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Measuring Livelihood Diversification and Forest Conservation Choices: Insights from Rural Cameroon

Jude Ndzifon Kimengsi ^{1,*}, Jürgen Pretzsch ¹, Mukong Alfred Kechia ^{2,3} and Symphorien Ongolo ⁴

¹ Institute for Tropical Forestry & Forest Products, Technische Universität Dresden, 01737 Tharandt, Germany; juergen.pretzsch@forst.tu-dresden.de

² Department of Economics, University of Namibia, Windhoek 13301, Namibia; amukong@unam.na or mukalf83@gmail.com

³ Carnegie Fellow, School of Economics, University of Cape Town, Cape Town, Rondebosch 7701, South Africa

⁴ Chair of Forest and Nature Conservation Policy, University of Göttingen, 37077 Göttingen, Germany; songolo@uni-goettingen.de

* Correspondence: jude_ndzifon.kimengsi@tu-dresden.de; Tel.: +49-3520-3383-1213

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Abstract: While forests' contribution to rural livelihoods has been unearthed scientifically, the patterns, determinants and forest conservation policy implications of livelihood diversification still beg for more scientific and policy edification. This paper makes a contribution in this regard, using household data ($N = 200$) from eight villages around the Kilum-Ijim Forest Landscape of Cameroon. The ordinary least square and the logit model are used to explore the determinants of livelihood diversification and the likelihood of forest dependence, respectively. The diversification patterns were analysed using a simple t -test, and the multinomial logit for conservation choices. We find that forest-related activities are a source of livelihood diversification for 63% of households, with non-timber forest products (NTFP) domestication (31%) and medicinal plant extraction (30%) being the most preferred. For non-forest activities, migration is the most preferred diversification strategy. Generally, households with favourable socio-economic status prefer non-forest to forest activities for livelihood diversification. The regression estimates indicate that older respondents are more likely to depend on the forest than the young, whereas males and individuals with at least some secondary education are less likely than their respective counterparts to rely on the forest. The results also suggest those who participated in training, educated household heads and older individuals are significantly more likely to choose high-valued diversification strategies. Concerning conservation activities, households with favourable socio-economic status are on average less likely to adopt NTFP domestication and more likely to adopt bee-keeping as a conservation choice. The results suggest the need for policy considerations to: (i) effectively integrate women in forest management processes, (ii) intensify trainings for conservation-friendly diversification approaches, (iii) regulate unclean energy use and (iv) encourage value chain improvement for conservation-friendly products.

Keywords: conservation choices; livelihood diversification; forest dependence; forest policy; Cameroon

1. Introduction

1.1. Livelihood Diversification and Conservation

Almost invariably, international and national development focus in low-income countries is tilted towards the rural areas [1–3]. In fact, rurality has been considered synonymous to poor peasantry and underdevelopment, necessitating permanent assistance and rural animation (including livelihood diversification) policies from development or governmental agencies [4,5]. Changes in livelihood

strategies are triggered by broader socio-political and economic policies, usually context-specific, evolving from natural-resource-dependent to less-natural-resource-dependent activities, and vice versa [6]. An extensive body of knowledge affirms the significant dependence of poor rural households on the natural resource base [3,4,7,8], including around forest conservation sites in tropical African countries like Cameroon [9–11]. However, single livelihood sources have proven over the years to be insufficient to emancipate the rural poor from their poverty trap, requiring the adoption of multiple options. Consequently, rural households rely on a range of natural-resource-dependent (such as timber and non-timber forest product extraction) and/or non-natural-resource-dependent activities such as microenterprise and outmigration [12–14]. This therefore highlights the important role of livelihood diversification in rural poverty alleviation. Livelihood diversification is construed as the process by which households employ a wide range of income-generating activities and social networks to construct a portfolio of livelihood activities for improved livelihood outcomes [15,16].

In retrospect, natural resource conservation and livelihoods represent two opposing positions—many conservation programmes (especially in forestry and wildlife) imply a deprivation of marginal communities of their livelihood assets [9,17–19]. This is buttressed by the leviathan paradigm which recommends policing and the use of coercive force to subject the rural poor to respect and protect the integrity of conservation sites, whether or not they have livelihood support [20]. According to [21], this will entail the dominance of rules monitored and implemented within formal governance structures (such as relevant state ministries). Understanding the patterns of livelihood diversification and their potential implications for resource conservation (forest, in this case) is vital to support current and future conservation choices.

More than 2 decades since the sustainable livelihoods framework was introduced by the Department for International Development (DFID), it has been applied in varying proportions by rural development policy makers [22]. However, for the most part, it has been linked to the recurrent application of qualitative analytical approaches. Such recurrence begs for innovative analysis [23,24], at least in the sphere of quantification approaches [25,26]. Recent attempts to quantify the dynamics of household-level livelihood strategies and their determinants using panel data [26–28] did not consider their implications for forest conservation choices in most sub-Saharan African (SSA) contexts. Perhaps importantly, they did not demonstrate clarity on the implications of livelihood diversification on current and future conservation approaches.

