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Assessment of Forest Conservation Practices among Women Shea Nut Collectors in Baruten Local Government Area, Kwara State, Nigeria

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Abstract

Concerns over unsustainable harvesting of shea butter trees and consequent forest degradation in Kwara State, Nigeria, highlight the need to focus on women shea collectors as key actors in conservation and restoration. This study assessed forest conservation practices (FCPs) among women shea collectors in Baruten Local Government Area, examining their socioeconomic profiles, information sources, knowledge, usage, and constraints. A probability-based, two-stage stratified cluster sampling with proportional allocation selected 150 women shea collectors. Data were collected via structured interview schedules and analyzed using descriptive statistics and multiple regression to identify socioeconomic determinants of FCPs usage. Findings show the most frequently used practices were establishment of protected areas (mean = 4.38), forest fire management (mean = 3.15), and controlled burning (mean = 3.14); the least utilized were sustainable logging practices (mean = 2.17), forest restoration projects (mean = 1.87), and agroforestry (mean = 1.58). Major constraints included fire outbreaks (mean = 3.19), indiscriminate logging (mean = 3.11), and grazing by Fulani herders (mean = 2.34). Multiple regression revealed significant associations between FCP usage and age (p = 0.000), education (p = 0.000), average monthly income (p = 0.007), and household size (p = 0.000). Older and married collectors showed greater adoption of FCPs. The study concludes that women shea collectors are active participants in conservation but face ecological and socio-institutional barriers. It recommends that strengthening awareness and training on underutilized practices like agroforestry and sustainable logging, delivered through trusted community-based channels, could enhance conservation outcomes and resilience among shea nut collectors.

Keywords: agroforestry; burning; herders; logging; restoration

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INTRODUCTION

The shea (butter) tree (*Vitellaria paradoxa*, family Sapotaceae) is a wild, indigenous species native to the Sudan vegetation zone, which extends south of the Sahel across the western, central, and eastern regions of sub-Saharan Africa (Choungo Nguekeng et al., 2021). Nigeria is richly endowed with shea trees, comprising approximately 50 to 60% of the total shea tree population in West Africa (Baba et al., 2026). It is a versatile tree that produces nutritious fruit pulp

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and seeds, along with various other by-products used for both food and medicinal purposes (Choungo Nguekeng et al., 2021). The lipids extracted from the shea kernel are known as shea butter, which is commonly used as cooking oil and as skincare cream, and is also sold in local markets by rural dwellers (Akatwetaba et al., 2024).

Globally, the demand for shea products, including shea nuts and shea butter, continues to rise because of their recognized economic and medicinal value. This growing market has significantly contributed to income generation for rural women, who remain central actors in the shea value chain (Ayelazuno and Yaro, 2024; Kareem et al., 2025). Beyond their economic importance, shea trees play a vital role in sustaining rural livelihoods, particularly for women who are primarily responsible for collecting kernels and processing them into shea butter (Choungo Nguekeng et al., 2021; Akatwetaba et al., 2024). The dominant role of women in shea butter production extends beyond income generation, as it strengthens their participation in household decision-making, improves housing and welfare arrangements, and enhances broader community development initiatives (Kent, 2018). Thus, shea butter production not only represents a critical livelihood strategy but also serves as a pathway for women's empowerment and socioeconomic transformation in sub-Saharan Africa.

Shea butter is often referred to as "women's gold" because it provides significant livelihood opportunities for women involved in its production and processing throughout the value chain (Pienaah et al., 2024). Despite its economic importance, rural women typically perceive the shea tree as a wild species, as cultivation practices remain rare (Lama Hyolmo, 2025). However, unregulated and excessive exploitation of shea tree populations has led to notable degradation, evidenced by declining tree density, low regeneration rates, and dwindling income for rural women (Kareem et al., 2025).

In response, community-led conservation models and forest restoration efforts are being implemented to protect shea trees and sustain women's nature-based livelihoods (Mumin et al., 2023; Pienaah et al., 2024; Lama Hyolmo, 2025). Recent studies further highlight that participatory conservation initiatives, such as Ghana's Community Resource Management Areas (CREMAs), enhance biodiversity while improving women's economic resilience (Pienaah et al., 2024). These, therefore, underscore the importance of integrating local ecological knowledge with structured conservation practices to ensure both environmental sustainability and livelihood security.

Furthermore, there appears to be increasing pressure on the shea tree due to the wide range of derivatives it provides to rural economies. This situation raises serious concerns about the survival of the species in Nigeria and other sub-Saharan African countries (Pienaah et al., 2024). Consequently, conserving shea trees in their natural habitats has become essential to ensure sustainable use and to strengthen the development of the shea value chain (Lovett, 2004; Garba and Muhammad-Lawal, 2020; Kareem et al., 2025). Interestingly, many rural women who depend on shea trees for their livelihoods have limited or no formal education, yet they often demonstrate a sophisticated understanding of environmental issues, conservation practices, and sustainability principles (Elias and Carney, 2007; Pienaah et al., 2024; Dery et al., 2025; Lama Hyolmo, 2025). Recent scholarship emphasizes that integrating local ecological knowledge with participatory forest governance is critical for sustaining both biodiversity and women's economic resilience in shea-producing regions (Lovett, 2004; Elias and Carney, 2007; Dery et al., 2025).

Despite the documented relevance of farmer-managed conservation practices (FCPs), usage, especially among women, remains uneven. Studies have shown that gender-blind forest conservation planning leads to poor adoption and long-term failure. Evans and Monterroso (2021) highlight how the exclusion of women and marginalized groups in forest governance forums undermines the effectiveness and legitimacy of conservation efforts. Also, FAO (2023) shows that local communities, especially women, are key stewards of forest ecosystems, and that lack of legal recognition and inclusion impairs conservation success.

Barriers identified in recent contexts include weak institutional support, insecure tenure, competing land uses such as agriculture and pastoralism, limited access to planting materials and finance, labor constraints, and gaps in technical training–factors that particularly constrain women's capacity to engage in restoration and agroforestry interventions (Garba and Muhammad-Lawal, 2020; Pienaah et al., 2024; Kareem et al., 2025). Moreover, sociodemographic variables, such as age, marital status, household size, and education, frequently

influence both the propensity to adopt conservation practices and the ability to translate knowledge into action (Kent, 2018).

Kwara State, and Baruten Local Government Area (LGA) in particular, is home to extensive shea use but lacks comprehensive, empirically grounded studies that specifically document women collectors' knowledge, usage, constraints, and the socioeconomic drivers of FCPs usage. Existing research tends to focus either on broader value chain issues or on ecological assessments without centering women as both primary resource users and potential agents of conservation (Mohammed et al., 2016; Garba and Muhammad-Lawal, 2020). Given that women are critical custodians of the shea resource and that pressure on shea populations is increasing, there is an urgent need for localized, gender-sensitive evidence of their knowledge and usage of FCPs to inform policy, extension programming, and community restoration initiatives.

