

Analysis of the exploitation of NTFPs and their contribution to the well-being of households around the Belabo-Doume-Diang intercommunal massif

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ABSTRACT

In the East region of Cameroon, forest resources are composed of Woody and Non-Timber Forest Products (NTFPs). These NTFPs have long been a source of food, medicine, construction tools and ornaments. The lack of information to assess the current and potential contribution of these products to household incomes and to improving food security, the absence of official programs and a structure for managing and promoting these products is one of the obstacles to the development of these resources. It is in this perspective that, as part of the "REDD+ Feasibility Study" project, a study was conducted in three municipalities (Belabo Doume Diang) of this region. The objective was to obtain information on the importance of NTFPs in rural households. To achieve this, a sample of 1051 households in 45 villages in the three municipalities was selected for the survey. The selection of each household for the survey was preceded by a preliminary survey of the local population for a good targeting of direct or indirect NTFP operators. From this study, it appears that 87 NTFP species are collected in these villages. This shows that like the forest areas, these villages constitute an important reservoir of NTFPs in Cameroon. This study also shows that about 64.6% are used within households for food, pharmacopoeia, packaging and handicrafts. The market and other uses such as construction with a total of only 34.4%. The most commonly used harvesting methods are picking, gathering and debarking. They account for 81.3% of the total, with the collection method having the highest rate of 31.2%, while the smoking method is the least used. It shows that 90.8% of the households surveyed stated that agricultural products contribute to their income while only 76.9% stated the same for NTFPs, in contrast to timber and livestock products, which contribute very little to household income (4.4% and 4% respectively). NTFPs contribute to the food security of local populations through the direct consumption of products within households and the income derived from the sale of NTFPs for the purchase of other food categories (oil, salt, meat, beverages) that households do not have. Harvesting the various organs (fruits, leaves, stems, bark, and roots) and sap of NTFPs can have an impact that varies from very low to very high. This could affect the sustainability of the resource. In Cameroon, the major challenge for the NTFP sector is to increase incomes from these products while considering their uses in the future. It would be necessary to envisage the organization of the actors while putting in place a strategy and action plan giving broad guidelines for the management of these resources.

Keywords: NTFP, food security, income, conservation, intercommunal forest massif.

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INTRODUCTION

With a surface area of 475,000 km², including 720,000 km² of potential agricultural land, Cameroon is a country

in the Central African sub-region rich in Non-Timber Forest Products (NTFPs) (Dadem et al., 2021). The latter

occupies a very important place in the subsistence of the majority of the population. According to DESA (2020), the Cameroonian population is estimated at 25,000,000 inhabitants and is made up of more than 90% rural families and 51% women. In the UNDP 2019 report, Cameroon ranked 150th out of 189 countries, which implies that the majority of socio-economic indicators are very low. Malnutrition is still present with strong disparities by region. The most affected regions in Cameroon are the Far North (41.9%), Adamaoua (37.8%), North West (36.1%), East (35.8%) and North (33.8%) (MICS, 2014). Economic growth has been affected by several crises (political crisis, financial crisis, social crisis and the Covid19 pandemic). Some Cameroonian households have a very unsatisfactory diet; it is estimated that 9.6% of rural households are food insecure, i.e. 2.2% in a severe form and 7.4% in a moderate form (WFP, 2011; WHO, 2018). More than 90% of a Cameroonian's daily ration is dominated by voluminous intakes poor in essential elements (tubers and roots, bananas) against very little or no sources of protein, lipids and trace elements (Yount-André, 2020). Moreover, the Caroli et al., (2021) indicates that in Cameroon, demographic pressure is particularly strong throughout the country and explains the exponential growth in the need for natural resources and agricultural land, giving rise to devastating incursions in many protected areas.

Forest resources consist of natural and artificial forests and are composed of wood and non-wood forest products. Besides the production of woody biomass, the country's forest formations have multiple roles and uses (soil conservation, biological roles, beekeeping production, etc.) of great importance in the socio-economic life of Cameroonians (Parthiban et al., 2018). Non-Timber Forest Products (NTFPs) have long been a source of supply of various products (meat, leather, fruit, honey, wax, fodder, medicines, vegetables, mushrooms, etc.) that benefit the populations in general and the local populations in particular. Non-Timber Forest Products are goods of biological origin other than wood, derived from forests, other wooded lands, and trees outside forests (Pourhashemi, 2021).

