Firewood Harvesting Practices and their Implications for Forest Sustainability and Rural Livelihoods in Owo Local Government Area, Ondo State

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DOI: https://doi.org/10.51244/IJRSI.2026.1308000067

Received: 22 August 2026; Accepted: 27 August 2026; Published: 03 September 2026

ABSTRACT

Across sub-Saharan Africa, rural households depend heavily on fuelwood, but in Nigeria, this reliance is intensified by rising oil prices, erratic electricity, rapid population growth, and inadequate rural energy infrastructure, collectively straining already vulnerable forests. This study examined fuelwood dynamics in Owo Local Government Area, Ondo State, using a structured survey of one hundred and twenty households to explore demographics, collection methods, livelihood roles, sustainability perceptions, and governance preferences. The results show a young, female-dominated workforce—60% were women and 76.7% were under twenty. Domestic cooking accounted for 63.3% of collection, with farmlands providing two-thirds of the wood. Although deadwood gathering (40%) and branch pruning (30%) were prevalent, 26.7% harvested live trees. Critically, 86.7% gathered without formal permission, and 60% viewed local regulations as absent or unenforced. While 76.7% recognized that excessive cutting degrades forests, only 30% practiced replanting. Scarcity is growing: 46.7% travel farther than five years ago, and 36.7% note declining availability. High costs (56.7%) and poor accessibility (40%) of alternatives hinder a shift away from firewood. Conclusively, fuelwood remains indispensable for rural livelihoods. Enhancing forest sustainability therefore demands stronger institutional governance and proactive community action to collectively regulate harvesting behaviours.

Keywords: Firewood harvesting, forest governance, rural livelihoods; sustainability, forest management

INTRODUCTION

Forests provide ecological, economic, and social benefits that reinforce rural livelihoods and global environmental stability. Beyond timber and non-timber products, they regulate climate, conserve biodiversity, protect watersheds, and sequester atmospheric carbon (Sheppard et al., 2020). Consequently, sustainable forest management has become a global priority, particularly in developing nations where population growth and resource dependence intensify pressure on forest ecosystems (FAO, 2022; IPCC, 2022).

Despite expanding modern energy infrastructure, biomass remains the dominant household fuel for roughly one-third of the world's population (Benti et al., 2021). In sub-Saharan Africa, firewood and charcoal continue to supply cooking and heating energy for billions, constrained by poverty, rapid demography, unreliable grid electricity, and the high cost of cleaner fuels (IEA, 2023). Nigeria is among Africa's largest fuelwood consumers; biomass energy remains the most affordable and accessible domestic fuel for millions of rural households (Benti et al., 2021). Unreliable power supply, rising liquefied petroleum gas prices, and limited rural energy infrastructure sustain this dependence, even as firewood consumption drives deforestation, forest degradation, greenhouse-gas emissions, and indoor air pollution (Yigezu & Jawo, 2021; Asefon & Adepoju, 2024; Fekadu et al, 2024).

The socio-economic role of firewood harvesting is double-edged. It secures household energy and generates supplementary income, particularly for women and youth, yet unregulated extraction reduces forest cover,

alters species composition, accelerates soil erosion, and diminishes carbon stocks (Ullah et al., 2021; Sintayehu Eshetu, 2025). Where harvesting outpaces natural regeneration, degradation can become irreversible, undermining both ecological integrity and the very livelihoods it supports (Fekadu et al, 2024).

Sustainable forest management seeks to balance resource use with ecological maintenance, biodiversity conservation, and socio-economic development (Sheppard et al., 2020). The FAO Sustainable Forest Management Toolbox (*SFM Toolbox | Food and Agriculture Organization of the United Nations*, 2026) emphasizes planning, legal compliance, post-harvest rehabilitation, and continuous monitoring. In practice, however, sustainable forest management in developing countries is frequently constrained by weak institutional capacity, inconsistent enforcement, limited environmental awareness, and energy poverty (Hassanzadeh et al, 2026). In Nigeria, although licensing systems and reforestation requirements exist, rural enforcement is often patchy, permitting informal extraction to continue largely unchecked (Akpan-Ebe, 2026).

