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CASE STUDY OPEN ACCESS

Impact of logging and participatory forest management practices on non-timber forest products availability: a case study from Southwest Cameroon

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Key words: Non Timber Forest Products (NTFPs), Participatory forest management, Logging impact, Competitive species, Anthropic activity

Abstract

To assess the impact of logging and participatory forest management practices on NTFP availability, this paper describes the use of NTFPs as food and income sources in a certified logging concession of Southwest Cameroon. Surveys were done using community questionnaires and participatory meetings. Sampling plots were established in exploited/unexploited landscape to assess the impact of logging on major NTFPs. Fifty four species encountered are used as food, traditional pharmacy, etc. Harvesting sites are located in agro-forestry sites, home gardens and concession. NTFPs are locally sold permanently or weekly and most seasonally. Multipurpose species, like the *Andok, Djasang*, *Moabi* and *Okan* have the distinction of interest to both the timber industry and the production of NTFPs. Most often, the greatest interest is focused on the wood rather than NTFP. During logging, management diameter set outweigh the RFD (Regular Fruiting Diameter). Compared to the minimum administrative cutting diameter of these species determined by forestry ministry, *Moabi, Okan* and *Djansang* meets the standard for natural regeneration. The average density of *Moabi* or *Okan* with at least 20 cm DBH in disturbed plots (0.06 tree/ha) is lower than data of spaces devastated by human activity even for the most popular species of the order of 0.5 tree/ha. But, 3 of the 4 competitive species, can cause immediate or long term conflicts of interest as object of covetousness on the part of local people and the logging company. Some recommendations are ameliorate the competitive NTFP harvest rate not to exceed the levels allowing sustainable maintenance of these samples; Learn new domestication techniques to no longer deal with potential conflicts regarding competitive NWFP and Organize in Common Initiative Group and set up a manufacturing Industry for self-used equipment's (chairs, rustic baskets,..) through the valuation of Raffia and Rattan.

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Introduction

Forests provide goods and services that are essential to 1.2 billion people in the world (FAO, 2004). The forests of the Congo Basin cover approximately 2.8 million km², contain a diversity of plants and animals unmatched in Africa, and continue to provide food, shelter and income to 25-30 million people (Bahuchet, 1995). Contrary to popular belief, these forests have over millennia, expanded, contracted and changed in species composition in response to climatic variability and disturbance by humans (Oslisly, 1998).

In the last 20 years, as a result of globalisation of market economies and growth in demand, the scale and rate of exploitation of non-wood forest products (NWFPs) has expanded faster than at any other time in history, and use of forest resources is approaching or exceeding sustainable thresholds in many locations across the Congo Basin.

Over-exploitation and eventual disappearance of NWFPs are of both local and global concern, because when a plant or animal goes locally extinct it can no longer contribute to the diet or economy of forest families and, risks the irreplaceable loss of species and genetic biodiversity that may contribute significantly to forest ecosystem production and resilience.

Given the number of products used by humans that originate from the forest (wood products as logs, sawn wood, poles, fuel wood, charcoal, and non-wood products as bark, roots, leaves, flowers, seeds, fruits, sap, resins, honey, fungi etc.); the factors that influence their availability over time and commercial uses for these products; and the complexity of the pathways along which forest products travel from producer to consumer, if the resource is not used sustainably, its abundance will decrease progressively so that at some time in the future it no longer becomes available as a source of nutrition, construction materials, medicine, or income to local communities.

Whenever humans use wild resources for domestic consumption or as a source of income the question of sustainability arises.

Thus, in an attempt to overcome these shortcomings, the logging company is aware of the current issues in sustainable forest management and has a management plan developed according to the principles of sustainable management and approved by the Ministry of Forestry and Wildlife (MINFOF) for the forest co Ancession.

This paper aims at identifying types of NTFP locally harvested, used or sold by local communities and those harvested by the logging company in the forest concession in accordance with the principles of sustainable management and national regulations.