All NTFPs live spontaneously due to the intensity of harvesting many products are disappearing. Information on the gathering, harvesting, exploitation and trade of NTFPs is important for developing sustainable sources of income and improving the livelihoods of forest people (Maua Odhiambo, 2021). However, available data is often deficient or may be lacking for designing programs and projects. Today, villages must travel long distances to harvest a significant amount, whereas a few years ago, most NTFPs were harvested close to villages. In contrast, efforts to improve national forest policy have tended to focus on timber forest products (timber), rather than on a secondary consideration of non-timber forest products from the forest. This leads to a lack of systematic information to assess the contribution of NTFPs to

household income and improved food security, and the absence of official programs for the management and promotion of these products is one of the obstacles to the prosperity of the NTFP sector and the improvement of the population's standard of living (Awono et al., 2016). It is in this perspective that the 'REDD+ Feasibility Study' project was carried out in the villages located around the Belabo-Doume-Diang intercommunal forest massif in the East Cameroon region.

The reasoning of this research is based on the following hypotheses, which will be discussed throughout this study. On one hand, the Belabo, Doumé and Diang intercommunal massif has a diversity of NTFPs. On the other hand, the population has a lot of endogenous knowledge related to NTFPs. Finally, the exploitation of NTFPs has an impact on the resource. The objective of the study was to provide essential background information to determine which NTFPs are valuable and how they can be taken into account in the calculation of the country's macro-economic indicators and, above all, in initiatives for sustainable management of the forest ecosystem.

METHODOLOGY

Presentation of the study area

In the framework of this study, three communes in the Eastern region were selected because of their proximity and dependence on a large forest massive called Belabo, Doume and Diang (BDD) inter-communal forest (Figure 1). These are the communes of Belabo, Doume and Diang in which 45 other villages were subjected to socio-economic analysis. This massif being between 4°0'0 and 5°10'0 north latitude and 13°05' and 13°40' east longitude and covers two departments: Lom-et Djérem (Belabo and Diang) and Haut Nyong (Doume). The three municipalities together cover an area of 11,000 km². The forest massif itself covers 280,557 ha divided into forest reserves and production forests. It is located in the equatorial Guinean climate with a bimodal four-season rainfall regime with an average temperature of 25°C and an average annual rainfall of more than 1500 mm. Numerous rivers and streams crisscross the forest massif, the main ones being the Sanaga (Belabo), the Doume (Doume) and the Lom (Diang). The vegetation cover in this ecosystem is characterized by primary and secondary dense forests with very rich biodiversity (Momo et al., 2016). There are innumerable wood and non-wood forest products. The populations practice very little mechanized agriculture but dominate their economic activities. The exploitation of non-timber forest products is rooted in the habits of the local populations who use them primarily for their consumption and the surpluses are turned towards commercial speculation.

Data collection

The data collection was completed in two main steps. First, a literature review was conducted to identify scientific works on Non-Timber Forest Products (NTFPs) and to determine how the works approached NTFP harvesting methods, the impact of harvesting on the resource and household income. It also allowed the collection of primary data on NTFPs. The second phase consisted of quantitative and qualitative data collection in the field through the household survey, group discussions and direct observations in the

