International Journal of Innovative Food, Nutrition & Sustainable Agriculture 14(2):58-70, April-June, 2026

 www.seahipublications.org ISSN: 2467-8481

DOI:10.5281/zenodo.20511010

Exploring Strategies for Promoting Sustainable Agriculture for Achieving Food Security and Poverty Reduction in Nigeria

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ABSTRACT
This study examined strategies for promoting sustainable agriculture as a pathway for improving food security and reducing rural poverty in Nigeria. Specifically, the study investigated the determinants of sustainable agriculture adoption, assessed the effectiveness of agricultural intervention programmes, and analysed the relationship between sustainable agricultural practices, household income, environmental sustainability, and climate resilience. A mixed-methods research design involving quantitative and qualitative approaches was adopted (Creswell & Plano Clark, 2017). Primary data were collected from 450 smallholder farmers across Nigeria's major agro-ecological zones using structured questionnaires, interviews, and focus group discussions. Quantitative data were analysed using Probit regression, Difference-in-Differences (DID), Ordinary Least Squares (OLS), and Structural Equation Modelling (SEM), while qualitative responses were subjected to thematic analysis. Findings revealed that access to extension services, education, farm size, and access to agricultural credit significantly influenced adoption of sustainable agricultural practices (Adewara et al., 2019; Ibrahim et al., 2018). The study further found that sustainable agriculture positively improved household income, food availability, dietary diversity, and environmental sustainability (Pretty, 2008; FAO, 2022). The study recommends strengthening agricultural extension systems, climate-smart agricultural policies, and rural financing mechanisms. The study contributes to existing literature by integrating food security, poverty reduction, and climate resilience within a unified analytical framework for sustainable agricultural development in Nigeria.
Keywords: Sustainable agriculture, food security, poverty reduction, climate resilience, rural development, Nigeria.

1.0 INTRODUCTION

Agriculture remains one of the most important sectors of the Nigerian economy despite decades of oil dependency and structural economic transformation (Magaji et al., 2025). The sector contributes significantly to employment generation, food production, rural livelihoods, and national income (Musa et al., 2025). According to the Food and Agriculture Organization (FAO, 2022), over 70 per cent of rural households in Nigeria depend directly or indirectly on agriculture for survival. Similarly, the National Bureau of Statistics (2023) estimated that agriculture contributes approximately 24 per cent of Nigeria's Gross Domestic Product (GDP) and employs more than 35 per cent of the labour force. Despite this strategic importance, the agricultural sector continues to face enormous challenges, including declining soil fertility, climate variability and conflicts, environmental degradation,

inadequate infrastructure, poor access to credit, and weak institutional support (Zailani et al., 2025; Ologbonori et al., 2025; Chinedu et al.,2021; Oluwalosijibomi et al., 2025).

Food insecurity has become one of the most pressing developmental concerns in Nigeria. The country continues to experience rising food prices, declining agricultural productivity, and increasing rural poverty. The Global Hunger Index (2023) classified Nigeria among countries facing serious hunger conditions. Millions of Nigerians experience food shortages, malnutrition, and inadequate dietary intake due to poor agricultural productivity and socio-economic instability (Bello et al., 2025). The situation has been worsened by conflicts, flooding, desertification, insecurity, and disruptions in agricultural supply chains (Jafaru et al., 2025; Jankoli et al., 2025).

Poverty also remains widespread, particularly in rural communities where agriculture constitutes the primary source of livelihood (Magaji et al., 2022). Rural poverty manifests as low household income, poor access to education and healthcare, inadequate infrastructure, unemployment, and food insecurity (Musa et al., 2024; Aluko & Magaji, 2020). According to the World Bank (2022), over 40 per cent of Nigerians live below the poverty line, with the majority residing in rural areas dependent on subsistence farming. Consequently, there is growing recognition that sustainable agricultural transformation is essential for reducing poverty and improving livelihoods.

