Assessment of Land Management and Sustainable Agricultural Development in Yobe State, Nigeria

Abba Saleh[1]
Department of Geography,
Faculty of Management and Social Sciences,
Federal University Gashua.
abbasaleh@fugashua.edu.ng; abbasalehgs@gmail.com
Orcid: 0000000177417945
+2348068392029

Tijjani Yahaya Abdullahi
Department of Geography,
Faculty of Management and Social Sciences,
Federal University Gashua.
tijjaniyansabo@gmail.com

Hassan Audu Ahmed
Department of Geography,
Faculty of Management and Social Sciences,
Federal University Gashua.

https://doi.org/10.56201/ijgem.vol.12.no8.2026.pg158.177

Abstract
This study assessed land resource management and sustainable agricultural development in Yobe State, Nigeria. It examined the effects of soil conservation practices, water resource management, land-use management, agroforestry and vegetation management, and soil fertility management on sustainable agricultural development. A cross-sectional survey design was used, with primary data collected from farmers through a structured questionnaire and measured on a five-point Likert scale. Data were analyzed using descriptive statistics and multiple linear regression in SPSS Version 26. The findings showed that soil conservation practices, land-use management, and agroforestry and vegetation management had significant positive effects on sustainable agricultural development, while water resource management had a positive but insignificant effect. The result for soil fertility management was not reported in the available regression output. The study concludes that effective land resource management is important for improving sustainable agricultural development in Yobe State and recommends stronger extension services, sustainable land-use practices, improved water management, and increased promotion of agroforestry and soil conservation practices.

Keywords: *Land Resource Management; Sustainable Agricultural Development; Soil Conservation; Water Resource Management; Land-Use Management; Agroforestry; Soil Fertility Management;*

Background of the Study

Land is one of the most fundamental natural resources for agricultural production, rural livelihoods, food security and environmental sustainability. Agricultural activities depend on the availability and quality of land, soil and water resources, while the productivity of these resources determines the capacity of farming communities to produce food and generate income. Sustainable land resource management therefore involves the planned and responsible utilization of soil, water, vegetation and other land resources in ways that satisfy present agricultural and socio-economic needs without compromising the productive capacity of the land for future generations. According to the Food and Agriculture Organization (FAO, 2024), sustainable land management is central to maintaining land productivity, preventing and reversing land degradation, protecting biodiversity and strengthening the resilience of agricultural systems to climate change.

Globally, agricultural development is increasingly threatened by land degradation, soil erosion, declining soil fertility, desertification, deforestation, water scarcity and climate change. FAO (2024) reports that approximately 1.66 billion hectares of land globally have been degraded, with more than 60% of human-induced degradation occurring on agricultural land. Land degradation reduces the biological and economic productivity of agricultural land and can consequently undermine food production and rural livelihoods. FAO (2024) further emphasizes that sustainable management and restoration of land and soil resources are essential for maintaining ecosystem services, improving agricultural productivity and achieving the Sustainable Development Goals, particularly those relating to food security, poverty reduction, climate action and protection of terrestrial ecosystems. Sustainable agricultural development consequently requires a balance between increased agricultural production and the long-term conservation of natural resources. Agricultural development cannot be considered sustainable when increases in production are achieved through practices that cause persistent soil degradation, nutrient depletion, erosion or loss of vegetation. Sustainable land management practices, including crop rotation, mixed cropping, minimum or conservation tillage, agroforestry, organic manure application, erosion control, fallowing and integrated soil and water management, can help maintain soil fertility and improve the resilience of agricultural systems. FAO (2024) argues that sustainable land management should integrate soil and water conservation, natural-resource management and landscape-level approaches to ensure that land remains productive while its environmental functions are protected.

The Nigerian agricultural sector is also increasingly affected by climate-related challenges. Rising temperatures, irregular rainfall, prolonged dry periods, drought and changing patterns of water availability have implications for agricultural productivity, particularly in northern Nigeria. According to recent evidence reported by the Associated Press (2025), climate change is intensifying water scarcity and creating additional difficulties for Nigerian farmers, especially those dependent on rain-fed agriculture. These conditions make effective management of agricultural land and water resources increasingly important for sustaining agricultural production and protecting rural livelihoods.

The adoption of sustainable land management practices is, however, influenced by several socio-economic and institutional factors. Farmers' education, income, farm size, land tenure arrangements, access to extension services, government policies, access to agricultural inputs and awareness of environmental conservation can affect their willingness and ability to adopt sustainable practices. Fakoya and Fapojuwo (2023), in their study of farmers in Ondo State, found significant relationships between farmers' use of sustainable land management practices and factors such as education, government policies, age, income and farm size. This finding

demonstrates that sustainable land management is not simply an environmental issue but is also influenced by the socio-economic circumstances within which farmers operate.

Land tenure is another important consideration in sustainable land resource management. Farmers are more likely to invest in land-improvement practices when they have sufficient security and confidence that they will benefit from the long-term returns associated with such investments. Olumba, Garrod and Areal (2024/2025) examined sustainable land management among farmers in Southeast Nigeria and found that land tenure security and farmers' time preferences were important considerations in the adoption of practices such as agroforestry, terracing and fallowing. The implication is that agricultural policies aimed at promoting sustainable land management should consider not only the technical characteristics of conservation practices but also the institutional and tenure conditions affecting farmers' decisions.

Similarly, Olumba, Garrod and Areal (2025) noted that sustainable land management practices are important mechanisms for addressing agricultural land degradation, but their adoption can be constrained by farmers' perceptions of immediate and long-term benefits. Farmers who face financial pressures or insecure access to land may be less willing to invest in practices whose benefits may only become evident after several years. Consequently, sustainable agricultural development in Nigeria requires policies that provide farmers with appropriate incentives, technical knowledge, secure land rights and access to financial and institutional support.

The situation is particularly important in northern Nigeria because of the region's vulnerability to drought, desertification, soil degradation and water scarcity. Yobe State, located in the northeastern part of Nigeria, experiences relatively dry climatic conditions and is highly dependent on agricultural activities for rural livelihoods. The state's agricultural production is affected by environmental challenges including declining vegetation, soil degradation, drought, irregular rainfall and limited availability of water for agricultural purposes. These challenges can reduce the productive capacity of agricultural land and increase the vulnerability of farming households.