Understanding who harvests firewood, how they harvest it, and how they perceive forest change is essential for designing interventions that are environmentally effective and socially equitable. Previous research indicates that gender, education, household size, and income shape biomass dependence and willingness to adopt sustainable practices (Arowolo et al, 2018; Lartey et al., 2025; Abba et al, 2026; Tsiboe et al., 2026). However, empirical evidence on the interplay between harvesting behavior, local perceptions of sustainability, and livelihood strategies remains sparse in south-western Nigeria, particularly at the community level where policies are ultimately implemented. This underscores the need for targeted research to inform effective policy development.

This study therefore assesses the socio-economic characteristics of firewood harvesters, examines prevailing harvesting practices, evaluates community awareness and perceptions of forest sustainability, investigates firewood's contribution to household livelihoods, and identifies policy measures capable of enhancing sustainable forest management in some communities of Owo Local Government, Ondo State, Nigeria. The findings are intended to inform evidence-based policymaking that balances household energy security with long-term forest conservation.

MATERIALS AND METHODS

Study Area

This study was conducted in Emure, Amurin, Upenme and Isuwada communities in Owo Local Government Area, Ondo State, Nigeria, where firewood harvesters concentrated. Owo is a community in Ondo state, Nigeria. They Yoruba speaking, and at the intersection of roads from Akure, Kabba, Benin City, and Siluko. Owo is situated around the halfway point between the towns of Ile Ife and Benin City. Owo Local Government Area in Ondo State, Nigeria, is located at approximately **7.1974° N, 5.5865° E** (or 7°11′46″ N, 5°35′11″ E) (Wikipedia, 2005). The area experiences a tropical climate with distinct rainy and dry seasons, and secondary forests, farmlands, fallow lands, and scattered woodlots dominate its vegetation. Rural livelihoods depend largely on farming, trading, artisanal activities, and the utilization of forest resources for domestic and commercial purposes.

Research Design and Sampling

The study used a cross-sectional survey design to examine firewood harvesting practices, socio-economic characteristics, awareness of forest sustainability, livelihood contributions, and policy preferences. Cross-sectional surveys are widely employed in forestry and environmental research because they provide reliable snapshots of respondent characteristics population, resource utilization patterns, and environmental perceptions at a specific point in time (Creswell & Creswell, 2018).

The target population comprised rural households engaged in firewood harvesting within the study area. A total of 120 respondents were selected through a purposive sampling technique. The respondents provided first-hand information on firewood harvesting practices, resource availability, sustainability perceptions, livelihood contributions, alternative energy use, and policy preferences within the study area.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI Volume XIII Issue VIII August 2026

Data Collection and Analysis

The study used primary data collected through a structured questionnaire. The instrument captured information that includes socio-economic characteristics, firewood harvesting practices, sources and methods, awareness and perceptions of forest sustainability, livelihood contributions, alternative energy use, and policy preferences. The questionnaire consisted mainly of closed-ended questions and was administered face-to-face to minimize non-response and improve the accuracy and completeness of the responses. Descriptive statistics such as frequencies and percentages, were employed to achieve the study's objectives. All analyses were carried on the Statistical Package for the Social Sciences (IBM SPSS) Version 27.0. The results were presented in tables and discussed using a combination of descriptive and narrative approaches

RESULTS AND DISCUSSION

Socio-economic Characteristics of Respondents

The results of the Socio-economic Characteristics of Respondents are presented in Table 1. From the results, women dominated the sample (60.0%), reflecting the central role of female household members in fuelwood procurement. The age distribution was strongly skewed toward youth: 76.7% were below 20 years, with smaller proportions aged 21–30 (6.7%), 31–40 (10.0%), and 41–50 (6.7%). Most respondents were single (83.3%), consistent with the youthful demographic, while 10.0% were married, 3.3% divorced, and 3.3% did not specify marital status.

