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Factors Influencing Non-Timber Forest Products on Household Welfare in Maraba Sector, Huye District, Rwanda

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Abstract

Non-timber forest products (*NTFPs*) *enhance rural household income. In Rwanda, natural forests cover 11.9% of the land and are key for biodiversity conservation, providing water catchment protection, tourism, medicinal plants, honey, and handicraft materials. Despite the forest sector's economic potential, rural residents dependent on NTFPs face challenges, leading to high unemployment and poverty. This research examines how socio-economic factors affect Huye District NTFP collectors' welfare. Using multi-stage sampling, 152 participants were selected, proportionally from four cells in Maraba Sector, based on the Yamane* (*1967*) *formula and systematic sampling, and data were collected through structured questionnaires in 2022. Data analysis used STATA version 16 for multiple linear regression. The study identified NTFPs used by households, with fruits* (*42.8%*)*, mushrooms* (*16.4%*)*, honey* (*9.9%*)*, traditional medicine* (*8.6%*)*, and building materials* (*7.2%*)*, such as bamboo, palm leaves, roof thatch grass, and wood (stick and poles) as the most commonly collected products. The main reasons for NTFP participation included food provision, income generation, education and health expenses, obtaining forage and fodder, building materials, and traditional medicine. Factors like distance to forest, training, extension services, credits, and market information significantly influenced household income. The study recommends increasing forestland allocation for NTFPs and implementing agroforestry systems to boost household income. Reforestation and afforestation initiatives should enhance forest conservation and biodiversity. The Ministry of Environment and stakeholders should establish payment systems for ecological services benefiting community residents.*

Keywords: *credit access, distance to forests, honey, mushrooms, traditional medicines*

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Introduction

Globally, more than 1.6 billion people use biological products from forests for fuel, nourishment, and animal feed that are not wood-based (Lovrić et al., 2020; Nerfa et al., 2020; Thammanu et al., 2021; Lepcha et al., 2022). In developing nations and emerging economies, non-timber forest products (NTFPs) are the main source of household nutrition, health, and income for 80% of rural inhabitants (Zubair et al., 2022; FAO & Dalberg Catalyst, 2024). Approximately 350 million indigenous people residing near tropical forests rely on "NTFPs" for their household well-being (Rahman et al., 2021; Derebe et al., 2023). Forests encompass 21% of Africa's land area, with many rural African residents harvesting various NTFPs for sustenance and income generation, thereby improving their household welfare (Zubair et al., 2022). These NTFPs, extracted from forests, woodlands, and trees outside forests for human use, include fruits, vegetables, edible roots, honey, medicinal plants, bush meat, wood carvings, gums, latex, rattan, seed, mushrooms, ecotourism, ornamental plants, fencing materials, and firewood (Thammanu et al., 2021; Miyake & Kohsaka, 2023).

NTFPs play a crucial role in supporting livelihoods by providing subsistence and trade goods for forest and rural communities through food production, job opportunities, income generation, and poverty reduction, thus enhancing the lives of rural populations in developing economies worldwide (Adongo et al., 2019; Mugido & Shackleton, 2019; Epanda et al., 2020; Miyake & Kohsaka, 2023).

In nations undergoing development, such as Rwanda, natural forests occupy 11.9% of the total land area and play a crucial role in conserving biodiversity. The government aims to increase forest coverage to 30% of the country's land through tree-planting initiatives (Ministry of Lands and Forestry, 2018). Rwanda's forest sector significantly contributes to employment, with charcoal production accounting for the largest share (61.8%) of jobs in non-timber forest-based products, followed by wood production

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(19.2%), and distribution and sales making up 6.2% and 12.8% respectively (Ministry of Lands and Forestry, 2018). A report on Rwanda's biomass sector indicates that firewood and charcoal contributed USD122 million to the national 5% GDP. Presently, the Rwandan government designates 18.7% of its total area for forest plantations across various agro-ecological zones (Ministry of Lands and Forestry, 2018; Hakizimana et al., 2020). The country's forests provide numerous ecosystem services, including fuel and construction wood, watershed protection, water purification, and non-timber forest products like medicinal plants, honey, and handicraft materials that support rural forest-based communities.