Sustainable agriculture refers to farming systems that maintain productivity while protecting environmental resources, improving social welfare, and ensuring economic viability for present and future generations (Abubakar et al., 2025). It involves the adoption of environmentally friendly practices such as crop rotation, agroforestry, conservation agriculture, integrated pest management, organic fertilisation, water conservation, and climate-smart farming technologies (Ephraim et al., 2025). Sustainable agriculture seeks to balance economic productivity with ecological conservation and social equity (Katuka et al., 2025).

The increasing impacts of climate change have intensified the urgency of promoting sustainable agricultural systems in Nigeria (Aminu et al., 2025). Rising temperatures, erratic rainfall patterns, flooding, drought, and land degradation have adversely affected crop yields and livestock production. Farmers are increasingly vulnerable to environmental shocks that threaten food availability and household income. Sustainable agriculture, therefore, offers pathways for building resilience, improving productivity, conserving biodiversity, and enhancing long-term food security.

The Nigerian government and development partners have introduced several policies and programmes to support sustainable agriculture. These include the Agricultural Transformation Agenda, Anchor Borrowers' Programme, National Agricultural Technology and Innovation Policy, Green Alternative Policy, and various climate-smart agriculture initiatives. However, implementation challenges, institutional inefficiencies, inadequate funding, and corruption have limited the effectiveness of these interventions.

This study, therefore, explores strategies for promoting sustainable agriculture in Nigeria to enhance food security and reduce poverty. Specifically, the study examines barriers to adoption, evaluates policy effectiveness, analyses socio-economic determinants, and identifies practical pathways for strengthening sustainable agricultural systems in Nigeria.

2.0 LITERATURE REVIEW

2.1 Concept of Sustainable Agriculture

Sustainable agriculture refers to farming systems that satisfy current food and fibre needs without compromising the ability of future generations to meet their own needs. The concept emerged from growing concerns regarding environmental degradation, declining soil fertility, biodiversity loss, and unsustainable resource exploitation associated with conventional farming systems.

Pretty (2008) defined sustainable agriculture as agricultural practices that enhance environmental quality, maintain economic profitability, and promote social equity. Similarly, Gliessman (2015) argued that sustainable agriculture integrates ecological principles into agricultural production systems to ensure long-term sustainability.

Sustainable agricultural practices include crop diversification, conservation tillage, integrated nutrient management, agroforestry, organic farming, water harvesting, integrated pest management, and climate-smart agriculture. These practices reduce dependence on synthetic inputs, improve soil fertility, conserve biodiversity, and enhance resilience against climate change.

In Nigeria, sustainable agriculture is increasingly viewed as a viable pathway for addressing food insecurity, environmental degradation, and rural poverty. However, adoption rates remain low among smallholder farmers due to institutional, economic, technological, and infrastructural constraints.

2.2 Food Security

Food security exists when all individuals have physical, social, and economic access to sufficient, safe, and nutritious food at all times. The FAO (2021) identified four dimensions of food security: food availability, food access, food utilisation, and food stability.

Nigeria faces significant food security challenges arising from low agricultural productivity, climate variability, insecurity, poor storage facilities, inflation, and poverty (Magaji & Musa, 2024). Food insecurity disproportionately affects vulnerable populations, including women, children, and rural households.

Several studies have established strong relationships between sustainable agriculture and food security. Sustainable farming practices improve crop productivity, reduce post-harvest losses, enhance resilience to climate shocks, and promote dietary diversity.

2.3 Poverty Reduction and Rural Development

Poverty reduction refers to deliberate efforts aimed at improving the living conditions and economic well-being of poor populations (Umar et al., 2025). Rural poverty in Nigeria is largely associated with low agricultural productivity, limited access to productive assets, weak infrastructure, and unemployment (Yusuf et al., 2025).

Agriculture plays a central role in poverty reduction because it provides employment opportunities, income generation, and food for rural populations. Sustainable agriculture contributes to poverty reduction by increasing farm productivity, reducing production costs, enhancing market access, and creating livelihood opportunities.

The Sustainable Livelihoods Framework emphasises the importance of enhancing human, financial, physical, natural, and social capital in reducing vulnerability and improving livelihoods. Sustainable agriculture supports these dimensions by strengthening rural resilience and improving household wellbeing.

