

Article

Contribution of non-timber forest products to the livelihoods of households residing adjacent to Loita Forest, Kenya

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Abstract: The use and commercialization of non-timber forest products (NTFPs) for livelihood development and their adverse impact on forest ecosystems have received significant academic attention recently. To conserve forests and ensure continued livelihood support, it is essential to harvest NTFPs in a sustainable manner. Thus, efforts to conserve such resources must be preceded by understanding how communities interact with them. This study aimed to clarify the relationship between participation in forest conservation and income earned from forests. The primary data were collected via a socio-economic survey of 151 households residing adjacent to Loita Forest in Kenya. The population in the study area extracts NTFPs, such as firewood, natural medicine, building poles, and honey. There is a positive relationship between participation in forest conservation efforts and income earned from the sale of NTFPs. Thus, the Loita Community Forest is a crucial source of essential NTFPs for adjacent households' subsistence. Therefore, these households should be encouraged to participate more in forest conservation efforts. Such endeavors would facilitate livelihood development of local communities and sustainable management of forests in Kenya.

Keywords: sustainable forest management; sustainable harvesting; NTFP; Loita Forest; ecosystem service

1. Introduction

Forest ecosystems support the livelihoods of rural communities by providing timber and non-timber goods, such as food and medicine (Ahammad et al., 2019). According to Langat et al. (2016), approximately 2 billion people worldwide rely on forests for subsistence, of whom approximately 200 million—mostly in rural areas—depend exclusively on forests for their livelihood. All tangible forest goods other than wood are referred to as non-timber forest products (NTFPs)—which include, for example, rattan, resins, essential oils, latex, nuts, spices, fruits, seeds, leaves, game, fish, birds, eggs, and honey (Adam et al., 2013; Mjoli and Shackleton, 2024). For residents of forested and nearby areas, NTFPs may be a vital source of sustenance and revenue. Collection of NTFPs is considered less harmful to the environment than harvesting timber (Shen et al., 2022). Moreover, globally, NTFPs are considered a fallback option for rural populations living adjacent to forests in case of emergency situations, such as insufficient agricultural production or natural disasters (Rahman et al., 2021).

Recently, academic interest in the impact and contribution of NTFPs has grown, coinciding with an increasing global focus on rural poverty and deforestation (Kar and Jacobson, 2012). A recent study found that there are an estimated 2.77 billion NTFP users in rural areas of the Global South. This is 73% higher than the frequently cited

figure of 1.6 billion people worldwide from the FAO (2001) (Shackleton and de Vos, 2022). NTFPs provide subsistence energy to people who live in and around forests (Rahman et al., 2021). In developing countries, particularly in Asia and Africa, NTFPs are viewed as a backup plan that fills in the gaps left by disasters or losses in agricultural output (Suleiman et al., n.d.). Although there is no consensus, a body of research suggests that NTFPs contribute meaningfully to poverty alleviation in a variety of contexts (Shackleton et al., 2024). Utilization and commercialization of NTFPs for livelihood development—especially, the overexploitation and degradation of forest ecosystems—has acquired significant attention in the recent past. Harvesting of NTFPs for commercial and subsistence adversely impacts plant species and forest ecosystems (Arnold and Pérez, 2001; Ndangalasi et al., 2007; Ticktin, 2004). Based on a literature analysis, de Mello et al. (2023) found that 65% of studies on the economic and ecological dimensions related to NTFPs indicated that the use and/or commercialization of such products was not ecologically sustainable. Meanwhile, deforestation and overexploitation lead to climate change, which in turn negatively impacts the ecosystem. This contributes to the decline in forest NTFP production. Ecosystems and NTFP production influence each other (Asamoah et al., 2023). Therefore, sustainable management of forests for the utilization of NTFPs is receiving scholarly attention. Following approximately five decades of over-extraction, in 1999, China initiated the Natural Forest Protection Program in major state forest regions. The aim was to prevent the depletion of its enormous natural forests, which are mainly located in upper reaches of river basins (Liu and Xu, 2019). Additionally, China has implemented programs to alleviate the pressure exerted on NTFPs—for example, the domestication of NTFPs by farmers, that is, growing NTFPs on farms (Stark et al., n.d.).

