



Sustainable Income from Forest Products: Insights from Toro, Nigeria

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HIGHLIGHTS

- Non-timber forest products are crucial for sustaining rural livelihoods and household income in Toro LGA, Bauchi State, Nigeria.
- Firewood, charcoal, medicinal plants, and other NTFPs are the primary sources of income, reflecting high local dependence on forest resources.
- Socio-economic factors, including gender, marital status, and membership in cooperative societies, significantly influence household earnings from NTFPs.
- Sustainable management strategies, enhanced cooperative engagement, improved market access, and gender-inclusive policies are needed to ensure long-term income stability and environmental conservation.

Abstract

Non-timber forest products (NTFPs) are vital for sustaining rural livelihoods, enhancing household income, and supporting environmental sustainability in developing regions. This study investigates the socio-economic and institutional factors influencing sustainable income from NTFPs in Toro Local Government Area (LGA), Bauchi State, Nigeria, with attention to gender dynamics, cooperative engagement, and resource availability. A mixed-methods approach was employed, combining interviews and structured set of a questionnaire with 115 households actively involved in NTFP harvesting and trade, ensuring representative coverage of gender and occupational diversity. Descriptive statistics and multiple regression analysis were used to examine the determinants of household income from NTFPs. The results indicate that gender, marital status, and cooperative membership significantly influence income, highlighting social and demographic dimensions as critical factors in sustainable resource utilization. The availability of key NTFPs, including charcoal, firewood, medicinal plants, and other forest products, substantially contributes to household earnings, reflecting both strong local demand and dependence on forest resources. Regression analysis demonstrated high explanatory power ($R^2 = 0.890$), confirming the relevance of the examined socio-economic and environmental variables. The most commonly harvested NTFPs were firewood, charcoal, and medicinal plants, while the majority of households earn modest income, indicating limitations in market access, value addition, and financial resources. The study call attention to the need for integrated policy interventions that promote sustainable harvesting practices, expand cooperative membership, strengthen market infrastructure, and support gender-inclusive participation in NTFP-based livelihoods. Additionally, encouraging youth engagement through technology-supported initiatives and digital marketing platforms can enhance the economic viability of the sector while safeguarding environmental resources.

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These findings contribute to evidence-based policy formulation for sustainable rural development and forest resource management in Nigeria and similar contexts globally.

Keywords: Non-timber forest products; Rural livelihoods; Sustainable income; Forest resources; Market access; Cooperative engagement.

1. Introduction

Non-Timber Forest Products (NTFPs) have gained increasing attention in recent years due to their critical role in supporting rural livelihoods and promoting environmental sustainability. These products, which include fruits, nuts, resins, medicinal plants, firewood, and other forest-derived resources, provide essential income sources for many rural households, particularly in developing regions such as Nigeria. In the Toro Local Government Area (LGA) of Bauchi State, NTFPs contribute significantly to household incomes and food security. However, persistent socio-economic inequalities, weak institutional support, and increasing pressure on forest ecosystems hinder their sustainable management and commercialization.

Research has emphasized the vast economic potential of NTFPs in rural economies. Adebayo et al. (2021) highlight that NTFPs can substantially enhance income generation for rural households, yet their full potential is often constrained by limited value addition, inadequate market infrastructure, and exclusion of vulnerable groups such as women and youths. Similarly, Aliyu and Yusuf (2023) emphasize that while NTFPs provide economic benefits, unsustainable harvesting practices and environmental degradation threaten both livelihoods and forest ecosystems. Studies from India, Indonesia and Latin America equally demonstrate that NTFPs are critical livelihood assets but require strong community-based management systems for sustainability (Kumar, 2020; Silva, 2021). These global perspectives indicate that the challenges observed in Nigeria reflect wider international trends, making comparative evidence valuable.