Many countries in the Congo Basin of SSA (including Cameroon) have secured significant proportions of their forestland surface for conservation; since 1970, the total area coverage of conservation sites in SSA increased nearly twofold [29]. Called “Africa in miniature”, Cameroon has over 30 protected areas, including wildlife sanctuaries, national parks and forest reserves, which span across the country covering over 4.4 million hectares [9]. These forests are directly or indirectly pressurized by adjacent timber exploitation and agro-plantation expansion. Even more pertinent are the activities of poor resource-dependent communities around conservation sites as they strive to secure a livelihood. One of these, the Kilum-Ijim Forest Landscape (totalling about 20,000 ha), contains unique flora and fauna [30,31] with over 300,000 people depending on the forests for their livelihoods [32,33]. Conservation and livelihood research has been extensively covered in the qualitative field. This suggests an immense research gap in employing quantitative tools to analyse livelihood diversification dynamics and their potential or actual implications for natural resource conservation, the main source of survival for the rural poor [26–28]. Even recent studies on livelihoods and conservation in the Kilum-Ijim Forest Landscape (KIFL) focused largely on qualitative analysis [33]. We make a contribution in this regard by analysing the diversification patterns of 200 households around the KIFL in Cameroon, and discussing their implications for conservation choices. Knowledge in this sphere is relevant in policy (re)orientation with regards to supporting livelihood strategies around conservation sites. This paper therefore addresses three questions: (i) What are the observed livelihood diversification patterns around montane forest conservation sites? (ii) What drives livelihood diversification around montane forest conservation sites? (iii) How does diversification affect forest conservation choices around the KIFL?

1.2. Livelihood Diversification in Cameroon

Real-world scenarios indicate that people combine different activities in a complex bricolage or portfolio of activities [24]. The determining forces of households' choice of livelihood strategies have been extensively covered in the context of welfare outcomes [34,35]. Conclusions along this line of study point to the fact that households' livelihood choices are dependent largely upon differential access to and control over the five types of livelihood assets. In addition, geographical location and distance to acquire these resources and/or market them were further considered to have a significant influence on the choice of livelihood strategy [16,36,37]. These aspects, including the state of infrastructure, militate either for or against livelihood diversification and conservation choices. The extent to which these variables operate is defined by framed socio-economic, political and institutional contexts (Figure 1). Scientific investigations have revealed positive relationships between livelihood diversification (especially nonfarm sector) and improved welfare outcomes [38–40]. These are considered similar to those put forward in the income diversification literature to include risk reduction, response to diminishing returns (from, for example, labor supply in the presence of land constraints), seasonality of different income opportunities, household-based skills and shocks [34,41,42]. Very few studies have actually examined the role of livelihood diversification as a predictor, or independent variable [43,44], especially of forest conservation choices. The livelihoods framework which represents the analytical construct of this study assumes a structured focus on rural household assets, activities and outcomes [42]. We adapt the livelihoods framework to emphasize our analytical variables—diversification strategies and conservation choices—using insights from the study area (Figure 1). The framework considers forest-dependent activities such as non-timber forest products (NTFPs) gathering and domestication, timber sales, medicinal plant extraction, arts and crafts and non-forest-dependent (private and civil service jobs, migration and petit trading) diversification strategies. It should be noted equally that many forest products are noncash and supply important parts of livelihoods related to medicine and housing materials, amongst others [45]. While conservation organizations continually propose a series of conservation strategies to target communities, some of these strategies do not always result in the intended conservation outcomes (e.g., alternative livelihoods); they rather contribute to the further diversification of incomes [46].

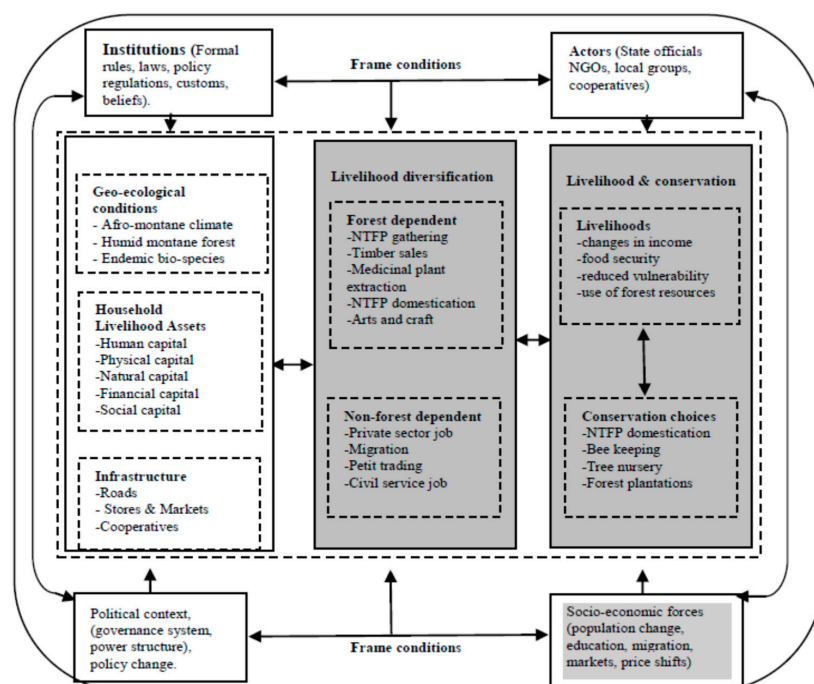


Figure 1. Conceptual framework on livelihood diversification and conservation choices. Adapted from [12–14,17,25,45].