Further, educational attainment was relatively high: 66.7% had completed secondary school and 30.0% tertiary education; only 3.3% lacked formal schooling. Households of four to six members were most common (60.0%), followed by seven to nine members (16.7%), one to three members (13.3%), and more than nine members (10.0%).

Occupational diversity was marked: trading (30.0%), civil service (23.3%), artisanal work (23.3%), farming (16.7%), and other activities (6.7%). Firewood harvesting thus supplements multiple livelihood strategies rather than serving as a primary occupation. Experience was generally limited: 53.3% had harvested for fewer than five years, 23.3% for five to ten years, 13.3% for more than fifteen years, and 3.3% for eleven to fifteen years; 6.7% did not indicate their experience.

Table 1 Socio-economic characteristics

Variables	Frequency	Percent
Gender		
Male	48	40
Female	72	60
Age		
<20	92	76.7
21-30	8	6.7
31-40	12	10
41-50	8	6.7
Marital status		
Single	100	83.3
Married	12	10
Divorced	4	3.3
No response	4	3.3
Educational level		
No formal education	4	3.3
Secondary	80	66.7

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI Volume XIII Issue VIII August 2026

Tertiary	36	30
Household size		
3-Jan	16	13.3
6-Apr	72	60
9-Jul	20	16.7
>9	12	10
Occupation		
Farming	20	16.7
Trading	36	30
Civil service	28	23.3
Artisan	28	23.3
Others	8	6.7
Years of experience		
<5 years	64	53.3
5-10 years	28	23.3
11-15 years	4	3.3
>15 years	16	13.3
No response	8	6.7

Source: Field survey, 2025

Firewood Harvesting Practices

The result of the firewood harvesting practices of respondents was presented in Table 2. The result revealed that domestic energy needs drove most harvesting (63.3%), with commercial sale (20.0%) and combined domestic-commercial use (16.7%) less common. Farmlands supplied the bulk of fuelwood (66.7%), followed by community forests (20.0%), plantation forests (10.0%), and natural forests (3.3%). Reliance on agricultural landscapes suggests that on-farm trees are a critical, yet potentially degrading, energy source.

Harvesting methods showed a mix of sustainability. Deadwood collection predominated (40.0%), with branch pruning at 30.0%. However, 26.7% cut live trees, and 3.3% uprooted stumps—practices that directly compromise stand regeneration. Cutlasses were the principal tool (73.3%), with axes and chainsaws each at 13.3%, underscoring the small-scale, labor-intensive nature of the activity. Frequency was predominantly weekly (63.3%), with monthly (20.0%), occasional (10.0%), and daily (6.7%) collection less common.

Governance emerged as a critical weakness. Only 13.3% obtained permission before harvesting; 86.7% collected without formal authorization. Moreover, 60.0% believed no local harvesting rules existed, while only 20.0% acknowledged their presence. Similarly, 60.0% perceived enforcement as absent, 30.0% considered it strong, and 10.0% weak.

Table 2 Firewood harvesting practice

Variables	Frequency	Percent
Purpose of firewood harvesting		
Household use	76	63.30
Commercial sales	24	20.00
Both	20	16.70
Source of firewood		
Natural forest	4	3.30
Plantation forest	12	10.00
Farmland	80	66.70

Community forest	24	20.00
Methods of harvesting		
Cutting live trees	32	26.70
Collecting dead	48	40.00
Pruning branches	36	30.00
Uprooting stumps	4	3.30
Tool used in firewood harvesting		
Cutlass	88	73.30
Axe	16	13.30
Chainsaw	16	13.30
Frequency of harvesting		
Daily	8	6.70
Weekly	76	63.30
Monthly	24	20.00
Occasionally	12	10.00
Harvesting permission		
Yes	16	13.30
No	104	86.70
Local rule in harvesting		
Yes	24	20.00
No	72	60.00
Maybe	24	20.00
Harvesting laws Enforcement		
Strongly enforced	36	30.00
Weakly enforced	12	10.00
Not enforced	72	60.00

Awareness and Perceptions of Forest Sustainability

The results for respondents' awareness and perceptions of forest sustainability are presented in Table 3. The result showed that environmental awareness was surprisingly high: 76.7% of respondents recognized that excessive firewood harvesting degrades forests (Table 3). However, this knowledge rarely converted to restorative action. Only 30.0% practiced tree planting after harvesting, as the remainder relied on natural regeneration or took no remedial steps.