In the academic field of forest management, numerous studies have explored the utilization of NTFPs. Households around forests depend heavily on forest products (Kamwi et al., 2020; Talukdar et al., 2021; Thammanu et al., 2021). There is a relationship between NTFPs and the social structure (Mushi et al., 2020; Rahman et al., 2021). Despite significant academic progress, there remain gaps in our understanding regarding how to influence communities in terms of NTFPs.

The study explores how participation in community forest management impacts the use of NTFPs, identifies which factors influence collection of NTFPs from the community forest, and explores community perceptions and attitudes toward NTFPs. We focus on the impact of utilization of NTFPs on the livelihoods of households adjacent to Loita Forest in Kenya. The investigation includes individuals who reside within 5 km from the forest boundary, assuming that their interaction with forest resources is the maximum.

The rest of this article is structured as follows. The second section presents the research methodology, including the research strategy. Data interpretation and analysis are presented in the third section. Finally, the fourth section concludes with an overview of the analyzed data, a summary of the study, and policy recommendations based on the findings.

2. Methods

2.1. Study area

The Loita community forest is a natural forest and a gazetted water tower in Kenya that is considered a key water catchment, providing grazing land during the dry season and numerous forest resources (Kariuki et al., 2016). Its significance for nearby households is evident in the fact that most of them rely on fuelwood and construction materials procured from the forest. Additionally, the forest provides fruits, berries, and honey while certain plants have medicinal applications (de Chavez and Malanes, 2013). In particular, the forest plays an important role in preserving biodiversity. It serves as an important wildlife corridor and habitat, with elephants and other animals migrating from the Maasai Mara Game Reserve to Loita for better feeding opportunities during the dry season (Nankaya et al., 2021). The forest is managed based on a traditional community-based forest management system. In a study that interviewed the Loita community about its role in forest management, 79% of household respondents perceived that the community played a main role in management. The government's role was minimal. However, unstable leadership over the years has led to significant loss to the forest (Mbuvi and Kungu, 2021). Furthermore, population expansion has led to an increase in logging and settlement in the area, threatening the local biodiversity and source of revenue for communities that depend on the forest (Kariuki et al., 2016). Thus, Loita Forest is a critical source of socio-economic development for the local community.

2.2. Research design and data-collection procedure

This was a two-step study. The first step involved the collection of primary data from households residing within 5 km from the forest boundary. A socio-economic household survey was conducted using questionnaires. Owing to the scarcity of secondary data related to the study area—that is, the Loita community forest—the researcher adopted this method to address the research questions. The second step involved analysis of the collected data utilizing appropriate statistical techniques. Specifically, we first collated demographic information as descriptive statistics, and then conducted frequency analysis on what types of NTFPs households use, their perceptions of NTFPs, the distribution of income from NTFPs, and the occupational groups of households sampled according to their income. We also used correlation analysis to examine the relationship between membership in conservation groups and forest product income, and binomial logit regression to determine which factors had a statistically significant impact on income from NTFPs. Finally, the findings and conclusions were compiled based on the data analysis and policy recommendations.

The data-collection survey was conducted in person through a field study by enumerators trained in data-collection techniques and conversant with the local dialect. The data were collected over a 1-week period (29 August–3 September 2022). The study aimed to interview the heads of households as the main respondents, assuming they were the main decision-makers in a household. In the absence of the household head, another adult in the household was interviewed. The population targeted for the study was 200 households. Villages were used as the sampling unit.

The study ensured the confidentiality and privacy of the data collected from the survey respondents. Only willing respondents were interviewed, as the study upheld the principle of voluntary consent. The data-collection process was conducted in the Narok South sub-county in the Narok County, south Rift valley (**Figure 1**). A total of 151 households participated in the survey. The demographic information of the respondents is detailed in **Table 1**.



Figure 1. Location of Loita Forest in Kenya.

Table 1. Demographic information of respondents.

		Frequency	Percentage
Ward	Enkutoto	19	12.6
	Loita	117	77.5
	Naroosura	15	9.9
Location	Elanga Enterit	19	12.6
	Entasekera	27	17.9
	Loita	28	18.5
	Moriyo	7	4.6
	Naroosura	15	9.9
	Oloorte	55	36.4
Number of HH members	0–3 (small HHs)	26	17.2
	4–6 members (moderate families)	56	37.1
	7–10 members (large families)	56	37.1
	Over 11 members (extremely large families)	13	8.6
Age	20–30	38	25.2
	31–40	44	29.1
	41–50	27	17.9
	Above 51	42	27.8
Gender	Female	57	37.7
	Male	94	62.3