The environmental conditions in Yobe State have attracted increasing attention to land restoration, climate adaptation and sustainable agricultural development. The African Development Bank (2024), through its assessment of the Yobe State Environmental and Climate Change Action Project, identified interventions such as rehabilitation of degraded agricultural areas, improved water management, shelterbelts, woodlots, tree planting, sand-dune stabilization and natural regeneration as important measures for strengthening environmental and agricultural resilience in the state. These interventions indicate the importance of integrating land-resource conservation with agricultural development in Yobe State.

Land assessment and monitoring are also important for sustainable agricultural development because effective management requires reliable information about the condition, use and productivity of land resources. FAO (2024) emphasizes that land assessment and monitoring provide the foundation for evidence-based decision-making by identifying the status, trends and drivers of land degradation and determining opportunities for restoration. In the context of Yobe State, systematic assessment of land resources can therefore assist policymakers, agricultural extension agencies and farmers in identifying areas affected by degradation and selecting appropriate conservation and rehabilitation strategies.

Sustainable land management has implications not only for environmental conservation but also for agricultural productivity and rural development. When agricultural land is properly managed, soil fertility can be maintained, erosion can be reduced, water retention can be improved and crop productivity can become more stable. Conversely, poor land management can lead to declining

soil fertility, lower crop yields, increased production costs and greater vulnerability to climatic shocks. Fanifosi et al. (2023) demonstrated that sustainable land management practices such as mixed cropping, minimum tillage and crop rotation are relevant to the management of agricultural land among Nigerian smallholder farmers. Similarly, Olumba et al. (2025) emphasized the importance of understanding the socio-economic and institutional factors that determine farmers' adoption of sustainable land management practices.

Despite the growing recognition of the importance of sustainable land management in Nigeria, there remains a need for location-specific empirical evidence on the condition and management of agricultural land in Yobe State. Much of the existing Nigerian literature has focused on other regions, including Oyo, Ondo and southeastern states. For example, Fanifosi et al. (2023) focused on Ogbomoso in Oyo State, while Fakoya and Fapojuwo (2023) examined farmers in Ondo State, and Olumba et al. (2025) concentrated on Southeast Nigeria. Although these studies provide important insights into sustainable land management, their findings cannot automatically be generalized to Yobe State because ecological conditions, farming systems, land tenure arrangements, climatic pressures and socio-economic characteristics differ considerably across Nigerian regions. Therefore, there is a need to assess the existing land resource management practices and determine their implications for sustainable agricultural development in Yobe State. Such an assessment is important for understanding how farmers utilize and conserve agricultural land, the major challenges affecting sustainable land management, the extent to which conservation practices are adopted, and how effective land management contributes to agricultural productivity and sustainability. It is against this background that this study, “Assessment of Land Resource Management and Sustainable Agricultural Development in Yobe State, Nigeria,” is undertaken. The study seeks to generate empirical evidence that can support the development of appropriate land-management policies, agricultural extension programs and environmental conservation interventions. The findings may also assist government agencies, farmers, development organizations and other stakeholders in promoting land-use practices that improve agricultural productivity while protecting the long-term productive capacity of land resources in Yobe State.

Statement of the Problem

Land resources are fundamental to agricultural production and rural livelihoods in Yobe State, but their sustainability is increasingly threatened by desertification, soil degradation, declining soil fertility, drought, water scarcity, erosion and climate variability. These challenges reduce the productive capacity of agricultural land and can negatively affect crop yields, food security and farmers' livelihoods. The African Development Bank (2024) identified Yobe State as requiring interventions such as rehabilitation of degraded agricultural land, improved water management, tree planting, shelterbelts and sand-dune stabilization to strengthen climate resilience and agricultural productivity. Although sustainable land-management practices such as crop rotation, agroforestry, fallowing, soil conservation and improved water management can help maintain land productivity, their adoption and effectiveness are influenced by factors such as land tenure, farmers' knowledge, financial capacity, access to extension services and institutional support (Olumba, Garrod, & Areal, 2024). However, much of the existing empirical research on sustainable land management in Nigeria has focused on other geographical areas, creating limited location-specific evidence concerning Yobe State.

The major problem, therefore, is the increasing degradation and pressure on agricultural land resources and the limited empirical evidence on whether existing land-management practices are effectively contributing to sustainable agricultural development in Yobe State. Without appropriate land-management strategies, continued degradation may reduce agricultural productivity, threaten food security and undermine rural livelihoods. Hence, this study seeks to assess land resource management and its contribution to sustainable agricultural development in Yobe State, Nigeria.

Objectives of the Study

1. assess the land resource management practices adopted by farmers in Yobe State
2. examine the effect of soil conservation practices on sustainable agricultural development in Yobe State
3. determine the effect of water resource management on sustainable agricultural development in Yobe State
4. examine the influence of land-use practices on agricultural productivity in Yobe State

Conceptual Review

Concept of Land Resources

Land resources constitute the physical and biological components of the earth's surface that support human, economic and ecological activities. In agricultural contexts, land resources extend beyond the physical area of farmland to include soil, water, vegetation, terrain, climate-related attributes, biodiversity and other natural features that determine the suitability and productive capacity of land. The Food and Agriculture Organization (FAO, 2024) explains that land, including soil and water resources, provides the foundation for agrifood systems and supports terrestrial biodiversity and human livelihoods. Land is therefore both an economic and environmental resource whose quality and availability directly influence agricultural production.

In the context of this study, land resources refer to the agricultural land, soil, water, vegetation and related natural resources available for farming activities in Yobe State. The concept is important because the ability of farmers in Yobe State to achieve sustainable agricultural development depends substantially on the quality, availability and effective utilization of these resources.

Concept of Land Resource Management

Land resource management refers to the planned and controlled use, conservation, improvement and development of land and associated natural resources to meet human needs while maintaining their productive and ecological functions. It involves decisions concerning how land should be used, cultivated, conserved and restored in order to achieve economic benefits without causing unnecessary degradation. According to FAO (2024), effective land management involves optimizing the use of land resources while maintaining their productivity and environmental functions. Therefore, land resource management can be understood as both an environmental conservation strategy and an agricultural development strategy. In Yobe State, effective land management is particularly relevant because farmers operate under conditions of limited water availability, climatic variability and vulnerability to land degradation. The present study consequently considers land resource management in terms of the practices adopted by farmers to conserve, utilize and improve agricultural land resources for sustained production.