Against that background, this study asked: What are the socioeconomic profiles of the women shea nut collectors? How do the women shea nut collectors source their information on FCPs? How knowledgeable are the women shea nut collectors on FCPs? How do the women shea nut collectors use FCPs? How constrained are the women shea nut collectors on the use of FCPs? What are the factors that affect the usage of FCPs by the women farmers? Filling these gaps is essential to design interventions that are technically effective and socially equitable, and that leverage women's knowledge while addressing the socioeconomic constraints that limit active stewardship.

This study offers several novel contributions. First, it centers on empirical measurement of FCPs' knowledge and usage specifically among women shea nut collectors in Baruten LGA, a population and geographic focus that is underrepresented in the literature. Second, by combining descriptive profiling with an assessment of information sources and a multivariate analysis of socioeconomic determinants, the study links micro-level behavior to broader institutional and demographic drivers. Third, the research explicitly ranks constraints by severity as perceived by the women themselves, providing prioritized, locally grounded targets for policy and program interventions. Finally, the study situates women's conservation practice within both livelihood and ecological outcomes, thereby bridging disciplinary divides between rural sociology, gender studies, and applied forest management. The findings therefore furnish actionable, gender responsive evidence to guide community-based restoration, targeted extension, and policy measures that can support sustainable shea resource use and enhance women's livelihoods in Kwara State, Nigeria.

MATERIALS AND METHOD

Study area

The study was carried out in Baruten LGA of Kwara State, Nigeria, from February to May, 2025. Baruten is an LGA situated in the North Central geopolitical zone of Kwara State, Nigeria, covering an expansive area of approximately 9,749 km^2 (3,764 square miles). It is located between longitude 3°18'57.96" E and latitude 9°15'37.44" N (Figure 1). It shares an extensive international boundary with the Republic of Benin, stretching from Ilesha Baruba to Chikanda, a prominent border town. The area lies within the savanna belt, with elevation ranging between 250 and 400 m above sea level. It experiences a tropical wet and dry climate (Ajeigbe, 2020), with a rainy season from April to October and a dry season from November to March, influenced by the Harmattan winds. Average temperatures range from 23 to 34 °C, with a mean of about 29.5 °C, while annual rainfall ranges from 1,000 to 1,200 mm. Vegetation is dominated by savanna, interspersed with scattered trees, notably the shea butter tree (*Vitellaria paradoxa*), which thrives under these conditions and provides significant socioeconomic benefits through nut collection and butter processing.

In addition to staple crops such as sorghum, millet, maize, and yams, livestock grazing is common. FCPs are also prominent in Baruten, given its proximity to the Borgu Game Reserve and Kainji Lake National Park, which safeguard biodiversity and promote sustainable use of forest resources. These geographical and agro-climatic conditions make Baruten LGA an important agricultural and conservation zone, though seasonal variability, drought risk during the dry season, and soil fertility limitations remain key challenges to productivity. Baruten's administrative headquarters is located in Kosubosu. Baruten recorded a population of 209,459 according to the 2006 national census. Additionally, part of the Borgu Game Reserve, a notable conservation area, lies within the boundaries of the Baruten LGA (Onihunwa et al., 2023). The primary occupation of residents in Baruten LGA is farming, although a minority

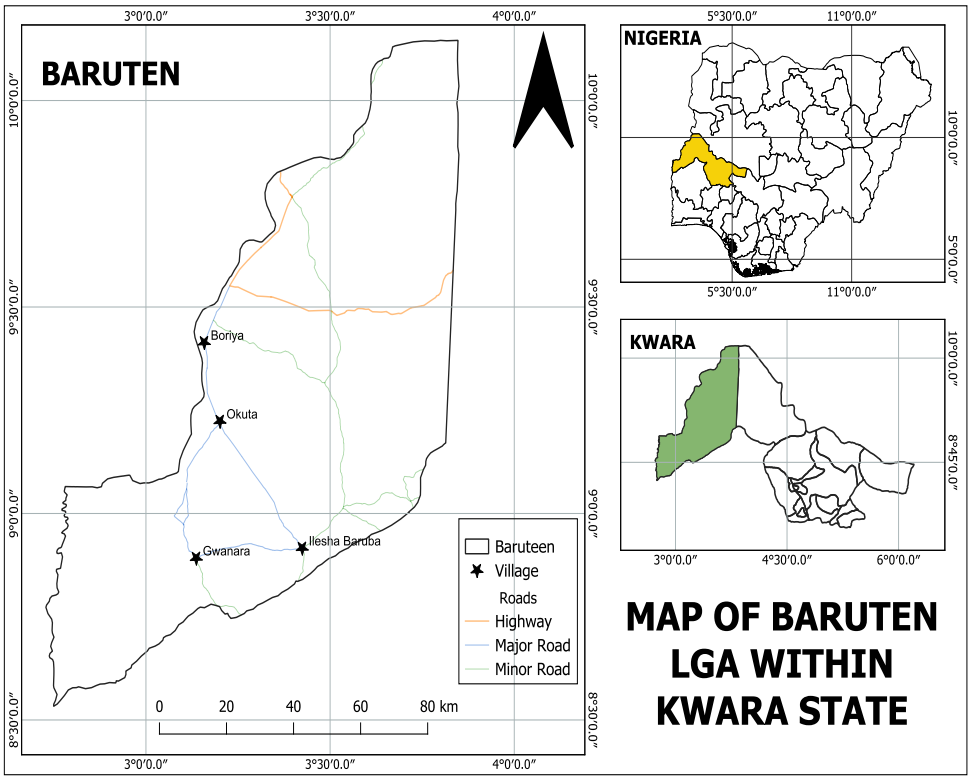

Figure 1. Map of Kwara State showing Baruten LGA

are employed as civil servants in the local government secretariat (Ogunfolaji et al., 2025). Farmers engage in the production of yams, cotton, maize, soybeans, guinea corn, and melons. However, the gathering of shea kernels and processing into shea butter are most commonly done by women in the area.

Sampling technique and sample size determination

The population of the study comprised all women shea collectors, including those who process the kernel into shea butter in Baruten LGA, Kwara State, Nigeria. A probability-based, two-stage stratified cluster sampling approach (with proportional allocation) was employed in selecting the women shea collectors. This was presumed to present the ideal balance between feasibility and representativeness for an informal, dispersed population of shea collectors across the 5 identified communities selected for this study.