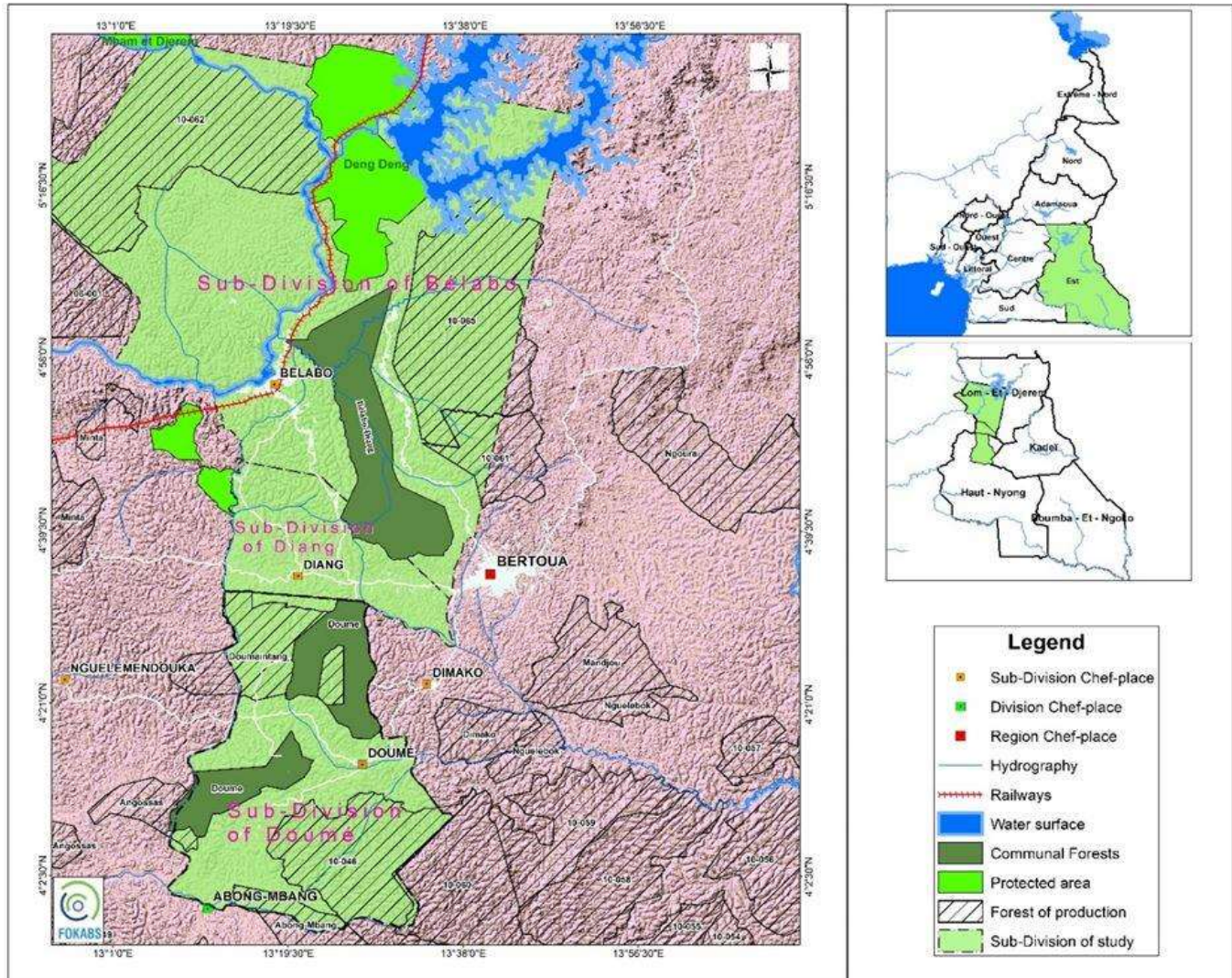


Figure 1. Location of the intermunicipal massif (Belabo, Doume, Diang).

different villages bordering the village of the Belabo forest massif, Doume Diang. The household questionnaire and group discussion guide were designed according to the objectives of the study. The sections covered questions on the identification of the different NTFP species exploited by the populations, the methods and reasons for exploitation, and the different sources of income of the populations. The surveys were carried out among 1051 households in 45 villages in the three communes of Belabo, Doume and Diang using the mobile application ODK Collect. The information collected during the field visits was analyzed using Microsoft Excel. This made it possible to assess the motives and methods of NTFP harvesting, the place of income from their sale in the different sources of income of the populations, the impact of the exploitation on the sustainability of the resource and food security in the study area. The NTFPs considered in this study are plant NTFPs including honey (a product repeatedly cited for its importance) due to the ease with which people can produce information about them, unlike animal NTFPs where details are difficult to clarify.