Materials and methods

Characteristics of the study area

A forest concession under sustainable management which is undergoing forest certification is chosen. Therefore, the study was conducted in the concession N° 1 086 containing the FMU 11 001, located in the Eyumodjock sub-division, Manyu Division, Southwest Region. Geographically, it extends between 5°18' and 5°37' North latitude and between 9°05' and 9 °23' East longitude. The size of this forest concession is estimated at 55 580 ha between UTM coordinates 585.796 and 622.149 N, 509.801 and 543.065 E (Fig. 1). The concession is bordered in the north by the villages Nkogho, Talangaye, Ossing, Kembong, Ewelle 1&2, Njeke 1&2 and Adjayukndip and in the south by Bakut, Basu, Bajoh, Abat, Mgbegati, Oselle, Okoroba, Mbinda-tabo, Bakogo, Bayenti, Etinkem, Bayip asibong and Akak.

Relief of this area contains the Mamfe basin characterized by depression area more or less circular between the west to east highlands, the Akwaya plateau in the north and Rumpi hills in the south.

In the northern part of the concession, the relief is fairly flat and corresponds to the bottom of the bowl.

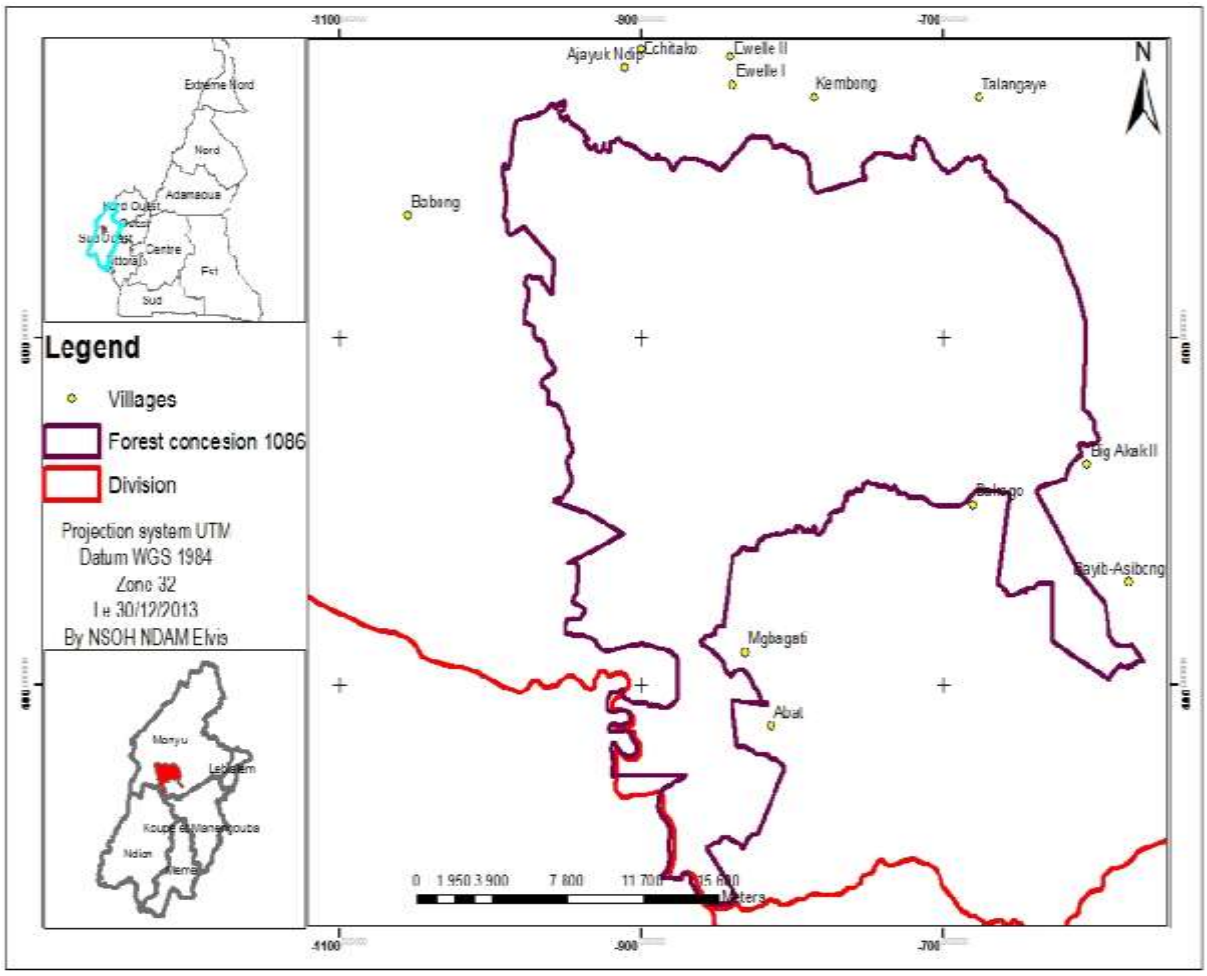

Fig. 1. Localization of the study area.