Although the forest sector offers substantial opportunities for Rwanda's economic growth and development, many rural residents who depend solely on NTFPs are facing challenges leading to unemployment and increased poverty (Olufunmilayo et al., 2019; Verkerk et al., 2021). This situation jeopardizes the household welfare of NTFP collectors in the forest-based communities of the Huye District-Maraba Sector, South Province of Rwanda (Nahayo et al., 2013).

While numerous studies have examined the ecological and economic significance of NTFPs globally (Belcher et al., 2005; Shackleton et al., 2011; Angelsen et al., 2014; Hakizimana et al., 2020), much of this research has focused on general patterns of forest dependency and the commercial potential of specific products. In the Rwandan context, existing studies have often emphasized biodiversity conservation and forest management strategies (e.g., Nsabimana et al., 2012; Hakizimana et al., 2020; Tuyisenge et al., 2023), with limited attention to how NTFPs directly influence household welfare outcomes such as income, food security, and socio-economic resilience. Moreover, previous research typically lacks localized, household-level analyses that consider the interplay of socio-economic factors influencing the welfare impacts of NTFPs. Few studies, if any, have used household income as a control variable to isolate the specific effects of NTFPs on welfare in rural Rwandan communities.

This study addresses these gaps by conducting an in-depth analysis in the Maraba sector of Huye District, focusing on the socio-economic drivers that shape how households access and benefit from NTFPs. By quantifying welfare outcomes concerning NTFPs use and controlling for total household income, the study offers a more accurate and policy-relevant understanding of the role NTFPs play in rural livelihoods. Furthermore, the study contributes to the broader international discourse on sustainable forest-based livelihoods by providing empirical evidence from Rwanda, a country undergoing rapid economic transformation under its Vision 2030 Agenda. This localized case offers transferable insights for other developing nations where forests serve dual roles in conservation and poverty reduction, thereby enhancing global understanding of NTFP in socio-economically dynamic contexts. The study's specific objectives included assessing the current NTFPs and their economic applications, as well as identifying the socio-economic factors that impact household welfare in Rwanda's Huye District.

Methods

Description of the study area This research was conducted in Huye district, one of eight districts in Rwanda's southern province. Huye borders Nyanza to the north, Gisagara to the east and south, Nyaruguru to the southwest, and Nyamagabe to the northwest. It comprises 14 sectors, 77 cells, and 508 villages, with a population of 319,000 (147,000 males and 172,000 females) (Huye District, 2013). The district, located in Rwanda's Southern Province, lies on the central plateau with a hilly landscape that becomes more mountainous in the west and northwest (Figure 1). It covers an area of 581.5 km^2, approximately between S230 to S250 latitude and 2950 longitude. The elevation ranges from 1,450 to over 2,000 m,

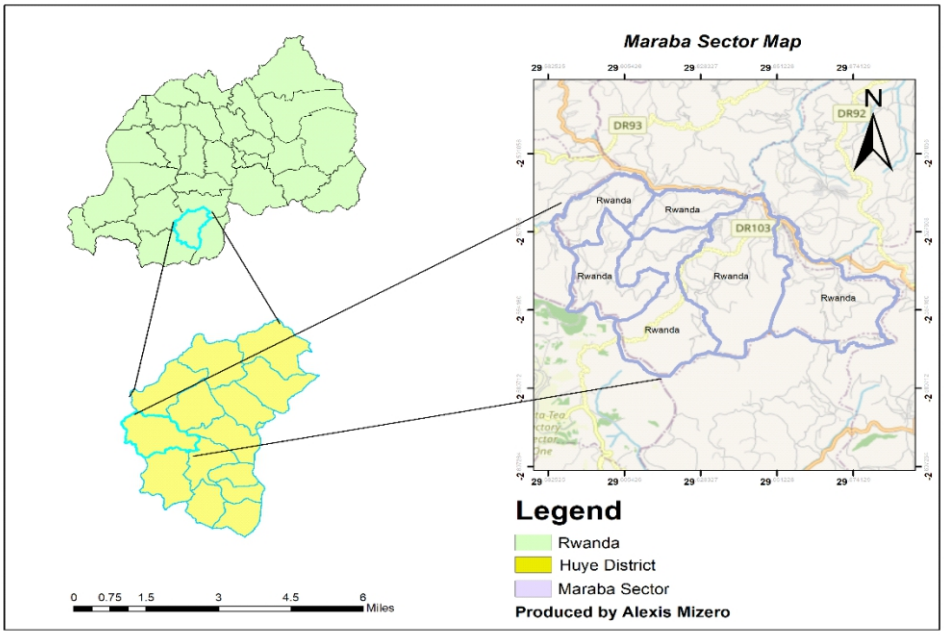

Figure 1 Maraba sector map.