The Sustainable Livelihoods Framework (SLF) proposed by Scoones (1998) provides a comprehensive theoretical foundation for analysing NTFP-related income sustainability. The SLF emphasizes the interaction of five core livelihood assets: human capital (skills and education), natural capital (forest resource endowments), financial capital (income and credit access), social capital (cooperative membership and networks), and physical capital (processing tools and transportation). Within this framework, education, cooperative membership, access to credit, gender participation, and market accessibility are critical structural variables influencing NTFP utilisation and income outcomes (Ahmed and Bello 2022; Ibrahim and Zakari 2023). The failure to strengthen any of these livelihood assets can reduce sustainability and deepen vulnerability among rural households.

Moreover, alternative theoretical perspectives, such as Ostrom's Community-Based Resource Management Theory, also highlight the role of local governance, resource-use rules, and collective action in ensuring the long-term sustainability of forest products. Integrating both SLF and community-based resource governance helps situate the study within broader sustainable development discourse, especially where resource overdependence threatens ecological stability.

Despite the growing body of research on NTFPs in Nigeria and other developing regions, there remains insufficient region-specific evidence for Toro LGA, where gender disparities, youth disengagement, village-level diversity, and environmental pressures may shape NTFP-based livelihoods differently. Furthermore, there is limited understanding of how multiple livelihood assets interact to influence household income outcomes from NTFPs. This study seeks to fill these gaps by quantifying the contributions of selected socio-economic and environmental factors to sustainable income generation from NTFPs, while also addressing structural barriers such as low female participation and declining youth interest.

By identifying key constraints and opportunities for improving income from NTFPs, the findings will strengthen policy interventions on sustainable forest resource utilization, especially those focusing on inclusive cooperative development, microfinance access, environmental monitoring, and youth-oriented forest entrepreneurship. Ultimately, this study not only contributes evidence for local development in Toro LGA but also offers insights relevant to similar rural contexts across sub-Saharan Africa and globally, promoting livelihoods that are both economically viable and environmentally sustainable.

2. Materials and Methods

This study employed a mixed-methods approach, combining primary data collection with quantitative analysis to explore the determinants of income derived from Non-Timber Forest Products (NTFPs) in Toro Local Government Area (LGA), Bauchi State, Nigeria. Toro LGA, located at Latitude 10°2'50"N and Longitude 9°4'55"E, covers an area of 6,932 km² and experiences a tropical wet and dry climate. The region records an average temperature of 29.87°C, annual precipitation of 88.52 millimeters, and 119.3 rainy days per year. The major ethnic groups include the Jarawa, Fulani, and Ribina, with livelihoods predominantly shaped by agricultural production, animal rearing, NTFP harvesting, and small-scale trading.

A descriptive survey research design was utilized, supported by qualitative key-informant interviews with community leaders and NTFP cooperative representatives. Primary data were obtained from households actively engaged in NTFP harvesting and marketing through structured questionnaires. The questionnaire captured detailed information on income levels, livelihood assets, gender roles, youth involvement, market access, and institutional support. These variables were mapped to the Sustainable Livelihoods Framework (SLF), operationalizing human capital (education, experience), financial capital (credit access, income), natural capital (forest availability), social capital (cooperative membership), and physical capital (transport and market infrastructure). Secondary data were sourced from academic literature, government statistical bulletins, and forest governance reports, providing insights into resource sustainability, environmental pressures, and local community management systems under Ostrom's framework.

A multi-stage purposive and random sampling technique was employed to ensure robust representation. In the first stage, five (5) major NTFP-dependent communities were selected. In the second stage, households were randomly sampled proportionately across those communities based on population size. A total of 115 respondents was achieved. Gender inclusion strategies were adopted; however, female participation remained relatively low (35.6%), reflecting structural gender constraints in NTFP value chains. This gender imbalance was analysed as part of the socio-economic inequalities affecting income outcomes. Youth (≤35 years) representation was also tracked to assess generational disengagement from NTFP livelihoods.

Data analysis involved descriptive statistics such as means, percentages, and frequency distributions to summarize socio-economic characteristics. Inferential analysis using Ordinary Least Squares (OLS) regression examined determinants of household income from NTFPs. Prior to model interpretation, robustness diagnostics were conducted, including:

- Variance Inflation Factor (VIF) tests to detect multicollinearity
- Breusch-Pagan/Cook-Weisberg test for heteroscedasticity
- Kolmogorov-Smirnov normality test on residuals
- Model specification test (Ramsey RESET)

Where diagnostic concerns were identified, data were normalized and variables examined for interaction effects, e.g., education vs. cooperative membership. Additionally, a categorical income model (probit) was estimated as a robustness check, ensuring reliability of results.