This flat area is limited in the southern part by the chain of mountains and Nkwende hills that offer through the layering of vegetation and range from 100 to 1 400 m and between Eyumojock and Akwaya. By its position on the coast of the Atlantic Ocean, the area has a dense river network. Among them include: Badi, Bakwé, Bakogho, Bagodo, Bakongo, Bablick, etc. The average annual rainfall calculated over a 10 year period (1997 to 2006), fall between 2 070 and 3 790 mm. The maximum mean monthly precipitation is in August (457 mm) while the minimum is observed in January (17.46 mm). Regarding temperatures, monthly statements made on the same 10 year period show that the difference between the minimum average monthly temperatures and average monthly maximum is 3.72°C. The average monthly temperature is 29.02°C. March is hottest. The area is subject to equatorial climate characterized by two seasons that mark the year ((A short dry season from mid-November to mid-March (4 months) and a long rainy season from mid-March to mid-November (8 months)). The Southwest Region has a good reputation for the quality of its soils. In the Manyu Division, lateritic soils are sandy in places. At low funds, contributions from the intense erosion of hillsides have contributed to the formation of sandy-clay soils. Plant formations encountered in the study area are those of the dense moist semi-deciduous characterized by many valuable species (MEDINOF, 2007).

Socio economic surveys

Actors involved in the harvesting, use and marketing of NTFPs were interviewed using social science methods. The study was carried out in 22 villages neighbouring the forest concession. Households were considered as sampling unit. These family units was selected based on the availability of residents found the day of our investigation and irrespective of gender.

Thus, the number of family units surveyed in each village represents 31% of 145 households. We applied 145 individual interviews (52% of men and 48% of women) using questionnaires. Interviews and discussions with key stakeholders working in the sector included the associations of NTFP exports, harvesters, local buyers and local retailers. Traders were selected based on the number of NTFPs they handled, their knowledge of NTFP markets and their willingness to respond to the questionnaires after an explanation of the objective of the study. More than 50 traders were interviewed in 04 main markets (Osing, Adjayukndip, Nfuni and Kembong markets) with stakeholders directly involved in the marketing of NTFPs. The purpose is to collect data on prices and quantities sold from NTFP traders through interview.

To support data collected during interviews, Participatory Rural Appraisal methods (PRA) were used through focus group meetings. Eleven group meetings were realized in 9 villages with the presence of more than 110 local residents (61% of men and 39% of women). A participatory map showing the NTFP collecting sites was developed. The ultimate requirement of the participatory meeting was the presence of at least the village chief or his regent and 02 members of village forest management committee. PRA seeks to improve certain elements that were identified or forgotten during the individual interviews.

In order to identify the level of priority and importance of a NTFP for a villager, we would use the priority criteria of NTFPs as defined by Wilkie (1999) and Clark and Sunderland (2004).

Therefore, to determine most logged species by the logging company, we used the annual cutting permit to have the quantity granted by the Ministry in charge of forestry and we use annual logging reports to determined annual logged quantities per species. These elements contribute to illustrate the notion of competitive species.

Inventory survey and data collection

An accent was done on NTFPs that are important to local communities, and found in the concession, exploited by the loggers, damaged during logging and eventually favoured by logging. NTFPs selected for this survey are trees whose are object of covetousness on the part of the local communities and the logger. Therefore, they are considered as competitive NTFPs because they can cause immediate or long term conflicts of interest. To assess the impact of logging on the existing potential NTFPs, sampling plots were established. The FAO method which was used in the assessment of national forest resources in Cameroon was used because it is the most convenient and most sought for multi-resource inventories (MINFOF/FAO, 2005). It is realized by applying a stratified systematic sampling to a degree with a sampling rate ranging from 0.5-1%. After a preliminary stratification of Forest Operating Units, the sampling units were distributed systematically depending on the types of vegetation, habitat and topography. Sampling plots were created in two different Annual Cutting Units; one which has already been exploited and the other unexploited. The Sampling Unit is a square of 1 km² in area (Fig. 2.). In the centre of each square, we materialized a square of 500 m side that has the same centre as the sampling unit. In each four corners of that square, we materialized counting plots of 20m x 250m size which is 5 000 m² (0.5 ha) in area and named P1, P2, P3 and P4. These are equidistant of 250 m from each other. The azimuths of these plots were respectively 0° for P1, 90° for P2, 180° for P3 and 270° for P4. Each plot consists of three Small Rectangular Plots (SRP) of 20 m x 10 m size which is 200 m² in area and 110 m equidistant from one another. The centres of the three Small Rectangular Plots were located respectively at 5 m, 125 m and 245 m at the beginning of each plot.

