ECONOMIC VALUE OF SMALL-HOLDER AGROFORESTRY FARMING FOR ENVIRONMENTAL SUSTAINABILITY IN THE MAKURDI LOCAL GOVERNMENT AREA OF BENUE STATE, NIGERIA

*Nnama, U. C., Iroha, G. A., William, O.
Department of Agricultural Economics, Joseph Sarwuan Tarka University (formerly, Federal University of Agriculture), Makurdi, Benue State, Nigeria.
Corresponding author's email: *ugonnama@gmail.com

ABSTRACT

This study assessed the economic value of agroforestry in enhancing environmental sustainability in Makurdi Local Government Area, Benue State, Nigeria. A survey research design was employed, with data collected from 150 farmers using a well-structured questionnaire administered across five council wards through simple random sampling. Descriptive statistics, independent t-tests, and multiple linear regression were used for data analysis. The findings revealed that agroforestry practitioners had a significantly higher mean annual net farm income (₦270,000) compared to conventional farmers (₦90,000), representing a 200% increase. Agroforestry systems contributed significantly more to environmental sustainability, with mean perception scores of 4.52 for soil fertility improvement ($t = 6.85$, $p = 0.000$), 4.61 for erosion control ($t = 7.60$, $p = 0.000$), 4.25 for water retention capacity ($t = 5.25$, $p = 0.000$), and 4.38 for biodiversity enhancement ($t = 8.11$, $p = 0.000$) compared to conventional farming. Major barriers to adoption included lack of knowledge/training (mean score 4.68), lack of initial capital/credit (4.45), and long gestation periods of trees (4.25). Regression analysis revealed that awareness of support policies ($\beta=0.391$, $p=0.000$), access to credit facilities ($\beta=0.325$, $p=0.000$), and access to extension services ($\beta=0.288$, $p=0.000$) were significant predictors of farmers' willingness to adopt agroforestry, with the model explaining 66% of the variance ($R^2 = 0.68$, Adj $R^2 = 0.66$, $F = 29.12$, $p = 0.000$). The study concludes that agroforestry offers a viable pathway to enhance farmers' livelihoods and promote environmental sustainability in Makurdi, and recommends that policymakers prioritize farmer education and training, facilitate access to credit and seedlings, strengthen agricultural extension services, and develop clear policy frameworks to promote the widespread adoption of agroforestry practices.

Keywords: Agroforestry, Economic Value, Environmental Sustainability, Barriers to Adoption, Policy Frameworks, Makurdi LGA

INTRODUCTION

Agroforestry, according to Sahoo, Roul, and Dash (2024), is a contemporary agricultural practice that involves cultivating tree crops, farming in and near forests, raising cattle, and managing forest lands of various sizes. Trees, crops, and occasionally livestock are combined in these systems in various ways, either geographically or sequentially over time (Schroth et al., 2020). Soil conservation is one of the main benefits that proponents of agroforestry emphasize. Adding trees to agricultural systems can improve soil health and long-term fertility by influencing important biophysical and biochemical processes (Sharma et al, 2026). As a sustainable land-use technique, agroforestry has attracted considerable interest because it offers a multifaceted approach to increasing productivity while addressing environmental issues, including soil erosion, biodiversity loss, and climate change (Nair et al., 2022).

Agroforestry systems can enhance soil health, retain more water, and create habitats for a variety of species by fostering a diversified ecosystem, all of which contribute to environmental sustainability (Kumar and Nair, 2020).
The economic potential of agroforestry as a strategy to accomplish the Sustainable Development Goals (SDGs) has been emphasized in recent studies. Agroforestry has the potential to improve lives and food security, especially in rural regions where traditional farming methods predominate, according to the Food and Agriculture Organization (FAO, 2022). Additionally, agroforestry can significantly contribute to carbon sequestration, hence reducing the negative consequences of climate change (Sanchez et al., 2021). The economic assessment of agroforestry becomes essential for developing policies and making investment decisions as countries work to comply with international environmental agreements. Nigeria is a strong option for agroforestry techniques that might improve environmental sustainability while offering financial advantages because of its abundant land resources and varied vegetation. Incorporating trees into agricultural systems enhances soil fertility and water retention while also helping to mitigate climate change and conserve biodiversity (Adekunle, 2020).

