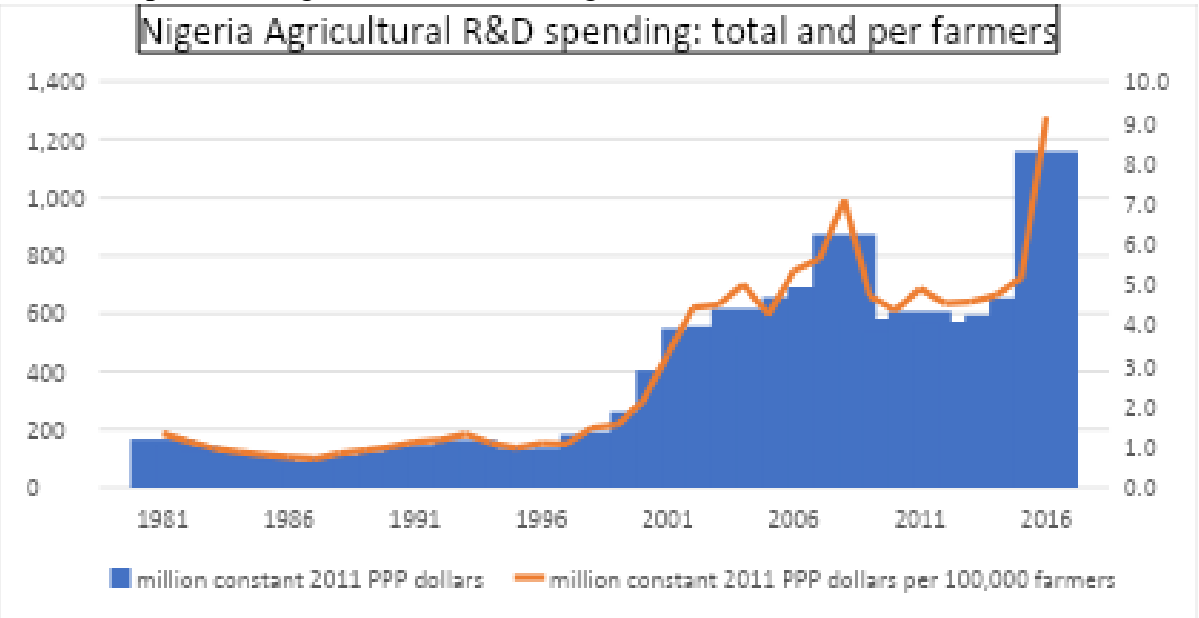
ASTI data reveal an equally ambivalent picture for Nigeria's specific public agricultural R&D spending. In absolute terms, Nigeria is one of the largest investors in agricultural research in Africa south of the Sahara, and total R&D expenditure more than doubled between 2000 and 2008, partly due to salary increases and rehabilitation of research infrastructure (Flaherty et al., 2010). However, when measured relative to the size of the agricultural economy, intensity remains very low: agricultural research spending fell from 0.39 % of AgGDP in 2008 to just 0.22 % in 2014, well below the NEPAD target of at least 1 % and behind several smaller African countries (Beintema; Nasir; Gao, 2017; Benin et al., 2016). Funding is also highly concentrated in federal sources, with donors and other partners contributing only about 1 % of total research resources, which makes the system vulnerable to domestic fiscal shocks and policy changes (Beintema; Nasir; Gao, 2017).

The consequences of this under investment are visible in human and physical research capacity. While Nigeria has almost 3,000 full-time equivalent public agricultural researchers, a large share of senior scientists are close to retirement and the proportion of staff with PhD training is still modest, particularly in some disciplines (Beintema; Nasir; Gao, 2017). Many institutes continue to operate with outdated laboratories, fields and equipment, constraining the quality and volume of research outputs (Flaherty *et al.*, 2010). At the same time, comparative international evidence shows that returns to agricultural R&D are among the highest of all public investments in rural areas, with average internal rates of return above 30–40 % in developing countries (Benin *et al.*, 2016). For Nigeria, empirical work links

better-targeted capital expenditure—including R&D, irrigation and rural infrastructure—to higher agricultural productivity and stronger private investment responses (ALABI, 2020).