2.4 Theoretical Framework

This study is anchored on the Sustainable Livelihoods Framework (SLF) developed by Robert Chambers and Gordon Conway in 1992. The framework explains how households utilise different livelihood assets and capabilities to achieve sustainable livelihood outcomes such as food security, poverty reduction, income generation, environmental sustainability, and resilience against socio-economic and climatic shocks. The SLF emphasises that livelihoods are sustainable when individuals and households can cope with stresses and shocks while maintaining or enhancing their capabilities and assets without undermining natural resources for future generations.

The framework identifies five major categories of livelihood assets, namely:

1. Human capital
2. Natural capital
3. Financial capital
4. Social capital
5. Physical capital

Human capital includes education, skills, knowledge, health status, and labour availability that enable individuals to pursue livelihood activities effectively. Natural capital refers to natural resource assets such as land, water, forests, soil fertility, and biodiversity required for agricultural production. Financial capital comprises savings, credit facilities, remittances, income, and other financial resources that support farming investments and livelihood diversification. Social capital involves social networks, farmer associations, cooperatives, institutional relationships, and community support systems that facilitate cooperation and access to resources. Physical capital includes infrastructure, transportation systems, irrigation facilities, farm equipment, storage facilities, and communication technologies that improve agricultural productivity and market access.

The Sustainable Livelihoods Framework is highly relevant to this study because sustainable agriculture depends significantly on farmers' access to productive resources, institutional support, infrastructure, agricultural financing, extension services, technology, and social networks. The framework further explains how vulnerabilities such as climate change, poverty, environmental

degradation, insecurity, and policy failures affect rural livelihoods and agricultural sustainability in Nigeria.

The SLF therefore provides a comprehensive analytical framework for understanding the interactions between sustainable agricultural practices, food security, poverty reduction, climate resilience, and rural development outcomes in Nigeria.

2.5 Empirical Review

Several empirical studies have examined sustainable agriculture and its implications for food security and poverty reduction.

Adewara et al. (2019) found that sustainable agricultural practices significantly improved household food security among rural farmers in Nigeria. Similarly, Ibrahim et al. (2018) established that climate-smart agriculture enhanced resilience against drought and flooding.

Okonkwo et al. (2019) reported that access to markets, extension services, and agricultural credit significantly influenced adoption rates among smallholder farmers. Oyewole and Adeyemi (2020) observed that organic farming practices increased farm profitability and reduced environmental degradation.

Despite these findings, existing studies have largely focused on isolated dimensions of sustainable agriculture without integrating food security, poverty reduction, institutional factors, and climate resilience within a comprehensive framework.

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted across selected states representing Nigeria's major agro-ecological zones including the rainforest, derived savannah, Guinea savannah, Sudan savannah, and Sahel savannah zones. These regions were selected to ensure adequate representation of diverse farming systems, climatic conditions, and agricultural practices.

Nigeria experiences considerable ecological diversity, with varying rainfall patterns, temperature regimes, vegetation types, and soil characteristics. Agriculture in these regions includes crop farming, livestock production, fisheries, and agroforestry.

3.2 Research Design

This study adopted a mixed-methods research design involving both quantitative and qualitative approaches in order to provide a comprehensive analysis of sustainable agriculture and its implications for food security and poverty reduction in Nigeria. The mixed-methods approach was considered appropriate because it enabled triangulation of findings, enhanced reliability, and facilitated deeper understanding of the research problem through the integration of numerical and contextual data (Creswell & Plano Clark, 2017). The quantitative component focused on generating measurable data regarding adoption of sustainable agricultural practices, socio-economic characteristics, food security outcomes, and poverty indicators among rural farmers. The qualitative component provided detailed explanations regarding farmers' perceptions, experiences, institutional challenges, and climate-related vulnerabilities affecting sustainable agriculture.

The quantitative aspect of the study involved the administration of structured questionnaires to selected smallholder farmers across different agro-ecological zones in Nigeria. The questionnaires contained both closed-ended and Likert-scale questions designed to obtain data on farming practices, access to agricultural inputs, extension services, credit facilities, market participation, and livelihood outcomes.