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with Huye Mountain exceeding 2,000 m. The climate includes two wet seasons (March to May and September to November) and two dry seasons (June to August and December to February), with temperatures from 10 to 34 °C (Republic of Rwanda, 2018). Agriculture and forestry are the main economic activities, significantly contributing to Rwanda's annual growth since 2008. Major crops include coffee, maize, rice, and cassava.

NTFPs in Rwanda include plants for traditional medicine, fodder, honey, fruits, tree seeds, essential oils, handicraft materials, mushrooms, ornamental plants, game, fish, and ecotourism (Ministry of Lands and Forestry, 2018). Huye District has limited forest coverage, with about 10% forested. The Huye Arboretum, covering approximately 200 ha, contributes to biodiversity conservation and research; however, as it primarily serves educational and scientific purposes, it may not fully meet the FAO definition of a forest.

Sampling procedure and sample size A multi-tiered sampling approach selected research participants. The Huye District was chosen purposively for its significant non-timber forest-based activities in Rwanda. The Maraba Sector was randomly selected for its extensive reserved forest areas and resident's dependent on NTFPs for livelihood. Four communities within Maraba. Shyembe, Shanga, Gasumba, and Kabuye were randomly chosen for proximity to the Maraba chain mountains. Systematic sampling selected every 35th respondent from each community. Lists of farm households, including NTFPs collectors, were provided by the Forests Department. Proportionate sampling, using the Yamane (1967) formula, determined sample size, ensuring representation from each community and minimizing sampling error. The specific formula used was as shown in Equation *[1]*.

$$n = \frac{N}{1+Ne^2} \quad [1]$$

Note: n = the sample size, N = the total population, and e = the error term (8%).

Data collection This non-experimental study used cross-sectional data from primary and secondary sources. Primary data gathered through structured questionnaire-based interviews with selected participants. Table 1 illustrates the distribution of the sample size according to the various communities in the Maraba Sector. A pilot study with 30 Kanyinya community members from March to April 2022 validated the data collection tools. The main tool was a structured survey_questionnaire. prepared in English and Kinyarwanda. Final questionnaires combined open and closed-ended questions. The main data collection occurred from July to September 2022, involving integrated farmers, beekeepers, artisanal craft makers, and firewood collectors. Primary data included household variables (position, age, education, gender, and farm size) and institutional factors (training, credit, extension services, and market information). The survey also gathered data on NTFP types, economic uses, and household welfare, incorporating a total income variable from farm, off-farm, and NTFP-derived income.

Data analysis The study employed SPSS Ver. 29 to analyze the economic aspects of NTFPs using participants' data. Descriptive and inferential statistics were used, including frequencies, percentages, bar charts, and distribution tables, to summarize economic variables related to socio-economic drivers and household welfare. Before multiple linear regression analysis, normality, multicollinearity, and heteroscedasticity tests were conducted on the economic variables. A multiple linear regression model identified socio-economic factors influencing household welfare was applied.

Econometric model specification A multiple linear regression model was employed to investigate the effect of socio-economic factors on household welfare related to NTFPs in Rwanda's Huje District-Maraba Sector, South Province. The econometric model assumed a linear relationship between variables, non-random socio-economic factors with fixed values, linear parameters, zero mean error term, homoscedastic error term, and no autocorrelation or multicollinearity among control variables (Gujarati & Porter, 2015). Slope coefficients represent changes in average household income for one-unit increases in factors, ceteris paribus (Thomas, 1997). The analysis depends on specified socio-economic variable values (Gujarati & Porter, 2015), and farm household welfare is affected by both socio-economic factors and random variables.

$$Y_i = f(X_i, \varepsilon_i) \quad [2]$$

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 \ldots + \beta_{10} x_{10} + \varepsilon_i \quad [3]$$

Note: Y_i = total household income per month, β_0 = constant term, β_1 = coefficient of the parameters to be estimated, X_i = socio-economic variables, and ε_I = stochastic term. The primary goal of multiple linear regression analysis is to determine how changes in socioeconomic variables affect total household income (Thomas, 1997).

