

Government Agricultural Intervention Programmes and Sustainable Farming Practices in North-Central Nigeria: An Integrated Conceptual Review

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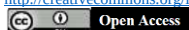
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ABSTRACT

Governments in developing countries often include agricultural intervention programmes in their agricultural development strategies to combat the problems of food insecurity, rural poverty, low agricultural productivity and environmental degradation. The Nigerian government has, for some time now, introduced a plethora of agricultural intervention programmes to enable accessibility of amenities and facilities such as agricultural inputs, credit, extension services, farm mechanization, modern farm technologies, and so on to farmers at different operational levels, to counter these challenges. Evidence on the long-term efficacy of these interventions on sustainable farming practices is scattered. Most of the studies available on record in respect to the performance of a government's intervention can be described at a general level. Also, the studies show an increase in productivity, change in beneficiary coverage, adoption of technology, and farm income. Furthermore, these are conventional indicators. Assessment of the outcomes of these programmes in relation to sustainability has received relatively less attention. This manuscript offers an analysis of government agricultural interventions and sustainable agricultural practices related to North-Central Nigeria. Based on current conceptual, theoretical, and empirical literature, the study critically synthesizes existing knowledge and spotlights the major trends, recurrent limitations, and outstanding conceptual issues. Review of the document reveals that government intervention enhances productivity, adoption, climate preparedness, and rural livelihood; however, the literature tests these constructs in isolation, resulting in a fragmented explication of intervention efficacy. According to the literature, intervention effectiveness is commonly measured by productivity-based indicators like crop productivity, pollution level, groundwater level, soil health, etc. It does not take into account the various intermediary variables through which agricultural interventions have an asymmetrical, multi-faceted effect. Agricultural Intervention Sustainability Nexus (AISN) is integrated as a conceptual perspective explaining the dynamic relationships among institutional effectiveness, innovation and knowledge transfer, sustainable farming practices, livelihood improvement, and sustainable agricultural transformation. Building upon this nexus, the paper further proposes the Sustainable Agricultural Intervention Effectiveness Framework (SAIEF) as a multidimensional framework for evaluating intervention effectiveness beyond traditional productivity-based indicators. Authorities implementing government agricultural interventions, such as fertilizer subsidies, to improve productivity are finding that outputs are not coming through, and that high fertilizer use is not environmentally sustainable. Assessment of government agricultural interventions must go beyond the output they deliver, as it must focus on whether they enable sustained uptake of sustainable farming practices through resilient institutions, dynamism of innovation, solid livelihoods and environmentally sustainable agricultural systems. According to the frameworks, policymakers, development practitioners and researchers will find useful guidance in the design, implementation and evaluation of the appropriate agricultural interventions to encourage sustainable agricultural transformation in Nigeria and other developing economies.

1. Introduction

Nigeria's agriculture plays a strategic role in its socio-economic development as it continues to play an important role in the national effort to ensure food security, generate jobs, reduce poverty, and diversify the economy. Although the oil industry generates the greatest portion of government revenue, agriculture supports more vulnerable people in Nigeria than any other industry. The majority of rural households derive their income mainly from the agricultural sector. In Nigeria, rural households predominantly rely on smallholder farming for their livelihood and food. Agro-based industries also depend on the agricultural sector for raw materials. Besides domestic economic activities, agriculture supports the overall national development agenda. India's Government before 1991 adopted a variety of structural reforms in relation to agriculture. The various structural reform policies before 1991 were like the MSP policy, movement of agricultural produce, agricultural inputs, and new technology adaptations. In spite of the fact that Nigeria has made a long-term commitment to agricultural policy, the sector is nevertheless paradoxical.

Despite farmers being capable of producing more, their current productivity is low due to various reasons such as poor access to quality inputs and finance, a weak extension system, poor rural infrastructure, post-harvest losses, insecurity, climate variability, and institutional weaknesses. Public investment in agriculture has expanded through numerous intervention programmes, yet many structural constraints justifying government intervention continue to limit agricultural transformation. The evidence indicates that low productivity, weak market integration, climate-related risks, and institutional constraints are limiting forces on sustainable agricultural transformation in Nigeria. The World Bank and the Food and Agriculture Organization (FAO) are reflective of this.

In light of this, international development organizations and agricultural specialists are now endorsing initiatives that simultaneously promote productivity, environmental, economic, and social inclusion goals that work together as sustainable agricultural systems. Studies from Nigeria, however, have shown that the willingness of farmers to deploy such practices relies heavily on institutional support; tenure conditions; access to information and the general policy environment. In this policy scenario, sustainable agriculture is becoming increasingly the primary objective of agricultural development rather than a mere environmental objective to be pursued simultaneously; it refers to production systems which improve agricultural productivity; conserve soil fertility; protect biodiversity; improve climate resilience; encourage efficient use of resources; and strengthen the long-term socio-economic wellbeing of farm households. As a consequence, the effectiveness of government agricultural interventions can no longer be gauged through the volume of agricultural inputs distributed or the volume of agricultural output produced. In due course, they ought to be assessed according to their effectiveness in leading farmers to adopt techniques that enhance productivity while conserving the ecological base on which sustained agricultural development relies.

This view coincides with recent reviews that promote re-orientation of agricultural policies towards long-term sustainability, resilience and transformation of food systems. As a result, agricultural policy has experienced a significant paradigm shift during the last twenty (20) years. Governments and development agencies used to just measure success by enhanced production or the number of agricultural inputs distributed. In the course of time, however, emphasis has been placed on resilience, environmental sustainability, efficient use of resources, and the ability of farming systems to absorb climatic and economic shocks. The shift stems from acknowledging that productivity gains alone cannot ensure food security if they compromise soil health, biodiversity, water, or the adaptive capacity of the farming system. Sustainable agriculture is gradually incorporated into national and international frameworks for agricultural development, such as the Sustainable Development Goals, the Comprehensive Africa Agriculture Development Programme (CAADP), and Nigeria's new National Agricultural Technology

and Innovation Policy 2022-2027. Within Nigeria itself, the policy focus has shifted attention to how government agricultural intervention programmes can aid the shift from conventional production systems to sustainable agricultural systems.

Within Nigeria, this changing policy orientation has renewed attention to the role of government agricultural intervention programmes in facilitating the transition from conventional production systems to more sustainable farming practices. Sustainable farming extends beyond increasing agricultural output to encompass farming systems that maintain soil fertility, conserve biodiversity, promote efficient water and nutrient management, enhance resilience to climate variability, and improve the long-term economic viability of farming households. Recent empirical evidence indicates that the adoption of climate-smart and sustainable agricultural practices improves household food security, dietary diversity, and resilience, but that adoption remains strongly influenced by access to institutional support, extension services, finance, knowledge, and enabling public policies.

These issues are particularly relevant in North-Central Nigeria, a region widely regarded as one of the country's principal agricultural belts because of its favourable agro-ecological conditions and substantial contribution to national food production. The region supports the cultivation of cereals, legumes, roots and tubers, vegetables, tree crops, and livestock, making it strategically important to Nigeria's food system. At the same time, farmers across the region face interconnected challenges, including declining soil fertility, climate variability, farmer-herder conflicts, land degradation, insecurity, and uneven access to agricultural support services. These challenges underscore the need for intervention programmes that not only increase agricultural productivity but also strengthen the sustainability and resilience of farming systems.

Although the literature on Nigerian agriculture has expanded considerably, existing literature and scholarly submissions remain fragmented. Most research concentrates on evaluating government agricultural policies, intervention programmes, and institutional reforms, primarily using indicators such as productivity, income generation, access to credit, or programme implementation, while some other literature examines sustainable agriculture, climate-smart farming, environmental conservation, and farmers' adaptation strategies. While both have generated valuable insights, they are not integrated into a coherent conceptual perspective capable of explaining **how** government agricultural intervention programmes influence the sustained adoption of sustainable farming practices. Recent reviews have similarly observed the need for stronger evidence synthesis and more integrated approaches to agricultural policymaking in Nigeria.

It is against this backdrop that this paper undertakes a conceptual review of government agricultural intervention programmes and sustainable farming practices in North-Central Nigeria. The paper critically synthesizes contemporary literature, policy documents, and relevant theoretical perspectives to examine the evolving relationship between public agricultural interventions and sustainable farming. Drawing from this synthesis, it advances the **Agricultural Intervention-Sustainability Nexus (AISN)** as a conceptual perspective for understanding the interaction between government interventions and sustainable farming outcomes and proposes the **Sustainable Agricultural Intervention Effectiveness Framework (SAIEF)**. According to the article, designed policies, institutional performance, adaptability of farmers, and learning may be the main drivers of the effectiveness of agricultural intervention programmes. The study elaborates on the conceptual piece of research on a crucial issue within agricultural policy literature, agricultural policies and their role in development that would inform further empirical research and evidence-informed policymaking in Nigeria.

2. Government Agricultural Intervention Programmes: Concept, Evolution and Contemporary Perspectives

2.1 Government Agricultural Intervention Programmes: Concept and Policy Rationale.

Government's Agricultural Intervention Programme is a declaration, public policy, or plan of action that a government designs to deliberately influence agricultural production, resource allocation, market performance, and rural development in pursuit of broader economic and social objectives. Unlike conventional market activities, agriculture is characterized by unique structural and institutional challenges, including production risks associated with climate variability, information asymmetry, imperfect credit markets, public goods, and positive environmental externalities that often justify government participation in the sector. The structures and institutional elements that exist in the agricultural sector make the business totally different from a normal business. Therefore, governments across developed and developing economies employ a range of policy instruments, including input subsidies, credit facilities, extension services, price support mechanisms, infrastructure development, research funding, crop insurance, and capacity-building programmes to address market failures and promote sustainable agricultural development (World Bank, 2024; FAO, 2023).

From an economic perspective, government intervention in agriculture is largely premised on market failure theory, which argues that markets alone may not allocate resources efficiently where public goods, externalities, imperfect information, or unequal access to productive resources exist. Agricultural production displays quite a number of these characteristics. Smallholder farmers frequently encounter barriers to affordable finance, quality inputs, technology, and market information, while environmental resources such as soil fertility, water, forests, and biodiversity generate benefits that extend beyond individual producers. Without appropriate public intervention, private investment alone may underprovide these socially desirable outcomes, thereby justifying government involvement in agricultural development (Stiglitz, 1989; World Bank, 2024).

These features cause difficulty for agricultural marketers. The agricultural business is different from other businesses in the convergence of nature. It involves the production of crops, raising of livestock, among other agricultural activities. Production is in danger because of climate, geographic, or seasonal conditions. People are not getting fair information due to a lack of proper knowledge. People can't get real market knowledge in the market due to poor information systems, etc. Beyond correcting market failures, agricultural interventions over time reflect broader developmental objectives. Governments now recognize agriculture not merely as a productive sector but as a strategic instrument for poverty reduction, food and nutrition security, employment creation, climate resilience, and inclusive economic growth. Impacts of soil fertility, water, forests, and biodiversity on production are more than what impacts an individual producer. Private investments can fall short of offering adequate social benefits on their own. Therefore, Government intervention in agricultural development is justified. Without appropriate public intervention, private investment alone may underprovide these socially desirable outcomes, thereby justifying government involvement in agricultural development (Stiglitz 1989; World Bank, 2024). This broader perspective aligns with the United Nations Sustainable Development Goals, particularly Goals 1 (No Poverty), 2 (Zero Hunger), 12 (Responsible Consumption and Production), and 13 (Climate Action), all of which acknowledge the central role of sustainable agriculture in achieving long-term development outcomes (United Nations, 2015; FAO, 2023).

In developing nations, especially in Nigeria, the need for government intervention is increasing because the agricultural sector is predominantly dominated by small-scale farmers who operate with low capital and technology, poor infrastructure, and are more vulnerable to environmental and market shocks. Public agricultural programmes are expected to stimulate production, build institutional capacity, facilitate technology transfer, improve access to markets and credit, and to enhance the environment for sustainable transformation of agriculture. But new evidence suggests that the adequacy of agricultural interventions can no longer be justified with reference to the volume of inputs distributed

or short-run output response. Under such circumstances, public agricultural programmes are expected not only to stimulate production but also to strengthen institutional capacity, facilitate technology transfer, improve access to markets and financial services, and create an enabling environment for sustainable agricultural transformation (IFAD, 2023; African Development Bank, 2024).

However, contemporary scholarship suggests that the effectiveness of agricultural intervention programmes should no longer be assessed solely by the quantity of inputs distributed or short-term increases in agricultural output. Over time, researchers argue that intervention effectiveness should be evaluated by the extent to which programmes generate lasting improvements in farmers' productivity, resilience, environmental stewardship, and adaptive capacity. In this regard, agricultural interventions are viewed over time as catalysts for sustainable behavioural change rather than temporary mechanisms for increasing production (Pretty, 2008; FAO, 2023; Smith et al., 2022).

The literature indicates that government agricultural intervention has broadened from a rather narrow production-support focus to a policy instrument for achieving sustainable agricultural transformation. Despite economic theory, public intervention still hinges on the correction of market failures; present-day experience does not lead to residual status for this justification. In other words, the success of agricultural programmes in the long run is likely to depend upon their capabilities to bring together economic efficiency, institutional effectiveness, environmental management and farmer-centric innovation. It is this basic idea which forms the essence of consideration of the historical evolution of agricultural intervention programmes and the changing philosophy behind contemporary agricultural policy.