The qualitative component utilised in-depth interviews and focus group discussions to generate contextual information and obtain detailed insights into the experiences of farmers, agricultural extension officers, community leaders, and other stakeholders. This approach enabled the researcher to capture socio-cultural, institutional, and environmental factors influencing sustainable agricultural adoption and rural livelihoods.

3.3 Population of the Study

The target population of the study comprised smallholder farmers engaged in crop production, livestock farming, agroforestry, mixed farming systems, and other agricultural livelihood activities across selected states in Nigeria. Smallholder farmers were specifically targeted because they

constitute the largest proportion of Nigeria's agricultural workforce and are highly vulnerable to food insecurity, poverty, climate variability, and environmental degradation.

The population included male and female farmers operating within different agro-ecological zones including the rainforest, derived savannah, Guinea savannah, Sudan savannah, and Sahel savannah regions. The inclusion of different ecological zones was necessary to ensure adequate representation of diverse climatic conditions, agricultural systems, and farming practices across the country.

3.4 Sample Size and Sampling Technique

The study employed a multistage sampling technique in selecting respondents for the research. The multistage sampling approach was adopted because of the wide geographical coverage of the study and the need to ensure representativeness across Nigeria's major agro-ecological zones.

At the first stage, states were purposively selected from different agro-ecological zones based on the predominance of agricultural activities and ecological diversity. At the second stage, selected local government areas and farming communities were randomly selected within the chosen states. At the third stage, systematic random sampling was used in selecting individual farmers from farming households and community registers.

A total sample size of 450 smallholder farmers participated in the study. The sample size was considered adequate for quantitative statistical analysis and qualitative interpretation because it provided sufficient representation of rural farming households across the selected study areas.

3.5 Data Collection Techniques

The study utilised both primary and secondary sources of data collection.

Primary data were collected through the following instruments and techniques:

- Structured questionnaires
- In-depth interviews
- Focus group discussions
- Field observations

The structured questionnaires were administered directly to farmers to obtain quantitative information relating to socio-economic characteristics, farming practices, food security conditions, access to agricultural services, climate adaptation strategies, and livelihood outcomes.

In-depth interviews were conducted with agricultural extension officers, community leaders, policymakers, and selected farmers to obtain qualitative insights regarding institutional support systems, policy implementation challenges, climate-related risks, and sustainable agricultural practices.

Focus group discussions were organised among farming groups and cooperatives to encourage interactive discussions and collective perspectives on sustainable agriculture, poverty reduction, and food security challenges. Field observations were also undertaken to assess farming systems, environmental conditions, irrigation facilities, storage infrastructure, and agricultural practices within the study areas.

Secondary data were obtained from government publications, National Bureau of Statistics (NBS) reports, Food and Agriculture Organization (FAO) reports, World Bank publications, journal articles, policy documents, textbooks, conference proceedings, and other relevant scholarly materials relating to sustainable agriculture, food security, climate change, and rural development in Nigeria.

3.6 Model Specification

The study utilised multiple econometric models in analysing the determinants, impacts, and interrelationships associated with sustainable agricultural practices, food security, poverty reduction, and environmental sustainability in Nigeria. The use of multiple analytical models enhanced the robustness, validity, and comprehensiveness of the study findings by addressing different dimensions of the research objectives.

3.6.1 Probit Regression Model

The Probit regression model was employed to analyse the determinants influencing the adoption of sustainable agricultural practices among smallholder farmers. The Probit model was considered appropriate because the dependent variable was binary in nature, indicating whether a farmer adopted sustainable agricultural practices or not. The model estimates the probability of adoption based on selected socio-economic and institutional variables.

The Probit model is specified as:

$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \mu$

Where:

- Y = Adoption of sustainable agriculture
- X1 = Education level
- X2 = Farm size
- X3 = Access to credit
- X4 = Extension services
- $\beta0$ = Constant term
- $\beta1-\beta4$ = Regression coefficients
- μ = Error term

The explanatory variables were selected based on existing literature and their relevance to sustainable agriculture adoption among rural farmers.