Results

Socio-economic characteristics of the respondents Table 2 summarizes the socio-economic profile of the respondents. The average age was 43 years, with an average of 8.7 years of formal education and 9.2 years of farming experience. The typical farm size was 1.2 ha, primarily dedicated to maize and cassava cultivation. Farms were located on average 1.7

Table 1 Distribution of respondents in Huye District, Maraba Sector, Rwanda

Community	Total population	Proportionate	Sample size
Shyembe	1,247	0.24	36
Shanga	1,430	0.27	41
Gasumba	1,026	0.19	29
Kabuye	1,585	0.30	46
Total	5,288	1.00	152

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km from forested areas, and respondents spent between 3 to 5 hours per trip gathering non-timber forest products (NTFPs). The average monthly household income was USD177, with 27.7% (USD49) derived from NTFPs, 58.4% (USD103) from farming activities, and 15.1% (USD27) from off-farm sources. Notably, 90% of respondents were household heads. Access to key support services varied, with 64% receiving agricultural extension, 59% forestry management training, 54% credit from financial institutions, and 62% access to market information relevant to NTFPs.

Type and uses of NTFPs Figure 2 details the spectrum of NTFPs collected by respondents. Fruits (guava, strawberry, orange, avocado) and vegetables (eggplant, waterleaf) were collected by 42.8% of respondents, honey by 9.9%, mushrooms by 16.4%, traditional medicinal plants such as *Vernonia amygdalin* and *Aloe vera* by 8.6%, and building materials like bamboo and thatch by 7.2%. These findings echo Demie (2019), who documented similar uses of NTFPs in Ethiopia's Chilimo natural forest, as well as research by Caspa et al. (2020), Miyake and Kohsaka (2023), Mohamed and Tesfaye (2020), and Panda et al. (2024).

Figure 3 illustrates how respondents utilize NTFPs to enhance household welfare. The majority (40.1%) used

Table 2 Descriptive statistics of socio-economic variables

Continuous variables	Mean	Std. Dev.	Min	Max
Age of farmer (years)	43.4	13.8	18.0	78.0
Farm size (hectares)	1.2	0.9	0.3	5.4
Education level (years)	8.7	3.6	0.5	16.0
Farming experience (years)	9.2	8.2	1.0	43.0
Distance to forest (kilometers)	1.7	1.25	0.5	7.0
Total household income (RWF)	177.01	83.875		544.58
NTFPs income (USD)	49.02	32.02	63.5	305.83
Farm income (USD)	103.36	80.105	25.0	416.66
Off-farm income (USD)	26.71	18.77	8.33	94.27
Categorical variables		**Category**	**Frequency**	**Percent**
Position of respondents in the farm household		Household head	137	90.1
		Spouse	6	3.9
		Siblings	6	3.9
		Others	3	2.0
Access to extension services		Yes	97	63.8
		No	55	36.2
Access to training		Yes	89	58.6
		No	63	41.4
Access to credit		Yes	82	53.9
		No	70	46.1
Access market information		Yes	94	61.8
		No	58	38.2