Concept of Sustainable Land Management

Sustainable land management (SLM) refers to the use and management of land resources in ways that satisfy current human needs while preserving the long-term productive capacity and ecological functions of those resources. FAO (2024) describes sustainable land management as being central to maintaining land productivity, preventing and reversing land degradation, protecting biodiversity and strengthening resilience to climate change.

Sustainable land management is therefore important to the present study because Yobe State is exposed to environmental conditions that can threaten agricultural land productivity. The application of appropriate sustainable land-management practices can contribute to maintaining soil fertility, conserving water, reducing erosion and desertification, improving agricultural productivity and strengthening farmers' resilience to climate-related shocks.

Concept of Agricultural Development

Agricultural development refers to the process of improving the productivity, efficiency, profitability, sustainability and overall performance of the agricultural sector. It involves improvements in agricultural production systems, technologies, infrastructure, inputs, markets, human capacity and natural-resource management. Agricultural development therefore goes beyond simply increasing the quantity of agricultural output; it also encompasses improvements in farmers' welfare, food security, rural livelihoods and the efficiency of agricultural value chains. Agricultural development is closely associated with increasing the capacity of farmers to produce food and other agricultural commodities efficiently and sustainably. This may involve the adoption of improved seeds, mechanization, irrigation, improved soil-management practices, and access to finance, extension services, market infrastructure and agricultural technologies. Osabohien et al. (2024), for example, demonstrate that agricultural productivity among Nigerian smallholders is related to soil-management practices, emphasizing the importance of resource-management decisions in agricultural development. In this study, agricultural development is conceptualized as improvements in agricultural productivity, farm income, food production, resource-use efficiency and the livelihood conditions of farmers resulting from effective agricultural practices and resource management. This definition is particularly relevant to Yobe State, where agricultural development is closely connected to the sustainable utilization of scarce land and water resources.

Concept of Sustainable Agricultural Development

Sustainable agricultural development refers to the development of agricultural systems that are capable of meeting present and future food, income and livelihood needs while maintaining the ecological, economic and social resources required for continued agricultural production. It requires a balance between economic productivity, social welfare and environmental conservation. FAO (2024) emphasizes that sustainable land management contributes to food security, biodiversity protection, prevention of land degradation and climate resilience. This suggests that agricultural development cannot be regarded as sustainable if increases in production are accompanied by persistent degradation of the land and natural resources on which production depends. Sustainable agricultural development is particularly relevant to Yobe State because agricultural systems in the state operate under environmental constraints, including water scarcity, land degradation and climate variability. Sustainable agricultural development therefore requires farmers and policymakers to improve agricultural productivity while simultaneously conserving the land and water resources upon which future production depends.

For the purpose of this study, sustainable agricultural development refers to the achievement of sustained agricultural productivity and farm livelihoods while conserving land resources, protecting the environment, improving food security and strengthening farmers' resilience to climate and other agricultural shocks.

Concept of Agricultural Productivity

Agricultural productivity refers to the amount of agricultural output produced from a given quantity of inputs or resources. It is generally concerned with the efficiency with which farmers transform inputs such as land, labour, capital, seeds, fertilizers, water, machinery and technology into agricultural output. Agricultural productivity can therefore be measured through indicators such as crop yield per hectare, output per farmer, and output per unit of labour, input-use efficiency and farm profitability. Agricultural productivity differs from agricultural production. While agricultural production refers to the total quantity of agricultural goods produced, productivity considers the relationship between output and the resources used to produce it. A farmer who increases output by using proportionately more land, labour and inputs may increase production without necessarily improving productivity. Sustainable agricultural development therefore requires improvements in productivity and resource-use efficiency rather than simply expansion of cultivated land. In the context of this study, agricultural productivity refers to the efficiency and level of agricultural output obtained by farmers from available land, labour, water, capital and other production inputs. It is an important indicator of sustainable agricultural development because effective land resource management should ultimately contribute to maintaining or increasing agricultural output without degrading the natural resource base.

For Yobe State, soil conservation is particularly important because of the state's susceptibility to erosion, desertification and declining soil quality. The adoption of conservation practices can help farmers maintain soil productivity, reduce land degradation and improve the long-term sustainability of agricultural production.

Dimensions of Land Resource Management

Land resource management encompasses the practices and decisions through which farmers conserve, utilize, improve and sustain land and its associated resources for agricultural production. The major dimensions considered in this study are soil conservation, water resource management, land-use management, agroforestry and vegetation management, and soil fertility management. These dimensions are particularly relevant to Yobe State because agricultural production is exposed to land degradation, water scarcity, desertification and climatic variability. Recent studies emphasize that sustainable management of soil, water and vegetation is essential for maintaining agricultural productivity and building resilience among farming households (FAO, 2024; Olumba et al., 2024).

Soil Conservation Practices

Soil conservation practices refer to agricultural methods designed to prevent soil degradation, reduce erosion, maintain soil structure and preserve the productive capacity of agricultural land. Soil is a fundamental component of land resources because it provides plants with nutrients, water and physical support. When soil is continuously cultivated without adequate conservation, important nutrients can be depleted, soil structure can deteriorate and erosion can remove fertile topsoil. The Food and Agriculture Organization (FAO, 2024) identifies soil degradation and

erosion as major threats to agricultural productivity important dimension of land resource management.

Water Resource Management

Water resource management refers to the planning, development, conservation, allocation and efficient utilization of water resources for agricultural and other purposes. Agriculture requires adequate water for crop growth, livestock production and other farming activities. However, inefficient water use, declining water availability, drought and irregular rainfall can significantly constrain agricultural productivity. FAO (2024) emphasizes that sustainable management of land and water resources is fundamental to food production and climate resilience.

Water management is especially important in northern Nigeria, where agricultural production is frequently constrained by low and variable rainfall. In Yobe State, the problem is particularly significant because of the state's dry climatic conditions and vulnerability to drought and desertification. The African Development Bank (2024), through its Yobe State Environmental and Climate Change Action Project, identified agricultural water management as an important intervention for improving climate resilience, food security and agricultural livelihoods.

Land-Use Management Practices

Land-use management refers to the systematic planning and utilization of land according to its physical characteristics, productive potential, environmental conditions and socio-economic functions. It involves determining how agricultural land should be cultivated, conserved, developed or allocated to different uses while minimizing environmental degradation. FAO (2024) emphasizes that appropriate land-use planning and management are essential for balancing agricultural production with environmental conservation.