3.6.2 Difference-in-Differences (DID) Model

The Difference-in-Differences (DID) model was used to assess the impact of agricultural intervention programmes on food security outcomes among participating and non-participating farming households. The DID model was appropriate because it enabled the researcher to compare changes in food security indicators before and after programme implementation between treatment and control groups.

The DID estimator is specified as:

$Yit = \alpha + \beta1Ti + \beta2Pt + \beta3(Ti \times Pt) + \varepsilon itY$

Where:

- Yit = Food security outcome for household iii at time ttt
- TiT = Treatment group dummy
- PtP = Post-intervention period dummy
- $Ti \times Pt$ = Interaction term measuring programme impact
- A = Constant term
- εit = Error term

The interaction coefficient measured the net impact of agricultural intervention programmes on food security outcomes.

3.6.3 Ordinary Least Squares (OLS) Regression Model

The Ordinary Least Squares (OLS) regression model was employed to analyse the relationship between sustainable agriculture adoption and household income. The model examined how sustainable farming practices influence economic wellbeing and poverty reduction among rural households.

The OLS regression model is specified as:

$Y=\alpha+\beta1X1+\beta2X2+\beta3X3+\beta4X4+\varepsilon Y$

Where:

- Y = Household income
- X1 = Sustainable agriculture adoption
- X2 = Market access
- X3 = Farm size
- X4 = Educational attainment
- α = Constant term
- ε = Error term

The OLS model enabled the estimation of the magnitude and direction of relationships between sustainable agriculture and household income.

3.6.4 Structural Equation Modelling (SEM)

Structural Equation Modelling (SEM) was utilised to examine the complex interrelationships among sustainable agriculture, food security, poverty reduction, climate resilience, and environmental sustainability. SEM was considered appropriate because it allows simultaneous estimation of multiple relationships among latent and observed variables.

The SEM framework examined both direct and indirect effects among the study variables, thereby providing a comprehensive understanding of the pathways through which sustainable agriculture influences rural livelihood outcomes.

The structural model is expressed as:

$\eta = B\eta + \Gamma\xi + \zeta$

Where:

- η = Endogenous latent variables
- ξ = Exogenous latent variables
- B = Matrix of relationships among endogenous variables
- Γ = Matrix of relationships between exogenous and endogenous variables
- ζ = Structural disturbance term

SEM provided deeper insights into the multidimensional relationships among agricultural sustainability indicators and rural development outcomes.

3.7 Method of Data Analysis

Quantitative data obtained from the field survey were analysed using STATA and SPSS statistical software packages. Descriptive statistics including frequencies, percentages, means, standard deviations, and cross-tabulations were employed to summarise respondents' socio-economic characteristics and major study variables.

Inferential statistical techniques including Probit regression, Difference-in-Differences (DID), Ordinary Least Squares (OLS), and Structural Equation Modelling (SEM) were used to test hypotheses and examine relationships among variables.

Qualitative data obtained from interviews and focus group discussions were analysed using thematic analysis. Interview responses were transcribed, coded, categorised, and organised into emerging themes relating to sustainable agriculture, climate resilience, institutional support, food security, and poverty reduction. The thematic approach enabled identification of recurring patterns, perceptions, and contextual issues affecting sustainable agricultural practices in Nigeria.

3.8 Ethical Considerations

Ethical approval for the study was obtained from relevant academic and institutional authorities before commencement of data collection. The researcher ensured that all ethical principles guiding social science research were strictly observed throughout the study.

Participation in the study was entirely voluntary, and respondents were adequately informed about the purpose, objectives, and procedures of the research before data collection. Informed consent was obtained from all participants prior to interviews and questionnaire administration.

Respondents were assured of confidentiality, anonymity, and privacy regarding the information provided during the study. Personal identities and responses were treated with strict confidentiality and used solely for academic purposes. Participants were also informed of their right to withdraw from the study at any stage without any form of penalty or consequences.

4.0 RESULTS

4.1 Socio-Economic Characteristics of Respondents

The socio-economic characteristics of respondents revealed that the majority of participants were male farmers within the economically active age group of 31–55 years. This suggests that agricultural activities in the study areas are predominantly undertaken by middle-aged individuals who possess substantial farming experience and labour capacity. The findings further showed that most respondents possessed at least basic formal education, indicating a moderate literacy level among rural farmers. Educational attainment is important because it influences farmers' access to agricultural information, innovation adoption, and decision-making regarding sustainable farming practices.