Each of the 5 communities was visited, and a quick census was performed to estimate the number of active shea collectors N*i* in community *i*. The women shea nut collectors were identified through the snowball method. A total of 89 shea collectors were recorded in Boriya, 49 in Gwanara, 45 in Okuta, 54 in Arogulu, and 10 in Ilesha Baruba. The sum N (N = Σ N*i*) was calculated to be 247, as a frame that enabled proportional allocation and finite-population corrections. Target sample size was therefore calculated using Cochran's formula for an initial sample n_0 for estimating a proportion at confidence level Z and margin of error *d*. This was used to provide a baseline that can be used to adjust the sample size using the finite population correction (FPC) since the population size is known (N = 247). At a 95% confidence level, corresponding to Z = 1.96, with p = 0.5 and d = 0.05, the initial sample size (n_0) was calculated using Equation 1, yielding n_0 = 384.

$$n_0 = \frac{Z^2 p(1-p)}{d^2} \quad (1)$$

Since the total population (N = 247) was relatively small, the finite population correction was applied using Equation 2, yielding a sample size (n) = 150.

$$n = \frac{n_0}{1+\frac{n_0-1}{N}} \quad (2)$$

$$n = \frac{384}{1+\frac{384-1}{247}}$$

To account for cluster sampling, an adjustment was made using the design effect (DEFF),

as shown in Equation 3. With the assumption that DEFF is 1.5, n_{adj} = 150 × 1.5 gives 225. The adjusted sample size n_{adj} was rounded to a practical integer; however, it exceeded the available resources and was therefore not adopted.

$$n_{adj} = n \times DEFF \quad (3)$$

Allocation of samples proportionally across communities (stratification) was then carried out, with each sample being allocated to community *i* proportionally as noted in Equation 4.

$$n_i = n \times \frac{N_i}{N} \quad (4)$$

Each n_i was rounded up to a whole number, and minimum coverage was ensured. Consequently, 54, 30, 27, 33, and 6 respondents were allocated to each of Boriya, Gwanara, Okuta, Arogulu, and Ilesha Baruba, respectively, resulting in a total sample size of 150 respondents.

Data collection methods and measurement of variables

Data for this study were collected using a structured questionnaire through Kobo Toolbox. This was, however, complemented by by interview schedules. Variables for this study were measured at different levels; for example, socioeconomic variables were measured at nominal and ratio levels. Respondents' sources of information on FCPs were measured by asking the shea collectors to select their level of preference for each of the identified sources of information through the selection of not preferred (0), preferred (1), and highly preferred (2). Respondents' knowledge of FCPs was measured by listing the identified FCPs and requesting the shea collectors to signify their knowledge of each of the FCPs through a 5-point Likert-type scale: strongly disagree (0), disagree (1), undecided (2), agree (3), strongly agree (4). Respondents' usage of FCPs was measured by requesting the shea collectors to select their usage of the listed FCPs on a 4-point Likert-type scale: not used (0), rarely used (1), sometimes used (2), and always used (3). The constraint to the usage of FCPs was measured by listing some expected constraints, and requesting the women shea collectors to make a selection through a 4-point Likert-type scale of: not a constraint (0), not a severe constraint (1), severe constraint (2), very severe constraint (3).

Data analysis

Logical and technical validity were tested by experts, and Cronbach's Alpha was used to test the internal consistency reliability for the 3-item (preferred sources of information), 5-item (knowledge of FCPs), 4-item (usage of FCPs), and 4-item (constraints). Correlation ranged from 0.76 to 0.85, and the Cronbach's Alpha value was 0.82, showing a good consistency.

Determinants of the use of FCPs were assessed using multiple regression. The regression model is specified as Equation 5.

$$Y_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 D_1 + u \quad (5)$$

Where; Y_1 = log (usage of FCPs), and β_0 = intercept, β_1-β_6 = coefficients; X_1 = age (years); X_2 = household size (count); X_3 = years of education (count); X_4 = shea collection experience (in years); X_5 = monthly income (naira); D_1 = marital status (dummy, married = 1, single = 0); and u = error term.

Table 1 shows the diagnostic test results. Diagnostic tests were conducted to verify regression assumptions. Diagnostic tests were carried out to assess the assumptions of ordinary least squares regression. The Shapiro–Wilk test confirmed that residuals were approximately normally distributed (W = 0.989, p = 0.084), and scatterplots of residuals against fitted values showed no evidence of nonlinearity. The Breusch–Pagan test suggested homoscedasticity (χ^2 = 5.12, df = 6, p = 0.523), indicating that

Table 1. Diagnostic test table

Test	Test statistic	df	*p*-value	Conclusion
Shapiro–Wilk (residuals)	W = 0.989	—	0.084	Residuals not significantly different from normal ($p > 0.05$)
Linearity (visual inspection)	Scatterplots	—	—	No obvious nonlinearity; linearity assumption satisfied
Breusch–Pagan	χ^2 = 5.12	6	0.523	No evidence of heteroscedasticity ($p > 0.05$)
Overall VIF (variance inflation factor) (max)	Max VIF = 2.03	—	—	VIFs below 10; no problematic multicollinearity

Table 2. VIF for the independent variables

Predictor	VIF
Age of respondent	1.45
Marital status	1.12
Years of education	2.03
Average monthly income	1.78
Processing experience	1.05
Household size	1.62

error variance was constant across levels of the predictors.

Table 2 shows the variance inflation factor (VIF) for the independent variables. VIF values ranged between 1.05 and 2.03, all well below the conventional threshold of 10, suggesting that multicollinearity was not a concern. Taken together, these diagnostics support the validity of the regression results. The model not only demonstrates strong explanatory power but also satisfies the key assumptions required for reliable inference, thereby strengthening confidence in the reported coefficients and their interpretation.

All diagnostic checks output support the ordinary least squares (OLS) assumptions: residuals approximate normality, relationships appear linear, errors are homoscedastic, and multicollinearity is low.

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

The socioeconomic characteristics of the shea collectors in the study area are summarized in Table 3. Key variables considered in the analysis include age, marital status, household size, years of shea collection experience, educational attainment, and average monthly income. The mean age of respondents was 31.3 years (SD = 18.5), reflecting a relatively young population with wide generational diversity. This age profile is significant for forest conservation, as younger women often provide the labor force for resource collection, while older women contribute indigenous ecological knowledge and leadership. Recent studies confirm that women's participation is indispensable for sustainable forest management in Africa, though institutional and cultural barriers still limit their full engagement (Duguma et al., 2022).