Overall, the literature indicates that Nigeria's public agricultural R&D investments are large in regional terms but low and inefficient relative to the size and potential of its agricultural sector. Increasing the volume, stability and quality of R&D funding—while re-balancing budgets away from subsidies toward long-term public goods—emerges as a key condition for achieving sustained productivity growth, poverty reduction and food security in the country (MAVROTAS *et al.*, 2018; BENIN *et al.*, 2016).

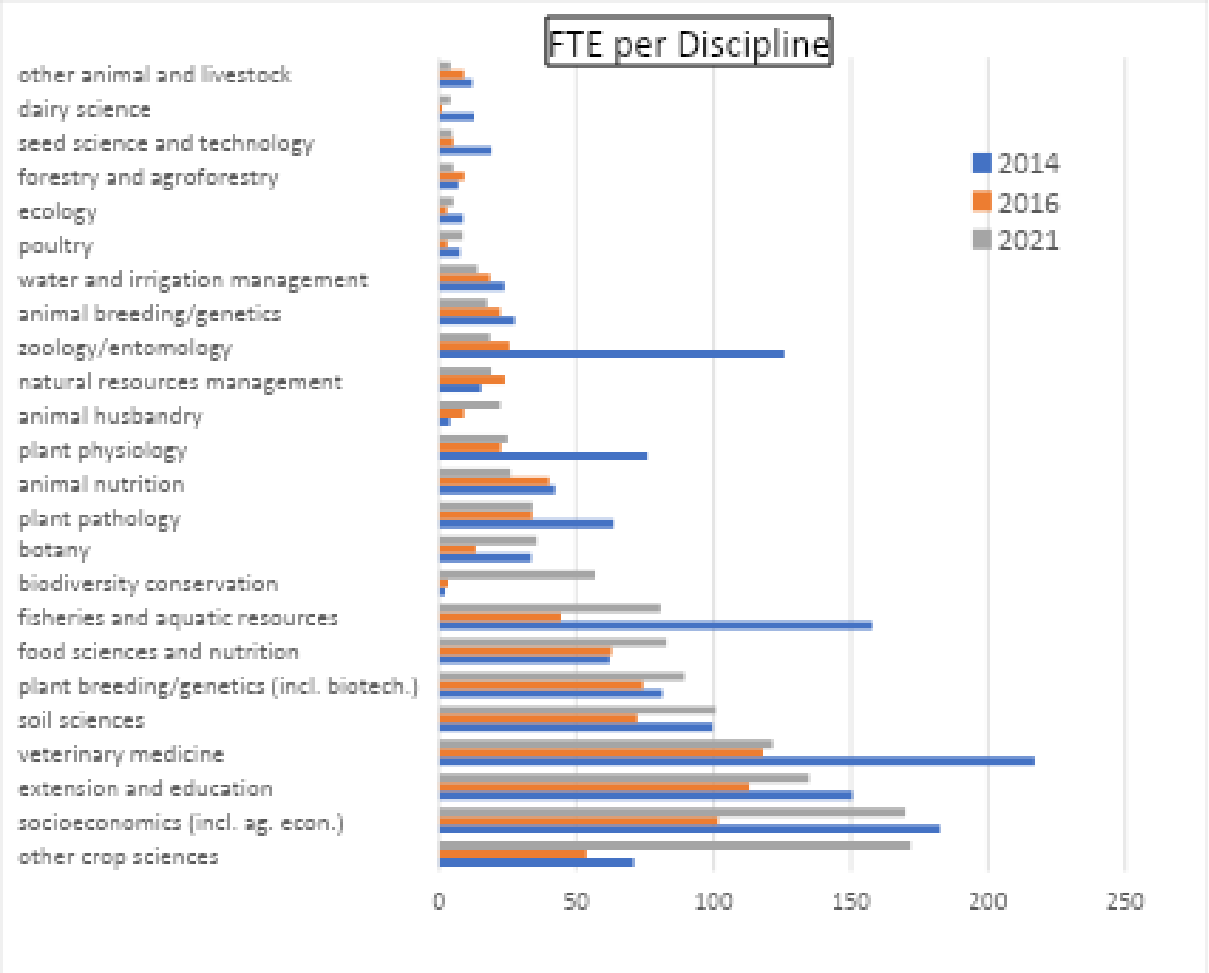
Graphic 17 – Agricultural R&D in Nigeria



Sources: ASTI (2025).