The impact of NTFP exploitation on the sustainability of the resource was assessed through an analysis of impact assessment parameters (Konsala et al., 2020) such as the method of harvesting the harvested organ, and the frequency and intensity of harvesting.

The contribution of NTFPs to food security was assessed according to the importance of NTFPs for direct consumption and the place of income from the sale of NTFPs in households in the study area (Foze et al., 2021).

Field data collection has faced challenges such as those related to the variability in the annual natural production of some NTFPs and therefore the difficulty of making clear population estimates. These natural dynamics of NTFPs can only be apprehended after monitoring the species for at least two successive years. The data collected in this context would present more of an annual reality than an average reality over a long period.

RESULTS

Overall, more than 644 plant species are already known in and around the Belabo-Doume-Diang intercommunal forest massif. A list of 60 species endemic to this forest area is known out of a total of 152 species at the national level. Regarding collection, 87 NTFP species are collected in or around the forest massif in these three

municipalities, only 30 species (34.5%) could be recognized through the respondents' description, 17 NTFP species totalling a percentage of 91.6% frequencies. At least two households surveyed cited these species. Among them, eight of them (53%) represent a cumulative frequency of 80%. Among which: *Ricinodendron heudolittii* locally called "Essessang" (consumed and marketed), Honey (beehive product consumed and marketed), *Irvingia gabonensis* locally called "Andok" (fruit consumed and marketed), *Piper guineensis* (fruit consumed and marketed), Mushroom (consumed and marketed), *Baillonella toxisperma* locally called "Moabi", *Tetrapleura tetraptera* (fruit consumed and marketed), *Eremospatha spp* (use of stems).

Rationale and method of harvesting NTFPs in and around the forest base in the study areas

The results of the surveys show that in Figure 2a, the reasons for harvesting NTFPs are overall about 64.6% used within households, that is, 38.2, 21.5, 2.1 and 2.8% respectively for food, pharmacopoeia, packaging and handicrafts. The market and other uses such as construction total only 34.4% of which 29.2 and 6.2% respectively. It can also be seen that the percentages of reasons for harvesting are identical in two municipalities (Diang and Belabo), although they remain low compared to the percentage of reasons for harvesting in Doume.

The results of the analyses presented in Figure 2b reveal that the main harvesting methods most frequently used are picking and debarking, which total 81.3% with 32.3, 27.1 and 21.9% respectively compared to other methods (cutting, smoking and uprooting). It also indicates that the percentage of the harvesting method was higher while the smoking method of harvesting NTFPs was at its lowest.

Household income from the marketing of NTFPs

The analysis of the different sources of household income revealed in Figure 3a shows that overall, NTFPs, the timber trade and other sources not specified by respondents contribute 59.8% of household income sources with a higher rate of contribution of fuelwood (23.4%) followed by other unspecified sources (18.9%). The other sources of income reported by the respondents are notably petty trade and work and/or handicrafts. The analysis also reveals that fishing activity contributes very little to household income with a rate of 6.7%.

The results presented in Figure 3b show that 90.8% of the households surveyed said that agricultural products contribute the most to their income. Only 76.9% of the households surveyed stated that collection NTFPs contribute to their income. This analysis also shows that the lowest categories of sources of contribution to household income are timber exploitation and livestock products at 4.4 and 4%, respectively.