3. Results and analysis

3.1. Different types of NTFPs harvested and used by households

Table 2 presents a summary of the uses of the NTFPs by the community. A majority of the Loita community members (86.8%, $n = 131$) harvested fuelwood from the forest. This was the most used NTFP by the community, followed by: natural medicine (43.7%), building poles (42.4%), fencing poles (40.4%), honey (34.4%), agricultural tools (29.1%), and wild fruits (16.6%). These observations are consistent with previous research in Loita Forest regarding the demand for NTFPs by locals for natural medicine and for building and fencing poles (de Chavez and Malanes, 2013; Nankaya et al., 2020). Moreover, the substantial collection of firewood in Loita could be attributed to the fact that over 90% of rural households rely on it as their primary source of energy. Firewood is preferred because of its widespread availability and affordability (Njenga et al., 2021).

Table 2. Use of different types of NTFPs by households.

NTFP component use	Yes (%)	No (%)
Fuelwood	86.8	13.2
Natural medicine	43.7	56.3
Building poles	42.4	57.6
Fencing poles	40.4	59.6
Honey	34.4	65.6
Agricultural tools	29.1	70.9
Wild fruits	16.6	83.4
Charcoal	8.6	91.4
Quarry stones	3.3	96.7
Murram	2.6	97.4
Bushmeat	2.6	97.4
Fodder	0.7	99.3
Mushroom	0.7	99.3
Wild Veges	0.7	99.3
Thatching grass	0.0	100.0

Table 3 illustrates the relationship between sex and various NTFP sources. Sex differences were significant only for fuelwood sources ($X^2 = 5.795$, Sig. 0.015, $p < 0.05$). More male respondents derived income from forest fuelwood, with 57.9% sourcing from public forests, compared to female respondents at 42.1%. Honey, (sig. 0.109), natural medicine (herbs) (sig. 0.231), building poles (sig. 0.538), fodder sources (sig. 0.619), and charcoal (sig. 0.316) showed no significant correlation with sex.

Table 3. Relationship between sex and NTFP collection.

Gender	Fuelwood	Honey	Natural medicine	Building poles	Fodder source	Charcoal source
Male	77 (57.9%)	45 (60.0%)	58 (56.9%)	48 (54.5%)	6 (54.5%)	21 (50.0%)
Female	56 (42.1%)	30 (40.0%)	44 (43.1%)	40 (45.5%)	5 (45.5%)	21 (50.0%)
Totals	133 (100.0%)	75 (100.0%)	102 (100.0%)	88 (100.0%)	11 (100.0%)	42 (100.0%)
Pearson Chi-square	5.795	1.948	0.829	0.005	0	0.434
Sig.	0.015	0.109	0.231	0.538	0.619	0.316

3.2. Community perceptions and occupational dependency on NTFPs

The results regarding the community perceptions toward different NTFPs collected in Loita Forest are presented in **Table 4**.

Table 4. Community members on the value of forest to their livelihoods.

Variable	Important	More important	Most important	Somewhat important
Importance of forest as a source of household income	80	47	17	7
Importance of forest as a source of household basic needs	34	37	79	1
Importance of forest as source of income and household basic needs for community future use	38	43	62	6

Regarding the perception of forest goods value to income, slightly above half of the members (53%) described it as important. Another 42.4% described the ecosystem as either more or most important in generating income to the household members. Similarly, regarding whether the forest was valuable for household basic needs, approximately three-quarters (76.8%) described the forest products' value as either more or most important. Only 0.7% indicated that the forest was somewhat important. These results reveal that majority of the households viewed the forest as the main source of subsistence livelihood. Similarly, a significant proportion of household members (41.1%) indicated that the forest's value was most important for future use. It is noteworthy that for 69.6% of the households the forest had significant value for future use.

Table 5 shows the summary of income from various economic activities. It was observed that 80.8% of the respondents did not obtain income from forest products, while 11.3% obtained an income ranging from Ksh. 1–10,000 from forest products. Another 7.9% obtained between Ksh. 10,000 and 50,000 from forests products. Expenditures were evenly distributed across the income ranges. This implies that only 19.2% of the community living adjacent to the forest benefited from the forest in terms of earning income from the sale of the NTFPs.

Table 5. Income from NTFPs.

