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Climate Change Adaptation through Agroforestry and Its Influence on Farmers' Income in Oyo State, Nigeria

Oyekunle Isaac Oyewo*

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ABSTRACT

Climate change poses significant risks to agricultural productivity and rural livelihoods in Nigeria, particularly among smallholder farmers whose activities are largely rain-fed. Agroforestry has emerged as a climate-smart agricultural practice capable of enhancing resilience while supporting income diversification. This study examined the role of agroforestry in climate change adaptation and its influence on farmers' income in Lagelu Local Government Area, Oyo State, Nigeria. Data were collected from 84 farmers using structured questionnaires and analyzed through descriptive statistics and regression analysis. Results indicated that farming is predominantly male-dominated (73.8%) and concentrated among older age groups (51–60 years), with most farmers operating smallholdings of 1–5 hectares and cultivating staple crops such as maize and cassava. Regression analysis revealed that farmers' years of experience (β=0.675, P<0.01), knowledge of climate change (β=0.89, P<0.01), and age (β=0.702, P=0.10) were positively associated with income from agroforestry, while larger farm sizes (β=-0.678, P<0.10) and initial adoption of new techniques (β=-0.089, P<0.01) negatively influenced income. Although 88.1% of farmers were aware of climate change, over half had no contact with extension services, highlighting a gap in practical knowledge dissemination. The findings underscore that agroforestry can enhance household income and resilience to climate change, but its effectiveness depends on farmers' knowledge, experience, and access to technical support. The study recommends strengthening extension services, promoting targeted training, facilitating access to credit and inputs, encouraging gradual adoption of new technologies, and fostering crop diversification to optimize agroforestry outcomes and improve smallholder livelihoods.

1. Introduction

Agriculture in Nigeria, which contributes about 23% to the national GDP, is predominantly rain-fed and highly vulnerable to climate variability (Nwajiuba, 2019). Lagelu LGA, like many parts of southwest Nigeria, has experienced irregular rainfall patterns, rising temperatures, and prolonged dry spells, which disrupt traditional farming practices (Adejuwon, 2021). Farmers in this region, therefore, need practical, adaptive solutions to maintain productivity and safeguard their livelihoods. Agroforestry has been identified as a viable strategy for reducing climate vulnerability, enhancing soil fertility, and diversifying income sources (Sileshi et al., 2007).

Climate change poses significant threats to agricultural productivity, livelihoods, and income generation, particularly for rural farmers in developing regions like Nigeria. Farmers practicing agroforestry in Lagelu

* Department of Agribusiness Management, Federal College of Forestry, Forestry Research Institute of Nigeria, PMB 5087, Jericho Hill, Ibadan, Oyo State, Nigeria. E-mail address: ojerry2@gmail.com, oyewo.io@frin.gov.ng (I.O. Oyewo).

Local Government Area face increasing challenges, including unpredictable rainfall patterns, rising temperatures, and extreme weather events, which affect their crop yields, livestock health, and overall income. Agroforestry, recognized for its potential to enhance resilience through diversified income streams and ecological stability, is increasingly viewed as a sustainable adaptation strategy to mitigate the adverse effects of climate change (Ajayi et al., 2020; FAO, 2018).

Despite its potential, the level of adoption of climate-smart agroforestry practices and their impact on farmers' income remains insufficiently understood. Many farmers lack access to critical resources such as technical knowledge, climate-resilient crop varieties, and financial support, hindering their ability to adapt effectively to climate change (Nair & Garrity, 2012). Furthermore, the socio-economic and environmental benefits of agroforestry in the context of smallholder farming systems in Lagelu Local Government have not been thoroughly investigated.

This gap in knowledge creates a critical need to examine the extent to which climate change adaptation through agroforestry influences the income levels of farmers. Understanding these dynamics will inform policies and interventions aimed at promoting sustainable agroforestry practices while enhancing the socio-economic resilience of farmers in the face of climate change.