Despite the acknowledged advantages of agroforestry, a number of obstacles prevent it from being widely used in many areas. There is a dearth of information regarding the financial benefits of agroforestry systems in comparison to traditional farming practices, and farmers are frequently unaware of these benefits (Mbow et al., 2019). Furthermore, farmers used to monoculture systems can be discouraged by the intricacy of agroforestry techniques (Schroth et al., 2020). Agroforestry's economic worth is frequently underestimated, which results in insufficient backing from financial institutions and policymakers. Stakeholders could ignore agroforestry as a workable way to improve environmental sustainability if they do not fully comprehend its financial advantages (Zomer et al., 2022). In order to provide insights that could impact policy and encourage broader adoption of these techniques in the Makurdi Local Government Area of Benue State, Nigeria, this study attempts to evaluate the economic benefit of agroforestry in promoting environmental sustainability.

METHODOLOGY

Makurdi Local Government Area (LGA) is a prominent administrative division located in Benue State, Nigeria. It was created in 1976 as part of a nationwide reorganization of local governments in Nigeria. Makurdi LGA is situated at a latitude of 7.7302° N and a longitude of 8.5238° E, covering an area of approximately 1,240 square kilometers. According to the 2006 National Population Census, Makurdi LGA had a population of approximately 300,000 people, comprising various ethnic groups, with the Tiv people being the most prominent. The administrative headquarters is located in the city of Makurdi, which serves as the capital of Benue State. Makurdi LGA experiences a tropical savanna climate, characterized by distinct wet and dry seasons. The wet season typically spans from April to October, while the dry season occurs from November to March.

The average annual rainfall ranges from 1,200 to 1,500 millimeters, supporting the cultivation of various crops including maize, yams, cassava, and beans.

Farmers in Benue State's Makurdi Local Government Area made up the study's population. A total of 150 farmers were chosen at random from five council wards: Ankpa/Wadata Ward (40 farmers), Mbalagh Ward (30), North Bank Ward (25), Wailomayo Ward (25), and Agan Ward (30). The Taro-Yamane formula was used in the study to calculate the sample size:

$n = N / [1 + N(e)]^2]$

Where n = sample size, N = total population size, 1 = constant, and e = the assumed error margin taken as 5% (0.05). Given that N = 150:

$n = 150 / [1 + 150(0.05)]^2] = 150 / [1 + 150(0.0025)] = 150 / [1 + 0.3]$

$n = 150 / 1.3$, $n = 115$ (approximately)

Using the formula n_h = n(N_h)/N, proportional sampling was employed to divide the samples across the several council wards. This resulted in 150 responders, with sample sizes of 40 for Ankpa/Wadata Ward, 30 for Mbalagh Ward, 25 for North Bank Ward, 25 for Wailomayo Ward, and 30 for Agan Ward.

A well-structured questionnaire was used to gather primary data, and 150 respondents from five chosen council wards were given it using a straightforward random sampling procedure to reduce bias. The researcher and two study assistants distributed and retrieved the questionnaires throughout the course of six days, from Monday through Saturday. 95% of the distributed surveys were retrieved, which also guaranteed appropriate supervision and direction.

The research instrument was validated for reliability by the supervisor of this research and other experts in the Department of Agricultural Economics, Joseph Sarwuan Tarka University, Makurdi, to ascertain the appropriateness of the research instrument.

Multiple linear regression, independent t-tests, and descriptive statistics were used in the data analysis. To summarize the sociodemographic traits of respondents and pinpoint adoption hurdles, descriptive statistics such as frequencies, percentages, means, and standard deviations were employed. The economic benefits (total revenue, total cost of production, net farm income, and number of income sources) between agroforestry practitioners and conventional farmers were compared using independent t-tests. Additionally, differences in the two groups' perceptions of environmental sustainability were evaluated. The factors impacting farmers' willingness to adopt agroforestry were investigated using multiple linear regression analysis, with the following model specification:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Where Y = willingness to adopt agroforestry,

X_1 = awareness of support policies,

X_2 = access to credit facilities,

X_3 = access to extension services,

X_4 = education level,

X_5 = farming experience, and ε = error term.