Income from NTFPs	Frequency	Percent
Ksh. 0	122	80.8%
Ksh. 1–10,000	17	11.3%
Ksh. 10,000 and above	12	7.9%
Total	151	100%

Table 6 presents the summary of the findings regarding different professions. Only pastoralists benefited more from the NTFPs from Loita Forest; they constituted approximately 18.4% of those who earned at least some income from the forest. Other categories of professions earned zero or little compared to the pastoralists.

Table 6. Forest income percentage by different occupational groups.

Primary occupation	Count 0	Count 1–10,000	Count over 10,000	% Of total 0	% Of total 1–10,000	% Of total over 10,000
Business	10	2	1	6.60%	1.30%	0.70%
Crop farmer	18	2	2	11.90%	1.30%	1.30%
None	2	0	0	1.30%	0.00%	0.00%
Pastoralists	86	11	9	57.00%	7.30%	6.00%
Retired (pensioner)	1	0	0	0.70%	0.00%	0.00%
Salaried/employed	4	0	0	2.60%	0.00%	0.00%
Unskilled labour	1	2	0	0.70%	1.30%	0.00%
Total	122	17	12	80.80%	11.30%	7.90%

3.3. Participation in community forest management and utilization of NTFPs

The Loita community forest operates under a traditional management system. It utilizes indigenous governance mechanisms for resource and forest stewardship. Recently, this management model has evolved to incorporate governmental stakeholders, expanding to include community-based organizations such as the Loita Community Forest Association (Mbuvi and Kungu, 2021). Evidence suggests that participation in conservation efforts, particularly via membership in conservation groups, results in tangible benefits for community members, surpassing those available to non-members (Mbuvi and Kungu, 2021). This dynamic suggests a positive correlation between forest-derived benefits and increased conservation engagement (Thammanu et al., 2021).

The survey revealed that 60.9% of respondents were affiliated with at least one forest conservation group, indicating a predominant inclination toward collective conservation efforts among households proximal to Loita Forest. This study aimed to examine the relationship between income from forest products and conservation group membership. The findings are presented in **Table 7**. The results showed that 39.1% of the participants were not affiliated with any conservation groups, compared with 60.9% who were satisfied. Income from NTFPs was categorized under binary outcomes: earners and non-earners. Among the conservation group members, 15.2% reported earning income from NTFPs, compared to 4.0% of non-members. Notably, 79.3% of group-affiliated respondents reported some income, highlighting a significant disparity with the 20.7% of non-earners.

Further statistical analysis using the Pearson chi-square tested the significance of the association between conservation group membership and income from forest products (**Table 8**), revealing a significant correlation ($\chi^2 = 5.095$, $df = 1$, $sig. = 0.018$, $p < 0.05$). This suggests that conservation group membership significantly enhances the likelihood of deriving income from forest products. Similarly, Thammanu et al. (2021) observed a positive relationship between NTFP income and active participation in forest management within Thai community forests, highlighting that equitable distribution of benefits and strict regulation enforcement enhance NTFP revenue. Additionally, in our study, a concerning trend emerged from the survey: more than half (60.3%) of the respondents noted a decline in the quantity of NTFPs over the last 5 years, indicating a reduction in NTFP harvesting activities (**Table 9**).

Table 7. Pearson Chi-square correlation of forest product income and membership of forest conservation group.

		NO	YES	
Forest product income	Count	53	69	122
	No income at all			
	% Within forest product income	43.40%	56.60%	100.00%
	% Within member of conservation group	89.80%	75.00%	80.80%
	% Of total	35.10%	45.70%	80.80%
	Some income			
	Count	6	23	29
Total	% Within forest product income	20.70%	79.30%	100.00%
	% Within member of conservation group	10.20%	25.00%	19.20%
	% Of total	4.00%	15.20%	19.20%
	Count	59	92	151
	% Within forest product income	30.10%	60.90%	100.00%
	% Within member of conservation group	100.00%	100.00%	100.00%
	% Of total	30.10%	60.90%	100.00%

Table 8. Chi-square tests for membership in conservation groups and forest product income.

Test	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson chi-square	5.095	1	0.024	-	-
Continuity correction <i>b</i>	4.184	1	0.041	-	-
Likelihood ratio	5.467	1	0.019	-	-
Fisher's exact test	-	-	-	0.033	0.018

N of valid cases: 151.

Notes:

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.33.

b. Computed only for a 2 × 2 table.

Table 9. Change in quantity of NTFPs over the last 5 years.