2.2 Evolution of Government Agricultural Intervention Programmes

The philosophy behind government agricultural intervention programmes has witnessed significant change in the last 70 years. Initial agricultural plans aimed to improve the production of different foods for the country, while global agricultural intervention objectives and implementation mechanisms have changed due to socio-economic, technological and climate concerns (FAO, 2023). Agricultural policies now pursue broader goals that integrate productivity, environmental sustainability, institutional resilience, social inclusion, and long-term food systems transformation. This evolution reflects the recognition that sustainable agricultural development requires interventions that address not only immediate production constraints but also the structural, institutional, and ecological factors influencing agricultural resilience and rural livelihoods (FAO, 2023; Organization for Economic Co-operation and Development [OECD], 2023).

2.2.1 Global Evolution of Agricultural Intervention Programmes

It was after the Second World War that agriculture was more and more government-managed. Many countries began adopting interventionist policies for ensuring food security, stabilizing agricultural markets, and improving rural livelihoods. At this time, much of the public support that agriculture received went to price guarantees, production subsidies, irrigation infrastructure, mechanization, agricultural research, and agricultural extension. Concerns about food shortages and the need to spur quick increases in output led to these measures. Indeed, their contribution certainly helped enhance global food availability in many parts. In addition, these productionist policies promoted fairly intensive farming systems. The serious problems caused by the system in many parts of the world include soil degradation, the loss of biodiversity, overuse of chemicals, and environmental degradation (OECD, 2023; FAO, 2023). As the 20th century neared its end, policy relating to agriculture evolved in tune with an integrated development agenda. The majority of policymakers came to realize that agricultural growth was not possible without attention to natural resource degradation, institutional weaknesses, rural poverty and vulnerability of farmers to climate and economic shocks. Over time, agricultural interventions which were originally restricted only to production, gradually expanded to cover natural

resource management, climate change adaptation and mitigation, sustainable land management, financial inclusion of rural areas, strengthening farmers' capacities, steering them into value chains, and building their resilience. International policy frameworks, including Agenda 2030 for Sustainable Development, the Paris Agreement on Climate Change, and the Comprehensive Africa Agriculture Development Programme (CAADP), have further reinforced the need for agricultural interventions that simultaneously promote economic productivity, environmental stewardship, and social equity (United Nations, 2015; FAO, 2023; African Union Commission, 2024).

Recent literature demonstrates that contemporary agricultural interventions are increasingly evaluated according to their contribution to sustainable food systems rather than their capacity to increase production alone. Concepts such as climate-smart agriculture, regenerative agriculture, agroecology, nature-positive agriculture, and sustainable intensification now influence agricultural policy across both developed and developing economies. Despite differences in terminology and implementation, these approaches share a common objective of improving agricultural productivity while conserving natural resources, strengthening farmers' adaptive capacity, and ensuring long-term sustainability (Pretty et al., 2018; IPCC, 2023; FAO, 2024).

This historical evolution demonstrates a fundamental transformation in agricultural policy thinking. Government intervention is no longer viewed merely as a mechanism for correcting production deficits but as an instrument for building resilient, inclusive, and environmentally sustainable agricultural systems. Therefore, the success of agricultural interventions is increasingly judged by their capacity to generate enduring improvements in productivity, institutional performance, environmental quality, and farmers' adaptive behaviour rather than by short-term production outcomes alone.

Synthesis

The evolution of government agricultural intervention programmes reflects a broader transformation in development thinking. Whereas earlier interventions concentrated primarily on increasing agricultural production, contemporary policies recognize that productivity, environmental sustainability, institutional effectiveness, and rural resilience are mutually reinforcing dimensions of agricultural development. This changing policy philosophy provides an important foundation for understanding the evolution of agricultural intervention programmes within Nigeria, where successive governments have similarly adapted intervention strategies in response to emerging economic, institutional, and environmental realities.

2.2.2 Evolution of Government Agricultural Intervention Programmes in Nigeria

Since gaining independence in 1960, there have been agricultural policies and intervention programmes by successive governments in Nigeria. These have undergone multiple incarnations, reflected changing development priorities and political regimes, and responded to new socio-economic challenges. Observe the changing face of public policy to agricultural development in Nigeria (FMAFS, 2022) in these various initiatives.

The post-independence initial development policies tried to promote higher food production, alleviate rural poverty, generate new employment, enhance the income of farmers, and strengthen national food security. All or a combination of these objectives are virtually manifested in the policies and programmes implemented thereafter. Despite having differences in philosophy, institutional design, source of funds, and implementation methodology, the policy initiatives bring to the fore the concern of government about the performance of agriculture (FMAFS, 2022).

During the period immediately after independence, the objectives were to modernize agricultural production, increase export earnings in foreign exchange of cocoa, groundnut, cotton, palm produce and rubber at that time. The Farm Settlement Scheme, which provides land, training and essential infrastructure required for commercial farming, is also one of the schemes. The development of these

programmes succeeded in various locations, but with national attention and resources being diverted to the lucrative petroleum industry, their implementation suffered from this constraint (Manyon et al, 2005; FMAFS, 2022).

In 1976, Operation Feed the Nation (OFN) and the Green Revolution Programme were both accepted and executed as a result of falling agricultural productivity during the oil boom in 1980. These two programmes aimed at increasing food production, reducing food importation, and encouraging political involvement in farming. The government's interventions for the period in question were essentially for the supply of subsidized agricultural inputs, extension services, mechanization and enlightenment.

Although both programmes did boost interest in growing crops, the long-run benefits of the programmes were limited by a lack of policy continuity, weak administrative structure, change of government, poor monitoring and evaluation (Ayoola, 2001; FMARD, 2016). Since the 1990s, Nigeria's agricultural policy has seen growing levels of participation, which has progressed from lack of or weak participation to stronger and more focused participation with an overall market orientation. This shift was largely evident through the strong influence of the World Bank-supported National Fadama Development Projects. Unlike many earlier intervention programmes, the Fadama Projects placed greater emphasis on local ownership, institutional strengthening, and sustainability, resulting in measurable improvements in farmers' productivity, household income, and rural infrastructure across participating states (World Bank, 2008; IFAD, 2023).

Fadama I-III Projects were different from most previous intervention initiatives. They were aimed at improving the livelihoods of rural farmer-based communities by promoting irrigation and infrastructure. Also, they enhanced farmers' participation and access to productive assets.

The projects' participatory orientation enhanced ownership and contributed to institutional strengthening and sustainability. In addition, Fadama Projects were well structured with designs that made impact easy to measure. In addition to this, Fadama Projects increased Nigeria's rural agricultural productivity; household income and rural infrastructure development in many areas.

The Agricultural Transformation Agenda (ATA) (2011 and 2015) also marked a further policy shift in Nigeria. The ATA viewed agriculture as a business rather than a development sector, which is a significant shift from past interventions. The program promoted private sector participation, agricultural value chain development, improved input distribution through the **Growth Enhancement Support Scheme (GESS)**, and increased investment in agricultural productivity. Given these changes, subsequent governments put the **Anchor Borrowers' Programme (ABP)** in place to enhance the access of smallholder farmers to credit, strengthen producers-processors' linkages and boost domestic output of strategic crops. Although these programmes have made significant progress in helping farmers access finance and inputs, a number of studies highlight existing implementation obstacles. These include loan recovery, beneficiary targeting, transparency, institutional coordination and long-term programme sustainability (Central Bank of Nigeria 2020; Liverpool-Tasie et al 2023).

Nigeria's agricultural policy today, derived from the **National Agricultural Technology and Innovation Policy (NATIP) 2022-2027**, suggests that the world is moving away from just raising agricultural productivity but focusing more on sustainable climate-resilient agriculture. Stated differently, this policy recognizes that a boost in agricultural productivity is not necessarily an assurance for ensuring food security unless there is a major contribution towards environmental sustainability, technology upgradation, climate-friendly practices, institutional strengthening, private participation, along with making rural development inclusive.

As stated in the Federal Ministry of Agriculture and Food Security (2022), contemporary measures for agricultural development include integrated agricultural interventions which combine productivity

enhancement and natural resource management sustainable use. Most significantly, it also highlighted digital agriculture, research and innovation, value chain development, and building resilience. The above description shows that there has been a clear evolution in Nigeria's policy thinking about agricultural intervention programmes. Initially, the interventions increased to boost agricultural production and lessen food shortages.

In view of the historical evolution of agricultural intervention programmes in Nigeria, transformation policy thinking illustrates a gradual but significant change in policy processing. Earlier interventions were designed to increase agricultural production and reduce food shortages, whereas contemporary policies increasingly recognized that sustainable agricultural transformation requires effective institutions, technological innovation, farmer participation, environmental stewardship, and long-term resilience. This progression reflects broader international developments in agricultural policy and provides an appropriate context for evaluating the effectiveness of government intervention programmes beyond traditional production indicators.

3. Sustainable Farming Practices: Concept and Contemporary Perspectives

3.1 Concept of Sustainable Farming Practices.

In the contemporary agricultural policy and development circles, it is the notion and practice of sustainable farming that is gaining traction. Specifically, an urgent challenge facing governments, researchers, and international development organizations is how to respond to this growing challenge while not undermining the natural resource base upon which agriculture ultimately depends. To be sure, escalating international demand for food, climate change, attrition of land, loss of biodiversity, water stress, environmental pollution, and similar factors have led agricultural evolution to move beyond a purely production-focused approach to one that also seeks to strengthen the economic viability, environmental sustainability, and social well-being all at the same time. Thus, sustainable farming has evolved from an environmental concern into a comprehensive framework for achieving long-term agricultural resilience and food systems transformation (FAO, 2023; IPCC, 2023).

The definition of sustainable farming can mean different things to different people and, despite the term being extensively used in the agricultural literature, there is no universally agreed definition. Due to diversity in agricultural systems, biophysical conditions, socio-economic conditions and policy imperatives among various countries, there are varying interpretations of sustainable agriculture. Everyone agrees that agricultural production must be able to meet the food and livelihood needs of the present, without compromising the ability of future generations to meet their own needs.

Sustainable farming is the application of sustainable development principles to agricultural production systems (Brundtland Commission, 1987, coupled with FAO, 2023). This requires the implementation of productive agriculture that is economically viable while at the same time protecting the natural resources and enhancing the natural environment. The Food and Agriculture Organization (FAO) defines sustainable agriculture as **“the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations”**. The conservation of land, water, plant and animal genetic resources must result from this. It should not harm other ecosystems” (FAO, 2023).

According to FAO, sustainable agriculture should have four (4) essential conditions: **“(i) it must not be non-degrading to the environment; (ii) it must be technically appropriate; (iii) it must be economically viable; and (iv) it must be socially acceptable”** (FAO, 2023). In other words, FAO states that sustainability must include environmental conservation, economic efficiency, institutional effectiveness, technological innovation, and social equity. According to the sustainable agriculture concept by FAO, as it stands today, it is not enough to only pay attention to the environment, as

contemporary researchers do. Sustainability does not refer to a list of environmentally friendly farming operations or practices. Instead, it is a production system that ensures a harmonious balance among productivity, profitability, resilience, and environmental responsibility.

The importance of sustainable agriculture is especially prevalent in Nigeria, where the agricultural ecosystem is characterized by producers who are mostly smallholder farmers and operate under a climate of increasing uncertainty, declining soil fertility, land fragmentation, low level of mechanization, limited access to extension, and a weak institutional framework. Thus, sustainable farming in Nigeria cannot be viewed only as environmental conservation. It would be farming in a way that enables farmers to increase productivity, enhance household income, conserve natural resources, adapt to climate variability, and strengthen livelihood resilience in the long run. This broadened view of Nigerian agriculture is tantamount to the actual realities facing the sector. It is also consistent with the evolving landscape of policy objectives that is captured in the National Agricultural Technology and Innovation Policy (2022–2027). The policy calls for productivity growth, environmental sustainability, technological innovation, and climate-smartness (Federal Ministry of Agriculture and Food Security, 2022).

Drawing from the foregoing literature, this paper conceptualizes sustainable farming practices as:

“A dynamic system of agricultural production that integrates environmentally responsible resource management, economic viability, social inclusion, institutional support, and continuous innovation to enable farmers to improve productivity while safeguarding the ecological systems and socio-economic conditions necessary for long-term agricultural sustainability”.

This definition extends existing conceptualizations by explicitly recognizing **institutional support** and **continuous innovation** as integral components of sustainability rather than external facilitating factors. This perspective is particularly relevant to the present study because government agricultural intervention programmes primarily operate through institutions, policies, technologies, and support services that influence farmers' decisions and capacity to adopt sustainable agricultural practices.

Synthesis

From just the environmental perspective, sustainable farming has recently evolved into a wider concept. In simpler terms, it includes components like economic, social, institutional, technological, and ecological stability. Sustainability of agriculture cannot be assessed in terms of its environmental result alone but also the ability to maintain productivity, adaptability, and resilient rural livelihoods for an extended period of time. The conception imparted above provides us with insight into the sustainable development principles, aspects of farming and linkages with Government Agricultural Intervention Programmes.