2. Materials and Methods

2.1. Study Area

The KIFL forms one of the over 30 protected areas in Cameroon [9]. Totalling about 20,000 ha, it contains unique flora and fauna [30,31] with over 300,000 people depending on the forests for their livelihoods [32,33]. It is one of the largest remaining West African montane forests and exhibits a high level of endemism in biodiversity [47], with numerous forest-dependent adjacent communities. Conservation efforts in the landscape began in 1931, leading to land dispossession for some families (see [30]). The extent to which this situation shaped livelihoods and conservation choices still needs to be further clarified. Communities around the KIFL (Figure 2) have a long history of cultural institutions, and they largely operate on the basis of a traditional centralized political system. Dominant cultural groups here include the Oku, Nso and Kom [48]. Apart from serving as habitat for endemic biodiversity species, the forests and Lake Oku are attached to endogenous cultural institutions which further shape their interactions with the forest in their quest for livelihood support. This is evident in the case of customary access and use rules around resources.

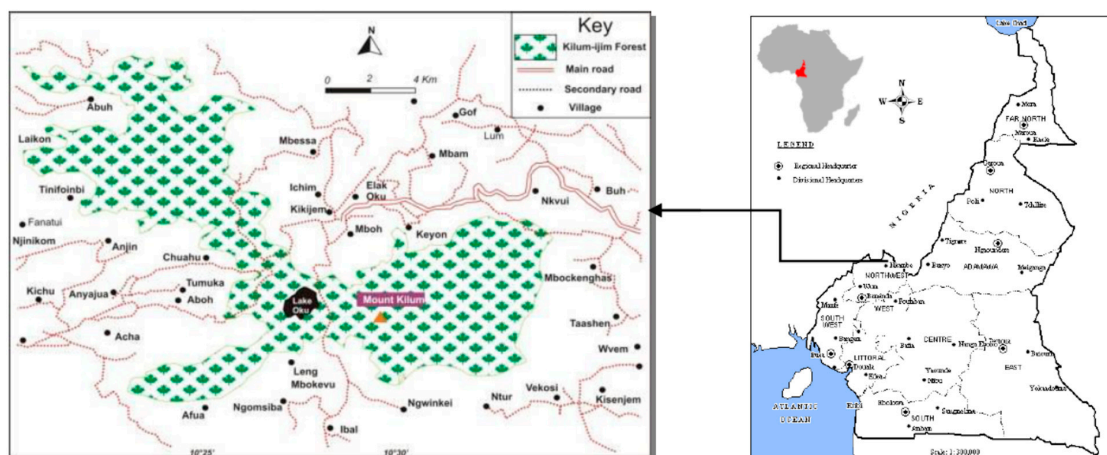


Figure 2. Kilum-Ijim Forest Landscape and adjacent communities.

2.2. Data Collection

The choice of households' livelihood diversification strategy is a reflection of their socio-economic characteristics [49]. The assumption under livelihood diversification is that people engage in a range of activities that produce livelihood outcomes by drawing from a range of livelihood assets [50]. Livelihood assets (or capital) are therefore important determinants of livelihood outcomes [51,52]. This paper approaches the study of the determinants of livelihood diversification in selected rural communities around the KIFL in Cameroon, with similar livelihood diversification strategies. We categorize livelihood diversification strategies, taking into consideration the available diversification opportunities of these forest-adjacent communities.

2.3. Empirical Model

The appropriate model to analyse the determinants of livelihood diversification and forest conservation choices is the multinomial logit (MNL) model—a choice model that is underpinned by the utility maximization concept [53,54]. The assumption is that households choose a livelihood diversification strategy that yields maximum utility given their characteristics. Their livelihood diversification choices, however, have implications for forest conservation choices. The utility function is specified as:

$$U_{ij} = (X_{ij}a_i + \varepsilon_{ij}) > U_{in} = (X_{in}a_i + \varepsilon_{in}) \quad \forall j \neq n \quad (1)$$

where U_{ij} is the utility to household i for choosing livelihood diversification strategy or conservation activity j , X_{ij} is a vector of household socio-economic characteristics, a_j is a vector of parameter estimates and ε_{ij} is the error term. U_{in} represents the household utility for any alternative livelihood diversification or conservation choice other than j . The MNL is based on probability of diversifying, j , from alternative J choices. The reduced form MNL is specified as:

$$P_{ij} = Pr(y_i = j) = \frac{\exp(X_{ij}a_j)}{\sum_{n=1}^J \exp(X_{in}a_n)}, \quad j = 1, 2, 3, \dots, J \quad (2)$$

where; y_i represents the livelihood diversification or conservation strategies available to the household i . There are eight diversification strategies identified in the study sites and considered in this paper.