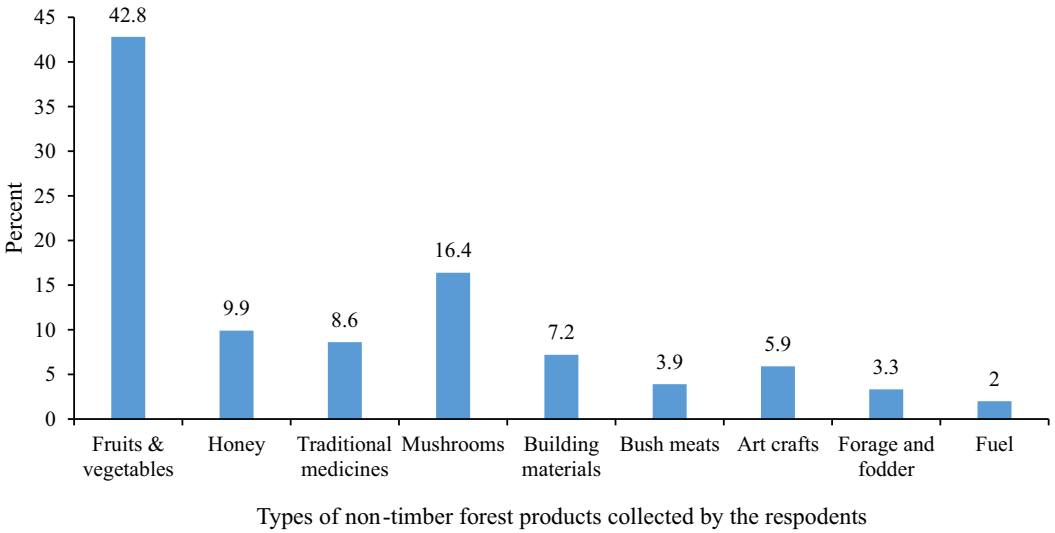

Figure 2 Types of non-timber forest-based products collected by the respondents in Maraba Sector in 2022.

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NTFPs primarily for household consumption. Income from NTFP sales supported education (21.1%), healthcare (12.5%), animal feed (10.5%), building materials (9.2%), and traditional medicinal treatments. These uses align with findings from Reta et al. (2020) in Eastern Ethiopia and Talukdar et al. (2021) in Northeast India, where rural populations depend on NTFPs for diverse subsistence and income needs.

Post-analysis evaluation Statistical diagnostics confirmed data suitability for regression analysis. The mean variance inflation factor (VIF) was 1.34, indicating no multi-collinearity. The Breusch-Pagan test ($\chi^2_{(1)} = 1.23$, p-value = 0.2671) suggested homoscedasticity, while the Kolmogorov-Smirnov test ($\chi^2_{(3)} = 8.75$, p-value = 0.0126) indicated a departure from normality.

Socio-economic drivers of non-timber forest-based products on household welfare Multiple linear regression analysis (Table 3) identified farm size, distance to forest, training, credit, and market information as significant predictors of household income. The model explained 60.1% of the variation in total household income ($R^2 = 0.601$, p-value < 0.001).

Farm size showed a strong positive effect (p-value < 0.01), with each additional hectare increasing income from NTFP sales by 13.9%. Distance to forest positively influenced income at the 10% significance level, with each kilometer increasing income by 0.1%. Training access enhanced household income significantly (p-value < 0.05), correlating with a 4.2% rise. Credit access surprisingly showed a negative relationship with income at the 10% level; a unit increase in credit access was associated with a 3.3% decrease in household income. Access to market information positively affected income (p-value < 0.10), where a 1% increase corresponded to a 6.3% income rise.

Discussion

The positive association between farm size and household income suggests that larger holdings provide increased resource availability and labor capacity, facilitating more effective NTFP collection and management. This finding contrasts with Demie (2019), who observed that Ethiopian households with higher agricultural and livestock incomes tended to rely less on NTFPs.

Proximity to forest areas proved important for income generation, as closeness reduces harvesting and transportation costs, enabling more frequent collection. This

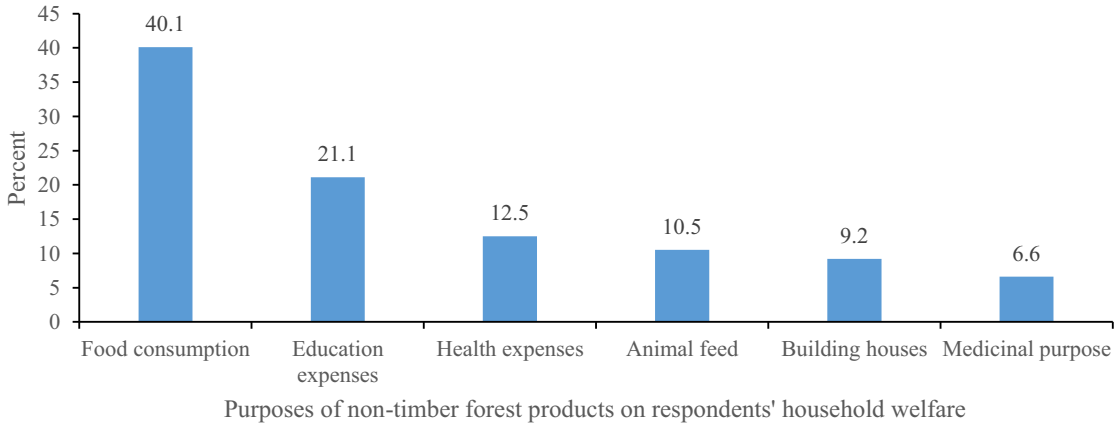

Figure 3 Purpose of non-timber forest-based products on respondents' household welfare in Maraba Sector.