Only tree species were considered in the inventory. In rectangular plots (250m x 20m), NTFPs with Diameter at Breast Height (DHB > 20 cm) were counted and recorded. This followed by a systematic counting of all NTFPs with 10 cm <DBH < 20 cm in small rectangular plots of 20 m x 10 m size (Table 1.).

Based on Minimum Cutting Diameter (MCD) and Minimum Fruiting Diameter (MFD), we recorded future producers and producible trees. At each sampling unit, the quantity of NTFP species considered as competitive was produced and experienced in the field with information on the local name, the frequency, the habitat, biological type, the mode of use and degree of use and the part of tree used. A herbarium specimen was collected for any NTFP that is unfamiliar or having a questionable identification. A total of 16 sampling units, 64 rectangular plots and 192 small rectangular plots were inventoried for a sampling rate of 0.94%.

Data analyses

The data on all species gathered from the different sources were entered into an excel sheet. Information on the species, names, values, parts, uses, and impact of harvest was included. The location maps of the forest concession were developed based on ArcGIS 10 software. The schematic representation of the sampling unit for forest inventory was developed using Adobe InDesign CC 9.2.2. The Statistical Package for Social Science (SPSS 12.0) software permit us to analyse data on available potential, producible and impact of logging on NTFPs which emerged from the calculation of average densities of different NTFPs in different types of plots.

Results and discussion

Identification of NTFPs most logged and harvested for use or marketing

NTFPs harvested by local communities

The population neighbouring the FMU, are not respecting management plan requirements. By abuse, they market their product harvested in forest areas. Despite the exercise of the user's rights granted, collection of NTFPs for commercial purpose is an illegal activity according to the Cameroon's forest law. But may consider as informal because it is income generating and unsustainable considering the harvesting method, people are forced to sell their collected products in order to improve their livelihoods by increasing food and income sources. This action is an infraction for traders because they need to acquire commercial permits issued by MINFOF.

Any commercial harvesting of forest resources by local communities might not directly requires a permit or license issued by the MINFOF. The law has to be flexible and gives them the right to collect forest products, fish and local wildlife for their livelihood in exception of protected species and any product harvested by user's right is intended not only for subsistence consumption but also marketing.

Table 1. Description of the sampling unit and counting units.

Unit	Shape	Size Area	Types or records	Number
Sampling unit (SU)	Square	1km x 1km 1km²(area)	-	16
Plot (P1, P2, P3, P4)	Rectangular	250m x 20m 5000 m²(area)	All NTFPs with DBH≥20cm	64
Small Plots (PPR)	Rectangular	20m x 10m 200m²(area)	All NTFPs with 10cm≤ DBH<20cm	192

This illegality or informality is motivated because of lack of inclusion of NTFPs in national accounting statistics making us believe that there is a shortfall in the Cameroon forest legislation.

To establish the key NTFPs in terms of trade and use/consumption, in order to consider some NTFPs as competitive and realize survey based on them, the historical literature was first examined to provide an initial list (Table 2.).

Table 2. Definition of priority NTFPs defined (Wilkie 1999; Clark and Sunderland, 2004).

Criteria	'Priority' or 'key' NTFPs defined (Wilkie 1999; (Clark and Sunderland 2004)
1	High value for domestic or market consumption (i.e. Livelihood value)
2	Demand for the product exceeding supply unsustainable exploitation (a function of In-situ conservation priority status and Domestication priority)
3	New markets potential: The validity of this last criteria outlined by Wilkie (1999) is however questioned, as this aspect deals with future supply rather than with current actual practice.
4	Species which have multiple (including conflicting) uses.
5	Species from which multiple parts are used.
6	Species which are classified as vulnerable or protected (for example, on the Red Data list, CITES listed and/or protected by national laws).