3.2 Principles of Sustainable Farming Practices

Sustainable agriculture refers to farming systems that use a set of interrelated principles. These principles aim to be able to sustain the capacity of the agro-ecosystem to produce for economic objectives. There will also be a sustained natural resource base. The economic and social well-being of farmers and farming communities is important too. Modern agricultural research sees sustainability as a process through which multiple goals are achieved at the same time with respect to environmental, economic, social and institutional factors. The normative foundation upon which sustainable agricultural policies and practices are built. This (2023) is referenced by FAO and OECD.

3.2.1 Environmental Sustainability

The fundamentals of sustainable farming rely on environmental sustainability. Agricultural production depends on the well-being of the ecosystem and natural resources. In view of this, it must always apply eco-friendly and sustainable technology that does not deplete and degrade the natural ecosystem.

Essentially, environmental sustainability is concerned with how farming practices maintain soil fertility, safeguard water resources, protect biodiversity, stop environmental damage, minimize greenhouse gases, and produce productive farming landscapes, regardless of whether they enhance agricultural productivity, improved or otherwise; they do so without prejudicing the environmental supports upon which agriculture depends. Practices such as conservation agriculture, crop rotation, integrated nutrient management, agroforestry, efficient irrigation, integrated pest management, and climate-smart agriculture exemplify environmentally sustainable approaches that enhance agricultural productivity without degrading ecological systems. Recent studies demonstrate that these practices improve soil health, increase resilience to climate variability, and contribute to long-term agricultural sustainability (IPCC, 2023; FAO, 2023).

3.2.2 Economic Sustainability

If producers do not have economic viability, agricultural sustainability cannot occur. The ability of farming families to earn a stable income is termed economic sustainability. It maximizes output and minimizes production expenses. It also helps create multiple sources of income, and that ensures an economically viable as well as a profitable agricultural enterprise over a period of time. A producer or farmer will be hesitant to take up or continue an environmentally benign practice should it jeopardize the household's livelihood security or reduce farming system profitability. As a result, present agricultural interventions are progressively embedding measures for sustainable development of wholesome access to markets, financial inclusion, agricultural insurance, value chain development, digital technologies and agribusiness. This means economic sustainability is trying to ensure environmental sustainability, which will directly benefit farmers (World Bank, 2024; IFAD, 2023).

3.2.3 Social Sustainability

The structural social dimension simply admits that agriculture is essentially for people. The agricultural production and farming systems that are sustainable should promote food and nutrition security, improve rural livelihoods, create decent employment opportunities, enhance gender equity, strengthen community participation, and improve farmer access to education, extension, and productive resources. The goal of social sustainability is to improve social inclusion. It realizes the need to allow women, youth, vulnerable groups, and smallholder farmers to benefit equitably from agricultural development activities. More and more, educationists stress that sustainable agriculture cannot be separated from rural social development, for resilient farming systems need resilient farming communities (United Nations, 2015; FAO, 2023).

3.2.4 Institutional Sustainability

Although the literature often focuses on the environmental, economic and social dimensions, we argue that institutional sustainability should also be given due consideration. Whether farmers adopt sustainable agricultural practices depends not only on their willingness but on their capacity, which is determined by institutions providing consistent policy, extension, research services, market regulation, access to finance, technology, monitoring and evaluation facilities. Weakness in institutions is often responsible for programme fragmentation, discontinuity of policies, weak accountability, and often poor adoption of agricultural technologies and innovations. It is therefore important to consider institutional effectiveness as an important element of sustainable farming, not as an exogenous enabling condition. The governance literature is increasingly showing that the quality of institutions is critical to good agricultural outcomes, a fact that is well captured by this conceptualization (World Bank, 2024; FAO, 2023; OECD, 2023).

The review stands out from existing conceptualizations of sustainable farming because it adopts institutional sustainability as an important focus area. Conceptual frameworks that exist today mostly cover the environmental, economic, and social pillars of sustainability and treat institutions as contextual

variables. We maintain that policies are made, resources mobilized, technology disseminated, and farmers supported in the adoption of sustainable practices with the help of institutions. The sustainability of the institution is very important for the stability and functioning of agriculture.

Synthesis

To put it differently, they are complementary and not competing. Social inclusion, environmental stewardship and economic viability, coupled with good institutional performance, are the four (4) pillars of sustainable agriculture. An intervention that is likely to be sustainable will have one or more of these dimensions: environmental, economic, social or institutional.

Consequently, it becomes easier to assess governmental programmes which perturb the agricultural sector in terms of their benefits. Focusing only on growth or supplying inputs for agriculture is unlikely to help with the farming systems as a whole. That is to say, partial (or incomplete) intervention refers to any intervention that strengthens only one aspect and does not strengthen other distant aspects. From the above discussion, we can understand the basis for different dimensions of sustainability and the practices that keep sustainability intact in agriculture today.

3.3 Dimensions of Sustainable Farming Practices

Alternative farming methods are being used through a combination of agricultural practices which improve productivity, conserve natural resources and enhance the resilience of farming systems. These practices are neither mutually exclusive nor uniformly applied across agricultural landscapes. Rather, they function as interconnected components of an integrated production system in which improvements in one dimension reinforce outcomes in others. The recent academic review of agricultural research shows that in most cases, sustainable agricultural practices are adopted successfully only when farmers and farmer groups have access to appropriate knowledge, technologies, institutional and financial resources, and an enabling policy and institutional environment, as the FAO and OECD (2023) say.

3.3.1 Sustainable Soil and Land Management

The role of healthy soils in sustainable agriculture cannot be downplayed, as they provide the foundation for biomass production, water and nutrient retention. Soil health refers to the integration of soil biological and chemical systems that can improve agricultural systems.

Sustainable soil and land management is the use of a specific set of farm practices like crop rotations, conservation tillage, cover crops and crop residues, organic manure application, integrated nutrient management, contour farming, control of erosion, etc. As a result of these practices, soil fertility will improve sustainably, land degradation will be reduced, carbon sequestration will increase, and resilience to climate variability will be increased. In Nigeria, where declining soil fertility and unsustainable land use practices continue to constrain agricultural productivity, effective soil management remains indispensable for achieving long-term agricultural sustainability (FAO, 2023; IPCC, 2023).

3.3.2 Sustainable Water Resource Management

Water is a critical resource for enhancing agricultural production, particularly in a region like ours that has been receiving an increasingly erratic pattern of rainfall along with long dry spells between rain events. The employment of technologies such as rainwater harvesting, drip irrigation, sprinkler irrigation, watershed management, water-efficient drains, precision irrigation systems, etc. may promote efficient utilization, conservation, and protection of water resources to sustain water management. These practices will assist in reducing water losses, improving efficiency, and preventing degradation of the environment while helping farmers to adapt to climate variability. According to the United Nations (2023) and FAO (2023), water management is a key component of sustainable agricultural production in the North-Central Nigerian environment.

3.3.3 Climate-Smart Agriculture

Climate-Smart Agriculture (CSA), as an innovative approach, is gaining increasing popularity due to its role in sustainable development in the context of climate change impact on food production systems. The agricultural climate practices that fall under the climate-smart approach seek to sustainably increase agricultural productivity and resiliency. It also strengthens the farmers' capacity for adaptation and the reduction, where possible, of greenhouse gas emissions.

Climate-Smart agriculture appeared first on Free-projects. The climate-smart practices used by farmers are numerous and diverse. Examples of important climate-smart practices include drought-tolerant varieties, improved weather information, diversified cropping, conservation agriculture, integrated crop-livestock systems, climate-informed farm management, etc. Research is showing more and more that climate-smart agricultural practices build household-level resilience to climate change and help countries transition to improved long-term food security and environmental sustainability (FAO, 2023; IPCC, 2023).

3.3.4 Agroforestry and Biodiversity Conservation

This is the integration of trees, crops, and livestock in the same production system to generate ecological, economic, and social benefits. Growing trees on the farm helps to conserve biodiversity, improve soil fertility, control soil erosion, increase carbon sequestration, moderate local climate, and diversify the income of the farmers. Generally, the conservation of biodiversity helps in maintaining stability in the ecosystem by maintaining healthy populations of useful insects and other effective pollinators, traditional native varieties of crops, and natural pest controllers. Agroforestry is presently gaining recognition and acceptance among diverse peoples and professionals as a formidable land rehabilitation measure that could enhance agricultural productivity and build climate resilience in poor farming-reliant rural communities in Nigeria (World Agroforestry Centre, 2023; FAO, 2023).

3.3.5 Integrated Pest and Nutrient Management

Sustainable farming encourages integrated pest control and nutrient management strategies that do not negatively impact ecosystems and damage agricultural production. Integrated Pest Management incorporates biological pest control, cultural practices, planting of disease-resistant varieties, and prudent use of pesticides so as to keep pest populations below the Economic Injury Level (EIL). Integrated Nutrient Management (INM) involves the use of both organic and inorganic nutrient sources in a complementary manner, keeping in view the site. While improving soil fertility and enhancing crop productivity, this curtails the overuse of chemical fertilizers. Better ecosystem services, reduced production costs, and enhanced yield are expected to be the benefits in the long run. These approaches contribute to healthier ecosystems, lower production costs, and improved long-term productivity (FAO, 2023; OECD, 2023).

3.3.6 Digital and Precision Agriculture

Changes in digital technologies are altering agricultural systems. Technology is improving decision-making at all farming levels from lower-input subsistence farming to commercial-scale production. This includes the development of Geographic Information Systems (GIS) and remote sensing. For example, precision agriculture can determine the application rate of fertigation and distances between point sources and crops under the assumption that soil texture is uniform within farm zones. Precision agriculture allows farmers to use digital technology to facilitate spatially and temporally "smart" farmer decision-making. Specifically, this farmer decision-making is in regard to the crop, soil health, and land condition. Artificial intelligence, mobile impact, mathematical modeling, satellite imagery, sensor-based monitoring, user participation, as well as machine learning, satellite imagery, soil sensors, and weather stations, remains relatively limited among Nigerian smallholder farmers due to infrastructural and financial constraints, digital agriculture presents significant

opportunities for improving the effectiveness and sustainability of future agricultural intervention programmes (World Bank, 2024; FAO, 2023).

Analytical Transition

The aforementioned dimensions illustrate that sustainable agriculture is not just about a few isolated farming practices but rather a comprehensive integrated production system whereby the agricultural practices of soil management, water conservation, climate adaptation, biodiversity conservation, rational input use and technological innovation, all operating together, enhance the overall agricultural resilience and productivity on a sustained basis. As a rule, the adoption of these practices does not occur by themselves nor is it due to the efforts of individual farmers.

The adoption and sustenance of technology may depend on policies, extension services, access to finance, innovation and institutional coordination. As such, the assessment of government agricultural intervention programmes should focus not only on the inputs being delivered but more on how these create the enabling environment in which these sustainable farming practices can be adopted, sustained and/or scaled. The basis for agricultural intervention that forms the backbone of the **Agricultural Intervention-Sustainability Nexus (AISN)** is developed subsequently.

4. Theoretical Perspectives

Interventions of public agricultural development programmes and sustainable agricultural practices are essentially multi-dimensional links having involvement of institutional processes, farmer behaviour, technological change, environmental management, and livelihood outcomes. As a result, this relationship cannot be explained by a single theory. This paper will take a multi-disciplinary theoretical approach based on critical reviews of the Systems Theory, Institutional Theory, Diffusion of Innovation Theory, and Sustainable Livelihoods Framework. When combined, these perspectives will offer complementary insight into how public policies affect farmers, alternative options, institutional quality, resource mobilization, and agricultural transformation.

4.1 Systems Theory

Systems Theory originated from the pioneering work of **Ludwig von Bertalanffy (1968)**, who argued that organizations and social systems should be understood as integrated wholes composed of interdependent components rather than isolated entities. According to the theory, changes occurring within one component inevitably influence the functioning of other components because the effectiveness of the system depends upon continuous interaction, coordination, feedback, and adaptation.

Within agriculture, Systems Theory conceptualizes farming as an interconnected socio-ecological system comprising farmers, government institutions, research organizations, extension services, financial institutions, markets, climatic conditions, and natural resources. Sustainable agricultural outcomes therefore emerge not from the effectiveness of a single actor but from the interaction among these multiple components. Therefore, government agricultural intervention programmes influence sustainable farming not only through the provision of financial or material resources but also by strengthening institutional relationships, facilitating knowledge exchange, promoting technological innovation, and improving policy coordination (Bertalanffy, 1968; Meadows, 2008).

The principal strength of Systems Theory lies in its holistic perspective, which enables researchers to appreciate the interconnected nature of agricultural development. Rather than viewing productivity, environmental conservation, institutional effectiveness, and farmer behaviour as independent variables, the theory recognizes their reciprocal relationships. However, critics argue that Systems Theory provides limited guidance regarding the behavioural mechanisms through which individual farmers adopt innovations and may therefore underemphasize human agency and institutional power dynamics (Checkland, 1999).