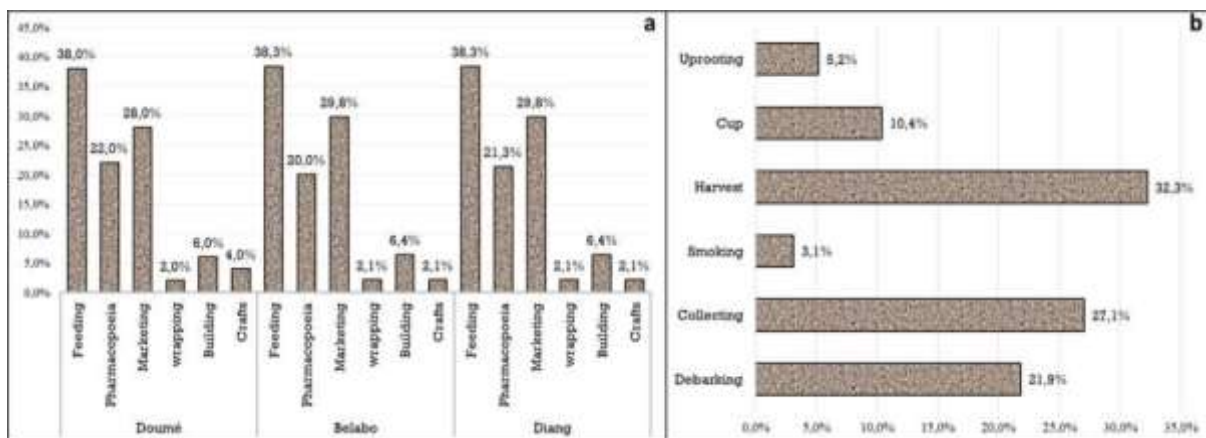


Figure 2. Contribution of NTFPs to various motives (a) and harvesting methods within households (b).

Contribution of NTFPs to household food security

NTFPs contribute to food security in two ways: either through direct consumption of NTFPs or through the purchase of food products as a result of the sale of NTFPs. The analysis in Figure 4 shows that households first consume edible NTFPs and surpluses are

transported to markets. NTFPs such as *Ricinodendron heudolittii*, *Irvingia gabonensis*, *Raphia* sp. and *Elaeis guineensis* also have the same 81.7% household consumption rate. However, other NTFPs such as mushrooms, honey and aframomum are consumed at different frequencies respectively 77.2, 49.9 and 40.8%. Vegetables such as *Gnetum africanum* and tubers such

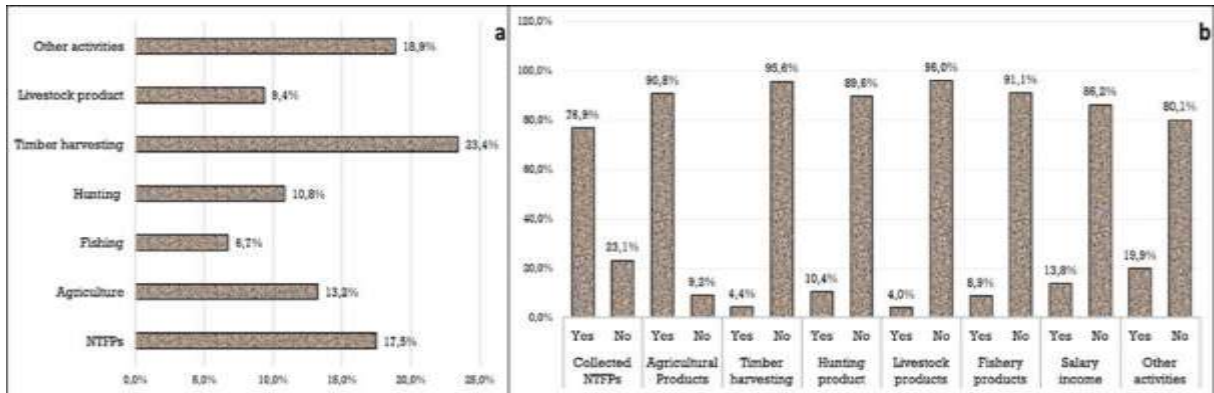


Figure 3. Contribution of various sources (a) and each source category (b) of income within households.