One key assumption of the MNL is the Independence of Irrelevant Alternatives (IIA). Under the IIA assumption, one would not expect a significant change in the results if one of the outcomes is excluded from the model. However, the IIA test results indicate that the difference between the full and reduced equation is significant, a violation of the IIA assumption. To address this limitation, we created an index from the different livelihood diversification strategies following the approach by [53] in calculating the human development indices and estimated the index using the ordinary least square (OLS). This index is written as:

$$IndexA_i = \frac{A_i - A_{min}}{A_{max} - A_{min}} \quad (3)$$

where A_i is the actual value of an indicator for household i , and A_{min} and A_{max} are the minimum and maximum values, respectively, of the indicator for the whole data set (1 for private/civil service and 8 for NTFP domestication). In the data, people were asked to list their most preferred diversification strategy. We used this information to rank the diversification strategies. We further grouped them under forest and non-forest livelihood strategies, and estimated the outcome using the logit model. The MNL model was used to estimate the determinants of forest conservation choices. The pattern of diversification as a function of socio-economic variables was analysed using the t -test.

The proposed model does not factor in political forces which in reality might directly or indirectly shape the livelihoods and conservation strategies. Some of these forces could include pressure to participate in conservation livelihood programs, competition from other village members, access to sites where such activities could be carried out, customary rules of access and the status of the people engaged in livelihood activities (migrants or non-migrants). These aspects could be further unraveled in subsequent investigations.

2.4. Data, Sample and Variables

This research forms part of a broader ongoing interdisciplinary, mixed-methods research on institutions and livelihood sustenance around forest communities in Cameroon, under the Excellence Initiative of the Technische Universität Dresden. The first part of the study, which was qualitative in nature, focused on the links between participatory forest management and community livelihoods around the KIFL. This formed the basis for a potential quantitative investigation on the livelihood diversification determinants, patterns and forest conservation policy implications for target communities around the study site.

Data for this study was collected for two months (between July and September 2018). The key instrument employed was a semi-structured questionnaire (50 items) which took into consideration household socio-economic status, livelihoods assets, livelihood diversification strategies and forest conservation choices. Both individual (age, gender, education, trainings, migration) and household (income, household size, number of dependents, education of household head, credit and main energy sources) socio-economic characteristics were considered in the study. Based on preliminary qualitative investigations, a range of key livelihood diversification strategies were identified to include

NTPF gathering/domestication, private/public service, migration, petit trading, timber sales, arts and crafts, and medicinal plant extraction and domestication. The proposed forest conservation choices included tree nursery/forest plantations, NTPF domestication/bee-keeping and conservation advocacy. The questionnaire was pretested during qualitative surveys ($N = 20$) and further refined to capture relevant diversification strategies. Eight villages judged to mirror the key diversification components were purposively selected for this study (Table 1). These villages were chosen based on preliminary qualitative investigations around the study sites, and based on their perceived intensity in employing the key livelihood diversification strategies. Another key consideration was proximity to the conservation site—the villages are located between less than 1 km to 3 km around the KIFL. Such proximity was judged to be crucial in guiding the interaction intensity. To ensure representativeness, we chose villages from the Kilum and the Ijim sections of the reserve.

Table 1. Target villages and their estimated distances from the KIFL.

SN	Village	Distance from Park	Target No. of HH
1	Manchok	<1 km	25
2	Keyon	<1 km	25
3	Elak	<1 km	25
4	Nkui	1–2 km	25
6	Nguvinkei II	1–2 km	25
7	Simonkoh	2–3 km	25
8	Kevu	2–3 km	25

Data was collected from 200 representative households using a systematic sampling design with a focus on male and female household representatives. Emphasis was placed on adult household members who have had some experience in the observed livelihood diversification strategies. The data were then coded and entered into Excel and analysed using STATA statistical software version 14 (Quantec, Cape Town, South Africa).

3. Results

3.1. Household Socio-Economic Characteristics and Livelihood Diversification Patterns

Generally, a majority of the respondents chose NTPF domestication (31%) and medicinal plant extraction (30%) as their most preferred livelihood diversification strategy. This preference is linked to their attachment, especially to apiculture. The proportion is relatively very small for those in the public/civil service (4%), NTPF gathering (5%) and those who prefer timber sales (8%). Approximately 10% and 12% of the respondents preferred arts and crafts and migration (mostly rural–urban), respectively, as their livelihood diversification strategy. In all, 63% of the sample chose forest-related activities as their preferred livelihood diversification strategy. This suggests that these communities depend highly on forests for livelihood (See Row 1 of Table 2).

Overall, males significantly constitute the majority in most of the livelihood diversification strategies compared to females. However, the proportion of women in forest-related livelihood strategies (77%) is significantly higher than that of men (55%). This is not surprising because the main activity of women in rural areas is agriculture. Over 73% of respondents with at most primary education, compared to 43% of those with at least secondary education, depend on the forest for their livelihood. If the household head is educated, the household is less likely to depend on the forest (56%) than when the household head is less educated (74%). It is surprising that more educated individuals are significantly less likely to choose private/civil service jobs and migration; however, educated household heads are more likely to choose these activities as their diversification options. This indicates that policies to enhance in situ conservation-friendly diversification approaches could further activate future conservation activities.