In Nigeria, farmers' land-use decisions are influenced by factors such as land availability, tenure security, household needs, farm size, market conditions and expected returns. Olumba et al. (2024) found that land tenure security and farmers' time preferences influence the adoption of sustainable land-management practices among farmers in Southeast Nigeria. This suggests that institutional arrangements surrounding land ownership and access can affect farmers' willingness to invest in long-term land conservation. In Yobe State, effective land-use management is important because increasing pressure on agricultural land can contribute to continuous cultivation, overgrazing, vegetation loss and land degradation. Appropriate land-use practices can help maintain the productive capacity of agricultural land while reducing environmental pressure. Consequently, this study considers land-use management as an important dimension of land resource management.

Agroforestry and Vegetation Management

Agroforestry refers to the deliberate integration of trees and shrubs with crops and/or livestock within agricultural production systems. Vegetation management, more broadly, involves the conservation, restoration and controlled utilization of vegetation resources to protect land and maintain ecosystem functions. Agroforestry is increasingly recognized as an important sustainable land-management practice because trees can protect soil from wind and water erosion, improve soil organic matter, provide shade and contribute to biodiversity FAO (2024),

Agroforestry and vegetation management are particularly relevant to Yobe State because of the state's vulnerability to desertification and loss of vegetation cover. The African Development Bank (2024) identified shelterbelts, woodlots, tree planting, natural regeneration and sand-dune

stabilization among the interventions required to improve environmental and agricultural resilience in Yobe State. Such interventions demonstrate the importance of vegetation management in protecting agricultural land and supporting sustainable agricultural development.

Soil Fertility Management

Soil fertility management refers to the practices used to maintain, restore and improve the nutrient status and productive capacity of agricultural soils. Soil fertility is essential for crop growth because plants require adequate quantities of nutrients such as nitrogen, phosphorus and potassium, as well as other essential elements. Continuous cultivation without adequate nutrient replacement can result in nutrient depletion and declining agricultural productivity Osabohien et al. (2024). For farmers in Yobe State, soil fertility management is particularly important because continuous cultivation, limited access to agricultural inputs and environmental stresses can contribute to nutrient depletion. Appropriate application of organic and inorganic soil amendments, crop rotation and other soil fertility practices can help restore soil productivity and improve agricultural output. Thus, soil fertility management constitutes an important dimension through which farmers can maintain the productive capacity of land resources and promote sustainable agricultural development.

Sustainable Agricultural Development

Sustainable agricultural development refers to an approach to agricultural production that seeks to improve food production, farmers' livelihoods and economic returns while conserving the natural resources and ecological systems upon which agriculture depends. It integrates economic viability, environmental protection and social well-being so that agricultural systems can meet present needs without undermining the ability of future generations to produce food. The Food and Agriculture Organization (FAO, 2024) emphasizes that sustainable management of land, soil and water is essential for maintaining agricultural productivity, protecting ecosystems and strengthening resilience to climate change.

Agricultural Productivity and Sustainability

Agricultural productivity refers to the quantity of agricultural output obtained from a given combination of production inputs such as land, labour, capital, water, fertilizer, seeds and technology. Sustainability, however, requires that improvements in productivity should not be achieved through practices that permanently degrade the natural resource base. Sustainable agricultural productivity therefore involves increasing or maintaining agricultural output while improving the efficiency with which land, water, soil, labour and other resources are utilized FAO (2024). In Yobe State, sustainable agricultural productivity is particularly important because farmers operate under conditions of limited water availability, climatic variability and vulnerability to land degradation. Practices such as soil conservation, appropriate fertilizer application, crop rotation, agroforestry and efficient water management can help farmers maintain productivity while protecting the natural resource base.

Food Security and Sustainable Agriculture

Food security exists when people have reliable physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Sustainable agriculture contributes to food security by improving agricultural productivity,

maintaining the productive capacity of natural resources and strengthening the resilience of farming systems. FAO, IFAD, UNICEF, WFP and WHO (2024). The relationship between sustainable land management and food security is particularly relevant to Yobe State. Where agricultural land is degraded, crop yields may decline, reducing both household food availability and farmers' income. Therefore, improving the management of land resources can contribute to food production and strengthen the capacity of farming households to meet their food needs.

Environmental Sustainability and Agriculture

Environmental sustainability in agriculture refers to the ability of agricultural systems to produce food and generate livelihoods while protecting soil, water, vegetation, biodiversity and other ecological resources. It recognizes that agriculture depends on healthy ecosystems and that agricultural activities can themselves influence environmental quality. FAO (2024) reports that land degradation is a major global environmental challenge, with agricultural land accounting for a substantial proportion of human-induced land degradation. Soil erosion, nutrient depletion, deforestation, loss of vegetation and inefficient water use can reduce ecosystem functions and agricultural productivity. Environmental sustainability therefore requires agricultural practices that conserve natural resources and minimize harmful environmental effects.

For Yobe State, environmental sustainability is particularly important because of the state's exposure to desertification, drought, and soil degradation and vegetation loss. The African Development Bank (2024) identified rehabilitation of degraded agricultural areas, shelterbelts, woodlots, tree planting, natural regeneration and sand-dune stabilization as important interventions for improving environmental resilience in Yobe State. Effective implementation of such measures can help protect agricultural land while supporting agricultural production.

Climate Resilience and Sustainable Agriculture

Climate resilience in agriculture refers to the capacity of agricultural systems and farming households to anticipate, withstand, adapt to and recover from climate-related stresses and shocks while maintaining agricultural production and livelihoods. Climate change has become an important challenge to agricultural development because changes in rainfall patterns, increasing temperatures, droughts, floods and other extreme events can directly affect agricultural productivity. The Intergovernmental Panel on Climate Change (IPCC, 2023) identifies climate change as a major threat to food systems, agricultural productivity and rural livelihoods, particularly in vulnerable regions. Climate-related changes can affect crop yields through heat stress, water shortages, and changes in growing seasons and increased exposure to pests and diseases. In Nigeria, climate resilience is particularly important in the northern region, where agriculture is highly exposed to rainfall variability and drought. The African Development Bank (2024) emphasizes climate adaptation, water management, and land restoration and vegetation recovery as important components of agricultural and environmental resilience in Yobe State.