2. Literature review

2.1 Climate Change Adaptation, Agroforestry, and Farmers' Income

Climate change has emerged as a major constraint to agricultural development, particularly in developing regions where livelihoods are closely tied to climate-sensitive natural resources. Across sub-Saharan Africa, increasing temperatures, unpredictable rainfall patterns, prolonged droughts, and more frequent extreme weather events have negatively affected agricultural productivity and rural income generation (IPCC, 2021). Nigeria's agricultural sector is especially exposed due to its reliance on rain-fed production systems and limited adaptive infrastructure (Nwajiuba, 2019; Adejuwon, 2021). As a result, adaptation strategies that enhance resilience while supporting sustainable income growth have become increasingly important.

2.2 Climate Change and Agricultural Income

Climate variability influences farmers' income through multiple interconnected pathways. Changes in rainfall and temperature affect crop performance, alter planting and harvesting schedules, and increase the incidence of pests and diseases, thereby raising production costs and income uncertainty. Empirical evidence from Nigeria indicates that these climate-related stresses reduce farm profitability and heighten vulnerability among smallholder farmers, particularly those with limited access to irrigation and financial resources (Nwosu et al., 2022; Oladipo, 2022). In this context, income diversification and adaptive land-use practices have become essential strategies for sustaining rural livelihoods under changing climatic conditions (Hassan & Knight, 2023).

2.3 Agroforestry as a Climate Change Adaptation Strategy

Agroforestry is widely recognized as a climate-smart agricultural approach because it combines ecological sustainability with economic viability. The integration of trees into crop and livestock systems improves soil structure, enhances organic matter content, conserves soil moisture, and moderates

microclimatic conditions, thereby supporting long-term land productivity (Nair & Garrity, 2012). These characteristics enable farming households to better manage climate-related risks while maintaining stable production levels. In addition, agroforestry contributes to climate change adaptation and mitigation through carbon sequestration, reduced land degradation, and improved ecosystem services (FAO, 2018).

Empirical studies from African farming systems demonstrate that agroforestry practices such as alley cropping, boundary planting, home gardens, and parkland systems can reduce farmers' exposure to climate risks while supporting food security and farm productivity (Ajayi et al., 2020; Olawuyi et al., 2023). In southwestern Nigeria, agroforestry has been associated with improved soil fertility, reduced erosion, and enhanced crop performance among smallholder farmers, highlighting its suitability as an adaptation strategy in climate-stressed environments (Adebayo & Akinyemi, 2021).

2.4. Agroforestry and Farmers' Income

In addition to its environmental benefits, agroforestry plays a significant role in enhancing farmers' income through enterprise diversification and risk reduction. Trees incorporated into farming systems provide fruits, timber, fuelwood, and other non-timber forest products that supplement income from annual crops (Tebkew et al., 2024). Evidence from Nigeria suggests that agroforestry households often achieve more stable income levels than non-adopters due to reduced dependence on single-crop production systems (Okoroafor et al., 2023).

Although the adoption of climate-smart practices may involve initial adjustment and investment costs, long-term income gains are frequently realized as farmers gain experience and improve management efficiency. Cohn et al. (2020) observed that income benefits from climate-smart agriculture tend to emerge gradually rather than immediately after adoption. Similar findings from Ethiopia and Malawi show that agroforestry-based systems help farming households withstand climate shocks and maintain income during adverse production seasons (Tebkew et al., 2024; Tikita & Lee, 2024).

2.5. Socioeconomic Factors Influencing Income of Agroforestry Farmers

The effectiveness of agroforestry as an adaptation strategy is strongly influenced by farmers' socioeconomic characteristics. Age, education, farming experience, access to credit, and extension services have been found to significantly affect adoption decisions and income outcomes (Adepoju & Adenegan, 2023; Hassan & Knight, 2023). Experienced farmers are often better positioned to interpret climate signals and adopt appropriate adaptation measures, while education enhances understanding of improved practices and technologies.

2.6. Access to extension services

Access to extension services plays a critical role in disseminating climate-related information and technical knowledge required for effective agroforestry implementation. However, limited extension contact remains a major constraint among Nigerian smallholder farmers (World Bank, 2023). Credit access is equally important, as agroforestry investments often require upfront costs that poor farmers may be unable to afford without financial support (FAO, 2022). Household size and farm size also influence income outcomes, as larger households may provide labor but also increase consumption needs, while larger farms may face higher management costs if not efficiently utilized.