A large proportion of trained individuals (74%) preferred forest-related activities for their livelihood compared to untrained individuals. This is not surprising because training received was largely unrelated to non-forest conservation activities. Training policies should be geared towards non-forest-linked activities and conservation-friendly diversification approaches. The proportion of non-migrants involved in forest-related livelihood strategies (79%) is significantly higher than the proportion of migrants (53%). This logically indicates that migrants already consider their action (movement) as a diversification strategy, as it generates remittances.

However, respondents with credit access significantly participated in NTFP domestication (67%). Such a result indicates potentials for more credit access to support the domestication of NTFPs, which does not significantly impact forest health. With regard to household energy use, a statistically significant difference in the proportion of dependence on the forest was observed among households that use unclean energy (fuel wood and charcoal) as livelihood strategies (66%) compared to households that use clean energy (55%). Enacting policies that promote access to clean energy (such as biogas) will stem the overreliance on forest products for household energy.

Table 2. Descriptive statistics of socio-economic characteristics according to livelihood diversification strategies.

		Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5	Strategy 6	Strategy 7	Strategy 8
All		0.05 (0.22)	0.04 (0.20)	0.12 (0.33)	0.08 (0.27)	0.10 (0.30)	0.31 (0.46)	0.30 (0.46)	0.63 (0.48)
Gender	Male	0.077	0.062	0.123	0.108	0.108	0.446	0.706	0.553
	Female	0.000	0.00	0.118	0.029	0.088	0.059	0.077	0.765
	Differences	0.08 ***	0.06 ***	0.005	0.08 **	0.02	0.39 ***	−0.63 ***	−0.21 ***
Education	At most primary	0.000	0.062	0.046	0.000	0.031	0.446	0.415	0.731
	At least secondary	0.147	0.000	0.265	0.235	0.235	0.059	0.059	0.426
	Differences	0.15 ***	−0.06 ***	0.22 ***	0.24 ***	0.20 ***	−0.39 ***	−0.36 ***	−0.30 ***
Education of HH	At most primary	0.081	0.000	0.129	0.081	0.000	0.483	0.226	0.743
	At least secondary	0.000	0.108	0.108	0.081	0.270	0.027	0.405	0.556
	Differences	−0.08 ***	0.11 ***	−0.02	0.00	0.27 ***	−0.31 ***	0.18 ***	−0.19 ***
Training participation	Did not participate	0.081	0.065	0.194	0.129	0.161	0.161	0.209	0.556
	Participated	0.000	0.000	0.000	0.000	0.000	0.556	0.444	0.736
	Differences	−0.08 **	−0.06 **	−0.19 ***	−0.13 ***	−0.16 ***	0.39 ***	0.23 ***	0.18 **
Migration	Did not Migrate	0.000	0.000	0.029	0.000	0.000	0.171	0.800	0.786
	Migrated	0.079	0.063	0.175	0.127	0.159	0.381	0.016	0.532
	Differences	0.08 **	0.06 **	0.12 ***	0.13 ***	0.16 ***	0.21 ***	−0.78 ***	−0.25 ***
Credit	Received credit	0.000	0.000	0.167	0.000	0.000	0.667	0.167	0.694
	Did not receive	0.061	0.049	0.111	0.097	0.122	0.232	0.329	0.616
	Differences	−0.06	−0.05	0.06	−0.05 *	−0.12 **	0.43 ***	−0.16 *	0.08
Main energy	Clean	0.000	0.138	0.138	0.034	0.345	0.103	0.241	0.552
	Unclean	0.070	0.000	0.113	0.099	0.000	0.394	0.324	0.662
	Differences	−0.07 **	0.14 ***	0.03	−0.06	0.34 ***	−0.29 ***	−0.08	−0.11

Strategy 1 represents NTFP gathering, Strategy 2 is private/civil service, Strategy 3 is migration, Strategy 4 is timber sales, Strategy 5 is arts and crafts, Strategy 6 is NTFP domestication, Strategy 7 is medicinal plant and Strategy 8 is forest-dependent. Differences refer to differences in mean of the various factors for a given strategy. Standard deviation in parentheses
 *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3.2. Determinants of Livelihood Diversification

As highlighted earlier, the multinomial logit (MNL) model is theoretically appropriate in analysing the determinants of livelihood diversification, but under the condition that the Independence of Irrelevant Alternatives (IIA) assumption is satisfied. Under the IIA assumption of the model, one would expect a significant change in the results if one of the outcomes is excluded from the model. We run the full and reduced form model by excluding one of the strategies (trading) and the results are compared using the Hausman test. The difference in the coefficient between the two models is systemically large. However, we present the MNL estimates in the Appendix A (Table A1) while our discussion focuses on the estimates presented in Table 3. Marginal effects from the logit model are presented in Columns 1 and 2.