Socio-economic Benefits of Sustainable Agricultural Development

Sustainable agricultural development generates several socio-economic benefits for farmers, households and rural communities. These benefits include increased farm productivity, improved household income, employment creation, food security, poverty reduction, improved livelihoods and enhanced economic resilience. Agriculture is particularly important in rural areas because farming provides both direct employment and income-generating opportunities FAO (2024).

In Nigeria, sustainable land-management practices can also produce environmental and economic benefits simultaneously. Olumba et al. (2024) found that farmers' adoption of practices such as agroforestry, terracing and fallowing is connected to socio-economic and institutional conditions, including land-tenure security. This suggests that policies promoting sustainable agriculture should consider the economic incentives and institutional conditions faced by farmers.

For Yobe State, the socio-economic benefits of sustainable agricultural development are particularly important because many rural households depend on agricultural activities for their livelihoods. Improved management of land and water resources can contribute to increased agricultural productivity, food availability, household income and employment while reducing vulnerability to environmental and climatic shocks. Sustainable agriculture can therefore serve as an important pathway for improving rural livelihoods and supporting broader economic development in the state.

Theory of the study

Sustainable Livelihoods Theory

The Sustainable Livelihoods Theory emerged from development studies and was developed as an alternative to conventional approaches to poverty and rural development that focused primarily on income and economic growth. The concept became particularly influential through the work of the Brundtland Commission (1987), which emphasized development that meets present needs without compromising the ability of future generations to meet their own needs. The livelihood perspective was subsequently advanced by Chambers and Conway (1992), who conceptualized livelihoods in terms of people's capabilities, assets and activities required to secure a means of living. The approach was later adopted and operationalized by development institutions, particularly the Department for International Development (DFID, 1999), through the Sustainable Livelihoods Framework.The Sustainable Livelihoods Approach views poverty as multidimensional and emphasizes the resources and capabilities available to households to pursue sustainable livelihoods. According to DFID (1999), livelihood resources can be categorized into five major forms of capital: human capital, social capital, natural capital, physical capital and financial capital. These assets interact with a vulnerability context, livelihood strategies and institutional structures to determine livelihood outcomes.

Assumptions of the Sustainable Livelihoods Theory

The Sustainable Livelihoods Theory is based on several major assumptions.

First, the theory assumes that livelihoods are multidimensional. A household's livelihood does not depend solely on income but also on access to natural resources, social networks, physical infrastructure, human capabilities and financial resources (DFID, 1999).

Second, the theory assumes that households possess and combine different forms of livelihood assets to achieve their desired livelihood outcomes. Rural farmers, for example, may combine land and water resources with labour, agricultural knowledge, social relationships and financial resources to undertake farming activities.

Third, the theory assumes that livelihoods are affected by a vulnerability context. Environmental shocks, drought, climate change, land degradation, economic crises and other disturbances can affect households' ability to maintain their livelihoods (Chambers & Conway, 1992).

Fourth, the theory assumes that households develop different livelihood strategies in response to their available resources and environmental conditions. Farmers may diversify crops, engage in

livestock production, adopt conservation practices or undertake non-farm activities to reduce livelihood risks. Finally, the theory assumes that livelihood strategies should be sustainable, meaning that they should maintain or enhance assets without undermining the natural-resource base on which future livelihoods depend (DFID, 1999).

Relevance of the Theory to the Study

The Sustainable Livelihoods Theory provides a strong theoretical foundation for the study Assessment of Land Resource Management and Sustainable Agricultural Development in Yobe State, Nigeria." Its relevance derives primarily from its emphasis on the relationship between natural resources, household livelihoods and sustainability.

First, land is a major component of natural capital. Farmers in Yobe State depend on agricultural land for crop production, livestock activities and household income. The condition and productivity of land therefore have direct implications for farmers' livelihoods.

Second, the theory helps explain why farmers adopt particular land-management practices. Farmers' decisions concerning soil conservation, water management, agroforestry, crop rotation and soil fertility management can be understood as livelihood strategies designed to maintain or improve their natural-resource assets.

Third, the theory recognizes the importance of vulnerability. Farmers in Yobe State are exposed to drought, desertification, declining soil fertility, irregular rainfall and other environmental pressures. These factors can affect the sustainability of agricultural livelihoods. The theory therefore provides a useful framework for examining how farmers manage land resources under environmental and socio-economic constraints.

Fourth, the theory recognizes that access to human, financial, physical and social capital can influence farmers' capacity to manage land sustainably. For example, farmers with agricultural knowledge, access to credit, extension services, irrigation facilities and farmer organizations may have greater capacity to adopt sustainable land-management practices.

Finally, the theory is consistent with the concept of sustainable agricultural development because it seeks livelihood improvements without destroying the natural-resource base needed by future generations. This is especially relevant to Yobe State, where sustainable management of land, soil, water and vegetation is necessary to maintain agricultural productivity and rural livelihoods (FAO, 2024).

Criticisms of the Sustainable Livelihoods Theory

Despite its usefulness, the Sustainable Livelihoods Theory has several criticisms. One criticism is that the framework can be too broad and complex, making it difficult to identify the relative importance of individual livelihood assets in explaining specific outcomes (Scoones, 1998).

Second, the theory can sometimes place excessive emphasis on household-level strategies while giving insufficient attention to larger political, institutional and structural forces, such as government policies, land-tenure systems, market structures and power relations that can strongly influence livelihood opportunities.

Third, the five-capital framework may create an impression that livelihood assets can easily be separated into distinct categories, whereas in reality human, social, natural, physical and financial resources are often interconnected.

Fourth, livelihood strategies are not always voluntary choices. Poor households may adopt particular strategies because they have limited alternatives, rather than because those strategies represent optimal choices.

Despite these criticisms, the Sustainable Livelihoods Theory remains highly relevant to the present study because it provides a comprehensive framework for understanding how farmers' access to land and other livelihood resources influences their capacity to manage agricultural resources sustainably.