Category	Frequency	Percent
Don't know decreased	1	0.7%
Decreased	91	60.3%
Don't know increased	22	14.6%
No change	1	0.7%
Increased	36	23.8%
Total	151	100%

3.4. Factors influencing the extent and patterns of forest-adjacent communities' NTFP collection

Binomial regression was performed to establish the kind of association between the socio-economic variables and the forest product income and patterns of use of NTFPs by forest-adjacent communities. Logistic binomial regression was applied to establish statically significant correlation between the socio-economic and demographic variables and use of NTFPs among the people living adjacent to the forest. The analysis was processed by using the binomial probability distribution and the logit link function (see **Table 10**).

Table 10. The test of goodness of fit.

Metric	Value	df	Value/df
Deviance	70.358	94	0.748
Scaled deviance	70.358	94	-
Pearson chi-square	85.755	94	0.912
Scaled Pearson chi-square	85.755	94	-
Log likelihood	-38.586	-	-
Akaike's information criterion (AIC)	135.172	-	-
Finite sample corrected AIC (AICC)	149.794	-	-
Bayesian information criterion (BIC)	222.287	-	-
Consistent AIC (CAIC)	251.287	-	-

Dependent variable: The outcome variable is binary, coded into two categories of "Forest product Income".

Model: Includes predictors such as (intercept), gender, age, relationship with head of household, level of education, primary occupation, family description, household size, and land acreage2.

Notes:

a. Information criteria are in small-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

As a rule of thumb in goodness of fit, large p -values indicate a good fit to the data, while small p -values less than 0.05 indicate a poor fit. For the data in this study, the p -values were high, above 0.05 (at 0.748 for deviance and 0.912 for the Pearson chi-square). Hence, the model was a good fit for the data (see **Table 11**).

Table 11. Test of model effects.

Variable	Wald chi-square	df	Sig.
Intercept	0	1	0.999
Gender	0.211	1	0.646
Age	1.415	2	0.493
Relationship with head house hold	2.157	5	0.827
Level of education	9.121	5	0.104
Primary occupation	4.039	6	0.671
Family description	1.951	3	0.583
Household size	4.285	3	0.232
Land size	12.807	3	0.005

Dependent variable: Forest product income into 2.

Model: (Intercept), gender, age, relationship with HeadHH, level of education, primary occupation, family description, HHSIZE, LandAcreage2.

The binomial logit regression revealed that only land size had a statistically significant influence on income from NTFPs (sig. 0.005). Holding other variables constant, land size was found to change family income by 12.8 units. Other socio-economic variables, such as household size (sig. 0.232), family description (sig. 0.583), primary occupation (sig. 0.671), level of education (sig. 0.104), relationship with the household head (sig. 0.827), age (sig. 0.493), and sex (sig. 0.646) had no statistically significant influence on income from NTFPs.

4. Conclusion

This study aimed to ascertain the impact of NTFPs on the livelihoods of communities residing adjacent to the Loita community forest. It particularly focused on understanding their perceptions of NTFPs' significance and the degree of dependency on these resources among different occupational groups. The objective was to augment the knowledge regarding how forests contribute to the livelihoods of households residing in proximity to forests in Kenya. This is pivotal for the development of policies aimed at forest restoration while acknowledging the significance of forest products to livelihoods.

The analysis of survey data collected from 151 out of the 200 distributed questionnaires—a 75.5% response rate—revealed that the NTFPs were predominantly used for subsistence. Additionally, a minor proportion of respondents engaged in the sale of NTFPs for income generation. This indicates a marginal contribution of NTFPs to overall household income. Notably, fuelwood emerged as the most extracted NTFP, underscoring its high demand within the community. Furthermore, the survey revealed a perceived decline in the availability of NTFPs over the past 5 years, highlighting concerns regarding resource sustainability. Nonetheless, the community's recognition of the forest and its NTFPs as vital components of their livelihood underscores the intrinsic value accorded to these resources. This study is significant because it directly captured the opinions of local people whose livelihoods depend on forest harvesting. This study also has implications for policy on the need to promote ecosystem services through conservation, as it shows that while the value of one ecosystem service increases, the value of different ecosystem services may conflict. In other words, the harvesting of NTFPs explored in this study can reduce the regulating services provided by forests, such as carbon fixation and carbon storage. Put differently, forests provide both regulating and provisioning services, but depending on human utilization, these ecosystem services may be difficult to promote simultaneously. Recognizing this trade-off, policymakers should consider using such policy tools as “payments for ecosystem services” to promote the regulating services of forests by adequately compensating people whose livelihoods depend on the provisioning services.