Despite this limitation, Systems Theory provides an important conceptual foundation for the present study because it supports the argument that sustainable agricultural transformation results from coordinated interactions among policy institutions, farmers, technologies, and environmental systems. This holistic perspective aligns closely with the **Agricultural Intervention-Sustainability Nexus (AISN)**, which conceptualizes agricultural intervention as a dynamic system rather than a collection of isolated government programmes.

4.2 Institutional Theory.

Institutional Theory emphasizes the influence of formal and informal institutions on organizational behaviour, policy implementation, and societal outcomes. The theory argues that institutions, including government agencies, legal frameworks, cultural norms, and governance structures, shape the behaviour of individuals and organizations by establishing rules, incentives, and expectations that guide decision-making (North, 1990; Scott, 2014).

Within agricultural development, Institutional Theory suggests that the effectiveness of government intervention programmes depends not merely on policy design but on the quality of institutions responsible for implementation. Agricultural policies may be technically sound, yet produce limited outcomes where institutions suffer from weak governance, inadequate funding, poor coordination, corruption, inconsistent policy implementation, or limited accountability. Thus, effective institutions facilitate access to extension services, agricultural finance, technological innovation, markets, and information, thereby creating conditions that encourage farmers to adopt sustainable agricultural practices.

A major strength of Institutional Theory lies in its capacity to explain why similar agricultural intervention programmes often produce different outcomes across countries and regions despite pursuing comparable policy objectives. The theory highlights institutional quality as a critical determinant of programme effectiveness. Nevertheless, critics argue that Institutional Theory tends to place greater emphasis on organizational structures than on individual behavioural choices, technological diffusion, or ecological processes (Scott, 2014).

In respect to this study, Institutional Theory is particularly relevant because government agricultural intervention programmes are fundamentally institutional mechanisms. The theory reinforces this paper's proposition that institutional sustainability should be regarded as a core dimension of sustainable farming rather than merely an external enabling condition. It also provides a strong theoretical justification for incorporating governance, policy consistency, extension services, and institutional learning into the proposed **Sustainable Agricultural Intervention Effectiveness Framework (SAIEF)**.

Analytical Transition

Systems Theory and Institutional Theory demonstrate that sustainable agricultural transformation cannot be understood solely in terms of agricultural production or environmental conservation, but rather, sustainable outcomes emerge through continuous interaction between institutions, policies, farmers, technologies, and ecological systems. While Systems Theory explains these interactions from a holistic perspective, Institutional Theory highlights the governance structures that shape their effectiveness. However, neither theory sufficiently explains **how farmers decide to adopt sustainable farming innovations**, thereby necessitating consideration of behavioural perspectives. The next section therefore examines **Diffusion of Innovation Theory**, which provides insight into the processes through which agricultural innovations are communicated, accepted, and sustained within farming communities.

4.3 Diffusion of Innovation Theory.

Diffusion of Innovation Theory was developed by **Everett M. Rogers (1962)** to explain how new ideas, technologies, and practices spread within a social system over time. The theory posits that

innovation adoption is not an instantaneous process but a gradual progression through which individuals acquire knowledge of an innovation, form attitudes towards it, decide whether to adopt or reject it, implement the innovation, and subsequently confirm their decision based on observed outcomes. Rogers argues that the rate and extent of adoption are influenced by the perceived characteristics of the innovation, communication channels, social networks, and the socio-economic characteristics of potential adopters (Rogers, 2003).

Within the context of agricultural development, the theory has been widely applied to explain farmers' adoption of improved technologies, climate-smart agricultural practices, conservation agriculture, precision farming, improved seed varieties, irrigation technologies, and other agricultural innovations. It suggests that farmers are more likely to adopt sustainable farming practices when they perceive clear advantages over existing methods, when innovations are compatible with local farming conditions and cultural practices, when they are relatively easy to understand and implement, and when their benefits can be observed through the experiences of other farmers. Extension services, farmer associations, demonstration farms, digital advisory platforms, and peer learning therefore play a critical role in accelerating the diffusion of agricultural innovations (Rogers, 2003; FAO, 2023).

One of the principal strengths of Diffusion of Innovation Theory is its ability to explain why farmers respond differently to similar agricultural intervention programmes. Even where governments provide subsidized inputs, financial support, or extension services, adoption rates often vary because farmers differ in their perceptions of risk, access to information, educational attainment, financial capacity, farming experience, and exposure to successful demonstrations. The theory therefore highlights the importance of communication, trust, and learning in achieving sustainable behavioural change rather than assuming that the provision of resources alone will automatically lead to innovation adoption.

Despite its widespread application, the theory has attracted criticism. Scholars argue that it places considerable emphasis on individual decision-making while giving comparatively less attention to broader structural factors such as institutional capacity, governance quality, market failures, policy inconsistency, and unequal access to productive resources. In developing countries, including Nigeria, farmers' adoption decisions are frequently constrained by inadequate infrastructure, limited access to finance, insecurity, weak extension systems, and policy discontinuity. Therefore, innovation diffusion cannot be fully understood without considering the institutional and policy environments within which farmers operate (Hall, 2007; World Bank, 2024).

For the present study, Diffusion of Innovation Theory provides an important behavioural perspective by explaining the mechanisms through which government agricultural intervention programmes influence the adoption of sustainable farming practices. Government interventions rarely achieve their intended outcomes simply by making technologies or resources available. Their effectiveness depends on the extent to which farmers become aware of innovations, understand their potential benefits, acquire the necessary skills, and receive sustained institutional support throughout the adoption process. The theory therefore complements Systems Theory and Institutional Theory by demonstrating that sustainable agricultural transformation ultimately depends on farmers' willingness and capacity to adopt and sustain improved agricultural practices.

Analytical Transition

Diffusion of Innovation Theory explains how sustainable farming practices spread among farming communities through learning, communication, and behavioural change. However, while the theory provides valuable insight into innovation adoption, it does not fully explain how these innovations contribute to long-term livelihood improvement and resilience. Sustainable agriculture ultimately seeks not only to promote the adoption of improved practices but also to enhance farmers' well-being, reduce

vulnerability, and strengthen their capacity to withstand environmental and economic shocks. These broader developmental outcomes are more comprehensively explained by the **Sustainable Livelihoods Framework**, which forms the next theoretical perspective examined in this paper.

4.4 Sustainable Livelihoods Framework (SLF)

The Sustainable Livelihoods Framework (SLF) emerged from the work of the United Kingdom's Department for International Development (DFID) during the late 1990's as a comprehensive framework for understanding how individuals and households construct and sustain their livelihoods under varying social, economic, institutional, and environmental conditions. The framework conceptualizes livelihoods as the capabilities, assets, activities, and strategies through which people secure the necessities of life while maintaining resilience in the face of external shocks and long-term vulnerabilities (DFID, 1999; Scoones, 1998).

Central to the Sustainable Livelihoods Framework is the proposition that livelihood outcomes are determined by the interaction between five forms of capital assets: **human, natural, financial, physical, and social capital** within a broader context of institutional processes, policies, governance structures, and external vulnerability. Rather than viewing agricultural development solely in terms of increased production, the framework emphasizes improvements in household income, food security, resilience, reduced vulnerability, environmental sustainability, and overall well-being. Therefore, sustainable livelihoods are achieved when individuals are able to enhance their productive capacities without undermining the resource base upon which future livelihoods depend (Scoones, 1998; DFID, 1999).

Within agricultural development, the Sustainable Livelihoods Framework has become one of the most influential approaches for evaluating the long-term effectiveness of agricultural policies and rural development programmes. Government agricultural intervention programmes influence livelihoods by improving farmers' access to productive assets such as agricultural finance, extension services, improved technologies, infrastructure, markets, education, and institutional support. These interventions strengthen farmers' capacity to diversify income sources, manage production risks, adapt to climate variability, and invest in sustainable farming practices. Accordingly, the framework provides a comprehensive perspective for understanding how agricultural interventions extend beyond immediate production gains to generate broader developmental outcomes (IFAD, 2023; FAO, 2023).

A major strength of the Sustainable Livelihoods Framework lies in its holistic orientation. Unlike approaches that evaluate agricultural programmes using productivity indicators alone, the framework recognizes that sustainable agricultural development encompasses economic security, environmental stewardship, social inclusion, institutional effectiveness, and resilience to external shocks. This broader perspective aligns closely with contemporary development thinking, which increasingly emphasizes resilience, climate adaptation, and inclusive growth as essential components of sustainable agriculture (United Nations, 2015; FAO, 2023).

Despite its strengths, the framework has been criticized for its broad scope and limited guidance regarding causal relationships among livelihood assets, institutional processes, and development outcomes. Some scholars argue that its comprehensive nature can make empirical measurement difficult, particularly where multiple livelihood indicators interact simultaneously. Others note that while the framework effectively describes livelihood systems, it provides less explicit explanation of how government policies influence individual behavioural decisions regarding technology adoption and innovation (Ashley & Carney, 1999; Ellis, 2000).

Notwithstanding these limitations, the Sustainable Livelihoods Framework remains highly relevant to the present study because it shifts the evaluation of government agricultural intervention programmes beyond short-term agricultural production towards broader measures of sustainable development. It supports the argument that intervention effectiveness should be assessed according to

the extent to which programmes enhance farmers' adaptive capacity, strengthen livelihood resilience, improve environmental sustainability, and contribute to long-term rural development. This perspective complements Systems Theory, Institutional Theory, and Diffusion of Innovation Theory by providing an outcome-oriented explanation of sustainable agricultural transformation.

Analytical Transition

The Sustainable Livelihoods Framework completes the theoretical foundation of this study by demonstrating that the ultimate objective of government agricultural intervention programmes extends beyond the adoption of agricultural innovations to the achievement of resilient and sustainable livelihoods. Nevertheless, each of the four theories reviewed explains only a particular dimension of the relationship between government interventions and sustainable farming. Systems Theory explains interdependence; Institutional Theory emphasizes governance and implementation; Diffusion of Innovation Theory explains behavioural adoption, while the Sustainable Livelihoods Framework focuses on long-term livelihood outcomes. Their individual strengths and limitations therefore necessitate an integrated theoretical perspective capable of explaining the complex interactions among institutions, farmers, innovations, and sustainable agricultural development. This integrated perspective is developed in the next section.

4.5 Integrated Theoretical Synthesis

The above review shows that the link between the government agricultural intervention programmes and sustainable agriculture is multi-faceted, and none of the theories above can explain the relationship. Each theory provides unique insights, but has limited scope for broader analysis of the process of agricultural transformation.

The holistic approach is rooted in Systems Theory, which posits that agriculture is an active socio-economic system of interrelatedness and mutual influence between four domains of agriculture and policy environments that continually shape the development outcome: farmers, natural resources/technologies, markets, and government institutions. The systems perspective is complemented by Institutional Theory, which emphasizes the significance of the quality of governance, institutional coordination, policy consistency, accountability, and the capacity of policy implementation agencies in the process of implementing agricultural interventions.

These theories describe the structural and institutional aspects of agricultural development, but have provided relatively little explanation of farmers' reaction to government action. The Diffusion of Innovation Theory (DIT) can contribute to addressing this gap by explaining some of the mechanisms of farmer behaviour that influence their learning about knowledge, evaluation of an innovation, and decision-making process for its adoption in sustainable farming. But without sustainable development of agriculture, successful adoption is not accompanied. The Sustainable Livelihoods Framework follows this analysis and shows how better agricultural practice can help to enhance livelihood resilience, reduce livelihood vulnerability, and enhance the environmental sustainability and long-term development of rural livelihoods.

All these theories are in agreement that the four processes of effective institutions, integrated agricultural practices, farmer adoption of new technologies, and improved livelihoods are mutually reinforcing to stimulate sustainable agricultural change. All these are related and interdependent. Effective institutions foster innovation, adopting innovation helps to raise productivity and sustainability, and better farming practices enhance livelihoods while resilient livelihoods contribute to long-term sustainability of agricultural systems.

This paper builds on this integrated theoretical underpinning for the development of the **Agricultural Intervention-Sustainability Nexus (AISN)** and the **Sustainable Agricultural Intervention Effectiveness Framework (SAIEF)**. The proposed frameworks are not seen as a

government intervention, farmers' action, institutional capacity, or sustainable agriculture per se, but rather, part of an agricultural transformation process. Therefore, the impact and performance of governments' agricultural intervention programmes should not only be measured in terms of the resources allocated and the quantity of short-term agricultural production produced, but also in terms of their ability to foster transformative change in the agricultural sector which is environmentally sustainable, economically viable, socially inclusive and institutionally supported, and which results in resilient livelihoods.

Synthesis

The theoretical review provides a solid theoretical base for the current study. The review accentuates the conceptualization of sustainable agricultural transformation as a dynamic process of policy, institutional, technology, farmers and rural communities' interactions and a systems-thinking and institutional-governance perspective on diffusion of innovations and livelihoods sustainability. This theoretical discussion is then complemented by an empirical analysis based on this integrated perspective, which explains the conceptual relationship between the two, as well as a synthesis of the government agricultural intervention programmes and sustainable farming. The next section will therefore review existing empirical evidence to see if past research supports, contradicts, or leaves the relationships identified in the theoretical review unsolved, thus providing the basis for the development of the Agricultural Intervention-Sustainability Nexus (AISN) and the Sustainable Agricultural Intervention Effectiveness Framework (SAIEF).