Table 3 Multiple linear regression estimates for NTFPs on household welfare

Variable	Coefficient	Standard error	*t*-statistic	P>t
Age of farmer (years)	0.001	0.001	1.350	0.178
Household position of the farmers	-0.022	0.018	-1.200	0.231
Farm size(ha)	0.139***	0.011	12.920	0.000
Education level (years)	0.005	0.010	0.470	0.639
Farming experience (years)	-0.002	0.001	-1.380	0.168
Extension services (yes)	-0.025	0.029	-0.860	0.392
Distance to the forest (km)	0.001*	0.001	1.730	0.086
Training access (yes)	0.042**	0.022	1.930	0.055
Credit access (yes)	-0.033*	0.019	-1.730	0.086
Access to market information (yes)	0.063*	0.038	1.670	0.098
Constant	5.097***	0.049	104.590	0.000

Number of observations = 152, $F_{(10,141)} = 21.24$, Prob > $F = 0.0000$, Pseudo $R^2 = 0.601$. Note: * = significant, p-value <0.1; ** = significant, p-value <0.05 and *** = significant, p-value <0.001.

aligns with Beyene et al. (2020), who reported similar relationships in Ethiopia's Yayu Coffee Forest Biosphere Reserve.

Training was a key factor enhancing income, likely by providing essential knowledge and skills for sustainable collection, processing, and marketing of NTFPs. This supports Chu et al. (2019), who found that training significantly increased household incomes among NTFP farmers in Vietnam.

In contrast, the negative correlation between credit access and income suggests possible issues in credit utilization or indebtedness constraining profits. This differs from Chu et al. (2019), indicating the need to explore credit program effectiveness in the study area.

Finally, market information access significantly boosted income by informing collectors of demand, pricing, and quality standards, allowing better decision-making and market engagement. These results align with Amusa et al. (2017), who reported improved income among Nigerian farmers with better NTFP market knowledge.

Conclusion

In Rwanda's Southern Province, NTFPs are vital for rural income. NTFPs play a crucial role in supporting rural incomes and livelihoods in Rwanda's Southern Province, particularly in the Huye District, Maraba Sector. This study highlights the diverse uses of NTFPs, including food, income generation, healthcare, and construction, and identifies key factors influencing household welfare, such as proximity to forests, access to training, extension services, credit, and market information. Notably, limited access to credit remains a significant barrier to maximizing the benefits of NTFP activities. The findings underscore the importance of integrated strategies that address these constraints, offering valuable insights for researchers and policymakers worldwide who seek to promote sustainable forest-based livelihoods and reduce poverty in similar contexts.

Recommendation

Based on the findings, five key socio-economic factors significantly influence household income from NTFPs: farm size, distance to forests, access to training, credit, and market information. Therefore, to enhance the livelihoods of NTFP collectors, interventions should prioritize expanding training programs and improving access to market information, both of which showed positive and significant effects on income. Efforts should also support sustainable land use planning to optimize farm size and forest proximity. Given the negative impact of credit access on income, policies must address barriers to effective credit use by improving financial literacy and providing tailored credit schemes for NTFP activities. Additionally, promoting forestry and expanding NTFPs, specific forest zones can support income diversification and forest conservation. Finally, introducing compensation mechanisms for ecosystem services could incentivize sustainable forest management among forest-dependent households.

References

Adongo, W. A., Osei, C. K., & Wongnaa, C. A. (2019). Contribution of nontimber forest products to rural household income in the Kassena-Nankana West district of Ghana. *Forest Products Journal*, *69*(3), 217–227. https://doi.org/10.13073/FPJ-D-18-00049

Amusa, T. O., Jimoh, S. O., & Azeez, I. O. (2017). Socio-economic factors influencing marketing of non-timber forest products in tropical lowland rainforests of South-western Nigeria. *Southern Forests*, *79*(2), 161–168. https://doi.org/10.2989/20702620.2016.1255411

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N. J., Bauch, S., Börner, J., Smith-Hall, C., & Wunder, S. (2014). Environmental income and rural livelihoods: A global-comparative analysis. *World Development*, *64*(S1), S12–S28. https://doi.org/10.1016/j.worlddev.2014.03.006