The results in Table 3 indicate that older individuals are more likely to increase the probability of using forest-related strategies than youths. For example, the probability of relying on the forest increases by 53% among individuals aged between 16 and 25, and 40% for those aged 55+, compared to those less than 16 years old. The probability increases to 55% and 41%, respectively, after controlling for additional household characteristics (see Columns 1 and 2 of Table 3 for comparison). This suggests the need for policies that encourage conservation advocacy among youths. Having at least some secondary education reduces the probability of choosing a forest-related livelihood diversification strategy by 18%. This effect reduces to 16% after controlling for additional household characteristics. The results contrasts with the case of educated household heads whose probability of depending on the forest increases by 14%. Being male significantly reduces the probability of choosing some forest-related livelihood diversification strategies by 34%. Household size, number of dependents, household per capita income and participation in formal trainings have no significant effect on the probability of using forest-related livelihood strategies.

The ordinary least square (OLS) results are presented in Columns 3 and 4 of Table 3. Being older contributes positively to variations in the livelihood diversification index. Since high values of the index implies highly valued livelihood diversification strategies, individuals aged 16–25 are 20% to 23% more likely to choose highly valued diversification strategies than those of age less than 16 years. The age group of 55+ shows a 28% to 30% likelihood of choosing highly valued diversification strategies. Males are 20%–21% less likely to use highly valued diversification strategies. The level of education of the household head reduces variation in the index by 14%. Participating in formal training increases variation in the livelihood diversification index by 22%, while the level of education of the respondent, household size, number of dependents and household per capita income has no significant influence on the index.

3.3. Determinants of Conservation Choices

Under conservation activities, the Independence of Irrelevant Alternatives (IIA) assumption is satisfied and we use the MNL to estimate the determinants of conservation choices (see Columns 5 and 6 of Table 3). The results show that being 26–55 years old reduces the probability of adopting NTFP domestication or bee-keeping by 25% while their chance of adopting tree nursery or forest plantation increases. Individuals with at least secondary education significantly reduce the probability of choosing tree nursery or forest planting as a conservation activity by 24%. Their involvement in NTFP domestication and bee-keeping is rather insignificant. The education of household heads reduces the chance of adopting NTFP domestication and bee-keeping by 14%. Male respondents have a reduced chance of using NTFP domestication and bee-keeping by 51% while their chance of pursuing tree nursery and forest planting increases by 53%. Participating in formal training reduces the chance of adopting NTFP domestication and bee-keeping by 22%, but increases the probability of adopting tree nursery and forest planting by 20%. Insignificant effects on the probabilities are observed for household per capita income (1%), household size (1%) and the number of dependents (1%).

Table 3. Estimated results for the determinants of livelihood diversification and conservation activities.

Variables	Logit Estimates		OLS Estimates		Multinomial Logit	
	(1)	(2)	(3)	(4)	(5)	(6)
Individual is aged 16–25	0.53 *** (0.09)	0.55 *** (0.10)	0.20 *** (0.06)	0.23 *** (0.07)	0.08 (0.12)	−0.09 (0.13)
Individual is aged 26–55	0.13 (0.10)	0.14 (0.10)	0.15 ** (0.06)	0.16 ** (0.06)	−0.25 *** (0.09)	0.39 *** (0.09)
Individual is aged 55+	0.40 *** (0.10)	0.41 *** (0.10)	0.28 *** (0.07)	0.30 *** (0.07)	0.68 (28.0)	0.34 (26.9)
At least secondary education	−0.18 *** (0.07)	−0.16 ** (0.07)	−0.07 (0.05)	−0.06 (0.05)	0.09 (0.07)	−0.24 *** (0.07)
Individual is male	−0.34 *** (0.08)	−0.34 *** (0.08)	−0.20 *** (0.05)	−0.21 *** (0.05)	−0.51 *** (0.07)	0.53 *** (0.08)
Education of household head	0.14 * (0.08)	0.14 (0.08)	0.14 *** (0.05)	0.13 ** (0.05)	−0.14 * (0.08)	0.03 (0.08)
Participated in formal training	−0.03 (0.08)	−0.02 (0.09)	0.22 *** (0.05)	0.21 *** (0.06)	−0.22 ** (0.09)	0.20 ** (0.09)
Household per capita income		−0.03 (0.04)		−0.03 (0.03)	−0.09 ** (0.04)	0.08 ** (0.05)
Household size		0.01 (0.02)		0.00 (0.01)	−0.05 *** (0.02)	0.01 (0.01)
Number of dependents		−0.02 (0.03)		−0.01 (0.02)	−0.06 * (0.19)	0.05 (0.03)
Livelihood indicator					0.04 (0.07)	0.04 (0.07)
Constant			0.40 *** (0.06)	0.66 ** (0.30)		
Observations	196	196	196	196	196	196
R-squared			0.28	0.29		