5. Empirical Review

5.1 Government Agricultural Intervention Programmes and Agricultural Productivity

Productivity is always considered a yardstick for government intervention programmes in agriculture. In both developed and developing countries, investments in agricultural supports and agricultural extension programmes, seed quality improvement, irrigation, mechanization, agricultural credit provision, and agricultural research have all been widely recognized as investments that will improve agricultural production, farm returns, and food security in the country. There has therefore been a good amount of empirical work on the effectiveness of government policies on agricultural activity. It has been suggested that there is a positive relationship, and productivity gains can be linked to the quality of institutions, programme design, programme effectiveness, and the farmers' ability to sustain the benefits of agricultural practice improvement (World Bank, 2024; FAO, 2023).

The findings from several countries are consistent that on farms, good agricultural intervention programmes can lead to substantial productivity gains when combined with good extension services and access to improved technologies and enabling institutional arrangements. In many corners of Asia and Latin America, government spending on irrigation, research and development on agriculture and other rural services and infrastructure has increased agricultural production and productivity and decreased rural poverty. But these studies also warn that productivity gains are more likely to be sustainable if actions promote ongoing innovation, conservation and farmer development instead of relying on repeat interventions of public financial support (Pretty et al., 2018; OECD, 2023).

Overall, the results are similar to those in sub-Saharan Africa, though there seems to be more variation in the results of the programmes. In Ethiopia, Rwanda, Ghana and Kenya, agricultural intervention programmes have achieved measurable improvements in agricultural productivity as a result of increased farmers' access to fertilizers, certified seeds, agricultural extension and market linkages. There are, however, some comparative studies that indicate that a significant and enduring productivity increase will only come with some institutional coordination and policy stability – and complementary services to the farmers. The long-term impacts of agricultural interventions have been

lost due to weak governance, weak monitoring, and weak implementation (AGRA, 2023; World Bank, 2024).

The various government agricultural intervention programmes such as the National Fadama Development Projects, Agricultural Transformation Agenda (ATA), Growth Enhancement Support Scheme (GESS) and Anchor Borrowers' Programme (ABP) have been the subject of several empirical studies in Nigeria, and their impacts on productivity have been noted. In conclusion, these studies have shown that the programmes have been effective in the ways mentioned above, especially in terms of improving the incomes of programme beneficiaries, as well as their access to improved inputs, agricultural finance and yields. Higher incomes of the households always go together with their participation in Fadama Projects, and higher productivity of the farms always corresponds to higher income. Further, there have been studies on the Growth Enhancement Support Scheme (GES) which are focused on improving access to subsidized fertilizers and better crop varieties for selected staple crops, while evaluations of the Anchor Borrowers' Programme (ABP) have proven increased output of selected staple crops for farmers who have been involved in the programme (Liverpool-Tasie et al., 2023; IFAD, 2023; World Bank, 2024).

Although promising, Nigerian studies also indicate the problems that militate against the effectiveness of agricultural intervention programmes in the long-term. The major issues noted are policy inconsistencies, politics, low-quality extension services, lack of targeting of beneficiaries, delayed delivery of inputs, weak monitoring and evaluation, and low loan recovery, in addition to a lack of post-intervention assistance. These obstacles can decrease programme sustainability and restrict the amount of productivity increase that can be sustained after the end of government support. The definition of success, which is based on short-term gains in crop production, is therefore a partial indicator of the effectiveness of the intervention, as it is often not enough to give the correct picture of programme effectiveness in terms of longer-term impacts or behavioural change, sustainability or institutional resilience (Federal Ministry of Agriculture and Food Security Services, 2022; World Bank, 2024).

Similarly, there is developing scholarship which is increasingly beginning to acknowledge that agricultural production is not the only purpose for agricultural action, or the whole of sustainable development. There is an increasing awareness that interventions whose only aim is to increase temporary production are not sufficient for sustainable agriculture unless they also strengthen farmers' adaptive capacity, promote environmentally sustainable agriculture and contribute to the strengthening of sustainable rural institutions. This shift is driven by a changing understanding that sustainable productivity must be realized fully, which should include technological innovation, institutional efficiency, environmental stewardship and farmer empowerment (FAO, 2023; IPCC, 2023).

Critical Synthesis

The findings indicate a good level of consensus in the literature that under some institutional and policy frameworks, the intervention programmes of the government in agriculture can improve agricultural productivity. However, it is also acknowledged in the literature that while productivity gains are a measure of the effectiveness of interventions, a single measure is not enough. The research evidence for the effectiveness of interventions is, however, primarily on yield, the number of units produced, or the farmer's income, rather than the likelihood that interventions result in long-term adoption of environmentally friendly farming practices or the ability of the intervention to enhance long-term agricultural resilience. Although there is a clear link between government interventions and agricultural productivity from previous research, it does not offer a more detailed insight into the role of government interventions in the process of sustainable transformation in agriculture. It is in this sense that the constraint will serve as the framework for the rest of the discussion of technology adoption that will eventually provide support for a wider assessment model of the effectiveness of interventions.

5.2 Government Agricultural Intervention Programmes and Technology Adoption

The introduction of new technologies in agriculture is one of the most important measures that governments attempt to promote sustainable agriculture and agricultural productivity. While a direct outcome of the agricultural programmes and interventions is the yield, the use of new technologies, new production methods, and new farming practices depends on the willingness and ability of the farmers. As a result, technology adoption is now an important measure of the success of agricultural development programmes in both developed and developing countries (Rogers, 2003; FAO, 2023).

Empirical evidence shows that government interventions have a consistent impact on farmers' adoption of innovations in agriculture by enhancing access to agricultural extension services, providing subsidized inputs, better seed varieties, mechanization, irrigation facilities, agricultural credit, weather information and digital advisory services. Public sector extension programmes have helped to scale up the use of improved crop varieties, conservation agriculture, ISFM and climate-smart agriculture in Asia, Latin America and some parts of Africa. This shows that financial assistance alone is not sufficient; government assistance can also help to reduce the information gap, strengthen farmers' technical abilities, and reduce the risks of using new technologies that farmers are not familiar with (World Bank, 2024; OECD, 2023).

There is also evidence from sub-Saharan Africa of the importance of institutional support for implementation of agricultural technology. The adoption of improved agricultural practices is significantly more likely in Ethiopia, Kenya, Rwanda, Ghana and Tanzania where farmers are provided with input support and encounter rural financial services, demonstration farms, farmer field schools and frequent extension agents. Subsidies, on the other hand, that are offered without continued technical support have been seen to have less uptake and little impact in the end of the day. The findings validate and reinforce the idea that the adoption of technology is an ongoing learning process, and not a programme implementation (AGRA, 2023; IFAD, 2023).

Nigeria's empirical studies have continuously established that government intervention programmes are important variables that affect smallholder farmers' adoption of agricultural technology. The findings of the assessment of the National Fadama Development Projects (NFDP), the Growth Enhancement Support Scheme (GESS), the Anchor Borrowers' Programme (ABP) and Agricultural Projects at various tiers of the government indicate that beneficiaries tend to adopt better seeds, use of fertilizer, irrigation technology, mechanization and modern agronomic practices as compared to non-beneficiaries. Farmers' engagement with extension officers, availability of agricultural finance, and farmer cooperatives (Liverpool-Tasie et al., 2023; Federal Ministry of Agriculture and Food Security (FMAFS), 2022) also increase their risk-taking attitude towards new production technologies.

But Nigerian studies reveal that there are remaining challenges that affect the uptake and adoption of innovations in agriculture. The barriers are low extension coverage, limited access to low-cost credit, limited rural infrastructure, insecurity, low literacy levels, high technology acquisition costs, inconsistent implementation of policies, and lack of post-intervention monitoring. In many cases, farmers start using improved technologies when the government is providing support, but when they need more money, they fail to support the technology, or when they have poor market access, they stop using the technology. These conclusions indicate that adoption should be seen as an ongoing process, which needs to be continually supported by institutional reinforcement, and not as a single behavioural choice (World Bank, 2024; FAO, 2023).

Empirical studies have also shown the increased relevance of digital agriculture in fostering the adoption of technology in recent years. There is a growing body of evidence that mobile advisory platforms, geographic information systems, remote sensing, digital weather forecasting, electronic input distribution, and precision agriculture technologies have increasingly facilitated easy access to

information for farmers and are helping to support their decision-making processes in agriculture. As of now, the adoption of digital technologies by many smallholder farmers in Nigeria has been limited, but it holds great promise to improve the outcomes of future agricultural intervention programmes (AIRs) in Nigeria's agricultural sector on the three dimensions of impact, transparency and sustainability (World Bank, 2024; FAO, 2023).

Synthesis

The facts and figures indicate that the overall opinion is quite unanimous on the importance of agricultural intervention programmes in technology improvement and innovations in agriculture. The literature also indicates, however, that the provision of technologies is less important for successful adoption than support through ongoing institutional support, effective extension, access to capital, and policy environments. Other than that, most of the previous research addresses the adoption of single technologies, and little research has been conducted on taking a long-term perspective of technologies as sustainable farming practices. It is evident that one of the pathways where agricultural interventions can have an impact on productivity is technology adoption, but this is not sufficient for making claims of agricultural transformation in terms of sustainability. The observation is a solid foundation for examining the contribution of government interventions to climate resilience, among the many elements of today's agricultural sustainability.

5.3 Government Agricultural Intervention Programmes and Climate Resilience

Climate change is one of the largest problems in agricultural development worldwide, especially in developing nations, where agricultural production systems are highly climate-dependent and rely heavily on natural rainfall. The short- and long-term impacts of higher temperatures and more extreme and unpredictable precipitation, land degradation, and growing pest and disease challenges continue to impact agricultural production and rural livelihoods. Hence, the focus on the adaptation, anticipation, and recovery of farmers in the face of climatic and environmental shocks has grown into one of the main goals of the government's agricultural intervention programmes, alongside production increase, due to the importance of the role of climate resilience in attaining long-term food security (IPCC, 2023; FAO, 2023).

Empirical evidence from various regions around the world has shown the importance of government-supported climate adaptation activities in improving farmers' climate resilience. Climate-smart public investments have been linked to increased adaptive capacity, decreased production risks, and food security, for irrigation infrastructure, drought-tolerant crop varieties, early warning systems, weather advisory services, conservation agriculture, and watershed management. There are numerous examples from Asia and Latin America that have shown that climate adaptation programmes for farmers are more effective for enhancing the climatic resilience of farmers when they are integrated in the programmes than when they are not integrated in the programmes (World Bank, 2024; OECD, 2023).

Moreover, there is growing evidence from sub-Saharan Africa that agricultural programmes with a small percentage of climate adaptation aspects are more likely to have a longer-term impact than those dedicated to the supply of inputs or production. Based on economic analysis, pro-adoption policies for CA, agroforestry, agro-ecology (ISFM), water-saving technologies, and CIS will enhance the resilience of household production and mitigate vulnerability to climate variability and drought in Ethiopia, Kenya, Rwanda, and Ghana/Mali. These studies also emphasize the need for quality extension, institutional coordination, and long-term government involvement for achieving resilience effects. Adaptation programmes in many countries and across the world have low implementation and institution-building capacity, limiting long-term benefits of such programmes (AGRA, 2023; IFAD, 2023).

Climate change has become a reality in Nigeria with the occurrence of floods, desertification, decreasing soil fertility, and more frequent irregular rains; hence, the need to develop climate-resilient

agricultural policies. Empirical research shows that many government programs have introduced aspects of climate adaptation, such as promoting better seeds, developing irrigation infrastructure, introducing soil conservation methods, and educating farmers. It also illustrates the increased awareness of agricultural resilience risks and adoption of adaptation measures among farmers who participate in the agricultural resilience assessment. However, research has long pointed out that the interventions are not yet effective, largely due to weak policy implementation, insecurity, poor rural infrastructure, and limited extension outreach, which are especially hampering the most vulnerable smallholder farmers who are most vulnerable to climate variability (Federal Ministry of Agriculture and Food Security, 2022; FAO, 2023).

There has also been an increasing focus in the literature on the need to consider climate resilience in a different way, rather than as individual technologies for adaptation. Environmental protection, institutional development, technological innovation, market development, and agricultural finance and community engagement are becoming more prominent in the policy integration process for sustainable resilience, with an inter-sectoral dimension. Therefore, the current agricultural interventions are increasingly being evaluated based on their ability to improve farmers' adaptive capacity, environmental sustainability, and the security of their livelihood. This new knowledge is a departure from the previous understanding of the success of programmes, which was mainly in terms of improvement in agricultural production (IPCC 2023; United Nations 2015).

There is also empirical evidence that there are notable limitations in the current literature. There are many studies that measure resilience in terms of one attribute of resilience such as drought tolerance, crop diversification, or irrigation. At the same time, there are not many studies that have investigated the extent of institutionalization of climate resilience (as it manifests in the continuous learning, adaptation, and adoption of sustainable farming practices by farmers and support from government institutions). Consistent with this limitation, the process of resilience is multi-dimensional and influenced by institutional, policy, technology, and farmer practices.