Farming constituted the primary source of livelihood for most respondents, confirming the critical role of agriculture in rural household survival and income generation in Nigeria. The study also revealed that approximately 68 per cent of respondents cultivated less than five hectares of farmland, indicating the dominance of smallholder farming systems across the study areas. This finding is consistent with existing literature which identifies smallholder farmers as the backbone of agricultural production in Nigeria.

Table 1: Socio-Economic Characteristics of Respondents

Variable	Frequency	Percentage
Male	292	64.9
Female	158	35.1
Primary Education	143	31.8
Secondary Education	201	44.7
Tertiary Education	63	14.0
No Formal Education	43	9.5
Farm Size Below 5 Hectares	306	68.0

Source: Field Survey, 2025.

The findings imply that smallholder farmers remain central to sustainable agricultural development and food production in Nigeria. The dominance of respondents with basic education further suggests the need for accessible agricultural extension services and simplified climate-smart agricultural technologies.

4.2 Determinants of Sustainable Agriculture Adoption

The Probit regression analysis examined factors influencing the adoption of sustainable agricultural practices among respondents. The results revealed that education level, farm size, access to credit facilities, extension services, and farming experience significantly influenced farmers' decisions to adopt sustainable agricultural practices.

Table 2: Probit Regression Results

Variable	Coefficient	P-value
Education	0.214	0.041
Farm Size	0.301	0.012
Access to Credit	0.425	0.008
Extension Services	0.533	0.002
Farming Experience	0.186	0.037

Dependent Variable: Adoption of Sustainable Agriculture.

The positive coefficient for education indicates that farmers with higher educational attainment were more likely to adopt sustainable farming practices because education enhances awareness, technical understanding, and access to information. Farm size also positively influenced adoption, suggesting that farmers with larger landholdings possess greater capacity to experiment with innovative and environmentally sustainable farming methods.

Access to agricultural credit emerged as a major determinant of adoption because financial resources enable farmers to purchase improved seeds, irrigation equipment, organic inputs, and other climate-smart technologies. Similarly, extension services recorded the highest coefficient, indicating that institutional support and technical advisory services significantly enhance adoption of sustainable agricultural practices.

Farming experience also positively influenced adoption, implying that experienced farmers are more capable of understanding long-term environmental risks and the benefits associated with sustainable farming systems. Overall, the findings demonstrate that farmers with greater institutional support, financial access, and educational exposure are more likely to adopt sustainable agricultural innovations.

4.3 Effects of Sustainable Agriculture on Food Security

The Difference-in-Differences (DID) analysis was employed to evaluate the effects of sustainable agricultural intervention programmes on household food security outcomes. The findings revealed moderate positive improvements in food security indicators among farmers participating in sustainable agricultural programmes.

Table 3: Difference-in-Differences (DID) Results

Variable	Coefficient	P-value
Programme Participation	0.442	0.062
Household Size	-0.115	0.084
Access to Markets	0.318	0.019
Climate Variability	-0.276	0.028

Source: Computed by Researcher, 2025.

The positive coefficient for programme participation suggests that sustainable agricultural interventions moderately improved food availability, dietary diversity, and household food access among participating farmers. Although the significance level was marginal, the results indicate that intervention programmes contributed positively towards enhancing food security outcomes.

Access to markets significantly improved food security because farmers with better market connectivity were able to sell produce efficiently, increase household income, and access diverse food products. Conversely, household size negatively affected food security due to increased consumption pressure on limited household resources.

Climate variability also negatively influenced food security outcomes. Flooding, delayed rainfall, drought, and pest outbreaks reduced agricultural productivity and food availability, thereby increasing household vulnerability. The findings therefore demonstrate that sustainable agricultural interventions contribute positively to food security but remain constrained by climatic and structural challenges.

4.4 Sustainable Agriculture and Poverty Reduction

The Ordinary Least Squares (OLS) regression model analysed the relationship between sustainable agriculture adoption and household income as an indicator of poverty reduction. The results revealed a statistically significant positive relationship between sustainable agricultural practices and household income levels.