When asked about observed environmental impacts, respondents most frequently cited soil erosion and wildlife loss—perceptions consistent with the ecological consequences of canopy removal and habitat fragmentation. Nearly half (46.7%) reported traveling longer distances to collect firewood than they had five years earlier, while 33.3% said distances had shortened and 20.0% detected no change.

Table 3. Awareness and perception of forest sustainability

Variables	Frequency	Percent
Aware of excessive harvesting		
Yes	92	76.70
No	28	23.30
Reduction in forest area over past 10 years		
Increased	60	50.00
Remained the same	24	20.00
Reduced slightly	28	23.30

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI Volume XIII Issue VIII August 2026

Not sure	8	6.70
What impacts have you observed		
Soil erosion	52	43.30
Loss of wildlife	52	43.30
Reduced rainfall	8	6.70
Longer distance to collect firewood	8	6.70
Practice tree planting after harvest		
Yes	36	30.00
No	84	70.00
Frequency of replanting trees		
Always	12	10.00
Sometimes	60	50.00
Rarely	48	40.00

Source: Field survey, 2025

Livelihood Contributions and Resource Trends

Table 4 shows the responses of the households according to the livelihood contributions and resource trend. About 40.0% of the respondents reported a moderate income contribution, 23.3% of the sample slightly agreed. At the extremes, 10.0% considered it a very high-income source, while 26.7% reported no income from fuelwood. Resource availability trends were mixed but troubling. While 30.0% perceived an increase in firewood availability and 33.3% saw no change, 36.7% reported a decrease. The plurality reporting decline, combined with longer collection distances, indicates that extraction in some areas is outpacing regeneration.

Despite these warning signs, 60.0% of respondents judged current harvesting practices to be sustainable, compared with 30.0% who considered them unsustainable and 10.0% who were uncertain. Alternative energy use remained limited. Gas was the most common substitute (60.0% of those using alternatives), followed by charcoal (30.0%) and kerosene (10.0%). However, adoption was constrained by high cost (56.7%) and limited availability (40.0%); only 3.3% cited cultural preference as the barrier. Economic and infrastructural obstacles, rather than tradition, therefore lock households into biomass dependence.

Table 3.4 Impact of firewood harvesting on livelihood and sustainability

Variables	**Frequency**	**percent**
Firewood harvest contribution to income		
Very highly	12	10.00
Moderately	48	40.00
Slightly	28	23.30
Not at all	32	26.70
Change in firewood availability over time.		
Increased	36	30.00
Decreased	44	36.70
Not changed	40	33.30
Change in distance compared to 5 years ago		
Shorter	40	33.30
Same	24	20.00
Longer	56	46.70
Do you think current harvesting practices are Sustainable		
Yes	72	60.00

No	36	30.00
Not sure	12	10.00
Alternative energy source		
Charcoal	36	30.00
Gas	72	60.00
Kerosene	12	10.00
Challenge in adopting alternate energy Source		
High cost	68	56.70
Lack of availability	48	40.00
cultural preference	4	3.30

Policy Preferences for Sustainable Forest Management

Table 3.5 presents the results of the Policy preferences for sustainable forest management by the respondents. From the results, capacity-building deficits were stark: 66.7% of respondents had never received training on sustainable forest management, while 30.0% had, and 3.3% were unsure. Attitudes toward regulation were divided. A slight majority (53.3%) did not support stricter harvesting rules, probably fearing restrictions on an essential livelihood and energy source; 46.7% favored stronger regulation.

When asked to identify measures that would improve forest sustainability, respondents distributed their preferences across government regulations (23.3%), community monitoring (23.3%), environmental education (23.3%), tree planting programs (20.0%), and promotion of alternative energy (10.0%).