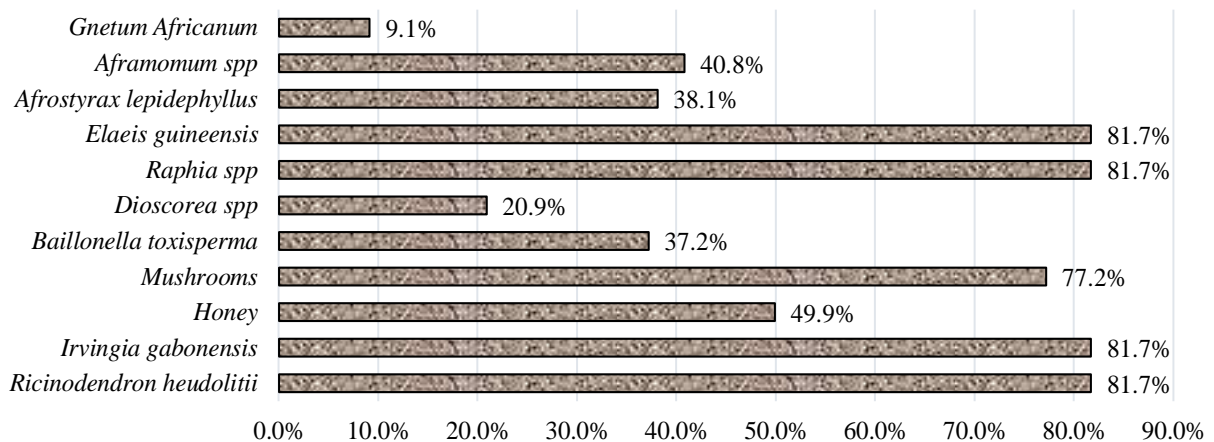


Figure 4. Relative proportions of some of the most consumed NTFPs in households.

as *Dioscorea* sp. are consumed in small proportions respectively 9.1 and 20%. These results show that edible NTFPs contribute significantly to household food security.

Impacts of the way NTFPs are harvested and how people perceive them

All the plant species listed in this study have bark, leaves, roots and fruits that are used by the population for medicine, food, construction and marketing. The exploitation of these vegetative organs identified in the different communes (Belabo, Doume and Diang) can have an impact on the resource (Tables 1, 2 and 3).

Depending on the organ removed, species are more or less exposed to degradation. The impact of harvesting on the main listed non-timber forest products is assessed according to the organ harvested, the harvesting method and the species typology.

The analysis presented in Table 1 indicates that the exploitation of almonds/pulps in the study communities is done by picking or gathering and that this method has a

low impact on the resource. Harvesting is done either by pole picking or by climbing on trees that are not very large (*Trichoscypha acuminata*, *Anonidium mannii*, *Elaeis guineensis*). Collecting is a common method for large trees. Harvesting pulp or almonds has a very low impact on the resource. For the harvest of almonds from large fruit trees, people wait until the fruit reaches maturity and falls off the tree so they move into the forest or agroforests to collect the fruit. The principle of felling trees for harvesting is very little used in the community for this purpose because these fruit trees do not regenerate easily and their domestication is not yet under the control of the population. In addition, the natural growth process of these trees takes a long time.

The result in Table 2 indicates that the bark of several species is harvested by debarking. This method of harvesting has a low impact that varies from low to high on the resource depending on the debarking technique. The bark is harvested primarily for medicinal or food use. The communities in the villages usually harvest them for family use and the exploitation is done throughout the year due to the permanent availability of the resource.

Table 1. Impact of pulp/almond exploitation on the resource in relation to the species typology and the part harvested.

Species typology	Portion taken	Collection method	Harvest Periodicity	Impact on the resource	Main species
Shrub / large tree / liana / plant	Pulp/Almond	Picking / Pick-up	Seasonal	**	<i>Irvingia gabonensis</i> , <i>Elaeis guinensis</i> , <i>Piper guinensis</i> , <i>Baillonella toxisperma</i> , <i>Aframomum</i> spp.
Large tree/shrub	Pulp	Picking / Pick-up	Seasonal	*	<i>Tetrapleura tetraptera</i> , <i>Trichoscypha acuminata</i> , <i>Anonidium mannii</i>
Large tree/shrub	Almond	Picking / Pick-up	Seasonal	*	<i>Ricinodendron heudelotii</i> , <i>Garcinia lucida</i> , <i>Afrostryax lepidophyllus</i> , <i>Monodora myristica</i> , <i>Voacanga</i> spp.

* Very weak; ** Weak; *** Strong; **** Very strong.

Table 2. Impact of bark and leaf harvesting on the resource in relation to the species typology and the part harvested.