2.7. Knowledge Gap and Study Contribution

Despite the growing body of literature on agroforestry and climate change adaptation, localized empirical studies linking agroforestry practices directly to farmers' income within specific Nigerian contexts remain limited. Most existing studies adopt regional or national perspectives, with insufficient focus on local government-level dynamics where policy interventions are implemented. In Lagelu Local Government Area of Oyo State, empirical evidence on how socioeconomic and climate-related factors interact to influence income among agroforestry farmers is scarce. This study addresses this gap by providing localized, empirical insights into climate change adaptation through agroforestry and its influence on farmers' income in Lagelu LGA. By integrating socioeconomic and climate variables into an income model, the study contributes to evidence-based policymaking and supports the promotion of agroforestry as a viable climate-resilient livelihood strategy for smallholder farmers in Nigeria.

H_{01}: There is no significant relationship between the socioeconomic characteristics of agroforestry farmers and their income in Lagelu Local Government Area.
H_{02}: Climate change adaptation-related factors have no significant influence on the income of agroforestry farmers in the study area.
H_{03}: Farmers' knowledge of climate change does not significantly affect income among agroforestry practitioners.
H_{04}: Adoption of agroforestry-related climate-smart practices has no significant effect on farmers' income.

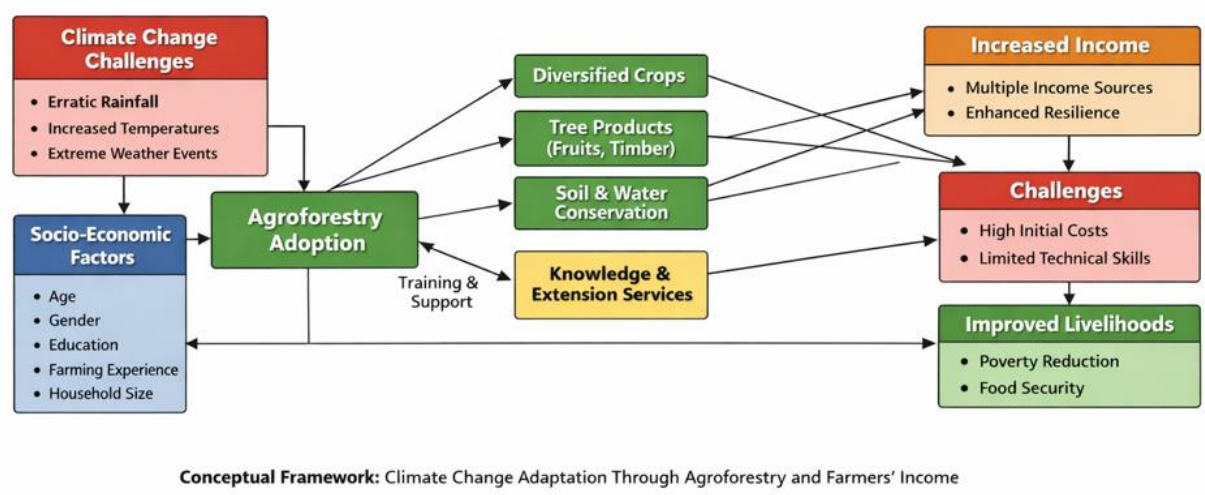

Figure 1. Conceptual Framework showing Climate Adaptation Through Agroforestry and Farmers Income

Source: Authors

3. Methodology

3.1. The study area

The study was carried out in Lagelu Local Government Area of Oyo state. Lagelu Local Government Area was created in the year 1976. Lagelu Local Government Area has an average temperature of 28 degrees Celsius and a total area of 338 square kilometers.

The Local Government Area has an average humidity of sixty-three percent and an estimated annual precipitation of two thousand millimeters. It has an area of 338 km2 and a population of 147,957 at the 2006 census. Lagelu local government area is subdivided into 14 wards: Ajara/Opeodu, Apatere/Kuffi/Ogunbode/Ogo, Arulogun Ehin/Kelebe, Ejioku/Igbon/Ariku, Lagelu Market/Kajola/Gbena, Lagun, Lalupon I, Lalupon II, Lalupon III, Ofa-Igbo, Ogunjana/Olowode/Ogburo, Ogunremi/Ogunsina, Oyedeji/Olode/Kutayi, Sagbe/Pabiekun. The village called Eleruko also falls under this local government. The local government is governed by an elected chairman and 14 councillors, one elected from each ward.