Belcher, B., Ruíz-Pérez, M., & Achdiawan, R. (2005). Global patterns and trends in the use and management of commercial NTFPs: Implications for livelihoods and conservation. *World Development*, *33*(9 SPEC. ISS.), 1435–1452. https://doi.org/10.1016/j.worlddev.2004.10.007

Beyene, A. D., Mekonnen, A., Hirons, M., Robinson, E. J. Z., Gonfa, T., Gole, T. W., & Demissie, S. (2020). Contribution of non-timber forest products to the livelihood of farmers in coffee growing areas: Evidence from Yayu Coffee Forest Biosphere Reserve. *Journal of Environmental Planning and Management*, *63*(9), 1633–1654. https://doi.org/10.1080/09640568.2019.1679615

Caspa, R. G., Nyambi, G. N., Amang, M. J., Mabe, M. N., Nwegueh, A. B., & Foahom, B. (2020). Socio-economic benefits of non-timber forest products to the AFCOE2M communities of Southern Cameroon. *Sustainable Agriculture Research*, *9*(3), Article 30. https://doi.org/10.5539/sar.v9n3p30

Chu, T. van, Thoai, T. Q., An, C. Q., Toai, P. M., Camacho, L. D., & Sam, H. van. (2019). Contribution of forest to rural households' livelihood: Evidences from da river basin in the northwest mountainous region of Vietnam. *Forest and Society*, *3*(2), 235–247. https://doi.org/10.24259/fs.v3i2.7050

Demie, G. (2019). Contribution of non-timber forest products in rural communities' livelihoods around Chilimo forest, West Shewa, Ethiopia. *Journal of Natural Sciences Research*, *9*(22), 25–37. https://doi.org/10.7176/jnsr/9-22-04

Derebe, B., Alemu, A., & Asfaw, Z. (2023). Contribution of nontimber forest products earn to livelihood in rural households and the type of use: A systematic review. *International Journal of Forestry Research*, *2023*, Article 9643290. https://doi.org/10.1155/2023/9643290

Epanda, M. A., Donkeng, R. T., Nonga, F. N., Frynta, D., Adi, N. N., Willie, J., & Speelman, S. (2020).

Contribution of non-timber forest product valorisation to the livelihood assets of local people in the northern periphery of the Dja Faunal Reserve, East Cameroon. *Forests*, *11*(9), Article 1019. https://doi.org/10.3390/F11091019

FAO & Dalberg Catalyst. (2024). *Building a sustainable bioeconomy in Africa through forest products-Trends, opportunities and challenges*. FAO & Dalberg Catalyst. https://doi.org/10.4060/cd2463en

Gujarati, D. N., & Porter, D. C. (2015). *Basic econometrics* (5th ed., vol. 5). McGraw Hill Irwin.

Hakizimana, E., Wali, U. G., Sandoval, D., & Venant, K. (2020). Environmental impacts of biomass energy sources in Rwanda. *Energy and Environmental Engineering*, *7*(3), 62–71. https://doi.org/10.13189/eee.2020.070302

Huye District. (2013). *District potentialities assessment for the integrated and self-centered local economic development*.

Lepcha, L. D., Shukla, G., Moonis, M., Vineeta, Bhat, J. A., Kumar, M., & Chakravarty, S. (2022). Seasonal relation of NTFPs and socio-economic indicators to the household income of the forest-fringe communities of Jaldapara National Park. *Acta Ecologica Sinica*, *42*(3), 180–187. https://doi.org/10.1016/j.chnaes.2021.03.002

Lovrić, M., Da Re, R., Vidale, E., Prokofieva, I., Wong, J., Pettenella, D., Verkerk, P. J., & Mavsar, R. (2020). Non-wood forest products in Europe–A quantitative overview. *Forest Policy and Economics*, *116*, Article 102175. https://doi.org/10.1016/j.forpol.2020.102175

Ministry of Lands and Forestry. (2018). *Rwanda national forestry policy 2018*. Ministry of Lands and Forestry.