Synthesis

The evidence indicates that a consensus of positive effects of government agricultural intervention programmes on climate resilience starts to emerge once they include technological innovation, institutional support, protection of the environment, and capacity building of farmers. The literature also implies that resilience goes beyond the attempt to adapt to climatic shocks and to adaptation strategies at the individual level. Rather, the resilience of agricultural systems is a result of a dynamic and effective interplay of institutions, supporting policies, sustainable farming practices, and farmer adaptive behavior, which is ongoing over time. This complexity is increasingly recognized in much of the current research, but here there is little support in terms of offering a framework to assess the impacts of multiple government interventions on the climate resilience of sustainable agricultural systems. This is an unaddressed challenge and indicates the need to formulate a better overall conceptualization to connect the agricultural intervention with ongoing adoption of sustainable production systems.

5.4 Government Agricultural Intervention Programmes and Sustainable Farming Practices

The recent growing concern about sustainable agriculture has prompted researchers to no longer limit their analyses of agricultural intervention programmes to measuring their productivity, but also to understand how they can help farmers adopt an environmentally responsible, economically viable and socially inclusive agriculture sustainably. However, the impact of policy intervention programmes on agricultural productivity, as a relevant policy target, is not the only dimension that has been applied in the literature to measure policy interventions. The impact of policy intervention programmes on sustainable agricultural systems itself also is relevant, as these can deliver sustainable agricultural

production over time, while at the same time conserving natural resources, enhancing climate change resilience and improving the livelihoods of rural people. (FAO, 2023; OECD, 2023).

There is empirical evidence in both the developed and the developing world that such agricultural intervention programmes are most effective when accompanied by sustainable goals and productivity improvement. Findings from other sustainable agricultural practices (e.g., conservation agriculture, agroforestry, integrated soil fertility management, sustainable irrigation systems and climate-smart agriculture) have consistently shown that sustainable institutional support is better at fostering the adoption of sustainable agriculture than short-term or input-based support. Results show that the more the policies are linked to financial support, extension services, technological innovation, and farmer education and ongoing institutional interaction, the higher the chances of sustainable farming practices emerging (Pretty et al., 2018; FAO, 2023).

As experience has demonstrated, more comprehensive agricultural development policies (combined policies with broader support for the transition towards sustainability) produce more comprehensive sustainability outcomes than more narrowly targeted policies focused on input delivery, even in Africa. Farmers who participate in the programmes with soil conservation projects, farmer field schools, extension services, water management technologies and community-based learning networks are more likely to continue to adopt sustainable farming practices on an ongoing basis on their farms, as demonstrated in Ethiopia, Rwanda, Kenya, Ghana and Malawi. However, these studies also suggest that policy continuity, institutional effectiveness, and market access and trust in the value of better practices are necessary for continued adoption (AGRA, 2023; IFAD, 2023).

In Nigeria, the interventions in agriculture by the government have been introducing sustainability-related aspects, including good soil management practices, development of irrigation, conservation and sustainable agriculture, application of climate-smart agriculture, agroforestry and extension-based farmer education. Programme assessments like the National Fadama Development Projects and other federally funded agricultural development programmes show positive impacts on the farming practices and sustainable land management knowledge of programme beneficiaries. However, not all the regions are the same and not all farming systems are the same, and many of the smallholder farmers that participated in the study have talked about the continued challenges to access extension services, access to credit, market access, insecurity, and policy implementation (Federal Ministry of Agriculture and Food Security, 2022; Liverpool-Tasie et al., 2023).

It is observed that some interventions in agriculture remain short-term, production-oriented, but are not yet tackling the long-term institutional dynamics needed to catalyze change in agriculture in Nigeria. Much of the focus is on the number of farmers targeted, the volume of inputs provided and/or the amount of output produced, but not on the adoption of sustainable farming by the farmers after the programme has ended. So, while existing evaluation methods can yield good evidence about the programme outputs, they offer limited insights into lasting changes in behaviour, institutional learning or environmental sustainability.

There has been growing skepticism in the past few years about the description "sustainable farming", which is seen as one of several possible outcomes of good farming intervention, but not one of the programme activities, in an ever-growing scholarship. The view here is that interventions will be successful when they build on the farmer knowledge, remain innovative, and reinforce the existing institutional support network, as well as enable environmental responsibility and resilient agricultural systems that will be able to support better practices after the intervention. This is a new way of working that fits into an agriculture world-changing paradigm, from production agriculture to agriculture for sustainability (FAO, 2023; IPCC, 2023).

Despite these significant developments, the empirical literature is still rather scattered. Several studies focus on a single aspect of sustainability, like soil management, adaptation to climate change, technology uptake, or productivity, but these aspects are not included in an overall assessment of intervention effectiveness. This implies that the understanding of various institutional, technological, behavioral, and environmental processes, which is necessary for the long-term implementation of sustainable agriculture practices using various government agricultural intervention programs, is still missing.

Synthesis

The experiences examined indicate that combined action of financial assistance, technological innovations, appropriate extension services, and institutional involvement can help in the process of achieving sustainable agriculture within the framework of agricultural intervention programmes of the government. Most of the programme evaluations made in the literature are also on short-term goals (productivity, technology uptake, inputs distribution, etc.), and sustainability of the farming systems is only a by-product. Besides, the current research tends to analyze a single aspect of sustainability rather than make the distinction between (interactions of) government intervention, institutional capacity, farmer behavior, technological innovations, and environmental stewardship to promote sustainable agricultural change. This unresolved relationship is one of the most prominent conceptual gaps in the literature and an incentive to move towards an integrated framework for the assessment of government agricultural intervention programmes for sustainable farming.

5.5 Institutional Factors influencing the effectiveness of Government Agricultural Intervention programmes

The quality of institutions is becoming a key factor in determining the effectiveness or otherwise of government agricultural intervention programmes. The financial investments, the improvement of technologies, the subsidized inputs, and the agricultural infrastructure are always key components of public agricultural policies, but empirical evidence always points out that these are effective when the institutions can design, implement, coordinate, monitor, and sustain intervention programmes. The recommendations of the World Bank and the OECD are called out in the present context of agricultural research, in which the actors of the institutions are both implementing institutions and strategic enablers of sustainable agricultural transformation (World Bank, 2024; OECD, 2023).

The agricultural institutions will be more efficient if they are effective rather than being poorly established and/or inconsistent. Studies from developed and developing economies have also suggested that in well-designed agricultural institutions, public investments in agriculture will be more successful, while in poorly designed agricultural institutions and/or with inconsistent policies, the success rate will be lower. Studies of agricultural support programmes across Europe, North America and Asia have shown that transparency of governmental processes, coordinated extension services, existing research centers, policy stability and good market information systems are significant for the effectiveness of agricultural support programmes in the long-term. In these environments, government policies are more likely to further drive up continued technology adoption, to reinforce environmental sustainability, and to improve farmers' economic and climate change resilience (OECD, 2023; FAO, 2023).

Empirical evidence from Sub-Saharan Africa also suggests institutional effectiveness as a key determinant in determining the results of agricultural interventions. Research conducted across the following countries – Ethiopia, Rwanda, Ghana, Kenya and Malawi – shows that programmes with high levels of coordinated institutional governance, and those perceived to have such governance, tend to achieve higher levels of farmer participation, higher uptake of technologies, higher productivity gains and sustainability than those with lower levels of governance and fragmented implementation. Strong extension systems, active farmer groups, effective monitoring and evaluation systems, and partnerships

between government, agencies and community (AGRA, 2023; IFAD, 2023) have always been linked to successful programmes.

One of the reasons given for the different successes of the various Government agricultural intervention programmes in Nigeria is institutional problems. Since then, several programs have been introduced relating to productivity and strengthening rural development, but the lack of coordination between institutions, poor extension service quality, bad management, late use of resources, program monitoring and evaluation, political interference, and lack of policy guidance have prevented implementation. Often, these institutional gaps hamper the effectiveness of good interventions and limit their potential in the long term to change sustainable agriculture over time (Federal Ministry of Agriculture and Food Security, 2022; World Bank, 2024).

Also, in some cases, the inter-agency coordination gap between the federal and state/county level could lead to duplication of efforts, lack of accountability, and reduced programme delivery in some Nigerian studies. The availability of extension services is still low, while institutional capacity is still limited; thus, the dissemination of agricultural knowledge and innovation is still limited to a small number of smallholder farmers. In addition, limited participation by farmers in terms of opportunities for ongoing participation, feedback, and follow-up monitoring, which limits learning in institutions and adaptive programme management. This leads to short-term results of agricultural interventions (such as improved yields) but with long-term problems in achieving long-term outcomes on development (Liverpool-Tasie et al., 2023; IFAD, 2023).

There has been growing scholarly interest in the concept of institutional effectiveness over the last few years, which is not only an administrative issue but a component of sustainable agricultural development. Effective institutions guarantee continuity of policies, boost the coordination of stakeholders, improve agricultural finance, transfer knowledge, foster technology innovation, and provide enabling environments for farmers' implementation and sustainability of greener practices. In this context, therefore, institutional capacity is a precondition and a result of successful agricultural intervention programmes and thus underlines the interdependency of governance and sustainability (FAO, 2023; World Bank, 2024).

While it seems that all agree that institutions matter, some conceptual issues have to be addressed in the literature. Most of the empirical research is on individual institutional issues (Extension services, institutional quality, policy implementation, etc.) and not as part of an integrated study of the institutional effectiveness- technology adoption-climate resilience-productivity and sustainable agriculture nexus. That is, there is much more information on the individual institutional factors, but little on the processes of institutions that enable the role of the government in agricultural intervention programmes in the context of sustainable agricultural transformation.

Synthesis

This experience demonstrates that the effectiveness of the government agricultural intervention programmes is closely related to institutional effectiveness. These are the factors of good governance, policy stability, extension, monitoring, stakeholder cooperation, and institutional learning, which can all impact productivity, technology adoption, climate change response and technology adoption and maintenance of sustainable farming systems. Despite this, the research efforts are still concentrated on these institutional aspects individually, and a lack of conceptualization of the interplay of these institutional aspects in a unified system of agricultural development. Fragmentation of this is a good sign, which means that a more conceptual approach is needed to assess how institutions and institutional quality relate to behaviour changes and subsequent environmental sustainability and agricultural transformation in the longer term.

5.6 Critical synthesis of empirical evidence

The results of the empirical literature reviewed in this study offer abundant proof of the positive impact of government agricultural intervention programmes over a wide range of national and regional contexts. In total, the current evidence shows that good quality interventions can increase productivity, support the uptake of technologies, increase the resilience of agricultural systems, create incentives for climate-smart farming and increase institutional capacity. The results reiterate the continuing relevance of public policy in resolving market failures, developing rural areas, and achieving national food security goals in the future (FAO, 2023; World Bank, 2024).

It is in the literature that one of the most significant findings is that in agriculture, success in the field of agricultural programmes is most often measured by productivity. In most of the empirical studies, the effectiveness of the interventions is measured by outcome measures such as crop yield, production quantity or input use, and farm income. These are helpful indicators to gauge the effectiveness of programmes, but they are largely short-term and are outputs of the programmes and not developmental outcomes. Thus, few studies offer any indication of whether productivity increases are secured by ongoing and continued use of environmentally friendly agricultural practices, or whether they help drive agricultural transformation (OECD, 2023; IFAD, 2023).

The literature also demonstrates that changes in technology usage are a major pathway for government interventions to influence agricultural performance. As the technology of improved varieties, mechanization, irrigation, digital advice, and extension becomes available, so farmers are more willing to adopt technology. But there is also evidence that it isn't a case of adoption equals sustainability. Many farmers have introduced new technologies under high-level government support but have disinvested once the level of support is reduced or withdrawn, or when technical assistance/institutional support is withdrawn. Hence, from the above observation, it can be seen that the institutions must be involved continuously, and not just a single intervention activity would be sufficient to create a sustainable behavioural change following Rogers (2003) and FAO (2023).

Similarly, empirical studies over the past decade have increasingly brought to the fore the need to build agricultural resilience to climate change. Awards have currently been made based on expansion of production, which focuses on improving farmers' adaptive capacity in the context of climate-smart agriculture, natural resource management, and risk management. Though this is a significant change in agricultural policy, resilience is often studied as a stand-alone result instead of as a part of a sustainable shift in agriculture. In the above context, little research has been conducted on mapping the linkage between resilience, institutional effectiveness, technology adoption, and sustainable farming in an integrated agricultural development system (IPCC, 2023; World Bank, 2024).

In addition, the review shows the increasing academic awareness that sustainable agriculture is the ultimate goal of government agricultural intervention programmes. However, most of the studies focus only on aspects of sustainability, including soil conservation, water management, climate adaptation, protection of biodiversity, etc., without making use of the synergies and interaction between these aspects when considering sustainable farming systems. The empirical literature on each of the sustainable practices is quite large, while the conceptual literature is smaller regarding government interventions to support sustainable practices and integration of their uptake into farming communities (FAO, 2023; Pretty et al., 2018).

The importance of institutional effectiveness may be the most consensus that has been achieved from the empirical studies. In both international and national studies, the quality of governance, extension services, policy stability, access to finance, stakeholder involvement, monitoring and evaluation, and institutional coordination are consistently shown to influence outcomes from programmes. But the above institutional factors tend to be analyzed individually and not in the context of a broader transformation process in agriculture. It is a piecemeal approach that does not enable an

integrated research approach to understanding the role of institutions in increasing productivity, extending technology adoption, adaptation to climate change, and sustainable agriculture in general (World Bank, 2024; AGRA, 2023).