RESULTS AND DISCUSSION

Socio-Demographic Characteristics of Respondents

The socioeconomic characteristics of respondents in the research area are summarized in Table 1. With a mean age of 45.8 years, the majority of Makurdi's farming population is middle-aged and male (61.3%). This implies a workforce that is physically capable of performing farming tasks. The respondents' statements about farming practices are credible because their average farming experience of 16.2 years suggests they are not beginners but rather possess extensive practical expertise. Since literacy makes it easier to comprehend technical knowledge, the majority (85.3%) have some formal education, which is a good sign for the possible acceptance of new agricultural advancements (Rogers, 2003).

Table 1: Socio-Demographic Profile of Respondents (n=150)

Variable	Category	Frequency	Percentage (%)	Mean
Gender	Male	92	61.3	-
	Female	58	38.7	-
Age (Years)	18-35	42	28.0	45.8
	36-50	78	52.0	
	51 and above	30	20.0	
Farming Experience	1-10 years	48	32.0	16.2
	11-20 years	68	45.3	
	21+ years	34	22.7	
Education Level	No Formal Education	22	14.7	-
	Primary	45	30.0	
	Secondary	60	40.0	
	Tertiary	23	15.3	

Source: Field survey, 2025.

Economic Benefits of Agroforestry vs. Conventional Farming

The findings in Table 2 offer solid factual proof that agroforestry is more profitable than conventional farming. All economic variables show a statistically significant difference ($p<0.05$) between the two groups according to the independent t-test. Compared to conventional farmers, who made total revenue of ₦315,000 ($t=5.92$, $p=0.001$), agroforestry practitioners made a mean total yearly revenue of ₦455,000. Additionally, the mean total cost of production for agroforestry farmers was much lower (₦185,000) than that of conventional farmers (₦225,000), with a t-value of -3.52 ($p=0.001$). The most notable result is that, with a highly significant t-value of 7.25 ($p=0.000$), the mean net income of agroforestry practitioners was ₦270,000, three times that of conventional farmers (₦90,000). Furthermore, with a t-value of 8.75 ($p=0.000$), agroforestry farmers had considerably more sources of income (mean of 3.4) than conventional farmers (mean of 1.1).

The economic value theory, which holds that integrating trees into farming systems yields both direct and indirect financial benefits, is consistent with this conclusion (Richard et al., 2019). Income diversification from the sale of fruits, timber, and medicinal plants is responsible for the greater revenue streams; this advantage has been repeatedly emphasized in the literature (Schroth et al., 2020; Zomer et al., 2022). According to Awoyemi and Aderinoye-Abdulwahab's 2019 study, adding trees to farming systems increased crop yields by improving soil fertility and moisture retention. Additionally, because trees improve soil fertility through natural nutrient cycling, the far lower production costs for agroforestry farmers highlight the cost-saving benefits of reduced reliance on external inputs such as chemical fertilizers (Nair, 2021). This is in line with Zomer et al. (2022), who noted that agroforestry techniques can reduce farmers' input costs by lowering the demand for chemical pesticides and fertilizers. In rural areas with limited economic opportunities, diversifying income streams through products such as timber, fruits, nuts, and medicinal plants is especially advantageous, as it reduces reliance on a single crop and increases resilience to market fluctuations and climate-related risks (Schroth et al., 2020).

Agroforestry's Contribution to Environmental Sustainability

The results in Table 3 demonstrate how agroforestry systems support sustainable environmental practices. Agroforestry farmers reported significantly higher mean scores ($p<0.05$) than traditional farmers on a 5-point Likert scale for each environmental indicator examined. Compared to traditional farmers (3.15), agroforestry farmers evaluated soil fertility enhancement higher (mean score of 4.52) ($t=6.85$, $p=0.000$). Soil erosion control was scored at 2.95 ($t=7.60$, $p=0.000$) by conventional farmers and at 4.61 by agroforestry farmers. Conventional farmers rated 3.28 for water retention capacity, while agroforestry farmers scored 4.25 ($t=5.25$, $p=0.000$) higher. The largest disparity was in the enhancement of biodiversity, with conventional farmers scoring 2.75 and agroforestry farmers 4.38 ($t=8.11$, $p=0.000$).