Miyake, Y., & Kohsaka, R. (2023). Climate change adaptation in non-timber forest products: How resilient are small shiitake producers? *Journal of Sustainable Forestry*, *42*(9), 922–946. https://doi.org/10.1080/10549811.2022.2123822

Mohamed, T. B., & Tesfaye, Y. (2020). Economic contribution to local livelihoods and household dependence on non-timber forest products: The case of Yeki Woreda Forests, Southwest Ethiopia. *International Journal of Scientific and Research Publications*, *10*(06), 489–509. https://doi.org/10.29322/ijsrp.10.06.2020.p10259

Mugido, W., & Shackleton, C. M. (2019). The contribution of NTFPS to rural livelihoods in different agro-ecological zones of South Africa. *Forest Policy and Economics*, *109*, Article 101983. https://doi.org/10.1016/j.forpol.2019.101983

Nahayo, A., Ekise, I. E., & Niyigena, D. (2013). Assessment of the contribution of non-timber forest products to the improvement of local people's livelihood in Kinigi Sector, Musanze District, Rwanda. *Ethiopian Journal of Environmental Studies and Management*, *6*(6), 698–706. https://doi.org/10.4314/ejesm.v6i6.13

Nerfa, L., Rhemtulla, J. M., & Zerriffi, H. (2020). Forest dependence is more than forest income: Development of a new index of forest product collection and livelihood resources. *World Development*, *125*, Article 104689. https://doi.org/10.1016/j.worlddev.2019.104689

Nsabimana, D. (2012). Seasonal variation of litter arthropods in some Eucalyptus plantations at the Arboretum of Ruhande in Rwanda. *Biology Agriculture and Healthcare*, *3*(9), 49–56.

Olufunmilayo, D. E., Jimoh, A. K., Oyewole, O. S., & Ayeni, E. A. (2019). Non-timber forest products (NTFPs) as a means of livelihood and safety net among the rurals in Nigeria: A review. *American Journal of Service Science and Management*, *6*(1), 27–31.

Panda, L. R. L., Uniyal, A., Kukreti, J., Ritu, & Singh, N. (2024). The role of non-timber forest products for livelihood diversification in Bundelkhand Region of Uttar Pradesh. *International Journal of Economic Plants*, *11*, 70–78. https://doi.org/10.23910/2/2024.5005

Rahman, M. H., Roy, B., & Islam, M. 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

Republic of Rwanda. (2018). *Republic of Rwanda Southern Province Huye District.*

Reta, Z., Adgo, Y., Girum, T., & Mekonnen, N. (2020). Assessment of contribution of non-timber forest products in the socio-economic status of peoples in Eastern Ethiopia. *Open Access Journal of Biogeneric Science and Research*, *4*(4).

Shackleton, C., Delang, C. O., Shackleton, S., & Shanley, P. (2011). Non-timber forest products: Concept and definitions. In S. Shackleton, C. Shackleton, & P. Shanley (Eds.), *Non-timber forest products in the global context* (pp. 3–21). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-17983-9_1

Talukdar, N. R., Choudhury, P., Barbhuiya, R. A., & Singh, B. (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*, Article 100042. https://doi.org/10.1016/j.tfp.2020.100042

Thammanu, S., Han, H., Marod, D., Zang, L., Jung, Y.,

Soe, K. T., Onprom, S., & Chung, J. (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

Thomas, R. L. (1997). *Modern econometrics: An introduction.* Addison Welsey Longman Ltd.

Tuyisenge, M. F., Kayitete, L., Tuyisingize, D., O'Malley, M., Stoinski, T. S., & van der Hoek, Y. (2023). Status of African authorship among conservation research output from sub-Saharan Africa: An African perspective. *Conservation Science and Practice*, *5*(10), Article 13013. https://doi.org/10.1111/csp2.13013

Verkerk, P. J., Hassegawa, M., van Bresselen, J., Cramm, M., Chen, X., Maximo, Y. I., Koc, M., Lovric, M., & Tegegne, Y. T. (2021). *Forest products in the global bioeconomy*. *Enabling substitution by wood-based products and contributing to the sustainable development goals*. FAO. https://doi.org/10.4060/cb7274en

Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.).

Zubair, M., Karim, M., & Hussain, S. B. (2022). Assessment of the potential of non-timber forest products in livelihoods' sustenance of the flood proximate communities of the Indus Basin, Pakistan. *Asian Journal of Research in Agriculture and Forestry*, *8*(4), 201–210. https://doi.org/10.9734/ajraf/2022/v8i4180