Species typology	Portion taken	Collection method	Harvest periodicity	Impact on the resource	Main species
Shrub/Small Shaft/Large Shaft	Bark	Debarking	Annual	** à ***	<i>Ricinodendron heudelotii</i> , <i>Garcinia lucida</i> , <i>Pentaclethra macrophila</i> , <i>Afrostryax lepidophyllus</i> , <i>Guarea</i> spp., <i>Alstonia boonei</i> , <i>Enantia chloranta</i> , <i>Sterculia tragacanta</i>
Shrub/Small tree/Large tree/Liana/Plant	Leaf	Harvest	Annual	* à ***	<i>Megaphrinium macrostachyum</i> , <i>Raphia</i> spp., <i>Gnetum africanum</i> , <i>Elaeis guineensis</i>

* Very weak; ** Weak; *** Strong; **** Very strong.

Table 3. Impact of stem, root and exudate harvesting on the resource in relation to the species typology and the organ harvested.

Species typology	Portion taken	Collection method	Periodicity	Impact on the resource	Main species
Trees/plant	Stems	Cutting/cutting	Annual	* à ***	<i>Eremospatha</i> spp, <i>Raphia</i> spp.
Plants	Roots/ Tuber	Uprooting	Seasonal	*** à ****	<i>Dioscorea</i> spp
Trees	Sap / Exudate	Harvest	Annual	**	<i>Raphia</i> spp, <i>Elaeis guinensis</i>

* Very weak; ** Weak; *** Strong; **** Very strong.

This community exploitation has a low impact on the resource because the isolation of the debarked area hinders a high level of exploitation for commercialization. Another method consists of gathering leaves from shrubs (*Megaphrinium macrostachyum*) and lianas. This leaf harvesting is carried out throughout the year and has an impact that varies from very high to low on the resource.

The result presented in Table 3 shows that the stems are removed either by cutting or by felling the species.

These stems are available for harvesting all year round. The analysis indicates that the impact of this method on the resource can be very low but can also vary to a high impact. The roots and stems exploited by the populations are used for food and marketing. Roots and tubers are harvested by uprooting and this method can have a strong impact on the resource. This strong impact can go as far as the definitive loss of the resource under certain conditions. The sap or exudate is harvested by picking

and this is done throughout the year. The impact on the resource is low.

DISCUSSION

This study aimed at establishing the baseline data for NTFPs in the Belabo-Doume-Diang inter-communal forest massif. The study identified plant species taken from the forest and used for food, medicine, handicrafts and construction, and then exuded. We can therefore accept hypothesis i) which stipulates that the inter-communal massif (Belabo, Doume, Diang) has a diversity of NTFPs.

The results of the study revealed that more than 87 species are exploited by the populations for various uses (food, handicraft, medicinal, fodder, litter, etc.). This number is close to that found by Asseng Ze (2008) in the Sustainable Management of Non-Timber Forest Products in the Pallisco forest concession. The results of this study show that the very high rates of reasons for harvesting NTFPs (food, pharmacopoeia and domestic uses) are sufficient proof that NTFPs contribute globally to the satisfaction of household needs and primarily to food. The finding is that the percentages of motivations and methods of collection or exploitation of NTFPs are the same in the three communes, which could be explained by the fact that these communes have the same cultural character and share the same climatic conditions that determine the distribution of species. The differences in the different methods could also be explained by the disappearance of certain species through the degradation process to which all the forests in Cameroon, especially those in the eastern inter-communal massif, are subjected. Yet the latter hosts several species classified as threatened in Cameroon (*Borassus aethiopum*, *Azela africana*, *Khaya senegalensis*, *Zanthoxylum zanthoxyloid...*), (Droissart et al., 2019; Action plus, 2010). However, this diversity, however weak it may be, is an asset for local people. It ensures them a qualitative variability in their diet and, consequently, a healthy and balanced diet that consists of diversifying it by consuming as many different foods as possible (Zekeng et al., 2021). All of these species are also part of the daily diet of these communities, so we can accept hypothesis ii) which states that the population has a great deal of endogenous knowledge related to NTFPs.