Note that results in Columns (1) and (2) are estimates of the probability of choosing forest-related activities as a livelihood diversification strategy, whereas results in Columns (3) and (4) are estimates of the effects of socio-economic characteristics on the livelihood diversification. The base category for age is less than 16 years, at most primary education for education, female for gender, and nonparticipation for formal training. Results in Columns (5) and (6) are marginal effect estimates of the determinants of conservation choices. The base category is conservation advocacy, Column (5) is NTFP domestication/bee-keeping, Column (6) is tree nursery/forest plantation. Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

4. Discussion

The forest livelihood field of inquiry is largely characterized by sparse country- and region-wide data on forests, poverty, health and other institutional factors. This hinders country- or region-wide comparisons, especially on forests' contribution to livelihoods and policy actions thereof [55]. We made an empirical contribution in this literature by answering three interlinked questions: (i) What are the observed livelihood diversification patterns around montane forest conservation sites? (ii) What drives livelihood diversification around montane forest conservation sites? (iii) How does diversification affect forest conservation choices around the KIFL? Household survey data ($N = 200$) from eight villages around the KIFL and quantitative techniques were used to answer these questions. Using the rural livelihoods framework lens, the systematic analysis of livelihood patterns, determinants and conservation choices was conducted by employing the ordinary least square, the logit model, the multinomial logit (MNL) model and a simple t -test.

On the choice of livelihood diversification options, forest-dependent livelihood diversification preferences account for a larger proportion of the sample. This result indicates a current and future tendency of further dependence on the forest for livelihoods. The results show a connection with over 21 cases across Asia, where NTFPs contributed more substantially (50% or more) to support households [55,56]. Also, the Center for International Forestry Research (CIFOR)'s Poverty and Environment Network (PEN)'s comparative study of cases drawn across 24 countries showed an average contribution of 27.5% forest and environmental income to households living in or near forests [57,58]. Within the central African region (including Cameroon), household support has been

linked to a number of NTFP collection activities [59,60]. What remains to be fully explored are the relevant local rules and national policies that could encourage more forest-conservation-friendly activities such as reliance on bee-keeping and other NTFPs.

With up to 12% of household members opting for migration as a livelihood diversification strategy, deeper investigations on whether remittances emanating from migration are skewed towards forest-conservation-friendly or unfriendly investments should be given due attention. Few studies have shown a negative relationship between conservation and the flow of migrant remittances in rural areas [61]. Exploring gender dimensions in forest conservation could further complement the literature study, and also pave the way for more context-specific gender inclusive policies as women depend heavily on the forest for their livelihood. More educated household heads and members were less likely to depend on forest-related diversification activities. However, their limited dependence on migration as a diversification option suggests that future activities might be directed towards the forest, should they witness shocks in current non-forest livelihood activities. Therefore, policies to enhance in situ conservation-friendly diversification approaches are required. Trained individuals were less likely to rely on the forest, indicating that diversification training approaches are required around the study site. Access to credit led to significant participation in NTFP domestication. The concept of microcredits postulated by [62] demonstrates significant potential to promote rural livelihood diversification and poverty alleviation. This logically explains why access to credit is positively linked to participation in livelihood diversification. A statistically significant difference in the use of forest-related strategies was observed between households that use unclean energy and households that use clean energy. Therefore, regulating the use of unclean energy and promoting access to clean energy (such as biogas) will reduce household overreliance on forest products. Biogas demonstrates significant potential as an alternative household energy source for households in Cameroon [63].

The regression estimates indicate that being older increases the probability of relying both on the forest and high-valued livelihood diversification strategies. Having at least some secondary education significantly reduces the chance of depending on forest-related livelihood diversification strategies. Viewed through the lens of Sen's capability approach [64], it can be concluded that capacities and capabilities enhanced through education have enabled the rural poor to discover other avenues for livelihood support [65]. A contrast is observed for household heads with at least some secondary education, and has no significant effect on the use of high-valued diversification strategies. Empirical research across Africa has shown a positive influence of education and training on livelihood diversification decisions [66,67]. The results further suggest that being male significantly reduces the probability of choosing forest-related livelihood diversification strategies.

The results for conservation practices indicate that being older (26–55 years) and being male significantly reduces the probability of adopting NTFP domestication (or bee-keeping) but increases the chance of adopting tree nursery or forest plantations as conservation activities. In other cases, age has often been considered crucial in the choice of high return diversification activities [68]. It remains to be fully determined the extent to which the above activities have a high-value status. Despite being considered as a potentially high-income livelihood diversification activity [69–71], and a strong incentive for forest conservation [72,73], studies still show that bee-keeping accounts for minor household incomes. This could be linked to the limited value addition and income benefits derived from the activity. Studies in Africa have attributed low forest product incomes to the lack of efficient forest resource processing techniques and unclear commercialization guidelines for a sustainable commodity chain [74,75]. A logical way forward is to consider gender inclusive policies that can improve the value chain for these conservation-friendly products and create strong platforms to ensure the sustainable commodification of NTFPs, including honey. Gender inclusiveness is required to encourage female participation in this activity. The inverse probability (22%) of participation in training and adoption of NTFP domestication and bee-keeping suggests that formal training has hardly targeted the sustainable production, processing and marketing of these forest products. Complementing agroforestry and forest plantation training with NTFP domestication and

bee-keeping could further increase participation in more conservation-friendly forestry activities. This should then be backed by rigorous market studies to map and upgrade the value chain of honey. Insignificant likelihood was observed for household per capita income, size and number of dependents on the reduction in bee-keeping and NTFP domestication. This contradicts earlier findings in Burkina Faso [76] and Nepal [77], which all indicate a more significant link between household incomes and forest dependence across poor and richer households.