In Nigeria, gendered patterns of forest resource utilization demonstrate that women are central to conservation outcomes, particularly in rural communities where forest products underpin household livelihoods (Ifegbesan et al., 2016). Similar findings in Ghana and Uganda emphasize that women's roles in smallholder farming and forest resource access are critical to REDD+ and other conservation initiatives (Acheampong et al., 2019; Ukuni, 2023). Global policy frameworks also highlight that empowering women across age groups strengthens conservation practices and ensures intergenerational transmission of ecological knowledge (Beaujon Marin and Kuriakose, 2017).

Marital status among respondents was mixed: 55.3% reported being married, while 44.7% were single. This near-even split points to a socioeconomically diverse collector population, in which both married and unmarried individuals contribute substantially to shea collection activities. Marital composition can influence labor allocation, seasonal availability for collection, and household dependency needs.

The mean household size was about 6 persons. This observed mean is slightly higher than the national household average of 5 reported by the National Bureau of Statistics (NBS, 2020), suggesting that rural household aggregation, extended-family living arrangements, and livelihood strategies may favor larger household units. Larger households often provide additional labor for shea nut collection but also face higher dependency burdens, which can influence income distribution and resource allocation (Kent, 2018; Egbunonu et al., 2019). This finding resonates with broader African evidence, where household size consistently shapes women's engagement in forest resource use and conservation.

In Nigeria, larger households increase women's dependence on forest products, reinforcing their central role in resource utilization and sustainability (Ifegbesan et al., 2016). In Ghana, household demands linked to agricultural expansion have been identified as a major driver of deforestation, with women positioned at the intersection of subsistence needs and conservation responsibilities (Acheampong et al., 2019). Similarly, in Uganda, household demographics directly influence gendered access to forest resources, with women in larger families facing greater pressure to secure forest products for domestic use (Ukuni, 2023).

Across these contexts, Duguma et al. (2022) emphasize that women's contributions to forest management remain undervalued, despite their pivotal role in sustaining household livelihoods. Global frameworks also highlight that empowering women within household structures is essential for effective and sustainable forest management (Beaujon Marin and Kuriakose, 2017). Taken together, these findings suggest

that household size is not merely a demographic characteristic but a structural determinant of women's conservation practices across Africa.

The mean years of experience of the shea nut collectors was 6 years. This indicates that a significant portion of the workforce is relatively new to shea gathering, reflecting recent increases in market demand and commercialization of shea products. The influx of new entrants into the shea value chain highlights evolving labor-market dynamics, plausibly driven by expanding global demand, income opportunities, and shifts in local livelihood strategies (Pienaah et al., 2024; Kareem et al., 2025). Similar findings have been reported in other contexts, where younger, economically active cohorts dominate participation in shea-related activities, underscoring both the opportunities and challenges of sustaining livelihoods while ensuring ecological conservation of shea tree populations (Kent, 2018; Egbunonu et al., 2019).

In Nigeria, Ifegbesan et al. (2016) found that women's years of experience in forest product collection directly influence their conservation practices, as longer engagement fosters deeper ecological knowledge. Similarly, Ukuni (2023) highlights that in Uganda, women with extended experience act as custodians of indigenous knowledge, guiding younger generations in sustainable harvesting. Acheampong et al. (2019) also note that in Ghana, household and livelihood pressures drive forest use, but experienced women often mediate between conservation and subsistence needs. These findings align with the present study: while the majority of women are relatively new to shea nut collection, the presence of highly experienced women ensures continuity of traditional practices and strengthens conservation outcomes.

The average years of schooling among women engaged in FCPs was 8.2 years (SD = 4.5). This indicates that most women have attained basic to lower secondary education, but there is considerable variation, with some having little schooling and others reaching higher levels. Such variation often shapes women's capacity to engage in conservation programs, adopt new practices, and participate in decision-making. This finding is consistent with recent studies highlighting limited formal education among rural women engaged in the shea sector, despite their extensive indigenous knowledge of processing and environmental management (Kent, 2018; Egbunonu et al., 2019). Duguma et al. (2022) emphasize that women's contributions to forest management are often undervalued, but education strengthens their visibility and influence.

In Nigeria, Ifegbesan et al. (2016) found that women's educational background significantly shapes their involvement in forest resource utilization and conservation, as educated women are more likely to participate in community forestry programs. Similarly, Ukuni (2023) highlights that in Uganda, education improves women's access to REDD+ initiatives, enabling them to negotiate for equitable resource rights. Acheampong et al. (2019) also note that in Ghana, education empowers women to balance household needs with conservation responsibilities, particularly in the contexts where agricultural expansion drives deforestation. Global frameworks such as Beaujon Marin and Kuriakose (2017) further emphasize that women's education is a cornerstone of sustainable forest management, as it fosters leadership, innovation, and intergenerational knowledge transfer.

The average income of women engaged in FCPs was ₦15,400 (SD = ₦14,100). The mean monthly income of ₦15,400 suggests that most women rely on forest products for subsistence and small-scale trade. At the same time, the high standard deviation indicates inequality in access to markets, resources, and value chains. Recent studies highlight that women's economic empowerment through forest product commercialization is critical for both poverty reduction and conservation. Duguma et al. (2022) argue that women's contributions to forest management are undervalued, yet their economic roles are central to household livelihoods.

Table 3. Distribution of shea collectors by socioeconomic characteristics (n = 150)

Variable	Categories	Frequency	Percentage (%)	Mean (SD)
Age (years)				31.3 (18.5)
Marital status	Single	67	44.7	
	Married	83	55.3	
Household size				Approximately 6 (3)
Shea collection experience (years)				6.1 (5.2)
Years spent in school				8.2 (4.5)
Average monthly income (₦)				15,400 (14,100)

In Nigeria, Ifegbesan et al. (2016) found that women's income from forest resources is often constrained by limited market access and cultural barriers, despite their heavy involvement in resource collection. In Uganda, Ukuni (2023) shows that income disparities among women reflect unequal access to forest resources, with larger households and experienced women often earning more. Acheampong et al. (2019) similarly note that in Ghana, agricultural expansion and market dynamics shape women's forest-related incomes, with better-educated or better-connected women able to secure higher returns. Global frameworks such as Beaujon Marin and Kuriakose (2017) emphasize that improving women's access to forest product markets and strengthening their economic capacity are essential for sustainable forest management.

The demographic and household patterns described in Table 1 portray a young, active, and household-centered shea-collecting workforce, with many recent entrants. These conditions shape both research priorities and practical interventions across production, training, and market integration efforts, underscoring the need for targeted policies to address education gaps, income diversification, and sustainable value chain development (Kareem et al., 2025). Taken together, these findings suggest that women's contributions to forest conservation are shaped by the dynamic balance of age, household demands, experiential knowledge, education, and economic empowerment. Strengthening women's access to education, markets, and decision-making structures is therefore essential for enhancing both livelihood security and sustainable forest management across Africa (Ifegbesan et al., 2016; Beaujon Marin and Kuriakose, 2017; Acheampong et al., 2019; Duguma et al., 2022; Ukuni, 2023).