Table 3: Comparison of Economic Returns between Agroforestry and Conventional Farming Systems

Economic Indicator	Farming System	Mean (₦)	Std. Deviation	t-value	p-value
Total Annual Revenue	Agroforestry (n=75)	455,000	98,500	5.92	0.001*
	Conventional (n=75)	315,000	85,200		
Total Cost of Production	Agroforestry	185,000	42,000	-3.52	0.001*
	Conventional	225,000	55,000		
Net Farm Income	Agroforestry	270,000	68,000	7.25	0.000*
	Conventional	90,000	48,000		
Number of Income Sources	Agroforestry	3.4	1.2	8.75	0.000*
	Conventional	1.1	0.3		

*Significant at $p < 0.05$

Source: Field survey, 2025

This finding directly supports the agroecological concept, which encourages complex, diverse systems that mimic natural ecosystems (Sanchez et al., 2021). Agroforestry farmers receive high ratings for soil fertility and erosion management because trees provide organic matter through litterfall, improve soil structure through their roots, and limit soil exposure to wind and rain (Kumar & Nair, 2020). This supports the findings of Olorunfemi et al. (2020), who noted that agroforestry is well known for its ability to protect both human activities and environmental resources. The idea that trees increase infiltration and reduce surface runoff, creating microclimates that support crop growth, is supported by the increased water retention (Zomer et al., 2022). By providing vital habitats and ecological niches for a range of species, agroforestry systems improve the overall health of ecosystems, as evidenced by significant differences in biodiversity perceptions (Mbow et al., 2019). According to Sanchez et al. (2021), agroforestry is a sustainable land management technique that increases productivity, preserves ecological stability, and fosters sustainable environmental development. Combining several plant species can increase resistance to pests and diseases and reduce the need for chemical treatments (Olorunfemi et al., 2020). Mbow et al. (2019), who further claimed that agroforestry has been shown to meet the objectives of sustainable development without adverse environmental effects, corroborate this study's findings.

Barriers to Adoption of Agroforestry

The results in Table 4 show distinct and important obstacles to non-adopter farmers in the study area adopting agroforestry methods. The "Lack of Knowledge/Training on Agroforestry" barrier, with a mean score of 4.68 and closely related to the "Complexity" characteristic in Rogers' Diffusion of Innovations theory (2003), is the most severe. Farmers are reluctant to embrace something they do not comprehend. Economic limitations come next, with "Lack of Initial Capital/Credit" receiving a score of 4.45. This is a typical obstacle for farmers with little resources. Compared with annual crops, the "Long Gestation Period of Trees" ranked third with a mean score of 4.25, which reduces the perceived "Relative Advantage" of agroforestry in the short term. "Perceived Complexity of Management" scored 3.75, and "Land Tenure Insecurity" scored 3.90, both indicating substantial obstacles.

These results are consistent with research conducted in sub-Saharan Africa by Mbow et al. (2019) and Nair (2021), which found comparable socioeconomic and knowledge-based limitations. According to Mbow et al. (2019), farmers' lack of awareness and information about the advantages and management of agroforestry systems is a major obstacle. Low adoption rates are due to limited knowledge of the financial benefits of agroforestry systems and insufficient information on their financial returns relative to traditional agricultural practices (Mbow et al., 2019). Farmers used to monoculture systems may be discouraged by the intricacy of agroforestry techniques (Schroth et al., 2020). Other socioeconomic obstacles that impede the adoption of agroforestry practices include limited financial availability and land tenure concerns (Nair, 2021). For smallholder farmers who need quick returns on their investments to cover everyday household expenses, the lengthy gestation period of trees is a particularly significant obstacle. Because these obstacles are interrelated and reinforce one another, this study emphasizes the necessity of interventions that simultaneously address knowledge gaps and economic constraints.