5. Conclusions

We draw the following conclusions from this study. First, livelihood diversification choices around the KIFL are largely skewed towards highly forest-dependent strategies; opportunities to encourage more conservation-friendly activities such as bee-keeping and other NTFP domestication initiatives should be further exploited. This option is considered feasible and can support the attainment of the twin objectives of conservation and livelihoods support in the context of a montane landscape like the Kilum-Ijim. Second, female-headed households largely prefer forest-related livelihood diversification, which seemingly contrasts with their less visible participation in forest management decisions. A rigorous study on gender dimensions is needed to ground this assertion. Thirdly, access to training and credit facilities can significantly reduce forest-related livelihood dependence. A prospective look at future livelihood choices suggests a possibility for increasing migration and the expansion of more forest-dependent activities. These results raise significant policy-making questions; the critical issue is whether policy makers should design policies to support the livelihood preferences which are lucrative yet significantly impactful on conservation, or design policies to augment the returns derived from less environmentally impactful diversification strategies. An in-depth, context-specific policy analysis is needed to unravel options along the lines of: (i) effective female integration in local forest management processes, (ii) intensification of local capacity (technical and financial) to undertake conservation-friendly diversification approaches, (iii) regulation of access to unclean energy use by digging into more clean energy sources and (iv) promotion of value chain improvement options for the identified conservation-friendly forest products. This should be further diagnosed in the context of institutional change [78–80], and also to understand the right forms of institutions (endogenous and exogenous) that can guarantee the effective application of the above-mentioned policy considerations. Given the increasing recognition of ecotourism as a tool to support conservation, further lines of research in this context should be directed towards a quantitative investigation of livelihood diversification and implications for ecotourism choices.

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Appendix A

Table A1. Multinomial logit estimates for the determinants of livelihood diversification.

Variables	(1)	(2)	(3)	(5)	(6)	(7)	(8)
Household per capita income	−0.57 (0.49)	−0.60 (0.32)	−0.94 (0.12)	−0.45 (0.32)	−0.14 (0.76)	−0.28 (0.52)	−0.99 ** (0.04)
Household size	−0.09 (0.74)	0.00 (0.98)	−0.19 (0.45)	0.20 (0.27)	−0.15 (0.43)	0.16 (0.35)	−0.11 (0.57)
Number of dependents	−0.22 (0.67)	−0.81 (0.11)	−0.99 * (0.08)	−0.76 * (0.06)	0.47 (0.28)	−0.68 * (0.09)	−0.44 (0.29)
At least secondary education	−1.83 (0.11)	1.21 (0.24)	0.82 (0.46)	−1.67 * (0.06)	−17.90 (0.99)	−1.37 (0.11)	−0.64 (0.44)
Individual is aged 16–25	−17.78 (0.99)	3.12 * (0.08)	−11.94 (0.99)	20.19 (0.99)	10.09 (0.99)	1.96 (0.16)	2.65 * (0.06)
Individual is aged 26–55	−5.40 *** (0.01)	−3.81 ** (0.03)	−6.19 *** (0.00)	15.30 (0.99)	8.18 (0.99)	−2.96 ** (0.03)	−2.03 (0.14)
Individual is aged 55+	−5.41 ** (0.02)	−2.66 (0.21)	−4.81 ** (0.03)	15.67 (0.99)	10.24 (0.99)	−1.66 (0.37)	2.45 (0.15)
Individual is male	−0.95 (0.60)	−1.15 (0.37)	−2.06 (0.21)	−3.49 *** (0.00)	15.04 (0.99)	−3.93 *** (0.00)	−5.02 *** (0.00)
Education of household head	−19.82 (0.99)	−3.41 ** (0.01)	−7.81 *** (0.00)	−2.81 ** (0.02)	−0.30 (0.86)	−2.48 ** (0.02)	−1.66 (0.14)
Participated in formal training	−6.09 *** (0.00)	−23.51 (0.99)	−22.27 (0.99)	−4.72 *** (0.00)	−1.50 (0.19)	−3.50 *** (0.00)	−3.77 *** (0.00)
Constant	13.99 (0.12)	11.09 (0.11)	19.85 *** (0.00)	−7.29 (0.99)	−22.15 (0.99)	8.76 * (0.07)	14.86 *** (0.01)
Observations	196	196	196	196	196	196	196

Column (1) represents private/civil service, (2) is timber sales, (3) is migration, (4) is medicinal plant, (5) is NTFP domestication, (6) is arts and crafts, (7) is NTFP gathering. The base category is trading. Probability values in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

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