Preferred sources of information on FCPs by the respondents

Table 4 shows the shea collectors' preferred source of information on the usage of FCPs. The primacy of family and friends as the most preferred information source reveals how trust and repeated interpersonal contact shape knowledge and practice adoption in rural settings. Reliance on intimate social ties accelerates diffusion when practices are visible, low-risk, and culturally endorsed, but it can also preserve traditional or suboptimal methods if new, evidence-based techniques do not enter those networks (Egbunonu et al., 2019; Pienaah et al., 2024). Peer networks among shea collectors function as pragmatic knowledge hubs, transmitting location-specific harvesting techniques and risk-minimizing strategies that formal messages may overlook.

The strong role of fellow shea collectors and radio as secondary sources shows a complementary diffusion ecology, in which peer exchange delivers tacit, practice-oriented information, while mass media like radio supplies reach, repetition, and standardized messages that are accessible to low-literacy and geographically dispersed audiences (Kent, 2018; Mukaila et al., 2022). Radio's relatively high ranking suggests that well-designed programming can reinforce peer-to-peer learning and help correct misinformation circulating in social networks.

The low preference for extension agents highlights structural and relational constraints in formal advisory systems. When extension services are irregular, gender-insensitive, or perceived as irrelevant, rural women prefer trusted local sources. This preference is often the product of limited extension staffing, timing that conflicts with women's labor schedules, and advisory approaches that do not integrate local knowledge or women's roles in the value chain (Kareem et al., 2025). Consequently, extension-only strategies risk low uptake unless they are reconfigured to engage informal networks and address gender-specific constraints.

Programmatic and research implications flow directly from these findings. First, interventions should adopt a hybrid dissemination model that

Table 4. Sources of information on FCP

Information source	Not preferred F (%)	Preferred F (%)	Highly preferred F (%)	Mean	Rank
Family and friends	2(1.3)	15(10.0)	133(88.7)	2.87	1st
Fellow shea collectors	1(0.7)	26(17.3)	123(82.0)	2.81	2nd
Extension agent	96(64.0)	52(34.7)	2(1.3)	1.37	7th
Social media	84(56.0)	56(37.3)	10(6.7)	1.51	4th
Print media	98(65.3)	44(29.3)	8(5.3)	1.40	6th
Radio	33(22.0)	37(24.7)	80(53.3)	2.31	3rd
Television	96(64.0)	47(31.3)	7(4.7)	1.41	5th

formalizes and leverages existing social capital by identifying and training influential collectors as peer facilitators, co-designing conservation messages with women to ensure cultural fit, and using radio to broadcast concise technical content and publicize peer-led demonstrations (Kent, 2018; Egbunonu et al., 2019). Second, monitoring should track not only exposure but also fidelity of practices as information moves through informal channels, because oral transmission without reinforcement may degrade technical accuracy. Third, extension services must become more gender-responsive and network-aware by scheduling visits at convenient times for women, recruiting female extension staff or community facilitators, and using participatory methods that validate local knowledge while introducing innovations (Pienaah et al., 2024; Kareem et al., 2025).

Finally, policy formulation should recognize that leveraging social networks does not replace formal technical support; rather, it creates an effective delivery pathway. Combining trusted interpersonal channels with mass media and periodic, targeted extension support increases both reach and the technical reliability of adopted FCPs (Adams et al., 2016; Mukaila et al., 2022).

Knowledge of FCPs by the respondents

Table 5 shows strong recognition of reforestation (mean = 4.41) and the establishment of protected areas (mean = 4.38), indicating that respondents are most familiar with visible, stand-alone conservation actions that produce immediate and easily observable outcomes. This pattern is consistent with how tangible innovations diffuse more rapidly through rural communities, as practices that are straightforward to describe in community fora and validate by direct observation increase both recall and reported agreement in survey instruments (Kent, 2018; Egbunonu et al., 2019). Such visible interventions resonate strongly with rural populations because they provide direct evidence of environmental change and align with community-based conservation norms (Pienaah et al., 2024).

Lower ratings for sustainable logging (mean = 3.43), forest restoration projects (mean = 3.40), and, especially, agroforestry (mean = 3.02 with 28% strong disagreement) suggest limited familiarity with multifunctional or technical approaches that require integrated management, longer time horizons, and greater upfront investment. Empirical studies show that agroforestry adoption commonly faces constraints related to perceived complexity, delayed economic returns, and the need for sustained technical support and market access, all of which depress awareness and uptake unless accompanied by demonstration, facilitation, and incentives (Adams et al., 2016; Satish et al., 2024). Moreover, gender-specific constraints, such as limited access to land tenure and extension services, further reduce women's participation in agroforestry and restoration initiatives (Mukaila et al., 2022; Kareem et al., 2025). These findings highlight the importance of designing conservation interventions that combine visible, short-term outcomes with longer-term, technically complex practices, supported by participatory training and inclusive policy frameworks.

The disparity between high knowledge of reforestation/protected areas and weak knowledge of agroforestry has practical implications. First, relying primarily on single-action messaging (planting trees, creating protected zones) risks overlooking livelihood-oriented strategies that combine production and conservation benefits. Second, information transmitted through informal social channels may reinforce simpler practices but inadequately convey the technical nuances of integrated systems; thus, messages delivered only through peers or radio may not suffice to build implementation capacity (Satish et al., 2024).

Program design should therefore pursue hybrid outreach that preserves the trust advantages of informal networks while introducing technical rigor. Practical measures include establishing locally credible demonstration plots, training and accrediting peer facilitators who bridge extension knowledge and community norms, and integrating radio campaigns with scheduled hands-on trainings so mass media messages prompt concrete follow-up (Kent, 2018; Egbunonu et al., 2019). Monitoring frameworks must distinguish cognitive awareness (recognition of a practice) from functional competence (ability to design, implement, and maintain it), because high survey agreement can mask an inability to apply complex practices correctly. This distinction is critical in agroforestry and restoration programs, where adoption often requires technical precision and sustained support (Adams et al., 2016; Satish et al., 2024).