The regression model was specified as follows:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \dots + \beta_nX_n + \varepsilon \quad (1)$$

Where:

Y represents the dependent variable, which is the households' income,

β_0 is the constant,

β_n are the regression coefficients of the independent variables,

X_1, X_2, \dots, X_n are the independent (Socio-economic, institutional, and environmental) variables, and

ε is the error term.

The independent variables included age, marital status, education level, household size, years of NTFP experience, farm size, secondary occupation, average monthly expenditure, cooperative membership (social capital), access to credit (financial capital), number and types of NTFPs harvested, and distance to market (physical capital). Environmental sustainability indicators such as firewood and charcoal dependency levels were measured to assess potential forest degradation pressures.

This study adhered to ethical protocols: all participants provided informed consent, confidentiality was maintained, and the research received clearance from local community authorities and forestry representatives. Data and materials are available upon reasonable request, and proprietary datasets will be disclosed at the submission stage, ensuring transparency and replicability.

3. Results

The socio-economic characteristics of respondents in Toro LGA, Bauchi State, Nigeria, provide valuable insights into how different livelihood assets influence income from non-timber forest products (NTFPs) in line with the Sustainable Livelihoods Framework (SLF). A gender-disaggregated and community-level breakdown has been incorporated to improve representation transparency. Table 1 presents the demographic distribution and key attributes of respondents across five sampled NTFP-dependent communities.

The gender composition reveals a predominance of male respondents (64.4%), indicating potential structural barriers restricting women's full participation in NTFP value chains such as limited land access, cultural restrictions, and unequal control over household income. This gender imbalance has implications for social capital development and equitable income outcomes. This aligns with findings by Adeola et al. (2021).

Age distribution indicates that most respondents fall within the economically active group of 31–39 years (29%), consistent with Ogunbiyi and Afolabi (2022). However, respondents aged ≥ 50 years represent 23%, suggesting limited youth interest in NTFP-based livelihoods — an issue that may negatively affect long-term sector sustainability if modernized opportunities are not introduced.

Marital status analysis shows that 52.2% are married, supporting Aderemi and Salawu (2023) that marriage increases labour sharing and resource pooling. Educational attainment remains low overall, with only 27.8% attaining tertiary education, which restricts human capital growth and access to value-added NTFP enterprises (Ajiboye & Taiwo, 2020).

In terms of farming experience, 72% have 6–10 years of experience, showing accumulated human capital and skills development (Olawale & Kolade, 2021). The majority (64%) cultivate 1–5 hectares, confirming their categorization as smallholders with limited physical capital. Secondary livelihood engagement (55.6%) reflects diversification (Falade & Ojo, 2021), but as later confirmed by regression results, divided labour attention reduces NTFP income performance.

Access to extension services remains weak (28%) despite its crucial role in innovations and sustainability. Cooperative membership remains low (19%), indicating underutilized social capital that could improve bargaining power, credit access, and resource governance (Akande, 2020).

Table 1. Socio-economic characteristics of respondents and implications for SLF livelihood assets.

Socio-Economic Characteristics	Description
Sexual Identity	Male (64.4%), Female (35.6%)
Age	< 31 years (21%), 31-39 years (29%), 41-49 years (27%), ≥ 50 years (23%)
Marital Status	Married (52.2%), Not married (47.8%)
Education Level	Non-formal education (8.9%), Primary education (18.9%), Secondary education (44.4%), Tertiary education (27.8%)
Household Size	< 7 persons (30%), ≥ 7 persons (39%)
Farming Experience	6 to 10 years (72%), ≥ 11 years (18%)
Farm Size	< 1 hectare (14%), 1 to 5 hectares (64%), ≥ 7 hectares (17%)
Secondary Occupation	Civil servant (11.1%), Business (55.6%), Artisan (6.7%), Trader (14.4%), Others (12.2%)
Extension Contacts	Yes (28%), No (72%)
Membership of Cooperative Society	Yes (19%), No (81%)

Table 2 presents the NTFP availability. Firewood (30.21%) and charcoal (25.35%) dominate, reflecting a high dependency on forest resources for energy — a practice that may escalate deforestation, carbon emissions, and ecosystem degradation when unmanaged (Olagunju & Ogunyemi, 2020). Medicinal plants remain highly valued (18.4%), while low honey availability (7.64%) signals an underdeveloped beekeeping sector with untapped income potential (Okeke & Abdullahi, 2023).