The above evidence indicates that the impact of agricultural intervention programmes can only be understood when taken together and not as the impacts of any single outcome measure or through any specific analytical approach. Productivity, innovation uptake, coping with climate change, institutional capacity, and sustainable development in agriculture are not goals, but rather are embedded in the process of agricultural development. Empirical studies of these dimensions have been relatively sparse, however, and explanations of what works with interventions have been somewhat disjointed, and the ability to design evaluation programs that address all dimensions is hindered.

Integrated Empirical Synthesis

From this review, it is clear that the effect of the government's agricultural development programme is multi-dimensional and happens along several interrelated pathways of agricultural development, institutional, technological, behavioral, environmental, and socio-economic. However, the literature on theory is still fragmented, even though there is lots of empirical evidence to which reference is made. The previous studies focus on the outcome of the programmes, but not on how the outcome is related to the process of sustainable agricultural change. There are therefore limited existing approaches that guide the success of interventions other than the standard productivity and programme output measures. The need for a holistic conceptual framework is highlighted by this disintegration, offering a space for developing a linkage between the interventions of the government and continued use of sustainable agriculture and farming practices, which can be established through the interaction of institutional effectiveness, innovation uptake, climate resilience, and livelihood improvement. This lack of clarity of concept is the basis that will provide a foundation to address the knowledge gap in the next section.

6. Knowledge Gap

The above conceptual, theoretical, and empirical review highlights the need for Agricultural Intervention programmes as essential tools for the development of agriculture, agricultural productivity, technology adoption, rural livelihoods, and strengthening the climate resilience of agriculture. Evidence from developed and developing countries confirms that judicious interventions can have a positive impact on the performance of agriculture if they are supported by good institutions, proper technologies, and conducive policy frameworks. So, a vast body of work exists on the effects of government agricultural intervention programmes on specific individuals.

The review also shows, however, that there are conceptual divisions and a lack of focus in the literature. The current research is mostly in isolation in different areas of agriculture, including agricultural productivity, technology uptake, climate resilience, institutional effectiveness, and sustainable agriculture, and a wide range of theories, assessment frameworks and methods. A great contribution has come from these studies in the field of empirical evidence, but not all of them have managed to capture the impact of the interrelated dimensions on the overall effectiveness of government agricultural intervention programmes for agricultural sustainable transformation.

Another weakness relates to the assessment of the effectiveness of the programme. Most of the empirical assessments continue to employ traditional indicators like yield production, volume of production, beneficiary coverage, farm income, distribution of the inputs, or technology adoption. These are still relevant but not the only markers of the long-term success of the programme. Very little research has been done to see if the government can support the continued use of sustainable farming methods, improved institutional learning, stewardship of the environment, resilience to shocks, and the building

of resilient farming systems that can continue to be productive after the government stops supporting them.

The literature also suggests that institutional factors such as good governance, extension services, policy consistency, including stakeholder involvement, access to finance, monitoring and evaluation, inter-agency coordination, and others, are important to the effectiveness of interventions. However, these institutional factors are usually studied individually or separately, and not as a part of the larger agricultural development system. Likewise, in terms of research on sustainable farming, studies tend to focus on a specific technology or approach, such as agroforestry, soil conservation, or climate-smart agriculture, and do not have a holistic view of sustainable farming, as a result of integrated government policies, institutional efficiency, research and innovation, and farmer behaviour.

Such conceptual restrictions are even more pronounced in Nigeria. Existing literature has been focused on the performance of some of the intervention packages like the National Fadama Development Projects, the Growth Enhancement Support Package, Agricultural Transformation Agenda and Anchor Borrowers' Programme. While these assessments provide programme-specific lessons to be drawn, few of them attempt to incorporate these lessons into a wider context that could account for the impact of the sum of all the agricultural policy measures on sustainable agriculture. Thus, the policy literature offers little conceptual aid to policy decision-makers interested in assessing the effectiveness of interventions other than through traditional productivity measures.

In this review, it was concluded that the major deficiency in knowledge was not simply the empirical evidence, but the lack of an integrated conceptual framework that could help to understand and assess the multi-faceted effects of the government agricultural intervention programmes. While there is some knowledge and experience from individual outcomes of the programmes, there is less on the linkages between institutional effectiveness, uptake of innovations, climate resilience, sustainable farming practices and future agricultural change. Some research has been conducted on the relationship of institutional effectiveness to the uptake of innovations, to climate resilience and to sustainable agriculture, and much of the literature has focused on individual outcomes.

This paper thus helps in bridging this gap by introducing the concept of Agricultural Intervention–Sustainability Nexus (AISN) as a concept reflecting the dynamic interaction between government agricultural intervention programmes and the potential for sustainable farming in the long-term. Drawing on this conceptual link, the paper also suggests the Sustainable Agricultural Intervention Effectiveness Framework (SAIEF), which is an integrated framework to assess the effectiveness of interventions beyond agricultural productivity. The complementary contributions offer a more comprehensive analysis lens for research, design, implementation, and evaluation of the effectiveness of Government agricultural intervention programmes for sustainable agricultural transformation under the North-Central Nigeria setting.

7. Agricultural Intervention–Sustainability Nexus (AISN)

7.1 Conceptualizing the Agricultural Intervention-Sustainability Nexus (AISN)

From an analysis of conceptual, theoretical, and empirical literature conducted for this paper, it is concluded that government interventions have some interdependent impacts in relation to the process of agricultural development. Previous studies have shown that public interventions can increase the productivity of the agricultural sector, aid farmers in the adoption of technology, build climate resilience, support strong institutions, and encourage sustainable agriculture. But these outcomes have been studied separately, and there are incomplete explanations of the effectiveness of interventions. Thus, the degree of conceptualization of the relationship between different dimensions that are required to create sustainable transformation in agriculture is very limited.

To fill this void, this paper proposes to evolve an integrated conceptual framework on the linkages between governmental agricultural intervention programmes and sustainable agriculture, which we propose to name the **Agricultural Intervention Sustainability Nexus (AISN)**. Nexus is a word intentionally used to emphasize interconnections and not linear causalities. It is understood that agricultural transformation is a dynamic and incremental process that emerges from the changing and complex interactions of public policies, institutional capabilities, technological innovations, farmers' actions, environmental management and livelihood improvements. So, the effectiveness of interventions needs to be viewed as a result of these interwoven factors and not from one particular aspect of the intervention.

The Agricultural Intervention Sustainability Nexus therefore proposes that the government agricultural intervention programmes should be part of a dynamic system that considers the role of institutional effectiveness on farmers' access to agricultural resources, knowledge, agricultural finance and agricultural technologies that in turn influence the adoption of sustainable farming, that sustainable farming leads to increased agricultural productivity, that sustainable farming contributes to enhanced climate and environmental resilience, that overall, it improves livelihoods, and it strengthens long-term sustainability of agricultural systems. Interestingly, it's a two-way street. Due to improved livelihoods and resilient farming systems, positive feedback can be realized, reinforcing farmer engagement, institutional learning, and the benefits of future policies, and fostering a "**cycle of agricultural change**".

The relationship between government policies and sustainable agricultural transformation, in AISN, is traditionally linked with productivity, but in AISN, sustainable agricultural practices are the impetus that drives the transformation process. Productivity is key, but in a more comprehensive sustainability process, where integrity of the environment, economic sustainability, social inclusion, institutional effectiveness, and shock resilience are all part of the package. This is a transition from a system's approach of effectiveness assessment based on outputs to that of the assessment of effectiveness based on the system.

The four (4) pillars that came to light from the literature review that underpin the nexus are:

1. **Institutional Effectiveness:** Governance quality, policy consistency, extension services, stakeholder collaboration, access to finance, monitoring and evaluation, and institutional learning.
2. **Innovation and Knowledge Adoption:** Access to new technologies, extension services, climate information, digital agriculture, and lifelong learning, which promotes behaviour change among farmers.
3. **Sustainable Farming Practices:** Sustainable agriculture and farming methods, such as climate-smart agriculture, soil conservation, efficient water management, agroforestry, integrated nutrient management, conservation of biodiversity, and environmentally responsible agricultural production.
4. **Sustainable Agricultural Transformation:** as measured by crop yields, improved climate resilience, rural livelihoods, environmental sustainability, and sustainable adaptive and prosperous capacity of agricultural systems.

The four pillars are not mutually independent. Ineffectiveness of institutions fails to adopt innovations; ineffective adoption of innovations results in unsustainable farming; unsustainable farming results in agricultural transformation; agricultural transformation results in institutional learning and policy development to better future innovations. ***The Agricultural Intervention-Sustainability Nexus, thus, considers agricultural development a process of adaptation and not a series of discrete programme outputs.***

The importance of AISN is its ability to connect together different strands of agricultural research which were previously unlinked to the other strands. Institutions, innovation diffusion, and sustainable

farming outcomes & livelihood outcomes are combined and represented in one analytical model in the nexus, providing a more comprehensive picture of the effectiveness of government agricultural intervention programmes on sustainable agriculture change. It also provides the conceptual framework to determine and assess the impact of interventions with indicators beyond productivity to include resilience, sustainability, institutional quality and the long-term developmental impact.

Critically contributing to AISN.

The Agricultural Intervention-Sustainability Nexus has a significant contribution to the literature in three (3) ways.

A. It builds a conceptual model that connects these scattered empirical findings, which shows that productivity, technology adoption, institutional effectiveness, climate resilience and sustainable farming are not discrete outcomes, but rather are various aspects of agricultural transformation.

B. It rethinks what the results of intervention programmes are, telling us to go beyond traditional productivity metrics to assess how well they stimulate the adoption of sustainable practices.

C. It offers the conceptual foundations of the Sustainable Agricultural Intervention Effectiveness Framework (SAIEF) to advance the tenets of the nexus in the assessment, development and enhancement of government policies and activities on agricultural interventions.

8. Sustainable Agricultural Intervention Effectiveness Framework (SAIEF)

8.1 The Sustainable Agricultural Intervention Effectiveness Framework (SAIEF)

This paper extends the Agricultural Intervention-Sustainability Nexus (AISN) while presenting a new composite framework for the evaluation of the effectiveness of government agricultural intervention programmes, called **Sustainable Agricultural Intervention Effectiveness Framework (SAIEF)**. This framework complements the literature that looks at the success of the programme based on one of the programme indicators available, including productivity, distribution of the inputs, coverage of beneficiaries, or technology adoption. While these are helpful indicators, they are not comprehensive of the effect of agricultural interventions on sustainable agricultural transformation.

SAIEF embraces the idea that the effectiveness of government agricultural intervention programmes should be judged by a multi-dimensional approach that takes into account the complexity of agricultural development. The effectiveness of intervention is not one of the goals of the framework, but rather it is a synthesis of the effectiveness of institutions, farmer behaviour change, environmental sustainability, improved livelihoods and long-term agricultural resilience. It does so, reflecting current sustainable development concepts and recognizing that changing agriculture in a lasting way cannot be merely about production.

It outlines five (5) dimensions to be considered in evaluating the effectiveness of intervention, all of which are interrelated.

1. Institutional Effectiveness: The first dimension evaluates the capacity of institutions responsible for designing, implementing, coordinating, and monitoring agricultural intervention programmes. Indicators include governance quality, policy consistency, extension service delivery, transparency, stakeholder participation, access to agricultural finance, monitoring and evaluation systems, and institutional learning. Effective institutions provide the enabling environment necessary for sustainable programme implementation and continuous improvement.

2. Innovation and Knowledge Transfer: The second dimension is concerned with the capacities of intervention programmes to spread and maintain agricultural knowledge and innovations. This involves greater access to enhanced technologies, training of farmers, demonstration, digital agricultural services, research and extension linkages, and ongoing technical assistance. In addition, particularly in terms of technology availability, the sustainability of farmers' capacities to understand,

adapt, and apply new technology for sustainable agricultural development is also dependent on their capacity to understand, adapt, and apply technology effectively.

3. **Sustainable Farming Practices:** The third dimension focuses on the adoption and continued application of environmentally responsible farming practices. Evaluation extends beyond the initial uptake of innovations to include their sustained use in improving soil health, water conservation, biodiversity protection, climate-smart agriculture, efficient resource utilization, and environmentally sustainable production systems. This dimension represents the central pathway through which government interventions generate long-term agricultural sustainability.

4. **Outcomes for Livelihood and Resilience:** The 4th dimension assesses the impacts of agricultural interventions on the broader developmental outcomes. These cover: household income improvement, food security, climate resilience, adaptive capacity, social inclusion, risk reduction, and productive livelihoods of the farming households in the changing environmental and economic conditions. This is the perspective that believes that sustainable agriculture is the key to improving the quality of life for those involved in agricultural practices.

5. **Sustainable Agricultural Transformation:** All the successful agricultural intervention programs are added together, and the result is the fifth dimension. It has been defined as the degree of sustainable development of agricultural productivity, capacity, environmental management, rural economies, and resilience from interventions, with the productive capacity of agricultural systems retained for future generations. Sustainability in agricultural transformation, therefore, is seen as the best measure of the success of intervention, rather than the results of programmes.