3.2. Population of study

The populations of the study were farmers practicing agroforestry in Lagelu local government area in Oyo state. The target populations of the study were selected farmers practicing agroforestry in Lagelu local government area.

3.3 Sampling procedure

The research was carried out in Lagelu local government area. Multi-stage sampling technique was used in selecting respondents in the study area.

Stage 1: Identification of wards in the local government. There are 14 wards in lagelu local government which include: Ajara/Opeodu, Apatere/kuffi/Ogunbode/ogo, ArulogunEhin/kelebe, Ejokun/igbon/ariku, Lagelu market/kajola/gbena, Lagun, Lalupon I, Lalupon Ii, Lalupon Iii, Ofa-igbo, Ogunjana/olowode/ogburo, Ogunremi/ogunsina, Oyedeji/olode/kutayi, Sagbe/pabiekun.

Stage 2: purposive selection of wards: Out of the 14 wards in Lagelu local government 4 wards were purposively selected which include Lalupon, Oyedeji, Lagun, Ogunremi.

Stage 3: Identification of villages: Lalupon: Lalupon, Akinsawe, Odo Oba, Iyana offa, Gidi Gidi, Idi Osan; Oyedeji: Aaje, Aba, Apatere, Ogo, Olode, Oyedeji; Lagun: Aba Egan, Akankan, Aromona, Bale-Oya, Lagun, Ogburo, Owode; Ogunremi: Alatare, Eleruko, Ogunremi, Ogunsina, Ogunsowo

Stage 4: Purposive selection of villages in the selected wards: Lalupon: Iyana offa, Lalupon, Akinsawe; Oyedeji: Oyedeji, Apatere; Lagun: Lagun; Ogunremi: Ogunsina

3.4 Sampling size and Data collection

A total number of 90 questionnaires were distributed in the purposive selected villages, only 85 were useful for the research analysis. 15 respondents were selected from Akinsawe, 15 respondents from Iyana Offa, 10 respondents from Lalupon, 10 respondents from Oyedeji, 10 respondents from Apatere, 10 respondents from Lagun and 14 respondents from Ogunsina village. Sample selection was based on the proportion to population of the farmers in the selected villages. Primary data was collected through the aid of a well-structured questionnaire and personal interview to elicit response from the respondents on issues that centres on the set objectives of the study. The secondary data was gathered from related journals and library.

3.5 Data analysis

Data was analysed using descriptive analysis which includes frequency table, and percentage, which was used to analyse objectives 1 and Multiple Regression was used to analyse objective 2.

Model Specification

$$Y = f(X) \qquad (1)$$

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \ldots\ldots\ldots\ldots + \beta_9 X_9 + \varepsilon \qquad (2)$$

Where,

Y= Income (₦)

X_1= Age (Years)

X_2= Access to extension services (Dummy variable)

X_3= Years of farming experience (Years)

X_4= Access to credit (Dummy variable)

X_5= Access to smart agricultural tools (Dummy variable)

X_6= Household size (Actual)

X_7= Knowledge of climate change (Dummy variable)

X_8= Size of farmland (hectare)

X_9= Adopting new farming techniques (Dummy variable)

β_o = Constant

ε = Error term

4. Results

Table 1 provides an overview of the socio-economic characteristics of the respondents. Most of the farmers were male (73.8%) which implies that gender roles in farming in Lagelu Local Government Area are largely male dominated. This could influence the type of labor available and the decision-making processes on farms. According to Adepoju & Adenegan (2023) found that male farmers in West Africa are more likely to adopt innovative agricultural technologies and attend extension training programs, primarily because such platforms are male-dominated and scheduled in ways that exclude women. A significant portion of the farming population falls within 51-60 age bracket (34.6%) suggesting an aging farming population. This has implications on the long-term sustainability of farming and the potential for adopting new technology and more of physically demanding adaptation strategies. A notable percentage (29.8%) of farmers had either primary or secondary education respectively. This level of education may influence their ability to understand and implement complex climate change adaptation strategies and agroforestry practices. Most households had a family size of 6-10 individuals (54.7%), which is large and could be a source of family labour and places high demands on food and affecting farmers household income. According to FAO (2022) noted that larger households in sub-Saharan Africa