These sources formed the basis for the NTFPs listed in Table 3. Defining what are 'key" and "priority" products is necessarily subjective. However a consensus is apparent between many studies, that priorities can be defined in terms of "uses" (FAO, 1999; Betti, 2007b). From the table 3, the results of the investigation and criteria of NTFPs priority show that 93% of NTFPs are of High value for domestic or market consumption for improving livelihood value, 7% of NTFPs are those with demand for the product exceeding supply unsustainable exploitation, 19% of NTPFs are of new markets potential, 30% of NTFPs are species which have multiple (including conflicting) uses, 22% of NTFPs are those from which multiple parts are used and 4% of NTPFs are species which are classified as vulnerable or protected (for example, on the Red Data list, CITES listed and/or protected by national laws).

Table 3. Classification of different NTFPs harvested in the forest concession.

Family	Species (Authors)	Common name	Local name	Category of NTFPs			Degree of Priority	Plant Parts Used	Role of NTFP
				Nutritional	Medicinal	Other uses			
Anisophylleaceae	*Poga oleosa Pierre*	Bush nuts	Nyollè	+			1	Seed	Edible seeds and vegetable oil
Annonaceae	*Annonidium mannii* Engl. & Diels	Annonidium	Ophim	+			1	Seed	Pulp freshly consumed
Annonaceae	*Annickia chlorantha* bark	Yellow stick	Olouck/Olouh	+	+		1	Bark	Strengthening whisky/Malaria/Jaundice and Typhoid
Annonaceae	*Monodora myristica* (Gaertn.) Dunal.		Ebgon-éra/Bèbè	+			1	Seed	Flavouring spices of sauces
Annonaceae	*Xylopia aethiopica* (Dunal) A. Rich	Kimba	Njobè	+			1 and 3	Fruit	Spices of local dishes
Arecaceae	*Calamus deeratus* G.Mann & H.Wendl.	Rattan	Afurè			+	1	Liana	Construction of local houses, Bridges and houses equipment
Arecaceae	*Lacosperma secundiflorum*	Small leaves rattan	Osirè			+	1	Liana	Local construction of houses
Apocynaceae	*Alstonia boonei* De Wild.	Milk stick	Owo'oh	+	+		1	Bark and sap	Attenuate palm wine/Back ache/Jaundice/Cough and Typhoid
Burseraceae	*Canarium schweinfurthii* Engl.	Bush plumb	Azuk-assong	+		+	1 and 5	Fruit and Exudate	Edible fruit/Fire lighter
Burseraceae	*Dacryodes edulis* (G. Don) H.J. Lam.	Plumb	Bakwa	+		+	1	Fruit and trunk	Edible fruit/Mortar manufacture
Fabaceae-Caesalpinioideae	*Anthonota macrophylla* P. Beauv		Serene			+	1	Stem	Construction of house walls
Fabaceae-Caesalpinioideae	*Scorodophleus zenkeri* Harms	Bush onion	Bekang	+			1 and 3	Seed and bark	Spices or binder in flavouring local dishes
Cecropiaceae	*Musanga cecropioides* R.Br. ex Tedlie	Umbrella tree	Berang		+		1	Exudate	Purgative against spiritual sexual relationship
Dilleniaceae	*Tetracera alnifolia* Willd.	Water rope	Touglock	+	+		1 and 4	Sap	Drink/intestinal worms
Dracaenaceae	*Draceana arborea (*Willd.) Link.	Dragon tree	Dragoneh			+	1	Tree	Farm demarcation
Ebenaceae	*Diospyros crassiflora* Hiern	Ebony	Ngiaktick		+		1 and 6	Exudate	Gastric ache
Euphorbiaceae	*Ricinodendron heudelotii* (Baill.) Pierre	Djansang	Oyock	+	+		1;2;3;4 and 5	Seed and bark	Condiment or binder in flavouring local dishes/Anaemia
Euphorbiaceae	*Tetracarpidium conophorum* Mull. (Arg)	Casu nuts	Nkareh/Nkat	+			1	Seed	Edible seeds
Euphorbiaceae	*Uapaca guineensis* Müll. Arg		Berong			+	1	Trunk	Manufacture of drums
Fabaceae-Mimosoideae	*Piptadeniastrum africanum* (Hook.f.) Brenan.	Dabema	Edja		+		1	Bark	Asthma