Table 3.5Suggestions and policy measures

Variables	Frequency	Percent
Have you received training on SFM		
Yes	36	30.00
No	80	66.70
Not sure	4	3.30
Will you support strict regulation on firewood Harvesting		
Yes	56	46.70
No	64	53.30
Measure of forest sustainability		
Tree planting programs	24	20.00
Government regulations	28	23.30
Community monitoring	28	23.30
Alternative energy promotion	12	10.00
Environmental education	28	23.30

DISCUSSION

Gender, Age, and the Social Profile of Fuelwood Harvesting

The female predominance in firewood collection aligns with extensive literature on gendered energy burdens in sub-Saharan Africa (Dadzie et al, 2019; Njenga et al, 2021; Gakuhi et al, 2025). Women and girls typically shoulder responsibility for domestic biomass procurement, a role shaped by traditional division of labor that restricts their time for education, paid work, and rest. However, the result is contrary to the report of Anna et al, (2026), who reported more males involved in firewood collection. The youthful age profile—three-quarters under 20—indicates that fuelwood collection is physically demanding work delegated to the most non-disabled household members. Because the sample is small and geographically concentrated, these demographics should be read as characteristic of the surveyed community rather than nationally representative. Nevertheless, they

highlight a vulnerable labor force whose educational potential may be compromised by recurrent collection duties.

The relatively high educational attainment presents both opportunity and paradox. Secondary and tertiary education should, in theory, facilitate understanding of conservation messages and participation in community forestry. However, many educated respondents still failed to replant after harvesting. This disconnect suggests that conservation behavior depends on more than knowledge alone; it requires institutional support, accessible planting material, secure tenure, and economic incentives that make stewardship rational (Drescher & Warriner, 2022; Yu et al., 2025; Appau et al, 2026).

Harvesting Behavior and the Governance Vacuum

The fact that farmlands supply two-thirds of fuelwood is significant. It implies that agricultural landscapes function as de facto energy reserves, buffering natural forests from more severe exploitation. However, repeated harvesting of on-farm trees without replacement gradually depletes shade cover, fodder, and soil-stabilizing roots, eroding agroforestry benefits over time (Msalilwa et al, 2016; Bajigo & Abraham, 2017). The reliance on deadwood (40%) and pruning (30%) offers some ecological reprieve, but the fact that over one-quarter of harvesters cut live trees—and a small fraction uproot stumps—signals that destructive practices persist within the informal sector.

The most alarming finding is regulatory failure. With 86.7% harvesting without permission and 60% perceiving no effective rules or enforcement, firewood extraction operates in a near-governance vacuum. Weak institutional capacity, limited monitoring budgets, and the geographic dispersion of rural harvesters all conspire to render paper regulations irrelevant. Comparable studies across Nigeria have documented similar informalisation, where fuelwood flows through unlicensed channels from farm, forest, and fallow to household and market (Bulama et al., 2022; Ali et al, 2023). Without credible enforcement, sustainable harvesting guidelines remain aspirational.

The Knowledge-Behaviour Gap

That 76.7% of respondents associate excessive harvesting with forest degradation suggests that environmental education campaigns have achieved partial success. However, awareness has not translated into restorative practice: only 30% replant, and even fewer do so consistently. This knowledge-behavior gap is a well-documented phenomenon in conservation psychology (it widens when structural barriers—such as lack of seedlings, insecure land rights, or immediate livelihood pressure—outweigh pro-environmental intentions (Neaman, 2025; Okoye, 2025; Yang et al., 2025).

Local perceptions of environmental change further complicate the picture. Respondents readily identified soil erosion and wildlife loss as consequences of forest decline, and many noted longer collection distances. However, a majority still judged current practices sustainable. This apparent contradiction likely reflects a livelihood-centered definition of sustainability: as long as fuelwood remains obtainable (even if farther away), the system is perceived to function. Ecological sustainability—measured by stand density, regeneration rates, and biodiversity indices—is less evident to harvesters and therefore less noticeably relevant (Okoye, 2025). Policy narratives must bridge this perceptual divide by linking distant resource trends to immediate household risks, such as rising collection costs and declining agricultural productivity from eroded soils.