tend to adopt home-based agricultural strategies to cope with food inflation and income limitations. Most farmers operate on small land sizes, with 84.5% farming 1-5 hectares. This suggests that smallholder farming is prevalent, which can limit the scale of agroforestry implementation and overall income generation. In terms of farming experience, 33.4% have 11-20 years of experience, indicating a seasoned farming community with established practices. This experience can be an asset in adapting to climate change, but it can also lead to resistance to new techniques if not properly introduced. FAO (2023) reported that farmers with 10-20 years of experience in smallholder systems are more likely to engage in input diversification and risk-reducing strategies, compared to their less experienced counterparts. The distribution on the household income varies, with 26.2% earning between ₦51,000-₦100,000. The relatively low-income levels highlight the vulnerability of these farmers to climate change impacts and the need for interventions that can enhance their income. Hired labour is the primary source of labour (45.2%), closely followed by a combination of family and hired labour (44.0%). This indicates a reliance on external labour, which can be an additional cost for farmers, especially those with small landholdings. Maize is the most grown crop (59.5%), followed by cassava (57.1%). The prevalence of these staple crops suggests a focus on food security, but also a potential lack of crop diversification, which could make farmers more vulnerable to specific crop failures due to climate change. According to Adebayo et al., (2023), maize is one of the top crops sold by smallholder farmers in Nigeria, with significant contributions to household income.

Table 1. Socio economic characteristics of respondents

Variables	Frequency	Percentage	Mean
Gender			
Male	68	56.7	
Female	52	43.3	
Marital status			
Single	7	5.8	
Married	93	77.5	
Divorced	10	8.3	
Widowed	10	8.3	
Age			
30-40	10	8.3	
41-50	60	50.0	
51-60	40	33.4	
>60	10	8.3	44.2
Religion			
Christian	56	46.7	
Islam	63	52.5	
Traditional	1	0.8	
Educational level			
No formal education	25	20.8	
Primary education	35	29.2	
Secondary occupation	60	50.0	
Household size			
2-4	65	64.2	2.6
5-7	16	13.3	
8-10	29	35.5	
Type of farm			
Peasant	68	56.7	

Variables	Frequency	Percentage	Mean
Commercial	37	30.8	
Both	15	12.5	
Do you belong to any cooperative organization			
Yes	59	49.2	
No	61	50.8	
Do you have access to credit?			
Yes	59	49.2	
No	61	50.8	
Source of credit			
Personal saving	61	50.8	
Commercial bank	29	24.2	
Agric bank	12	10.0	
Cooperative	18	15.0	

Source: Field survey, 2025

Slightly more than half of the farmers (51.2%) have access to credit, with cooperative societies being the main source of income (47.6%). Access to credit is crucial for investing in adaptation strategies and improving farm productivity. The role of cooperative societies is significant in facilitating this access and promoting collective action. A significant proportion of farmers (66.7%) utilize technological tools with autonomous tractors (41.7%) and other tools (45.2%) being the most common smart tools used. This indicates a willingness to adopt technology, which is a positive sign for the implementation of modern agroforestry and climate-smart agriculture practices. Most farmers (81.0%) generate income from trees/fruits directly linking agroforestry practices to income generation. Most farmers (88.1%) have knowledge of climate change, suggesting a high level of awareness of the issue. However, more farmers reported no extension contact (54.8%) than yes (45.2%). This implies a significant gap in knowledge dissemination and practical training from extension services, despite awareness. For those with access to extension services, 46.4% reported no access, 41.6% had 1-5 contacts, and 12.0% had 6-13 contacts. This further underscores the need to strengthen extension services to effectively transfer knowledge and skills related to climate change adaptation and agroforestry. A substantial portion of farmers (45.2%) have a moderate understanding of climate change, while 38.1% have a high understanding. This indicates that while awareness is high, the depth of understanding varies, which could affect the effectiveness of their adaptation strategies. According to Okorie et al., (2023), climate-aware farmers in Nigeria were significantly more proactive in adopting adaptation strategies than those with low awareness levels.