Gnetaceae	*Gnetum africanum* Welw.	Eru	Mfoh	+	+		1;2 and 3	Leaves	Edible leaves/Fresh wounds and whitlow
Guttiferae	*Garcinia kola* Heckel	Bitter cola	Gnigna	+	+		1 and 5	Seed and bark	Seeds used as aphrodisiac/Strengthening palm wine
Guttiferae	*Garcinia mannii* Oliv.	chewing stick	Esie			+	1	Stem	Local toothbrush
Invingiaceae	*Irvingia gabonensis* (Aubrey-Lecomte ex O. Rorke) Baill.	Sweet bush mango	Njibè nseng	+			1;2;3;4 and 5	Fruit and seed	Thickening sauce and fruits consumed fresh
Invingiaceae	*Irvingia wombulu* Vermoesen. D. Harris	Bitter bush mango	Ngui nseng	+			1;2;3 and 4	Seed	Thickening sauce
Fabaceae-Papilionoideae	*Ptedocarpus soyauxii* Taubert	Red wood	Betale			+	1	Trunk	Manufacture of mortar and drums
Fabaceae-Mimosoideae	*Tetrapleura tetraptera* (Schum. & Thonn.)Taub.	4 side fruit	Eko'oh/Ekekoh	+			1 and 3	Fruit	Fruits and shell used in flavouring sauces
Loganiaceae	*Strychnos spinosa* Lam.	Fish poison	Mbom			+	1	Fruit	Local masher and fish poison
Marantaceae	*Maranthocloa purpurea* (Ridl.) Milne-Redh.	Bobolo leaves	Obwong			+	3	Leaves	Wrapping up leaves
Marantaceae	*Megaphrynium macrostachyum* (K.Schum.) Milne-Redh.	Ngongo leaves	Nkapbobong			+	4 and 5	Leaves and stipe	Foodstuff wrapping up leaves and manufacture of mats
Fabaceae-Mimosoideae	*Cylicodiscus gabunensis* (Taub.) Harms	Okan	Ossong		+		1;3 and 4	Sap	Cough/Bronchitis/Appetizing trigger
Moraceae	*Milicia excelsa* (Welw.) C.C. Berg	Iroko	Nsan		+		1	Sap	Cough and wounds
Moraceae	*Treculia africana* Decne ex.	Beller food	Obong	+			1	Seed	Edible seeds
Myceteae	*Fungus*	Mushroom	Ntchoh	+			1	Conk	Protein sauce
Myristicaceae	*Pycnanthus angolensis* (Welw.) Warb.	Ilomba	Ngotcha		+		1	Bark	Yellow fever
Ochnaceae	*Lophira alata* Banks exC.F.Gaertn	Iron wood				+	1	Bark	Tattoo during rituals
Arecaceae	*Elaeis guineensis Jacq.*	Palm tree	Ngah	+	+	+	1;4 and 5	Fruit, seed, sap, rip and stipe	Palm and nuts oils, palm wine/Spleen, sleeplessness/brooms and cocoa drier
Arecaceae	*Raphia hookeri G.Mann & H.Wendl*	Raphia	Okah			+	1;4 and 5	Leaves and stipe	Roofing mat and building material
Piperaceae	*Piper guineense* Schumach. & Thonn	Bush pepper	Osibè/Nsinsibè	+	+		1;4 and 5	Fruit and liana	Wine stimulant to hurry his fermentation and sauce spices/Heavy cough and pectoral pains
Poaceae	*Arundinaria alpina* K.Schum.	Indian bamboo	Nignang			+	1 and 4	Stem	Local construction of houses, beds and chairs
Poaceae	*Dendrocalamus strictus* (Roxb.) Nees	Rattan	Essang			+	1 and 4	Liana	Manufacture of farm and hunting baskets
Polygalaceae	*Carpolobia alba* G.Don	Cattle stick	Besui			+	3	Stem	Bow carrier/Stick use to beat cattle
Rosaceae	*Prunus africana* (Hook. f.) Kalkman	Pigeum			+		1 and 6	Bark	Sexual transmitted diseases
Rubiaceae	*Massularia acuminata* (Pink Magic)	Chewing stick	Beboh			+	3;4 and 5	Stipe and fruit	Chewing stick and Fish poison
Rubiaceae	*Strinus* spp,	Strinus	Kwapkwaplè		+		1	Bark	Malaria, gastric ache and intestinal worms
Sapotaceae	*Autranella congolensis* (De Wild.) A. Chev.	Mukulungu			+	+	1 and 4	Seed	Spiritual ability against witchcraft/Ornamental neck chains
Sapotaceae	*Baillonella toxisperma* Pierre	Djabe	Mfouoh	+	+		1;2;4 and 5	Seed and bark	Plant oil from Djabe/Tooth ache/back pains
Sterculiaceae	*Cola acuminata* (P.Beauv) Schott & Endl.	Cola nut	Atara	+			1	Seed	Edible seeds
Sterculiaceae	*Cola lepidota* K.Schum	Monkey cola	Ebgonwoo	+			1	Fruit	Hungry cutter/Appetizer
Sterculiaceae	*Cola nitida* (Vent) Schott et Endl	Bush cola	Ebligui/Ebli'ih	+	+		1;4 and 5	Seed and bark	Aphrodisiac/Spleen/Whitlow
Cecropiaceae	*Myrianthus arboreus* P. Beauv	Bush pineapple	Etchimbok	+			1	Fruit	Edible fruit
Zingiberaceae	*Afromomum giganteum* (Oliv. & D.Hanb.) K.Schum.	Edible Alligator pepper	Omang	+			1	Fruit	Edible fruit
Zingiberaceae	*Afromomum melegueta* K.Schum	Alligator Pepper	Besuk/Besuh		+		1 and 4	Fruit	Cough/Witchcraft illness
Zingiberaceae	*Afromomum* spp	Medicinal alligator	Nsibeyan		+		1	Fruit	Fresh wound