The results show a steady rise in Nigeria's agricultural R&D spending from the late 1990s going forward which was driven by the increased government commitment and periodic spikes in funding. However, spending per farmer remains low and highly volatile, revealing a persistent mismatch between total investment growth and the needs of Nigeria's large farming population.

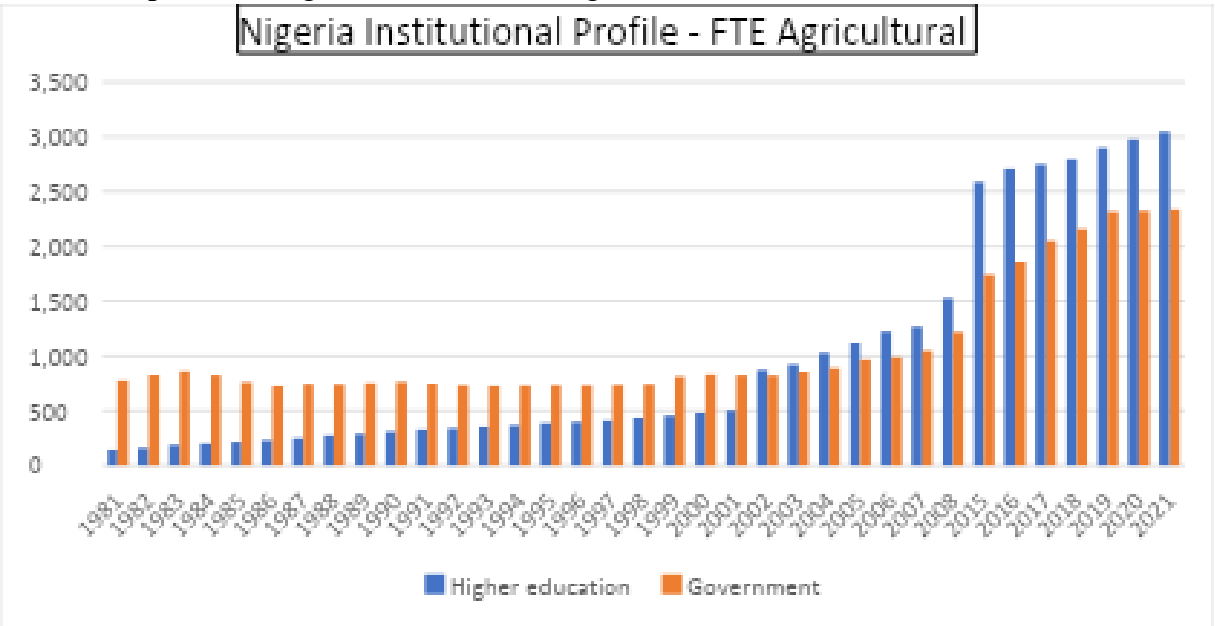
Graphic 18 – Agricultural R&D in Nigeria – Selected Indicators



Sources: ASTI (2025).

The results show that Nigeria's R&D workforce is heavily concentrated in disciplines such as veterinary medicine, fisheries, extension, and socioeconomic research, which consistently recorded the highest FTE levels across all years. In contrast, critical areas like plant physiology, pathology, forestry, and seed science remain severely understaffed, indicating gaps in scientific capacity. Overall, the distribution reveals an unbalanced research structure, with Nigeria investing more human resources in service-oriented fields while core crop and natural resource sciences receive comparatively limited attention.