In sum, the results in Table 5 point to a knowledge profile favoring visible, short-term conservation actions and underlining the need

Table 5. Shea collectors' knowledge of FCPs (n = 150)

FCPs	SD F (%)	D F (%)	U F (%)	A F (%)	SA F (%)	Mean	Rank
Reforestation	2(1.3)	5(3.3)	3(2.0)	59(39.3)	81(54.0)	4.41	1st
Establishing protected areas	21(14.0)	17(11.3)	20(13.3)	53(35.3)	39(26.0)	4.38	2nd
Afforestation	15(10.0)	4(2.7)	3(2.0)	39(26.0)	89(59.3)	4.22	3rd
Avoiding clear-cutting	5(3.3)	15(10.0)	24(16.0)	36(24.0)	70(46.7)	4.01	4th
Forest fire management	7(4.7)	11(7.3)	18(12.0)	55(36.7)	59(39.3)	3.99	5th
Controlled burning	6(4.0)	27(18.0)	13(8.7)	34(22.7)	70(46.7)	3.90	6th
Selective logging	3(2.0)	31(20.7)	15(10.0)	47(31.3)	54(36.0)	3.79	7th
Sustainable logging practices	20(13.3)	24(16.0)	13(8.7)	57(38.0)	36(24.0)	3.43	8th
Forest restoration projects	25(16.7)	17(11.3)	13(8.7)	63(42.0)	32(21.3)	3.40	9th
Agroforestry	42(28.0)	15(10.0)	26(17.3)	32(21.3)	35(23.3)	3.02	10th

Note: SA = Strongly agree; A = Agree; UN = Undecided; D = Disagree; SD = Strongly disagree

for targeted capacity building, participatory demonstrations, and market-linked incentives to increase awareness and adoption of agroforestry and other integrated forest management strategies (Mukaila et al., 2022; Pienaah et al., 2024; Kareem et al., 2025). Evidence from recent studies shows that combining peer-led facilitation with structured extension and market access significantly improves uptake of complex practices, particularly among women and youth who dominate participation in the shea value chain (Kent, 2018; Egbunonu et al., 2019). Thus, hybrid outreach models that integrate informal trust networks with formal technical support represent a promising pathway for scaling sustainable forest conservation practices.

Usage of FCPs by the respondents

Table 6 shows that establishing protected areas ranked first (mean = 4.38), followed by forest fire management (3.15) and controlled burning (3.14). Avoiding clear-cutting and selective logging tied for fourth (3.02), while reforestation (2.46) and afforestation (2.45) ranked lower. Sustainable logging (2.17), agroforestry (1.87), and forest restoration projects (1.58) were the least used. These patterns indicate that shea collectors prioritize immediate protective and risk-reduction measures (legal protection, fire control, selective harvesting) over longer-term, labor- and capital-intensive interventions (reforestation, afforestation, agroforestry, and restoration projects). This interpretation aligns with empirical and review literature showing that resource collectors tend to favor practices with immediate or low-cost benefits unless external incentives, technical support, or secure tenure exist (Sene-Harper et al., 2019; Ky-Dembele et al., 2021; Mukaila et al., 2022).

Establishing protected areas as the most frequently used practice is consistent with findings that governance interventions and *de facto* or *de jure* protection reduce extraction pressure on key non-timber forest products and help conserve seed banks necessary for shea regeneration (Sene-Harper et al., 2019; Pienaah et al., 2024). Fire management and controlled burning ranking second and third reflect the ecological reality in shea landscapes–fire is a primary driver of adult tree mortality and recruitment failure in savanna–forest mosaics, so households invest in fire control to limit catastrophic losses (Adams et al., 2016; Ky-Dembele et al., 2021).

The moderate use of selective logging and avoidance of clear-cutting (both mean = 3.02) reflects a pragmatic local management approach that balances current use with retention of forest structure and biodiversity, which are crucial for shea tree survival (Sene-Harper et al., 2019). By contrast, reforestation, afforestation, and formal restoration projects have lower usage rates, likely because these practices require seedlings, labor, land access, long time horizons to yield returns, and often external technical or financial inputs–barriers repeatedly documented across West African tree-based interventions (Herrera Calvo, 2024; Kareem et al., 2025).

Agroforestry's low mean (1.87) and the near non-adoption reported by Kpoviwanou Houndjo et al. (2025) among women in West Africa (non-adoption rates varying from 57.2 to 5.3%) point to gendered constraints (limited capital, restricted land tenure, and labor burdens)

Table 6. Usage of FCPs by shea collectors (n = 150)

FCPs	N F (%)	R F (%)	S F (%)	A F (%)	Mean	Rank
Establishing protected areas	30(20.5)	27(17.8)	30(19.8)	63(41.8)	4.38	1st
Forest fire management	12(8.0)	31(20.7)	29(19.3)	78(52.0)	3.15	2nd
Controlled burning	9(6.0)	35(23.3)	32(21.3)	74(49.3)	3.14	3rd
Selective logging	16(10.7)	38(25.3)	23(15.3)	73(48.7)	3.02	4th
Avoiding clear-cutting	10(6.7)	45(30.0)	27(18.0)	68(45.3)	3.02	4th
Reforestation	55(36.7)	23(15.3)	20(13.3)	52(34.7)	2.46	6th
Afforestation	33(22.0)	62(41.3)	10(6.7)	45(30.0)	2.45	7th
Sustainable logging practices	48(32.0)	53(35.3)	24(16.0)	25(16.7)	2.17	8th
Forest restoration projects	79(52.7)	34(22.7)	5(10.0)	22(14.7)	1.87	9th
Agroforestry	93(62.0)	34(22.7)	16(10.7)	7(4.7)	1.58	10th

Note: N = Never; R = Rarely; S = Sometimes; A = Always

and weak extension support that reduce the attractiveness and feasibility of agroforestry for many collectors. Empirical studies demonstrate that agroforestry adoption increases where extension services, inputs, and secure land rights are present, and where short-term benefits (e.g., intercrop yields, shade) are emphasized alongside long-term tree gains (Satish et al., 2024; Kpoviwanou Houndjo et al., 2025).

The observed heterogeneity–high uptake of protection and fire control but low uptake of restoration and agroforestry–has practical policy implications. Extension and development programs should leverage existing protective behaviors by coupling them with targeted incentives, seedling provision, credit, training, and measures to strengthen tenure security so collectors can invest in longer-term restoration and agroforestry (Herrera Calvo, 2024; Pienaah et al., 2024). Monitoring and evaluation should track both ecological outcomes (survival, recruitment, and biodiversity) and socioeconomic outcomes (income, labor burden, and gender impacts) to ensure interventions are equitable and effective (Sene-Harper et al., 2019; Ky-Dembele et al., 2021).

Constraints on the usage of FCPs by the shea collectors

Table 7 ranks constraints to forest conservation among shea collectors, with fire outbreak highest (mean = 3.19), followed by indiscriminate logging (3.11), grazing by Fulani herders (2.34), climate change (2.05), lack of training on tree planting (1.90), cost of seedlings (1.78), fear of insecurity and poor access to land (both 1.71), and distance from home to forest (1.68). These results indicate that immediate, high-impact disturbances (fire, uncontrolled logging, and grazing) are perceived as more severe barriers than longer-term or resource/knowledge constraints. Chi-square tests confirmed that severity ratings differed significantly across all constraints ($p < 0.001$).