The assessment of the level of knowledge and exploitation of NTFPs found that some species are used through their organs. The most commonly used are fruits, leaves, bark and roots. This finding is similar to that obtained by Dibong et al. (2011) and Yogom et al., (2020) in their investigations in the Douala market. This could be explained by the diversity of forest plant resources in the area and/or the diversification of medicinal and dietary knowledge related to NTFPs. The impact of leaf harvesting on resources varies from strong to very

strong, a result comparable to that obtained by Ouédraogo et al. (2022) in the classified forest of Niaouli. The result attesting to the high use of leaves is also similar to that obtained by Lokonon et al., (2021) during the ethnobotanical study in the Amsittène forest.

NTFPs are sold in research villages. The most widely sold organs are fruit and seeds and sap. They concern the species: *Ricinodendron heudelotii*, *Elaeis guinensis*, *raffia spp*, *mushrooms* and *Irvingia gabonensis*. To these are added the processing products that are sold to supplement the financial income of certain households. These findings are in line with those of Dash and Behera (2016) for whom the marketing of forest plant food resources is very flourishing and helps to supplement household income.

According to Thammanu et al. (2021), the impact of particular use on a tree will depend on the part used and the sampling method. The Belabo inter-communal massif, Doume Diang is under strong anthropogenic pressure not only for NTFP exploitation but also for timber and fuelwood. The populations are passive and exert strong pressure on this forest since it is not classified. Removal of roots, leaves and stems appears to have more negative ecological impacts than fruits and leaves.

However, the harvesting of bark and fruit could also have an impact on the natural regeneration process and the conservation of the species because, according to Lankoandé et al. (2021), the maintenance of regeneration capacity depends, among other things, on the maintenance of the main principles of regeneration such as pollination, seed development and dispersal, germination and plant growth. According to the same authors, oilseeds such as *Baillonella toxisperma* seeds are recalcitrant and lose their germination capacity very rapidly after harvest. In addition, given the socio-economic and cultural importance of certain species such as *Pentaclethra macropbila*, populations tend to harvest the entire fruit production. This practice prevents or limits the natural regeneration of the species. However, it is not only what is harvested that is important, but also above all, how it is harvested. The most commonly used methods of harvesting in the study area are standing and picking. However, harvesting is dangerous for the dynamics of the species if all the products are harvested. Therefore, hypothesis iii) which states that the exploitation of NTFPs has an impact on the resource can be accepted here.

Conclusion

Around the Belabo-Doume-Diang inter-municipal forest massif, the NTFP sector plays an important role in reducing hunger and diversifying income. Due to their diversity, the NTFP sector is a significant provider of employment. The sector generally employs the most

vulnerable social groups, namely women. Thus, it guarantees and stabilizes incomes for these categories. Women are more active in marketing. As a result, they have a guaranteed daily income while men collect bamboo, raffia, palm wine and therefore have a guaranteed weekly income. Income from the sale of NTFPs is used to solve specific problems in the home. These include nutrition, health and education of children. The increasing importance of food and income is likely to put a great deal of pressure on the resource. Furthermore, in Cameroon, particularly around the Belabo-Doume-Diang intercommunal forest massif, there are no statistics on the quantities of NTFPs available in the forests, nor on the quantities produced, marketed or consumed. To sustainably manage these NTFPs, a few ideas are proposed:

- Promote the marketing of NTFPs through the organization of the sector. The different actors in the sector should be mobilized by organizing gatherers or traders;
 - Facilitate information and collaboration between the different actors. This includes information on price, quality and even promising markets (local or international);
 - Given the long distances between the places of collection and mass consumption, this link will allow the formalization of exchanges between producers and buyers;
 - Decrease distances from collection sites. It can be done through domestication.
- Since the study was conducted over a short period, much of the data needed to determine the level of sustainable biological exploitation of NTFPs is still lacking. For more in-depth studies, consider the few avenues of research such as:
- The identification of all the ecological impacts of NTFP exploitation and various anthropogenic actions at various levels: individual, population, community and ecosystem;
 - Determining the limit rate of organ removal without compromising the future of the populations with models that integrate the growth, production and survival rates of the species;
 - The identification of the social, economic, technical and political conditions necessary for the sustainable exploitation of NTFPs;
 - Moreover, populations have a great deal of endogenous knowledge that must be valorized by obtaining it from its holders before their death, to integrate it into development programs.

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