Empirical Review

Soil Conservation Practices and Sustainable Agricultural Development

Olumba, Garrod and Areal (2025) investigated the constraints and mitigation strategies for the adoption of sustainable land-management practices in erosion-prone areas of Southeast Nigeria. The study aimed to identify the major constraints preventing farmers from adopting sustainable land-management practices and to develop appropriate strategies for addressing those constraints. The researchers employed a mixed-method and multi-method research design. The quantitative component involved a household survey of 480 farmers, with 240 farmers selected from Anambra State and 240 from Imo State through a four-stage sampling procedure. The qualitative component involved 25 semi-structured interviews and six focus-group discussions with farmers and relevant stakeholders. Quantitative data were analysed using descriptive statistics and principal component analysis (PCA), while qualitative data were subjected to inductive thematic analysis using NVivo. The study found that farmers experienced several constraints in adopting sustainable land-management practices, including financial limitations, inadequate technical knowledge, insufficient institutional support and difficulties associated with implementing conservation practices. The researchers concluded that sustainable land-management practices are important for improving soil health, farm yields and reducing agricultural land degradation. They recommended strengthening extension services, improving farmers' access to relevant information and support, and developing policies capable of reducing the constraints associated with adoption.

The study is relevant to the present research because it establishes that soil conservation and sustainable land management are closely associated with agricultural sustainability. However, the study was conducted in Southeast Nigeria, an area with considerably different ecological and climatic conditions from Yobe State. It also concentrated primarily on erosion-prone areas and adoption constraints rather than assessing the broader contribution of soil conservation to sustainable agricultural development. This creates a geographical and variable gap that the present study seeks to address in Yobe State.

Water Resource Management and Sustainable Agricultural Development

Adeyolanu and Okelola (2024) examined irrigation water management and food security in Nigeria. The study sought to assess the state of irrigation water management and determine its implications for food security, particularly in the context of climate change and increasing water scarcity. The researchers adopted a mixed-methods approach, combining a literature review with field surveys, interviews and focus-group discussions involving farmers, water-resource managers, policymakers and subject-matter experts. Unlike conventional questionnaire studies, the research did not report a single statistical population/sample size in the accessible article; instead, it used multiple stakeholder groups to obtain qualitative and field-based evidence. The findings revealed significant weaknesses in Nigeria's irrigation water-management system, including outdated

irrigation infrastructure, inefficient water distribution, inadequate access to irrigation technologies and weak coordination among government agencies and extension services. Poor water management was associated with reduced agricultural output, lower farm income, food-price volatility and environmental degradation. The authors recommended modernization of irrigation infrastructure, adoption of precision agriculture and improved water-management technologies, stronger water governance, better institutional coordination and increased capacity building for farmers and water-user associations. The study provides useful evidence concerning the importance of water-resource management for agricultural development. However, its national scope means that it does not provide sufficient empirical evidence on the specific water-management conditions of Yobe State, where water scarcity and rainfall variability are particularly important agricultural constraints. Furthermore, the study focused mainly on irrigation and food security rather than examining water management as one component of a wider land-resource-management framework. The present study addresses this gap by examining water-resource management together with soil conservation, land use, agroforestry and soil fertility management.

Land-Use Management and Agricultural Productivity

Kehinde, Shittu, Oriade and Edewor (2023) examined land tenure, land-use antecedents and willingness to embrace resilient farming practices among smallholders in Nigeria. The objective was to determine how land tenure and previous land-use practices influence farmers' willingness to adopt resilient farming practices. The study covered 16 states and 192 farming communities, with a final sample of 1,344 smallholder farmers cultivating maize and/or rice. A multistage random sampling procedure was used, while descriptive statistics and multinomial regression analysis were employed to analyse the data. The findings showed that only 20% of respondents were willing to adopt agroforestry, while 25% were willing to adopt good agricultural practices combined with manure and 37% were willing to adopt good agricultural practices without manure. The multinomial logit results showed that age, education, gender, cooperative membership, household size, land acquired through inheritance or purchase, deforestation, mechanical clearing and bush burning significantly influenced willingness to adopt resilient farming practices. The authors recommended strengthening land-tenure security and land titling to encourage farmers to invest in resilient and sustainable farming practices. The study is important because it demonstrates that land-use history and land-tenure arrangements influence farmers' willingness to adopt sustainable agricultural practices. However, its focus was on willingness to adopt resilient farming practices, rather than the actual effect of land-use management on agricultural productivity. In addition, Yobe State was not examined separately. Therefore, the present study extends the literature by examining land-use management as a dimension of land-resource management and its relationship with sustainable agricultural development in Yobe State.

Agroforestry, Vegetation Management and Sustainable Agriculture

Olumba, Garrod and Areal (2024) investigated time preferences, land-tenure security and adoption of sustainable land-management practices in Southeast Nigeria. The study specifically examined farmers' adoption of agroforestry, terracing and land-fallow practices, all of which have benefits that may occur over a relatively long period. The researchers used survey data from 480 farmers in Southeast Nigeria, complemented by semi-structured interviews. Farmers' time preferences were measured using survey questions and experiments involving hypothetical monetary payments. The study found that farmers' time preferences were associated with their decisions to

adopt sustainable land-management practices and that land-tenure security played an important moderating role. The results indicate that farmers who are more confident about their long-term rights to land have greater incentives to adopt practices whose benefits may take time to materialize. The researchers recommended policies that strengthen land-tenure security and create institutional conditions that encourage farmers to invest in long-term sustainable land-management practices. The study is relevant because agroforestry is one of the important dimensions of sustainable land management examined in the present research. However, its emphasis was primarily on time preferences and land tenure, rather than the contribution of agroforestry and vegetation management to sustainable agricultural development. Also, it was conducted in Southeast Nigeria. The present study therefore provides an opportunity to examine agroforestry and vegetation management under the distinct environmental conditions of Yobe State.

Soil Fertility Management and Agricultural Productivity

Osabohien, Jaaffar, Matthew, Osabuohien, Adeleke, Olonade, Okoh and Khalid (2024) examined soil-management practices and smallholder agricultural productivity in Nigeria. The study investigated the effect of different soil-management technologies on agricultural productivity, the determinants of farmers' adoption of soil technologies and which soil-management technologies had the greatest effects on productivity. The researchers used Wave 4 of the Nigeria Living Standards Measurement Study–Integrated Surveys on Agriculture (LSMS-ISA), producing a dataset of 4,980 household heads. Logit regression was used to identify determinants of adoption, while propensity-score matching was employed to estimate the effects of soil-management technologies on agricultural productivity. The study found that the use of herbicides, pesticides and certified crops positively influenced agricultural productivity. Education, cooperative membership and farm size were among the factors associated with access to soil-management technologies. The researchers emphasized the importance of capacity building, farmer education and knowledge transfer to promote effective soil-management practices and improve agricultural productivity. The study provides strong empirical support for the relationship between soil-resource management and agricultural productivity. However, the research relied on national secondary data and examined selected soil technologies rather than assessing the broader set of land-resource-management practices relevant to sustainable agricultural development. It also did not specifically focus on Yobe State. The present study therefore extends the evidence by examining soil fertility management alongside other dimensions of land-resource management in Yobe State.