Table 4: Ranking of Barriers to the Adoption of Agroforestry Practices (n=75 Non-Adopters)

Barrier	Mean Score	Standard Deviation	Rank
Lack of Knowledge/Training on Agroforestry	4.68	0.57	1st
Lack of Initial Capital/Credit	4.45	0.72	2nd
Long Gestation Period of Trees	4.25	0.88	3rd
Land Tenure Insecurity	3.90	1.10	4th
Perceived Complexity of Management	3.75	1.15	5th

|Source: Field survey, 2025

Policy Frameworks and Adoption of Agroforestry

The multiple regression analysis examining the variables influencing farmers' inclination to implement agroforestry is presented in Table 5. The regression model explains 66% of the variance in farmers' willingness to adopt agroforestry (Adjusted $R^2 = 0.66$) and is statistically significant (F-stat., p = 0.000). Awareness of Support Policies (β=0.391, p=0.000), Access to Credit Facilities (β=0.325, p=0.000), and Access to Extension Services (β=0.288, p=0.000) are the strongest drivers of willingness to adopt, according to the analysis. Farming Experience (β=0.085, p=0.159) was not statistically significant, while Education Level also had a substantial beneficial influence (β=0.148, p=0.022).

This result emphasizes the importance of institutional and governmental support in encouraging the implementation of agroforestry. It implies that financial incentives, information sharing, and technical assistance through extension agents are likely to be very successful policies (FAO, 2022). The significance of understanding support policies shows that merely having policies in place is not enough; farmers must actively receive information about these policies. This is consistent with Rogers' Diffusion of Innovations theory, which highlights the crucial role of communication channels in the adoption process (Rogers, 2003). The need for financial structures that reduce the initial investment burden of establishing agroforestry systems is underscored by the substantial impact of loan availability.

Given the lengthy gestation period of trees, which was noted as a significant obstacle in Table 4, this is especially important. As the main point of contact between research institutions and farmers, extension services play a crucial role in promoting adoption by converting technical information into useful, on-farm applications. The importance of developing human capital and the necessity of educational interventions that enhance farmers' literacy and numeracy skills are reinforced by the positive impact of education level. This is because these skills help farmers comprehend technical information and calculate economic returns (Rogers, 2003).

Table 5: Multiple Regression Analysis of Factors Influencing Willingness to Adopt Agroforestry

Independent Variable	Coefficient (β)	Std. Error	t-value	p-value
(Constant)	0.540	0.215	2.511	0.013
Awareness of Support Policies	0.391	0.082	4.768	0.000*
Access to Credit Facilities	0.325	0.076	4.276	0.000*
Access to Extension Services	0.288	0.071	4.056	0.000*
Education Level	0.148	0.064	2.313	0.022*
Farming Experience	0.085	0.060	1.417	0.159

$R^2 = 0.68$, Adjusted $R^2 = 0.66$, F-statistic = 29.12, p = 0.000* *significant at $p < 0.05$

Source: Field survey, 2025

CONCLUSION AND RECOMMENDATIONS

The study's results lead to the following conclusions:
The greater economic feasibility of agroforestry systems in Makurdi LGA was demonstrated by the significantly higher net farm income (₦270,000) attained by agroforestry practitioners compared to conventional farmers (₦90,000).

Across all assessed metrics, agroforestry systems had a significantly greater contribution to environmental sustainability. The gains in soil fertility (mean score 4.52), erosion control (4.61), water retention (4.25), and biodiversity conservation (4.38) were especially noteworthy.

Lack of knowledge and training (4.68), inadequate initial capital (4.45), and the lengthy wait time for trees to grow (4.25) were the main obstacles keeping farmers from implementing agroforestry; these three obstacles ranked highest among non-adopters.

Policy-driven factors such as awareness of support policies (β=0.391), availability to credit (β=0.325), and interaction with extension services (β=0.288) have a significant impact on farmers' desire to adopt agroforestry; the regression model explains 66% of the variance in adoption willingness.