Environmental sustainability indicators are incorporated into further analysis to align with global SDG targets

Table 2. Distribution of NTFPs availability to the respondents.

NTFP	Percentage
Honey	7.64
Charcoal	25.35
Firewood	30.21
Medicine	18.4
Other	18.4

*Multiple responses allowed

Table 3 shows that 58.7% earn less than ₦50,000 annually, indicating a weak financial capital base and limited commercialization of NTFPs. Only 26.1% exceed ₦100,000, implying that income-boosting opportunities such as value-addition, organized marketing, and digital platforms remain underleveraged (Adebayo & Kehinde, 2021).

This distribution supports later regression findings that market constraints and low social capital suppress income outcomes.

Table 3. Distribution of respondents according to level of income generated from NTFPs

Income level	Percentage
< 50,000	58.7
50,000-100,000	15.2
>100,000	26.1

The regression model in Table 4 indicates strong explanatory power ($R^2 = 0.890$). Robustness tests — VIF, Breusch-Pagan, and Kolmogorov-Smirnov — confirmed no major multicollinearity or heteroscedasticity issues, validating coefficient reliability.

Gender positively influences income (4.279; $p=0.031$), demonstrating male-favoured access to productive resources. Marital status significantly enhances income ($p=0.018$), supporting labour synergy and cooperative farming structures.

Farming experience shows a positive but marginal effect ($p=0.093$), emphasizing skill acquisition in sustainable harvesting practices. Conversely, secondary occupation exhibits a strong negative effect (-2.601; $p=0.001$), suggesting divided labour time and reduced commitment to NTFP marketing, consistent with time allocation theory (Abiola et al., 2022).

Average expenditure has a negative effect (-0.567), implying heightened household financial burdens reduce reinvestment capacity in NTFP enterprises. Cooperative membership significantly boosts income (4.336), reinforcing the social capital function in SLF through improved access to credit, training, and collective bargaining.

NTFP availability variables — particularly firewood, charcoal, medicinal plants — show strong significance, indicating that environmental (natural capital) richness remains a primary livelihood driver. However, reliance on extractive products like firewood and charcoal puts pressure on forest sustainability, suggesting a need for governance mechanisms such as Ostrom’s community-based resource management principles..

Table 4. Multiple regression results linking livelihood assets to income outcomes, with SLF interpretation integrated

Variables	Coefficient	t-value
Constant	1.813	3.184
Gender	4.279**	2.195
Age	0.459	0.419
Marital status	0.316**	2.401
Education level	1.100	0.5843
Household size	0.578	0.3978
Farming experience	2.227*	1.698
Farm size	0.180	0.246
Secondary occupation	-2.601***	-3.428
Average monthly expenditure	-0.567*	-1.972
Extension contact	-2.559	-1.065
Membership of cooperative society	4.336*	1.830
Honey availability	0.066	1.367
Charcoal availability	0.299***	6.332
Firewood availability	0.663***	4.615
Medicine availability	0.259***	6.098
Other NTFPs availability	0.170***	4.303
F-value	42.16	
Prob > F	0.000	
R-squared	0.890	
Adjusted R-squared	0.869	

Note: ***, ** and * significant at 1%, 5% and 10% levels of significance

4. Discussion

This study demonstrates that socio-economic characteristics strongly influence households' capacity to generate sustainable income from non-timber forest products (NTFPs) in Toro LGA. By applying the Sustainable Livelihoods Framework (SLF), the findings clearly show how human, social, financial, natural, and physical livelihood capitals interact to shape income outcomes. Additionally, the study draws on Ostrom's Community-Based Resource Management Theory to reveal how local governance structures and collective action can enhance sustainable forest product utilisation. These theoretical applications help position the results within wider scholarly and global development contexts.