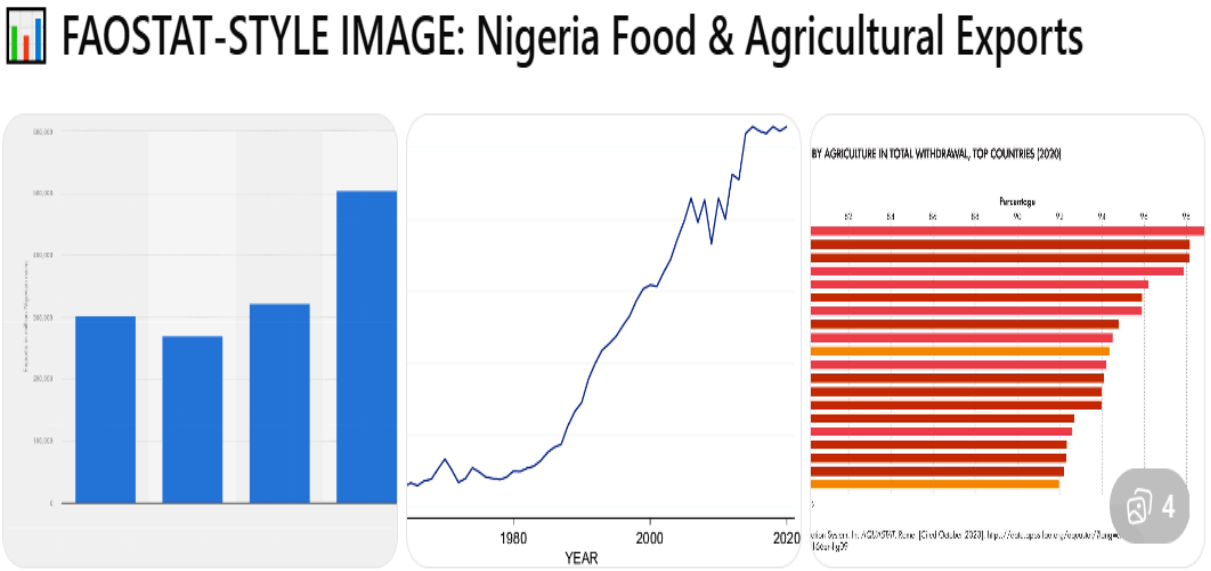
Graphic 19 – Agricultural R&D in Nigeria – Selected Indicators



Sources: ASTI (2025).

The results show a remarkable expansion of Nigeria's agricultural research workforce since the early 2000s, driven largely by rapid growth in higher-education researchers alongside steady increases in government-employed scientists. This upward trend reflects rising national commitment to agricultural R&D capacity, positioning universities and research institutes as central actors in strengthening innovation for Nigerian agriculture.

Graphic 20 - Nigeria food and agricultural exports (value and composition)



Source: FAOSTAT (2025).

This figure presents the evolution and composition of Nigeria's food and agricultural exports. Export performance remains relatively limited and concentrated in a narrow range of primary commodities, such as cocoa, sesame, cashew, and selected palm oil derivatives. Compared to food imports, which show a steady upward trend, agricultural exports exhibit low growth and high volatility. This contrast reveals a structural imbalance in Nigeria's agri-food trade, reflecting limited productivity gains, low value addition, and weak international competitiveness. Insufficient public investment in agricultural research and development (R&D) constrains technological innovation, quality improvement, and processing capacity, thereby limiting Nigeria's ability to expand and diversify its food exports

5 CONCLUSION

This dissertation demonstrates that Nigeria's public investment in agricultural research and development (R&D) is simultaneously significant and insufficient. Although the country accounts for nearly 40% of total public agricultural R&D spending in Sub-Saharan Africa (ASTI, 2023), its investment intensity remains far below international standards only 0.2–0.4% of AgGDP compared with the recommended 1% benchmark (Beintema; Nasir; Gao, 2017; Benin *et al.*, 2016). As a result, the sector continues to rely on expanding land rather than productivity gains, while food imports, malnutrition and yield stagnation persist (FAO, 2023). The study reveals that Nigeria's agricultural budget remains heavily skewed toward short-term subsidies instead of long-term research, irrigation and innovation-driven public goods (Alabi, 2020; Mogues *et al.*, 2008). Even where R&D spending increases, funding instability and low per-farmer investment weaken research continuity. Human-resource patterns deepen this vulnerability: although researcher numbers have grown, PhD-level capacity is limited, ageing scientists dominate senior ranks, and core crop and natural-resource sciences remain understaffed (Flaherty *et al.*, 2010; Beintema; Nasir; Gao, 2017).