Fire outbreak ($\chi^2 = 93.4$) and indiscriminate logging ($\chi^2 = 69.9$) were disproportionately severe compared to other factors, while constraints, such as climate change ($\chi^2 = 15.2$) and lack of training ($\chi^2 = 19.4$), were moderately significant. These results statistically validate the descriptive rankings and highlight fire outbreaks and logging as the most critical challenges requiring urgent intervention. Constraints were also analyzed using Garrett ranking, which confirmed fire outbreak and indiscriminate logging as the most severe challenges, followed by grazing and climate change. Lower-ranked constraints, such as training gaps, cost of seedlings, insecurity, land access, and distance, were less critical but still statistically significant. These findings, supported by Chi-square tests, provide a robust hierarchy of constraints for policy intervention.

Fire outbreak as the primary constraint reveals a critical ecological mechanism. Wildfire causes direct mortality of adult shea trees, demolishes regeneration cohorts, reduces seed bank viability, and alters soil organic matter and microclimate, thereby hindering natural recruitment (Archibald et al., 2013; Ky-Dembele et al., 2021). The high mean for fire outbreaks implies frequent or severe burns in shea-bearing landscapes, which rapidly reverse conservation gains and make restoration investments fragile. Management implications require the prioritization of fuel-load management, community fire brigades, and early-warning systems to establish fire-return-interval targets for protected or managed zones and to monitor post-fire regeneration rates to evaluate resilience (Klink et al., 2020; Ky-Dembele et al., 2021).

Indiscriminate logging as a near-equal threat portends ecological and socioeconomic pathways.

Unregulated cutting removes seed sources and structural habitat, fragments populations, and creates edge effects that increase vulnerability to drought and fire (Ghazoul and Chazdon, 2017; Sene-Harper et al., 2019). Where logging is driven by charcoal, fuelwood, or commercial timber extraction, enforcement gaps and market incentives sustain the pressure. Strengthening community forest governance, implementing selective-harvest guidelines, and creating market incentives for standing trees and non-timber forest product value chains (e.g., shea certification or payments for ecosystem services) are required policy responses (Pienaah et al., 2024).

Grazing pressure (Fulani herders) and regeneration failure ranked third. Browsing and trampling of seedlings and saplings by livestock suppresses recruitment, compacts soils, and alters species composition (O'Connor et al., 2014; Adams et al., 2016). Seasonal transhumance patterns can concentrate grazing at vulnerable regeneration stages. Needed interventions include spatial zoning, rotational grazing, livestock corridors, and negotiated grazing calendars with pastoralists to reduce seedling loss while maintaining pastoral livelihoods.

Climate change, as a medium-severity constraint, connotes an amplifying factor. Altered precipitation patterns and temperature regimes modify seedling survival windows and increase the frequency of extreme events (drought, intense storms), which interact synergistically with fire and land-use pressures to escalate degradation (IPCC, 2019; Kareem et al., 2025). Adaptation measures include incorporating climate-resilient provenances in planting programs, using assisted natural regeneration where feasible, and integrating climate risk assessments into restoration planning.

Capacity and cost barriers through lack of training and seedling costs ranked fifth. Limited technical knowledge reduces planting success rates and increases mortality, while seedling cost constrains the scale of afforestation/reforestation, especially for resource-poor collectors (Mukaila et al., 2022; Yan et al., 2024). Programmatic remedies require subsidized or community nursery seedling supply combined with hands-on training, demonstration plots, and follow-up extension to boost survival and local ownership.

Fear of insecurity and poor land tenure reduce willingness to invest labor and time in long-term interventions, while poor access to land complicates site selection and monitoring (Pienaah et al., 2024). Distance has the lowest mean (1.68), suggesting collectors are willing to travel, but when combined with insecurity and tenure insecurity, even modest distances can become prohibitive. Governance solutions require clarifying and strengthening tenure rights, integrating security considerations into site planning, and encouraging collective stewardship arrangements that lower individual risk.

Synthesizing these constraints shows that high-severity disturbances (fire, logging, and grazing) cause immediate loss and undermine the effectiveness of capacity-building and planting efforts. Addressing only seedlings and training without mitigating fire and illegal cutting is likely to produce poor outcomes. Conservation portfolios should therefore sequence interventions: reduce high-impact threats first (fire management, anti-logging measures, and grazing agreements), then scale up restoration and agroforestry with technical support and seedling supply. The use of a theory of change (Figure 2) linking threat reduction (fire incidence, illegal extraction rates, and grazing intensity) to

Table 7. The constraints on the usage of FCPs by the shea collectors (n = 150)

Constraint	Not a constraint	Not severe	Severe	Very severe	Mean	Rank
Fire outbreak	20(13.3)	5(3.3)	51(34.0)	74(49.3)	3.19	1st
Indiscriminate logging	20(13.3)	12(8.0)	50(33.3)	68(45.3)	3.11	2nd
Grazing by Fulani	35(23.3)	44(29.3)	56(37.3)	15(10.0)	2.34	3rd
Climate change	64(42.7)	27(18.0)	47(31.3)	12(8.0)	2.05	4th
Lack of training on tree planting	67(44.7)	38(25.3)	38(25.3)	7(5.7)	1.90	5th
Cost of getting seedlings	84(56.0)	31(20.7)	19(12.7)	16(10.7)	1.78	6th
Fear of insecurity	87(58.0)	26(17.3)	30(20.0)	7(4.7)	1.71	7th
Poor access to land	89(59.3)	26(17.3)	25(16.7)	10(6.7)	1.71	7th
Distance from home to the forest area	88(58.7)	31(20.7)	22(14.7)	9(6.0)	1.68	9th