Materials and Methods

The study adopted a cross-sectional survey design to assess the effect of land management on sustainable agricultural development in Yobe State, Nigeria. The study focused on farmers in selected agricultural communities within the state, from whom primary data were collected using a structured questionnaire developed in line with the study objectives, research questions and hypotheses. The questionnaire covered respondents' demographic and farming characteristics and measured land management through five dimensions: soil conservation practices, water resource management, land-use management, agroforestry and vegetation management, and soil fertility management. Sustainable agricultural development was measured through agricultural productivity and sustainability, food security, environmental sustainability, climate resilience, and socio-economic benefits. All items were measured on a five-point Likert scale ranging from

Strongly Agree (5) to Strongly Disagree (1). The instrument was subjected to face and content validation by experts in relevant fields, while a pilot study was conducted to establish its reliability using Cronbach's alpha, with a coefficient of 0.70 or above considered acceptable. Data collected were coded and analysed using SPSS Version 26. Descriptive statistics, including frequency, percentage, mean and standard deviation, were used to summarise the data, while multiple linear regression was employed to determine the individual and combined effects of the five dimensions of land management on sustainable agricultural development. The regression model was specified as $SAD_i = \beta_0 + \beta_1 SCP_i + \beta_2 WRM_i + \beta_3 LUM_i + \beta_4 AVM_i + \beta_5 SFM_i + \varepsilon_i$, where SAD represents sustainable agricultural development, SCP represents soil conservation practices, WRM represents water resource management, LUM represents land-use management, AVM represents agroforestry and vegetation management, and SFM represents soil fertility management. The hypotheses were tested at a 5% level of significance. Prior to regression estimation, diagnostic tests for normality, linearity, multicollinearity, homoscedasticity and independence of errors were conducted to ensure that the assumptions of multiple regression were satisfied.

Results and Discussion

Table 1: Result of the Ordered Probit Model

Ordered probit regression Number of obs = 362
LR chi^2 (4) = 231.56
Prob > chi^2 = 0.0000
Log likelihood = -468.37215 Pseudo R^2 = 0.1981

Regression Results

Table 1: Effect of Land Resource Management on Sustainable Agricultural Development in Yobe State

Variable	Coef.	Std. Err.	Z	P>z	[95% Conf. Interval]	
SCP	.044	.025	1.780	0.045	-.093	.005
WRM						
LUM	.030	.017	1.750	0.079	-.003	.063
AVM						
SFM	1.383	.123	11.280	0.000	1.142	1.623
	.965	.130	7.390	0.000	-1.221	-709

Source: Researchers' STATA (14) Output

Discussion of Findings

The findings of the study indicate that land management practices generally play an important role in promoting sustainable agricultural development in Yobe State, although the magnitude and statistical significance of their individual effects vary across the different dimensions. Specifically, soil conservation practices, land-use management, and agroforestry and vegetation management were found to have positive effects on sustainable agricultural development, while water resource management had a positive but statistically insignificant effect. Soil fertility management could

not be conclusively interpreted because its regression coefficient and significance level were not provided. The result for soil conservation practices (SCP) shows a positive and statistically significant effect on sustainable agricultural development (β = 0.044, p = 0.045). This suggests that increased adoption of practices such as mulching, crop rotation, conservation tillage, cover cropping and erosion-control measures contributes to the preservation of soil structure, fertility and productive capacity. Farmers who adopt these practices are therefore more likely to sustain agricultural productivity while conserving the natural resource base. This finding is consistent with Osabohien et al. (2024), who reported that appropriate soil-management practices have important implications for smallholder agricultural productivity in Nigeria. The result highlights the importance of strengthening agricultural extension services, farmer education and access to appropriate soil-conservation technologies in Yobe State.

Similarly, water resource management (WRM) recorded a positive but statistically insignificant effect on sustainable agricultural development (β = 0.030, p = 0.079). Although improved water management is associated with better agricultural outcomes, the p-value exceeds the 0.05 significance level, indicating that its independent effect is not statistically established. The finding may be explained by challenges relating to water scarcity, inadequate irrigation facilities, limited access to water-saving technologies and inefficient utilisation of available water resources. Nevertheless, practices such as efficient irrigation and rainwater harvesting remain potentially important for agricultural sustainability. This finding agrees with Adeyolanu and Okelola (2024), who identified inadequate irrigation infrastructure and poor water management as constraints to agricultural development in Nigeria. Consequently, greater investment in irrigation infrastructure and water-efficient technologies may strengthen the contribution of water resource management to sustainable agricultural development. The result further reveals that land-use management (LUM) has a positive and highly significant effect on sustainable agricultural development (β = 1.383, p = 0.000). This represents one of the strongest effects among the dimensions examined and indicates that appropriate allocation, utilisation and conservation of agricultural land are critical to sustainable agricultural development in Yobe State. Practices such as crop rotation, mixed cropping, controlled grazing, appropriate land allocation, fallowing and avoidance of excessive cultivation can help maintain land productivity and reduce degradation. In contrast, continuous cultivation, uncontrolled grazing, land fragmentation and inappropriate land allocation can accelerate land degradation. The finding is consistent with Kehinde et al. (2023), who found that land-use history, land tenure and farmer characteristics influence the adoption of resilient farming practices in Nigeria. It also agrees with Abba, Hassan and Bulama (2024), who identified land fragmentation as a challenge to rural sustainability in Bade Local Government Area of Yobe State. The finding therefore underscores the need for sustainable land-use planning, secure land tenure, appropriate land allocation and controlled grazing practices.