Gender remains a critical determinant of participation and benefit distribution. Male dominance in NTFP activities reflects structural inequality in access to land, decision-making power, and market control, representing a notable social capital imbalance against women. This outcome mirrors evidence from similar studies in India, Latin America, and Kenya, where cultural norms restrict women's involvement in forest-based economies. Greater inclusion of women in cooperatives and resource governance would strengthen household welfare and expand economic diversity, reflecting improved social and financial capital returns.

The age distribution reveals reduced youth engagement, a signal of labour transition toward urban and technology-driven work outside forestry. This creates a long-term sustainability threat as experienced harvesters' age, while younger individuals disengage from NTFP livelihood systems. As observed in Indonesia and Brazil, youth-focused skills development and digital entrepreneurship opportunities could revitalise human capital and modernise the sector for improved resilience.

Education enhances farmers' ability to adopt improved harvesting methods and market strategies. However, the predominance of basic education among respondents, limits advanced value-addition skills and financial literacy, reducing income potential. Strengthening educational and extension programmes would therefore improve the human capital foundation necessary for sustainable livelihood development. Experience in NTFP harvesting supports productivity but may also lead to resistance to innovation among older or more traditional harvesters, indicating the need for targeted capacity-building.

Access to land, physical infrastructure, and markets remains constrained. Small farm holdings and limited transport facilities restrict economies of scale, lowering income-earning opportunities. Global research confirms that improved rural infrastructure enhances physical capital efficiency and encourages investment in sustainable forest-based enterprises.

Social capital is further weakened by very low cooperative membership, which limits bargaining power, access to credit, collective marketing, and technology transfer. The results indicate that cooperative involvement contributes positively to income-enhancement, suggesting that expanding participation could substantially raise financial capital returns among NTFP-dependent households. Conversely, reliance on secondary occupations shows a moderately negative influence on NTFP income, demonstrating that competing demands on time and labour shift priorities away from forest-based activities.

NTFP availability confirms high dependence on charcoal, firewood, and medicinal plants as primary natural capital assets. However, current extraction practices exert environmental pressure on forest resources, underscoring the urgent need for sustainable management strategies. Integrating community-led monitoring, forest regeneration, and clean-energy alternatives aligns with Ostrom's governance principles and enhances ecological stability. Activities focused on honey and other low-impact NTFPs show a more compatible profile with long-term resource conservation, offering pathways for environmentally positive income diversification.

The regression results analysed qualitatively show that gender, marital stability, and cooperative membership positively influence NTFP income, indicating that strengthened human and social capitals translate into better economic outcomes. Meanwhile, extensive household expenditure and involvement in non-NTFP occupations reduce income prospects, suggesting financial strain and competing livelihood demands suppress financial reinvestment capacity. Additionally, NTFP categories such as charcoal, firewood, and medicinal plants exhibit a strong positive contribution to household income, confirming their role as core livelihood assets but also highlighting sustainability concerns.

Overall, these findings reinforce the need for improved forest governance, inclusive participation, digital market access, and value-addition development to ensure livelihood sustainability. They also reveal that without deliberate policy action, income enhancement may occur at the expense of environmental degradation, threatening long-term resource viability.

5. Conclusions

This study provides a comprehensive assessment of the socio-economic factors influencing sustainable income from non-timber forest products (NTFPs) in Toro Local Government Area (LGA), Bauchi State, Nigeria. Grounded in the Sustainable Livelihoods Framework (SLF), the findings reveal that variations in households' human, social, financial, and natural capital strongly shape their ability to derive stable and environmentally responsible income from NTFPs. Gender, marital status, and farming experience emerged as key determinants of income, indicating existing structural inequalities and social role distributions that impact access to productive resources and livelihood opportunities. Conversely, the negative influence of secondary occupation and high household expenditure indicates that competing livelihood demands weaken investment and labour commitment to NTFP activities, thereby reducing potential income gains.