The regression table 2 revealed that the farmer's years of farming experience (β= 0.675, P<0.01) and their knowledge of climate change (β= 0.089, P<0.01) were significant had positively related to the income of farmers practicing agroforestry.

Table 2. Socio economic and climate change adaptation factors influencing farmer's income

Variable	Beta	Standard error	T-value	Sig.
C = Constant	39.041	5.512	7.083	.000
X_1 = age	.702*	.396	1.775	.080
X_2= Access to extension services	.255	.313	.813	.419
X_3= Years of farming experience	.675***	.070	9.635	.000
X_4= Access to credit	-1.039	1.729	-.601	.550

Variable	Beta	Standard error	T-value	Sig.
X_5= Access to smart agricultural tools	.054	.504	.107	.915
X_6= Household size	.621	.398	1.559	.123
X_7= Knowledge of climate change	.089***	.029	3.074	.003
X_8= Size of farmland	-.678*	.405	-1.675	.098
X_9= Adopting new farming techniques	-.089***	.028	-3.121	.003
R^2		0.680		

* Significant at 10% level; ** Significant at 5% level; ***Significant at 1% level

Source: Author Data Analysis, 2025

This implies that a proportionate increase in the number of years of farmer experience and an increase in their level of awareness or understanding of climate change are both associated with higher income levels among the agroforestry farmers. Age of farmer (β= 0.702, P=0.10) was also significant and positively related with the income of the farmers. This indicates that older farmers may have slightly higher incomes, possibly due to accumulated knowledge, stronger networks or better access to resources over time. Other predictors like size of farmland (β= -0.678, P=< 0.10) and adoption of new farming techniques (β= -0.089, P= <0.01) were negatively significant, implying that larger farm size do not necessarily translate to higher income and may even reduce it possibly due to higher maintenance costs or inefficient land use. Similarly, the adoption of new technological methods initially incurs cost or that farmers may not yet be using these techniques effectively enough to increase income. R^2 was 0.680 indicating 68% level of variation which could be explained by the variable combination of the model specification while the remaining 32% could be explained by the error term. This result is consistent with the findings from previous studies, such as Hassan and Knight (2023) demonstrated that years of farming experience significantly correlate with climate change awareness, which in turn enhances adaptation and income strategies. Similarly, Tebkew et al., (2024) found that age, experience and agroforestry engagement significantly influence income, and reported that larger farmland sizes can negatively impacts income due to inefficiencies and higher management cost. Additionally, Cohn et al., (2020) highlighted that the adoption of new techniques may lead to an initial reduction in income before benefits are realized, which aligns with findings of this study. It was however concluded that age of farmers, years of farming experience, farmer's knowledge of climate change, size of farmland and adoption of new farming were the major variables influencing farmers income in the study area.

5. Conclusions

Agroforestry is an effective strategy for climate change adaptation and contributes positively to farmers' income in Lagelu Local Government Area, Oyo State, Nigeria. Farming in the area is predominantly male dominated, with an aging population operating smallholding primarily cultivating staple crops. Farmers' years of experience, knowledge of climate change, and age were found to positively influence income, while larger farm sizes and initial adoption of new techniques sometimes reduced earnings due to higher costs or inefficiencies. Despite high awareness of climate change, limited access to extension services constrains the effective adoption of agroforestry and climate-smart practices. Overall, agroforestry holds substantial potential for improving livelihoods and building climate resilience among smallholder farmers in the study area.

Recommendations

Strengthen agricultural extension services to provide continuous, practical guidance on agroforestry and climate change adaptation. Implement targeted training programs for younger and female farmers to enhance adoption of climate-smart practices. Facilitate access to credit, farm inputs, and modern technologies through cooperative societies and microfinance initiatives. Encourage gradual adoption of new farming techniques with adequate technical support to minimize initial income losses. Promote crop diversification to reduce vulnerability to climate-related shocks and enhance household resilience. Provide technical guidance on efficient land management to optimize small farmland for agroforestry income. Leverage experienced farmers as mentors to support knowledge transfer and adoption of best practices.

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