Based on these findings, the following recommendations are proposed for consideration by policymakers and stakeholders.

- Future policy formulation should incorporate the socio-economic and demographic characteristics of communities residing adjacent to the Loita Community Forest, ensuring that sustainable forest management strategies are tailored to local needs.
- The critical role of the Loita Community Forest in providing subsistence goods (e.g., fuelwood, medicinal resources, and construction materials) must be acknowledged, and exploration into the domestication of NTFPs should be promoted.
- Efforts should be directed toward developing alternative, clean, affordable, and accessible energy sources to alleviate dependence on firewood, thereby addressing energy needs in a sustainable manner.
- Government agencies are urged to devise NTFP utilization plans that prioritize conservation and sustainable use, recognizing the essential role these resources

play in local livelihoods.

- Further research is essential to quantify the total economic value of NTFPs within Loita Forest, supporting efforts to secure funding from national and international partners for the forest's protection and sustainable management.

This research highlights the broader importance of sustainable NTFP management, and its potential to improve livelihoods in Kenya as well as similar forest-dependent communities around the world. These findings contribute to a universal framework for balancing enhanced ecosystem services and human needs by showing how NTFP utilization can support economic stability while encouraging conservation. Thus, our research yields relevant insights for policymakers and stakeholders in different geographic and cultural contexts to promote sustainable approaches to forest resource management.

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References

- Adam, Y. O., Pretzsch, J., & Pettenella, D. (2013). Contribution of Non-Timber Forest Products livelihood strategies to rural development in drylands of Sudan: Potentials and failures. *Agricultural Systems*, 117, 90–97. <https://doi.org/10.1016/j.agsy.2012.12.008>
- Ahammad, R., Stacey, N., & Sunderland, T. C. H. (2019). Use and perceived importance of forest ecosystem services in rural livelihoods of Chittagong Hill Tracts, Bangladesh. *Ecosystem Services*, 35, 87–98. <https://doi.org/10.1016/j.ecoser.2018.11.009>
- Arnold, J. E. M., & Pérez, M. R. (2001). Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics*, 39(3), 437–447. [http://doi.org/10.1016/S0921-8009\(01\)00236-1](http://doi.org/10.1016/S0921-8009(01)00236-1)
- Asamoah, O., Danquah, J. A., Bamwesigye, D., et al. (2023). The perception of the locals on the impact of climate variability on non-timber forest products in Ghana. *Acta Ecologica Sinica*. <https://doi.org/10.1016/j.chnaes.2023.07.004>
- de Chavez, R., Malanes, M. (2013). *Indigenous Peoples, Forests & REDD Plus: Sustaining & Enhancing Forests Through Traditional Resource Management*. Tebtebba Foundation.
- de Mello, N. G. R., Gulinck, H., Van den Broeck, P., et al. (2023). A qualitative analysis of Non-Timber Forest Products activities as a strategy to promote sustainable land use in the Brazilian Cerrado. *Land Use Policy*, 132, 106797. <https://doi.org/10.1016/j.landusepol.2023.106797>
- Kamwi, J. M., Endjala, J., & Siyambango, N. (2020). Dependency of rural communities on non-timber forest products in the dry lands of southern Africa: A case of Mukwe Constituency, Kavango East Region, Namibia. *Trees, Forests and People*, 2, 100022. <https://doi.org/10.1016/j.tfp.2020.100022>
- Kar, S. P., & Jacobson, M. G. (2012). NTFP income contribution to household economy and related socio-economic factors: Lessons from Bangladesh. *Forest Policy and Economics*, 14(1), 136–142. <https://doi.org/10.1016/j.forpol.2011.08.003>
- Kusters, K., Achdiawan, R., Belcher, B., et al. (2006). Balancing Development and Conservation? An Assessment of Livelihood and Environmental Outcomes of Nontimber Forest Product Trade in Asia, Africa, and Latin America. *Ecology and Society*, 11(2). <https://doi.org/10.5751/es-01796-110220>
- Langat, D. K., Maranga, E. K., Aboud, A. A., et al. (2016). Role of Forest Resources to Local Livelihoods: The Case of East Mau Forest Ecosystem, Kenya. *International Journal of Forestry Research*, 2016, 1–10. <https://doi.org/10.1155/2016/4537354>
- Liu, S., & Xu, J. (2019). Livelihood mushroomed: Examining household level impacts of non-timber forest products (NTFPs)