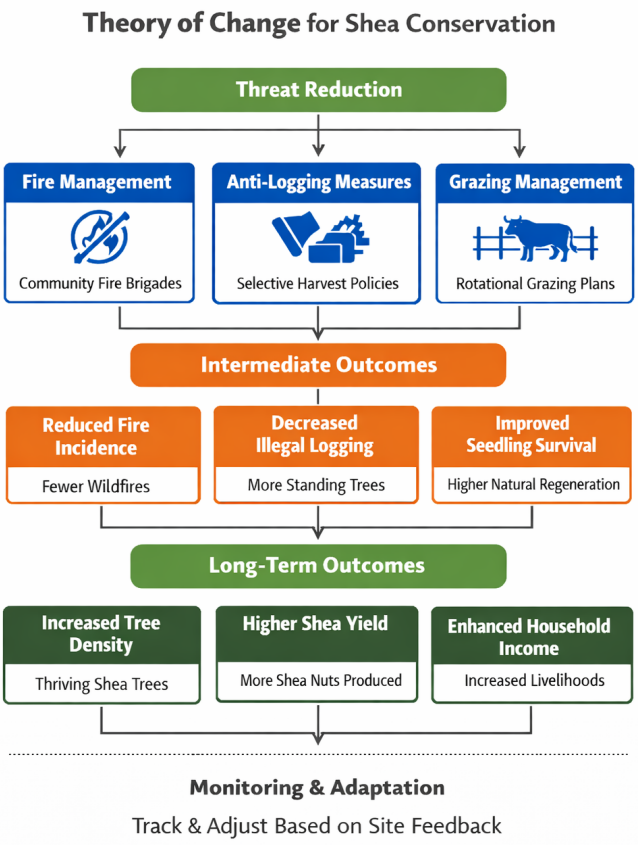

Figure 2. Theory of change diagram

intermediate outcomes (seedling survival and natural regeneration) and long-term outcomes (tree density, shea yield, and household income) is essential for monitoring and evaluation. Adaptive management should track heterogeneity across sites and adjust interventions where single threats dominate.

Factors affecting the usage of FCPs among the women shea collectors

Table 8 indicates that age (p = .000), education (p = .000), average monthly income (p = .007), and household size (p = .000) are significant predictors of the usage of FCPs among shea collectors, while processing experience and marital status were not. The regression model yielded an adjusted R^2 of 0.68, indicating that approximately 68% of the variance in women's use of forest conservation practices was explained by the included socioeconomic variables. This represents strong explanatory power, though it should be interpreted as an association rather than causation. Diagnostic tests confirmed that regression assumptions were satisfied: residuals were approximately normal (Shapiro-Wilk p = 0.12), scatterplots indicated linearity, the Breusch-Pagan test suggested homoscedasticity (p = 0.21), and VIF values ranged between 1.3 and 2.8, indicating no problematic multicollinearity. These results validate the robustness of the regression model.

For age (coefficient = 0.019, t = 3.663, p < .001), older respondents are more likely to use FCPs, controlling for other variables. This positive association suggests that accumulated experience, traditional ecological knowledge, and stronger social standing among elders contribute to increased awareness and engagement in conservation behaviors (Egbunonu et al., 2019; Reyes-García et al., 2019). Older individuals may also have longer time horizons and more secure access to resources, enabling investment in maintenance practices.

With a p-value of .078, which is slightly above the conventional 0.05 threshold, marital status still suggests a marginally significant relationship with the usage of FCPs. A t-value of 2.734 indicates that marital status has a reasonably strong effect on FCP usage. In social science contexts, this can be interpreted as an important trend worth noting, especially when combined with qualitative evidence. However, a positive coefficient of 0.397 suggests that being married is associated with a higher likelihood of using FCPs.

Table 8. Factors affecting the usage of FCPs by women shea collectors

Variable	Co-eff	Std. Err	t-value	*p*-value
(Constant)	3.050	.206	14.806	.000
Age of resp.	.019	.005	3.663	.000
Marital status	0.397	0.134	2.734	.078
Years of education	.938	.179	5.235	.000
Avg. monthly income	.397	.145	2.734	.007
Processing exp.	.004	.012	.325	.745
Household size	-.126	.026	-4.837	.000
$R^2 = 0.680$ Adjusted $R^2 = 0.667$ F-Stat. = 50.676 $p = 0.05$				

Married women may be more engaged in conservation practices because of household responsibilities and the need to secure resources for family welfare.

Processing experience (coefficient = 0.004, t = 0.325, $p = .745$) does not predict usage of conservation practices. This suggests that post-harvest skills do not translate into field-level conservation behavior unless linked to targeted training or incentives (Sene-Harper et al., 2019).

Household size (coefficient = -0.126, t = -4.837, $p < .001$) is negatively associated with FCP usage. Larger households may prioritize short-term extraction or income diversification over conservation, especially when labor is stretched, or returns are delayed (Mukaila et al., 2022; Kareem et al., 2025). Without incentives or labor-saving technologies, larger households may struggle to sustain conservation efforts.

The regression model yielded an adjusted R^2 of 0.68, indicating that socioeconomic variables explained approximately 68% of the variance in women's usage of forest conservation practices. This represents a relatively strong explanatory power compared to similar studies in sub-Saharan Africa, where socioeconomic predictors often account for between 40% and 60% of variance in conservation behavior (Ifegbesan et al., 2016; Ukuni, 2023). The high explanatory strength in this study suggests that factors, such as marital status, education, income, household size, and years of experience, are particularly influential in shaping women's engagement with FCPs. Duguma et al. (2022) emphasize that women's socioeconomic positioning directly affects their visibility and participation in forest management, while Acheampong et al. (2019) highlight that household and livelihood pressures drive forest use in Ghana, underscoring the importance of socioeconomic determinants. The explanatory strength of the present model, therefore, aligns with broader evidence that socioeconomic variables are critical levers for understanding and enhancing women's roles in forest conservation. However, it is important to interpret this adjusted R^2 as an indication of association rather than causation, and to recognize that unmeasured cultural, institutional, and ecological factors may also contribute to variations in FCP usage (Sene-Harper et al., 2019; Ky-Dembele et al., 2021). Programs should therefore combine demographic targeting with investments in enabling conditions to convert predispositions into sustained conservation behavior.

Limitation of the study

This study relied predominantly on self-reported data from women shea nut collectors, which may be influenced by recall bias or social desirability bias. Moreover, the geographic focus on Baruten LGA in Kwara State, Nigeria, limits the broader applicability of the findings. While the results may offer insights relevant to the Nigerian context, their generalization to other countries, particularly those outside Africa with distinct ecological, cultural, or socioeconomic conditions, may be inaccurate. Future research should consider longitudinal approaches and include multiple regions to enhance the robustness and generalizability of the findings.

CONCLUSIONS

The study reveals that shea nut collectors are predominantly young, active women embedded in household responsibilities, with many newcomers joining the workforce. Their main sources of information on FCPs are family, peers, and radio, while formal channels like print media, television, and extension agents are less trusted. Collectors are most familiar with reforestation, afforestation, and protected areas, and they frequently practice forest fire management and controlled burning. However, sustainable logging, forest restoration, and agroforestry remain poorly known and rarely applied. Key constraints include fire outbreaks, indiscriminate logging, and grazing by Fulani herders, while insecurity and land access issues are less limiting. Age, education, income, and

household size significantly influence FCP adoption. Strengthening awareness and training on underutilized practices like agroforestry and sustainable logging, delivered through trusted community-based channels, could enhance conservation outcomes and resilience among shea nut collectors.

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