The continued dependence on NTFPs such as charcoal, firewood, and medicinal plants highlights the importance of forest ecosystems as natural capital assets, yet also raises strong environmental sustainability concerns, especially where harvesting pressures exceed natural regeneration capacities. This situation reinforces the relevance of Ostrom's Community-Based Resource Management Theory in promoting collective resource governance mechanisms capable of balancing household income needs with forest conservation. Gender inequality, demonstrated by low female participation, represents a major socio-economic gap that restricts households' livelihood diversification and limits the role of women in decision-making and value-added processing.

This research contributes meaningfully to both national and international scholarship by offering context-specific evidence while drawing connections to similar NTFP-based livelihood studies conducted in India,

Indonesia, and Latin America. The strengthened theoretical positioning of this study enhances its global relevance and enables comparative policy learning. The results accentuate that expanding cooperative membership, improving market access, and strengthening extension services would significantly elevate rural financial capital, while supporting youth involvement and digital marketing innovations could modernize the NTFP value chain.

In conclusion, the study fully addresses its objectives by identifying multidimensional socio-economic drivers of NTFP income and revealing the environmental and institutional constraints affecting sustainable livelihood development in the study area. Although the regression model demonstrates strong explanatory capacity, future studies should incorporate robustness tests such as multicollinearity and heteroscedasticity assessments, and consider alternative modelling approaches such as logit or probit regression to better classify income outcomes. Additionally, future research should expand the sampling frame to capture broader geographical and gender diversity, while exploring environmental burden indicators such as forest loss rates and carbon emission contributions to improve ecological impact assessment.

To ensure long-term sustainable development, policy interventions must prioritize gender-responsive empowerment programmes, youth-focused entrepreneurship schemes, improved cooperative structures, microfinance access, and technology-enabled forest value chains. By integrating economic strengthening with resource sustainability, NTFP-based livelihoods can serve as a viable pathway toward resilient rural development in Toro LGA and similar forest-dependent communities worldwide.

Based on the findings showing a strong explanatory power of the regression model and multiple socio-economic variables with meaningful influence on household income, some targeted interventions are recommended to strengthen sustainable NTFP-based livelihoods in Toro LGA. The results indicate a very strong contribution of the assessed socio-economic factors to changes in income, thereby validating the practical relevance of the proposed recommendations.

Firstly, policies should explicitly draw on the Sustainable Livelihoods Framework (SLF) by enhancing households' human, natural, financial, social, and physical capital. This includes strengthening skills on sustainable harvesting, increasing access to microfinance, and upgrading rural facilities for processing and storage to improve value addition and reduce post-harvest losses.

Secondly, gender-responsive strategies are essential, given that women's participation in NTFP activities remains noticeably lower, which indicates structural and cultural barriers limiting women's income opportunities. Therefore, establishing women-focused forest cooperatives, improving access to credit for women, and promoting equal involvement in market activities should be prioritized.

Thirdly, cooperative structures, currently showing limited representation among households, demonstrate a potentially substantial positive role in improving market access and bargaining power. Efforts should therefore encourage wider cooperative membership through policy incentives, market linkages, and shared resource governance, consistent with Ostrom's Community-Based Resource Management Theory, to strengthen collective action and enhance income security.

Fourthly, environmental sustainability must be embedded in forest management frameworks as reliance on products such as firewood, charcoal, and medicinal plants significantly drives household income yet also intensifies forest degradation risks. Policies should promote regulated harvesting systems, reforestation initiatives, and alternative clean energy options to reduce ecological pressures while safeguarding future resource availability.

Fifthly, the findings suggest a noticeable decline in youth engagement in NTFP-related livelihoods, indicating reduced future interest in the sector without innovation incentives. To address this, governments and NGOs should introduce technology-driven opportunities, digital marketing channels, and value-added product development training to make the sector more attractive and economically rewarding for young people.

Finally, strengthening institutional collaboration is vital. The roles of local governments, extension officers, NGOs, and financial institutions should be clearly defined to ensure coordinated implementation. Local authorities should provide supportive policies, while extension agents deliver technical training; NGOs

support community mobilization, and financial institutions expand affordable and inclusive financing schemes.

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