- under new management regime in China's state forests. *Forest Policy and Economics*, 98, 44–53.
<https://doi.org/10.1016/j.forpol.2018.06.001>
- Mbuvi, M. T. E., & Kungu, J. B. (2021). A transforming traditional community based forest management: the case of Loita community forest, Kenya. *Heliyon*, 7(6), e07380. <https://doi.org/10.1016/j.heliyon.2021.e07380>
- Mushi, H., Yanda, P. Z., Kleyer, M. (2020). Socioeconomic Factors Determining Extraction of Non-timber Forest Products on the Slopes of Mt. Kilimanjaro, Tanzania. *Human Ecology*, 48(6), 695–707. <http://doi.org/10.1007/S10745-020-00187-9/TABLES/5>
- Nankaya, J., Gichuki, N., Lukhoba, C., et al. (2021). Prioritization of Loita Maasai medicinal plants for conservation. *Biodiversity and Conservation*, 30(3), 761–780. <https://doi.org/10.1007/s10531-021-02116-8>
- Nankaya, J., Nampushi, J., Petenya, S., et al. (2020). Ethnomedicinal plants of the Loita Maasai of Kenya. *Environment, Development and Sustainability*, 22(3), 2569–2589. <https://doi.org/10.1007/s10668-019-00311-w>
- Ndangalasi, H. J., Bitariho, R., & Dovie, D. B. K. (2007). Harvesting of non-timber forest products and implications for conservation in two montane forests of East Africa. *Biological Conservation*, 134(2), 242–250.
<https://doi.org/10.1016/j.biocon.2006.06.020>
- Njenga, M., Gitau, J. K., & Mendum, R. (2021). Women's work is never done: Lifting the gendered burden of firewood collection and household energy use in Kenya. *Energy Research & Social Science*, 77, 102071.
<https://doi.org/10.1016/j.erss.2021.102071>
- Rahman, Md. H., Roy, B., & Islam, Md. S. (2021). Contribution of non-timber forest products to the livelihoods of the forest-dependent communities around the Khadimnagar National Park in northeastern Bangladesh. *Regional Sustainability*, 2(3), 280–295. <https://doi.org/10.1016/j.regsus.2021.11.001>
- Shackleton, C. M., & de Vos, A. (2022). How many people globally actually use non-timber forest products? *Forest Policy and Economics*, 135, 102659. <https://doi.org/10.1016/j.forpol.2021.102659>
- Shackleton, C. M., Garekae, H., Sardeshpande, M., et al. (2024). Non-timber forest products as poverty traps: Fact or fiction? *Forest Policy and Economics*, 158, 103114. <https://doi.org/10.1016/j.forpol.2023.103114>
- Shen, J., Zhang, Y., Zhou, W., et al. (2022). Dynamics and determinants of household's non-timber forest products collection in the giant panda nature reserves of China. *Forest Policy and Economics*, 137, 102705.
<https://doi.org/10.1016/j.forpol.2022.102705>
- Stark, M., Min, D., Yongping, Y., (n.d.). Eco-certification of non-timber forest products in China: addressing income generation and biodiversity conservation needs.
- Suleiman, M. S., Wasonga, V. O., Mbau, J. S., et al. (2017). Non-timber forest products and their contribution to households income around Falgore Game Reserve in Kano, Nigeria. *Ecological Processes*, 6(1). <https://doi.org/10.1186/s13717-017-0090-8>
- Talukdar, N. R., Choudhury, P., Barbhuiya, R. A., et al. (2021). Importance of Non-Timber Forest Products (NTFPs) in rural livelihood: A study in Patharia Hills Reserve Forest, northeast India. *Trees, Forests and People*, 3, 100042.
<https://doi.org/10.1016/j.tfp.2020.100042>
- Thammanu, S., Han, H., Marod, D., et al. (2021). Non-timber forest product utilization under community forest management in northern Thailand. *Forest Science and Technology*, 17(1), 1–15. <https://doi.org/10.1080/21580103.2020.1862712>
- Ticktin, T. (2004). The ecological implications of harvesting non-timber forest products. *Journal of Applied Ecology*, 41(1), 11–21. <http://doi.org/10.1111/J.1365-2664.2004.00859.X>