Compared to smaller African countries that invest more intensively and maintain stronger scientific depth, Nigeria appears as a system with strong potential but fragile foundations (Stads; Nin-Pratt; Beintema, 2021). Methodological constraints including the absence of primary data from national research institutes necessitated reliance on secondary datasets such as ASTI; however, this allowed the study to produce the most updated, internationally comparable overview of Nigeria's R&D landscape. Looking forward, stronger evidence is needed to link R&D spending to farm-level outcomes, examine institutional governance, and learn from countries like Brazil, where sustained, mission-oriented research transformed tropical agriculture (Buainain *et al.*, 2014). Overall, the findings show that Nigeria stands at a pivotal moment. With its population, land resources and scientific base, the country has the capacity to become a global leader in tropical agricultural innovation. Achieving this requires shifting from volatile, subsidy-heavy spending toward stable, strategic and innovation-oriented R&D investment. By strengthening research institutions, investing in high-level scientific training and promoting climate-resilient technologies, Nigeria can enhance productivity, reduce dependence on food imports and set a trans-formative example for Africa and the Global South.

5.1 Main results

The study shows that Nigeria is the largest investor in agricultural R&D in Sub-Saharan Africa, yet its R&D intensity remains far below global standards, limiting productivity growth. Public spending is dominated by short-term subsidies, while long-term research and innovation receive insufficient and unstable funding. Research capacity is growing, but PhD-level expertise, critical crop sciences, and institutional infrastructure remain weak. Overall, Nigeria's agricultural system operates below its potential due to under investment, funding volatility, and gaps in scientific capacity, despite having enormous agro ecological and human-resource potential.

5.2 Constraints and difficulties for the research

This research was constrained by the absence of primary data, as none of the targeted Nigerian research institutions returned the questionnaires, limiting direct insight into internal budgeting and governance. The study therefore relied solely on secondary data, which, although reliable, restricted analysis of project-level impacts and institutional performance. Inconsistencies and gaps within national datasets also posed challenges for building complete time series. Overall, these limitations reduced the depth of empirical validation but did not diminish the importance or relevance of the study's findings.

5.3 Future research

Future research should deepen the linkage between R&D investments and farm-level productivity by using household surveys, Geo spatial data, and panel econometrics to quantify the real impact of public research on yields, income, and food security. Studies are also needed to explore institutional governance within Nigerian research agencies, examining budget flows, accountability systems, and the effectiveness of project implementation. Further investigation should assess the aging scientific workforce, PhD gaps, and disciplinary imbalances to design strategies for human-capital renewal. Regional analyses comparing northern and southern research capacities would help address equity challenges. Research should also evaluate Brazil–Nigeria agricultural cooperation to identify which models of technology transfer generate measurable improvements. Climate-resilient innovation, seed system reforms, and digital agriculture deserve targeted empirical study. Finally, a long-term national R&D tracking framework is urgently required to monitor spending, performance, and outcomes, ensuring more evidence-based agricultural policy making for Nigeria

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APPENDIX 1 – RESEARCH QUESTIONARY

PROPAGA

UnB

FAV Faculdade de Agronomia e Medicina Veterinária

Agriculture R&D in Nigeria, Innovation Survey

SECTION A: GENERAL INFORMATION

ORGANIZATION DETAILS

A1. Name of organization : **Started In the Year:**
A2. Address of organization
A3. Contact Email
A4. Company website
A5. The company is (please ✓put at relevant boxes)

i. Headquarters with a majority of local ownership ☐

ii. Government Research Organization? ☐

iii. Partly owned by government? ☐

iv. Affiliated with a foreign company headquartered elsewhere ☐

v. Not for profit organization or foundation ☐

	2016	2017	2018	2019	2020	2021	2022	2023
1. Total number of local employees:								
2. Total R&D expenditure (USD):								
3. % of total R&D from food & agricultural related products:								

SECTION B: PRODUCTS AND SERVICES WHICH WORK WITH

B1. Agricultural Businesses (please ✓ whichever is applicable)

Agricultural Inputs Markets		**Farms and Process Agricultural Final Products**	
Seeds/Planting materials		Maize/Cassava	
Fertilizers		Cocoa	
Pesticides		Palm Oil	
Farm Machinery		Cow/Piggs/ Chicken/Eggs	