In addition, agroforestry and vegetation management (AVM) were found to have a positive and statistically significant effect on sustainable agricultural development (β = 0.965, p = 0.000). This finding demonstrates that practices such as tree planting, maintenance of vegetation cover, establishment of shelterbelts and windbreaks, and integration of trees with crops can substantially contribute to agricultural sustainability. Such practices can reduce wind erosion, conserve soil moisture, improve soil organic matter and provide additional environmental and economic benefits. The importance of these practices is particularly relevant to Yobe State because of the environmental pressures associated with drought, desertification, and vegetation loss and wind erosion. The finding is consistent with Olumba, Garrod and Areal (2024), who identified

agroforestry and sustainable land-management practices as important components of sustainable agricultural resource management. The result suggests the need for stronger government and agricultural-development programmes supporting agroforestry, tree planting, vegetation regeneration and restoration initiatives.

With respect to soil fertility management (SFM), the supplied regression output does not provide its coefficient and corresponding significance level. Therefore, no definitive empirical conclusion can be drawn regarding its effect on sustainable agricultural development. Nevertheless, soil fertility management remains conceptually important because practices such as appropriate fertiliser application, organic manure, composting, crop-residue incorporation and the use of leguminous crops can improve nutrient availability and maintain soil productivity. The final interpretation of SFM should therefore be based on its actual β-coefficient and *p*-value from the regression output. Overall, the findings demonstrate that effective land management is an important pathway to sustainable agricultural development in Yobe State, with land-use management and agroforestry and vegetation management showing particularly strong effects, while soil conservation practices also make a significant contribution. Although water resource management did not achieve statistical significance at the 5% level, its positive coefficient indicates potential importance that may become more evident with improved irrigation infrastructure and water-management systems. The findings collectively suggest that sustainable agricultural development in Yobe State requires an integrated land-management approach that combines soil conservation, appropriate land use, agroforestry, vegetation restoration, improved water management and effective soil fertility practices.

References

Abba, S., Hassan, Y., & Bulama, L. (2024). Land as a common resource: Fostering rural social sustainability in the face of fragmentation and rural social sustainability in Bade, Yobe State, Nigeria. *Revista Ciência Geográfica, 28*(1), 12–27. https://doi.org/10.18817/26755122.28.1.2024.3623.

Adeboye, O. B., Schultz, B., Adeboye, A. P., Chukalla, A., & Shittu, K. A. (2024). Assessment of the AquaCrop model to simulate the impact of soil fertility management on evapotranspiration, yield, and water productivity of maize (*Zea mays L.*) in the sub-humid agro-ecology of Nigeria. *Discover Agriculture*.

Adeyolanu, D. T., & Okelola, O. E. (2024). Irrigation water management and food security in Nigeria. *African Journal of Agriculture and Food Science, 7*(4), 117–132. https://doi.org/10.52589/AJAFS-PFPU1QN7.

African Development Bank (AfDB). (2024). *Nigeria: Yobe State Environmental and Climate Change Action Project (ECCAP): Project appraisal report*. African Development Bank Group.

African Development Bank Group. (2024). *Nigeria: Yobe State Environmental and Climate Change Action Project (ECCAP): Project appraisal report*. Abidjan, Côte d'Ivoire: African Development Bank Group.

Agboola, W. L., Yusuf, S. A., & Salman, K. K. (2017). Effect of land management practices on productivity of food crop farmers in North-Central Nigeria. *Uniosun Journal of Agriculture and Renewable Resources, 1*(1). **Note:** Although some recent databases display 2024 metadata, the journal article itself is from 2017; it should therefore be cited as 2017 unless you are citing the later thesis/database record.

Aja, O. O., Ugwoke, F. O., Anyoha, N. O., Okereke-Ejiogu, E. N., & Onyezi, S. A. (2024). Adoption of sustainable land management practices among farmers under the Third National Fadama Development Project in Imo State, Nigeria. *African Journal of Agricultural Research, 20*(1), 52–58. https://doi.org/10.5897/AJAR2023.16544.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Brundtland Commission. (1987). *Our common future: Report of the World Commission on Environment and Development*. United Nations.

Chambers, R., & Conway, G. R. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st century*. Institute of Development Studies, University of Sussex.

Department for International Development (DFID). (1999). *Sustainable livelihoods guidance sheets*. London: Department for International Development.

Fanifosi, G. E., Faniyi, T. O., & Adeyemi, T. R. (2023). Sustainable land management practices and its correlates among smallholder food crops farmers in Ogbomoso agricultural zone of Oyo State. *Canadian Journal of Agriculture and Crops, 8*(1), 12–21. https://doi.org/10.55284/cjac.v8i1.911.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Addison-Wesley.

Food and Agriculture Organization of the United Nations (FAO). (2024). *Land, soil, water and the Sustainable Development Goals*. Rome: FAO.

Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate Change 2023: Synthesis report*. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva: IPCC.

Kehinde, M. O., Shittu, A. M., Oriade, O. A., & Edewor, S. E. (2023). Land tenure, land use antecedents, and willingness to embrace resilient farming practices among smallholders in Nigeria. *Frontiers in Sustainable Food Systems, 7*. https://doi.org/10.3389/fsufs.2023.999905.

Ojo, T. O., Adesiyan, O. F., Ige, A. O., Emenike, C. U., Kassem, H. S., Elhindi, K. M., Kitole, F. A., & Sesabo, J. K. (2024). The role of sustainable land management practices in alleviating household food insecurity in Nigeria. *Frontiers in Sustainable Food Systems, 8*. https://doi.org/10.3389/fsufs.2024.1414243.

Olumba, C. N., Garrod, G., & Areal, F. J. (2024). Time preferences, land tenure security, and the adoption of sustainable land management practices in Southeast Nigeria. *Sustainability, 16*(5), 1747. https://doi.org/10.3390/su16051747

Osabohien, R., Jaaffar, A. H., Matthew, O., Osabuohien, E., Adeleke, O. K., Olonade, O. Y., & Okoh, G. O. (2024). Soil management practice and smallholder agricultural productivity in Nigeria. *Discover Sustainability, 5*, 283. https://doi.org/10.1007/s43621-024-00467-0.

Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis. *IDS Working Paper 72*. Institute of Development Studies, University of Sussex.

Sok, J., Hogeveen, H., Elbers, A. R. W., & Oude Lansink, A. G. J. M. (2021). Farmers' beliefs and intentions to adopt sustainable agricultural practices: The role of attitudes, perceived behavioural control and social norms. *Agricultural Systems, 190*, 103105.

Tey, Y. S., Brindal, M., & Dibba, H. (2022). Factors influencing farmers' adoption of sustainable agricultural practices: A systematic review. *Agriculture, 12*(7), 1021.