The study unequivocally shows that agroforestry is an excellent land-use system in Makurdi LGA, providing a synergistic solution to environmental and economic problems and making it a viable approach for increasing farm incomes, fostering resilience, and conserving natural resources.

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

1. The government and policymakers should create and implement a clear national or state-level policy on agroforestry that includes all-encompassing incentives, including carbon credit programs, tax breaks for agroforestry products, and subsidies for tree seedlings. A strong awareness campaign should go hand in hand with this to ensure farmers are aware of available assistance policies and how to obtain them.

2. To highlight effective agroforestry models and lessen the sense of complexity, NGOs and Agricultural Development Agencies could set up farmer-to-farmer learning networks and demonstration plots. Structured training programs that address the knowledge gaps identified as the main obstacle to adoption should be added to these useful, hands-on demonstrations.

3. To provide collective access to loans, better inputs, and markets for a variety of agroforestry goods, financial institutions and the government must support the establishment of cooperatives and farmer groups. Create specialized agroforestry loan programs with flexible repayment terms that account for the long gestation period of trees.

4. In order to ensure that extension agents have the technical know-how to effectively advise farmers, agricultural extension services should be strengthened and expanded with specialized training on agroforestry practices. With a focus on the economic advantages and management techniques of various agroforestry systems, extension programs should incorporate agroforestry training into their standard curricula and mandates.

REFERENCES

Adekunle, V. A. J. (2020). Trends in forest reservation and biodiversity conservation in Nigeria. In E. Okoko, V. A. J. Adekunle, & S. A. Adeduntan (Eds.), *Environmental sustainability and conservation in Nigeria* (pp. 82–98). Environmental Conservation and Research Team, Federal University of Technology, Akure.

Awoyemi, A., & Aderinoye-Abdulwahab, F. (2019). Agroforestry practices and their impact on crop yields in Nigeria. *Journal of Sustainable Agriculture*, *34*(2), 145–159.

Food and Agriculture Organization. (2022). *The role of agroforestry in achieving sustainable development goals*. Food and Agriculture Organization. http://www.fao.org

Ingwe, R., Ushiel, M., Ojong, F. E., & Okeme, I. (2009). Pursuing sustainable development through agroforestry in Nigeria: Geodemographic and spatial analysis of agroforestry implementation in 36 states and capital territory. *Journal of Sustainable Development in Africa*, *11*, 101–133.

Kumar, A., & Nair, P. K. R. (2020). Agroforestry systems: Benefits and challenges. *Renewable Agriculture and Food Systems*, *35*(3), 267–277.

Nair, P. K. R., Kumar, B. M., & Nair, V. D. (2022). *An introduction to agroforestry: Four decades of scientific developments*. Springer.

Olorunfemi, F., Ogunleye, K., & Olaniyi, O. (2020). Agroforestry and environmental sustainability in Nigeria. *Journal of Environmental Management*, *45*(3), 234–248.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Sahoo, G., Roul, P. K., & Dash, A. C. (2024). Approaches and principles in agroforestry: A tool for land policy initiatives to improve soil health and mitigate climate change. In *Soil, water pollution and mitigation strategies: A spatial approach* (pp. 47–65). Springer Nature Switzerland.

Sanchez, P. A., Palm, C. A., & Rojas, C. (2021). Sustainable land use: Agroforestry systems in the tropics. *Agricultural Systems*, *190*, 103071. https://doi.org/10.1016/j.agsy.2021.103071

Schroth, G., Nair, P. K. R., & Kaimowitz, D. (2020). *Agroforestry and biodiversity conservation in tropical landscapes*. Island Press.

Sharma, P., Upadhyayb, L., Megha, B., Anas, M., Rastogi, M., & Painkra, D. S. (2026). A review on agroforestry practices for biodiversity restoration and ecosystem resilience. *Archives of Current Research International*, *26*, 312–331.

Zomer, R. J., Trabucco, A., & Bossio, D. A. (2022). Global agroforestry: A framework for assessing its potential in climate change mitigation. *Nature Sustainability*, *5*(3), 233–245.