Energy Poverty and the Limits of Voluntary Conservation

The economic data reveal that firewood dependence is not primarily a cultural preference but a market failure. When 56.7% of respondents cite high cost and 40% cite poor availability as barriers to gas or kerosene adoption, the path to reduced biomass pressure runs through energy economics, not moral suasion alone (Ali et al, 2023; Anuruddha et al., 2025; Okoye, 2025). Nigeria's energy transition policies have often prioritized grid expansion and LPG promotion in urban centers, leaving rural households with prices and supply chains that exclude them. Without targeted subsidies, pay-as-you-go clean-cooking systems, or decentralized renewable energy, voluntary reduction in firewood use is unlikely at scale.

Firewood's modest but real income contribution—40% of respondents reported moderate financial benefit—further complicates substitution. For the poorest households, fuelwood is simultaneously a free energy input and a safety-net commodity. Removing it without replacing both the energy service and the cash flow risks deepening poverty. Interventions must therefore be energy-livelihood bundles: clean stoves or biogas digesters that reduce wood demand, alongside agroforestry or non-timber forest product enterprises that sustain rural incomes.

POLICY IMPLICATIONS AND LIMITATIONS

The policy preferences expressed by respondents—government regulation, community monitoring, and environmental education in roughly equal measure—support an integrated, multi-level governance approach. Top-down regulation alone will fail without local legitimacy; community-based monitoring alone will struggle without legal backing; and education alone will falter without material alternatives. Successful models elsewhere in West Africa combine participatory forest management with community woodlots, farmer-managed natural regeneration, and results-based conservation incentives (Girma et al., 2023; Chesire et al., 2025). Such packages merit piloting in southwestern Nigeria.

This study has clear limitations. The cross-sectional design captures a single moment, precluding causal inference about resource trends. The sample of thirty respondents, while sufficient for descriptive profiling, is too small to support statistical generalization or multivariate analysis. Selection focused on two rural communities, and findings may not transfer to other agro-ecological zones. Future research should expand the sample, incorporate control sites with stronger governance, and use longitudinal or quasi-experimental designs to evaluate intervention impacts. Despite these constraints, the study offers an empirically grounded snapshot of harvesting practices and perceptions that can inform both local management and larger-scale survey design.

CONCLUSION

Firewood harvesting in rural communities in Owo local government, Ondo State, Nigeria exemplifies a common developing-country dilemma: an essential livelihood and energy activity that, under current governance and market conditions, erodes the natural resource base it depends upon. Women and young people dominate an informal, largely unregulated activity that draws heavily on farmland trees, employs often destructive methods, and operates with minimal replanting. Awareness of environmental consequences is relatively high, but structural barriers—energy poverty, weak enforcement, and limited extension—prevent that awareness from translating into sustainable behavior.

Achieving sustainable forest management therefore requires simultaneous action on three fronts. First, forest governance must move beyond paper regulations to credible, community-supported enforcement that permits harvesting while protecting critical stands. Second, environmental education must be paired with practical incentives: accessible seedlings, secure tenure for planted trees, and perhaps payment for ecosystem services where feasible. Third, and perhaps most critically, the energy transition must reach rural households through affordable, reliable alternatives that respect their income constraints. Only by bundling conservation with energy security and livelihood support can policymakers hope to reduce pressure on Nigeria's remaining forest resources while honoring the needs of those who depend upon them most directly.

DECLARATIONS

Funding: we did not receive any external funding for this research.

Conflict of Interest: The authors declare no known financial or personal conflicts of interest.

Ethical Approval: Participation was voluntary. Respondents were informed of the study's purpose before the interview, and verbal informed consent was obtained from all participants. Confidentiality and anonymity were maintained throughout, and information was used solely for academic and research purposes.

Statement: The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request.

Acknowledgments: The authors thank all respondents for their time, as well as community leaders and field assistants who facilitated data collection. Special thanks to Dr. Johnson B. for his guidance in preparing the final draft.

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