Sustainable agricultural transformation leads to sustainable farming practices that boost livelihoods and resilience, which in turn leads to institutional effectiveness supporting innovation and knowledge transfers to improved practices of farming. This results in confidence-building of stakeholders, policy learning of institutions and programme design, thereby creating a policy learning–policy improvement cycle, and thus, contributing to the **Agricultural Intervention–Sustainability Nexus**.

8.2 Practical implications of SAIEF

The Sustainable Agricultural Intervention Effectiveness Framework can be beneficial to a variety of stakeholders. The scope of the framework is expanded to offer broader support for the design and evaluation of agricultural intervention programmes for policymakers, while considering institutional quality, sustainability outcomes and long-term resilience, besides productivity. It provides development partners with a tool to measure the effectiveness of a programme, not just the output, and helps them to make decisions on investments based on facts.

SAIEF offers an integrated analytical approach which can guide future empirical research on the multi-dimensional implications of agricultural interventions. The framework focuses on the importance of ongoing farmer engagement, institutional learning, adaptive management of programmes, and a role for all stakeholders in agriculture geared towards achieving sustainable agricultural transformation.

SAIEF Scholarly contribution

One of the key aspects of SAIEF is the reconceptualization of what effective intervention is. Current evaluation approaches are more geared towards **what interventions produce**, whereas SAIEF emphasizes **what interventions sustain**.

It also assumes that interventions implemented by the State do not succeed, even if agricultural inputs are produced or shared more, or if more people participate in the intervention. However, they work when they assist in maintaining the transition to more sustainable agricultural practices, through solid institutions, continuous innovation, resilient livelihoods and environmentally friendly agriculture.

Finally, as a complement to the Agricultural Intervention-Sustainability Nexus, SAIEF contributes in this respect by providing a framework of operational propositions which can support policy analysis, programme evaluation and agricultural research for a sustainable future.

9. Policy Implications

The policy and programme applications of this paper are tremendous, as are the institutional applications and areas for future research. The paper indicates that the effects of government agricultural intervention programmes are not just in the short-term increase in productivity, and recommends a re-think of the design and implementation of agricultural policies which should embrace sustainable agriculture at the core of the policy. Therefore, the **Agricultural Intervention-Sustainability Nexus (AISN)** and **Sustainable Agricultural Intervention Effectiveness Framework (SAIEF)** provide actionable recommendations to governments and development actors to improve long-term outcomes from agricultural interventions.

9.1 Policy implications of agricultural policy.

The overall review suggests that agricultural policies should go beyond a production focus to a more comprehensive approach that fosters productivity and sustainable environmental, institutional, climate, and rural livelihood results. While the nation's priority is to increase production, interventions in the future should further promote the adoption of sustainable agricultural technologies that can sustain production without causing harm to natural resources. This is more a question of the sustainability of the programme in the long run than about any administrative or political successes.

In Nigeria, this calls for a continuity of agricultural policies, coordinated and evidence-based planning of agricultural development at the Federal, State and Local government levels. The discontinuity of policies and intervention implementation has led to low effectiveness of many of the intervention programmes. This is because institutional stability and policy consistency are crucial to enable sustainable agricultural transformation.

9.2 Implications for Programme design and implementation

Agricultural intervention programmes are viewed as a system in this paper, instead of being considered a single programme. The elements of financial support, improved inputs, mechanization, water use and agricultural finance, extension services, market access, digital agriculture and climate adaptation need to be jointly integrated in a coordinated implementation framework.

Evaluation of the success of a programme should not be made at the end of the intervention cycle only. Ongoing monitoring of feedback and institutional learning, and adaptive programme management would allow implementing agencies to meet new challenges and to enhance the effectiveness of the programme over time. This is especially applicable in North-Central Nigeria where the farming systems and socio-economic conditions vary, and with climatic variability, there is a need for flexible and context-specific intervention strategies.

9.3 Implications for Agricultural Institutions

Effective interventions in agriculture are often cited as being grounded in the effectiveness of institutions. Hence, governments need to invest in the strengthening of agricultural institutions by investing in extension, capacity building of professionals, building links between extension and research, developing digital advisory systems, monitoring and evaluation systems, and inter-agency collaboration.

Agricultural institutions also need to use participatory approaches which incorporate the participation of farmers, farmer organizations, community-based organizations, private sector actors, and development partners in the programme planning and implementation process. These partnerships build ownership and a sense of responsibility, boost farmers' ownership of the farm, and enhance the odds of sustainable farming practices after the project's end.

9.4 Implications for monitoring and evaluation.

One of the main contributions of this paper is to suggest that the effectiveness of a programme should be evaluated not only based on productivity measures but by looking at multidimensional indicators as well. Thus, the measurement of institutional effectiveness, sustainable technology uptake, environmental sustainability, climate resilience and livelihood improvement, and ongoing sustainable farming should be incorporated into monitoring and evaluation frameworks.

A multi-dimensional evaluation system can be developed with the use of the Sustainable Agricultural Intervention Effectiveness Framework (SAIEF), which is a convenient conceptual model. It incorporates economic, institutional, behavioural, environmental and social aspects of agricultural development and provides a more balanced perspective of the performance of programmes and longer-term developmental outcomes to the policy-maker.

9.5 Implications for future studies.

There are several empirical research opportunities for the future in the Agricultural Intervention-Sustainability Nexus (AISN) and SAIEF. The proposed framework can be tested in Nigeria and other developing countries in various agricultural contexts by adopting either a quantitative, qualitative, or mixed-method approach. The effect of interventions on the various geopolitical zones, farming systems, or even on agricultural programmes will provide additional information on the multi-dimensional relationships that were identified in this paper.

The indicators for each dimension of SAIEF could be quantified, empirical models to assess the proposed linkages could be developed, and the link between SAIEF and institutional quality, climate variability and socio-economic conditions could be examined in further studies. These would be a continuation of the conceptual inputs of this paper and evidence for Agricultural Policy and Programme evaluations.

Integrative Reflection

This is another important dimension of this review which needs to be reiterated in the Policy recommendations in this document: the role of government agricultural intervention programmes should not be regarded as the only policy instruments and should not be used only to boost agricultural production. Rather, they should be seen as investments in institutions to improve the sustainability of agriculture, and the resilience of rural livelihoods and environmental sustainability of food production. The Agricultural Intervention-Sustainability Nexus and the Sustainable Agricultural Intervention Effectiveness Framework are therefore complementary conceptual frameworks that can inform future research, policy and programme evaluation of the effectiveness of interventions, as well as of their intersections with agricultural sustainability.

10. Recommendations

Based on the proposed Agricultural Intervention-Sustainability Nexus (AISN) and Sustainable Agricultural Intervention Effectiveness Framework (SAIEF), the following recommendations have been made to improve the design, implementation, monitoring and evaluation of government agricultural intervention programmes in Nigeria, particularly in North-Central Nigeria.

1. Adopt Sustainability-Oriented Evaluation Frameworks: Government departments responsible for the implementation of agricultural intervention programmes should broaden their assessment, going beyond traditional assessment criteria (crop production, distribution of inputs and beneficiaries' numbers). In addition, the indicators of effectiveness need to include sustainable farming practices that will continue in the future, institutional effectiveness, environmental sustainability, climate resilience, and long-term improvements of livelihoods. The Sustainable Agricultural Intervention Effectiveness Framework (SAIEF) outlined in this paper offers a good foundation for the development of multi-dimensional evaluation systems.

2. Strengthen Agricultural Extension Services: The extension services should be continued to strengthen farmers' technical knowledge, weather and climate information, advisory services in digital format, and continuous capacity building. Extension personnel should encourage improved production methods and environmentally friendly agricultural production systems that will assure sustainable long-term agricultural productivity.

3. Improve Institutional Coordination: There is a need for a greater synergy among the Federal, State and Local government institutions in agricultural development, both in terms of programme planning/implementation as well as monitoring and evaluation. There would be less duplication of effort, more accountability, better use of resources and continuity of policies between governments with improved institutional co-ordination.

4. Maintain Continuity in Long-Term Policies: Programmes of agricultural intervention should be part of consistent and predictable policies, which are not subject to political turnovers. Policy continuity will help to increase farmers' confidence and more investment in agriculture and sustainable agriculture.

5. Integrate Climate Resilience into Agricultural Interventions: The design of agricultural intervention programmes should include climate adaptation and sustainable environmental outcomes as a part of the programme. Improving the resilience of agriculture is still far from adequate and needs to be strengthened by facilitating better climate-smart agriculture, efficient water use, soil conservation, agroforestry and better practices of integrated nutrient management and sustainable land-use.

6. Promote Participatory Programme Design: The planning, implementation, monitoring and evaluation of agricultural intervention programmes should be influenced by the participation of all stakeholders such as farmers, cooperatives, local community-based organizations, research institutes, private sector and development partners. Participatory practices ensure relevance, increased local ownership, and increased chances of sustainable practice following the intervention of the government.

7. Enhance Monitoring, Evaluation, and Institutional Learning: The monitoring and evaluation should be continuous and not a one-day activity at the end of intervention programmes. Feedback mechanisms should be put in place to make sure that the learning outcomes from the interventions are carried over to influence future decisions on the policy and future changes to the programme by the implementing agencies.

8. Perform Empirical Investigations in Future: The Agricultural Intervention-Sustainability Nexus (AISN) and Sustainable Agricultural Intervention Effectiveness Framework (SAIEF) need to be field-tested at all levels of our multi-geopolitical zones, multi-farming systems, and multi-agricultural intervention programme levels in Nigeria. These investigations would further help to build up evidence for the development of agricultural policies and enhance their effectiveness.

11. Conclusion

Government agricultural intervention programmes have remained central to agricultural development policies across both developed and developing economies because of their potential to improve agricultural productivity, strengthen food security, reduce rural poverty, and stimulate economic development. In Nigeria, successive governments have implemented numerous intervention programmes aimed at supporting smallholder farmers through input subsidies, agricultural credit, extension services, irrigation development, mechanization, and technology dissemination. Despite these sustained efforts, questions regarding the long-term effectiveness and sustainability of these interventions continue to attract considerable scholarly and policy attention.

The conceptual, theoretical, and empirical works on government agricultural intervention programmes and sustainable agriculture in Nigeria, specifically north-central Nigeria, were reviewed. The review finds a body of existing research that is well-supported with strong evidence of linkages

between agricultural interventions, improved agricultural production, incorporation of new technologies, climate resilience, institutional development, and rural livelihoods. In general, these studies call for a government role in agricultural transformation and particularly in developing countries where market imperfections continue to exist, as do scarcity of resources and institutional flaws.

But the current state of knowledge is also found to be fragmented, as revealed in the review. Little attention has been focused on the interplay between these dimensions and how these impact the effectiveness of government agricultural intervention programmes, with the existing research being focused on productivity, technology adoption, climate resiliency, institutional efficiency/effectiveness and sustainable agriculture. Likewise, the impact of the programmes is assessed mainly on short-term results and indicators such as agricultural production, beneficiary coverage, input distribution, etc., while the long-term results such as '**sustainable farming**' or '**sustained adoption of sustainable farming**' are not put under the magnifying glass as a measure of programmes' success.

These limitations led to the development of this paper, which introduced an integrated conceptual framework, called the **Agricultural Intervention-Sustainability Nexus (AISN)**, to explain the dynamic interactions among the four (4) components of the model: institutional effectiveness, innovation and knowledge transfer, sustainable farming practices, livelihood improvement, and sustainable agricultural transformation. This nexus was then further expanded, and the **Sustainable Agricultural Intervention Effectiveness Framework (SAIEF)** was developed to include a multidimensional approach to the assessment of government agricultural intervention programs, in addition to productivity.

As the primary product of this paper, it is important to rethink what interventions are and how effective they are. The paper does not restrict the scope of its definition of success in agricultural interventions to the amount of output produced, but rather emphasizes the potential of intervention programmes to be a catalyst for the future uptake of sustainable farming, including enhancing the effectiveness of institutions, innovation, resilient livelihoods, and environmentally friendly agricultural systems. This is because agricultural sustainability imbalances must be more than just increased production; they must have a solid institutional, environmental, technological, and social base for future agricultural development.

This is a paper of ideas, but its implications go beyond the academic realm. The AISN and SAIEF are indicators and a baseline for further empirical research, can be used as a bigger picture for programme design and evaluation for policymakers, and offer a model for programme development practitioners to engage with integrated approaches that embrace productivity and sustainability.

The challenge is that interventions by the government into agricultural markets must be carefully thought out and evaluated differently, in order to facilitate the process of sustainable agriculture transformation. Improvements in agricultural production, if achieved on an occasional basis, are not enough to guarantee sustainable agricultural development. Instead, it requires coherent institutions, educated farmers, ongoing innovation, robust agricultural policy, and agricultural system processes that allow for sustainable practices to endure beyond the duration of the intervention programme. From this general standpoint, the **Agricultural Intervention-Sustainability Nexus (AISN)** and the **Sustainable Agricultural Intervention Effectiveness Framework (SAIEF)** seek to contribute to contemporary agricultural policy and scholarship.

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