Table 4: OLS Regression Results

Variable	Coefficient	P-value
Sustainable Agriculture Adoption	0.614	0.001
Market Access	0.271	0.023
Education	0.194	0.041
Climate Shock	-0.337	0.017

$R^2 = 0.61$; F-statistic = 18.42.

The findings indicate that adoption of sustainable agricultural practices significantly improved household income and contributed to poverty reduction among rural farmers. Farmers who adopted conservation agriculture, agroforestry, crop diversification, integrated soil fertility management, and organic fertilisation recorded higher income levels than non-adopters.

Market access also positively influenced household income because farmers with access to profitable markets obtained better prices for agricultural produce and reduced post-harvest losses. Educational attainment positively affected income generation by enhancing managerial efficiency, technological adoption, and productivity.

Conversely, climate shocks negatively affected household income due to crop failures, livestock mortality, and reduced productivity associated with climatic uncertainties. The relatively high R^2 value indicates that the explanatory variables accounted for a substantial proportion of variations in household income among respondents.

4.5 Structural Equation Modelling (SEM) Results

The Structural Equation Modelling (SEM) analysis examined the direct and indirect relationships among sustainable agriculture, environmental sustainability, food security, poverty reduction, and climate resilience.

Table 5: SEM Path Coefficients

Path Relationship	Coefficient	P-value
Sustainable Agriculture → Food Security	0.587	0.001
Sustainable Agriculture → Environmental Sustainability	0.624	0.000
Environmental Sustainability → Poverty Reduction	0.418	0.013
Food Security → Household Welfare	0.532	0.004
Sustainable Agriculture → Climate Resilience	0.611	0.002

The SEM findings revealed strong positive relationships among the study variables. Sustainable agriculture significantly enhanced food security, environmental sustainability, and climate resilience. The findings further showed that environmental sustainability positively contributed to poverty reduction by improving long-term agricultural productivity and reducing vulnerability to environmental degradation.

The positive relationship between food security and household welfare demonstrates that improved food availability and dietary diversity contribute substantially to better living standards and poverty alleviation among rural households. Overall, the SEM analysis confirms that sustainable agriculture contributes significantly to long-term livelihood security and rural development outcomes.

4.6 Qualitative Findings

The qualitative interviews and focus group discussions revealed several recurring themes relating to sustainable agriculture, institutional support, climate change, and rural livelihoods.

4.6.1 Perception of Sustainable Agriculture

Most respondents perceived sustainable agriculture as highly beneficial for long-term soil fertility, environmental conservation, crop productivity, and household food supply. Farmers who adopted agroforestry, crop rotation, composting, and organic fertilisation reported improvements in soil quality and reduced dependence on expensive chemical fertilisers.

One respondent stated:

> 'Sustainable farming helps us preserve our land for future generations and reduces our dependence on expensive chemicals.'

The findings suggest growing awareness among rural farmers regarding the environmental and economic benefits of sustainable agriculture.

4.6.2 Institutional Constraints

Farmers identified weak government support, inadequate agricultural extension services, corruption in agricultural programmes, limited financing, and poor infrastructure as major barriers to sustainable agricultural adoption.

Many respondents expressed dissatisfaction regarding delays in agricultural input distribution, inadequate rural roads, and poor access to irrigation facilities. These institutional weaknesses significantly undermine agricultural productivity and sustainable rural development.

4.6.3 Climate Change and Vulnerability

Respondents acknowledged increasing climatic uncertainties including delayed rainfall, flooding, drought, soil erosion, and pest outbreaks. Many farmers indicated that climate variability has reduced crop yields and increased livelihood vulnerability.

However, several respondents believed that sustainable agricultural practices improved their adaptive capacity against climate-related shocks by enhancing soil moisture conservation, biodiversity, and resilience against environmental degradation.

4.6.4 Youth Participation

The study revealed low youth participation in agriculture due to unemployment, rural-urban migration, poor perceptions regarding farming profitability, limited access to farmland, and inadequate government support for agricultural entrepreneurship.

Many respondents argued that improving mechanisation, access to agricultural finance, digital agriculture, and market opportunities could encourage greater youth involvement in sustainable agriculture and rural development.

5.0 DISCUSSION OF FINDINGS

The findings of this study corroborate previous empirical studies indicating that sustainable agriculture contributes significantly to food security, poverty reduction, and environmental sustainability in developing countries.

The positive relationship between education and sustainable agriculture adoption supports the findings of Okonkwo et al. (2019), who argued that educated farmers are more likely to adopt innovative farming technologies due to greater awareness and access to information.

Similarly, the significance of extension services confirms the importance of institutional support systems in facilitating agricultural transformation. Extension officers play critical roles in disseminating knowledge regarding climate-smart agriculture, pest management, conservation practices, and improved farming techniques.

The positive impact of sustainable agriculture on household income and food security aligns with the Sustainable Livelihoods Framework, which emphasises the role of livelihood diversification, natural resource management, and institutional access in reducing vulnerability and enhancing wellbeing.

The findings also reveal that climate variability negatively affects agricultural productivity and food security. This supports the Intergovernmental Panel on Climate Change (IPCC, 2023), which warned that African agriculture remains highly vulnerable to climate-related disruptions.

The qualitative findings further revealed persistent structural challenges affecting agricultural sustainability in Nigeria. Poor rural roads, inadequate irrigation systems, post-harvest losses, limited rural finance, insecurity, and policy inconsistencies continue to undermine agricultural productivity.

Furthermore, the study found that many agricultural intervention programmes in Nigeria suffer from implementation inefficiencies, political interference, elite capture, corruption, and weak monitoring mechanisms. These institutional weaknesses reduce the effectiveness of policies aimed at promoting sustainable agriculture and poverty alleviation.

Despite these challenges, the study demonstrates that sustainable agriculture remains a viable strategy for achieving long-term food security, climate resilience, rural development, and poverty reduction in Nigeria.

6.0 CONCLUSION

This study examined strategies for promoting sustainable agriculture for achieving food security and poverty reduction in Nigeria. The findings established that sustainable agriculture positively influences food availability, household income, environmental sustainability, climate resilience, and rural livelihoods.

The study found that adoption of sustainable agricultural practices is significantly influenced by education, extension services, farm size, access to credit, and institutional support. Sustainable agriculture contributes to poverty reduction through increased farm productivity, livelihood diversification, and improved household welfare.

However, several challenges continue to hinder widespread adoption, including inadequate financing, poor infrastructure, weak policy implementation, insecurity, corruption, climate change, and institutional inefficiencies.

The study therefore concludes that sustainable agriculture constitutes an indispensable pathway towards achieving inclusive rural development, food sovereignty, poverty alleviation, and environmental sustainability in Nigeria.

7.0 RECOMMENDATIONS

Based on the findings of the study, the following recommendations are proposed:

i. Government should strengthen agricultural extension systems to improve farmers' access to sustainable farming knowledge and climate-smart agricultural practices.
ii. Rural farmers should be provided with affordable access to agricultural credit facilities and insurance schemes to support sustainable farming investments.
iii. Public investment in rural infrastructure such as roads, irrigation facilities, storage systems, and rural electrification should be increased.
iv. Government and development partners should promote climate-smart agriculture, agroforestry, conservation agriculture, and water management technologies.

v. Policies promoting sustainable agriculture should be effectively implemented with improved transparency, accountability, and monitoring mechanisms.
vi. Youth participation in agriculture should be encouraged through land reforms, agricultural entrepreneurship programmes, mechanisation support, and digital agricultural innovations.
vii. Farmers' cooperatives and community-based organisations should be strengthened to improve market access, knowledge sharing, and collective bargaining power.
viii. Research institutions and universities should intensify research on sustainable agriculture, indigenous farming systems, and climate adaptation technologies suitable for Nigeria's ecological conditions.
ix. Public-private partnerships should be encouraged to facilitate agricultural financing, mechanisation, processing, and value chain development.
x. Environmental conservation policies should be integrated into agricultural development strategies to ensure long-term sustainability of natural resources.

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