The forest concession overflows a very important floristic diversity both in quantity and quality. A qualitative inventory of NTFPs associated with the data recorded during the interviews and observations collected directly in the field allows for the identification of different NTFPs exploited, used and marketed by local populations (Table 3.).

A total of 54 species and priority uses identified during the survey include:

29 edible species with different parts use for food, particularly seeds (*Ricinodendron heudelotii*), fruits (*Irvingia gabonensis, Canarium schweinfurthii* and *Dacryodes edulis*), nuts (*Tetracarpidium conophorum*), barks (*Scorodophleus zenkeri*) etc. Food products that can be eaten after cooking or unprocessed or raw as some fruit. They are thus prey to the lust of many collectors, some of whom have only concern for the immediate financial profit maximization.

Barks are used to fortify wines or Strengthening whisky (*Alstonia boonei* and *Annickia chlorantha*) while seeds are either edible raw (*Poga oleosa*), used as spices for flavouring local dishes (*Scorodophleus zenkeri* and *Ricinodendron heudelotii*) or aphrodisiac (*Garcinia kola*).

The shell is used in flavouring sauces (*Tetrapleura tetraptera*), sap used as drinking water when thirsty in forest (*Tetracera alnifolia*), edible leaves (*Gnetum africanum*), conk of fungus are used in meals and wine stimulant to catalyse fermentation (*Piper guineense*).

Table 4. Data of logged competitive NTFPs by the logging company.

Species	ACA 1-1 (2006)			ACA 1-2 (2007)			ACA 1-3 (2008)			ACA 1-4 (2009)			Degree of priority
	Granted by ACP	Logged	Proportion logged (%)	Granted by ACP	Logged	Proportion logged (%)	Granted by ACP	Logged	Proportion logged (%)	Granted by ACP	Logged	Proportion logged (%)	
Baillonella toxisperma Pierre 1890	58	56	96,55	53	50	94,34	67	62	92,54	20	20	100	1;2;3 & 5
Cylicodiscus gabunensis (Taub.) Harms	324	324	100	649	570	87,83	577	550	95,32	335	320	95,522	1;3 & 4
Ricinodendron heudelotii (Baill.) Pierre	6	6	100	20	20	100	8	8	100	116	110	94,828	1;2;3;4 & 5
Irvingia gabonensis (Aubry-lecomte ex O' Rorke) Baill.)	0	0	0	1	0	0	0	0	0	0	0	0	1;2;3;4 & 5

With: ACA as Annual Cutting Area and ACP as Annual Cutting Permit.

21 species used for medicinal use, including plants or plant parts used locally for traditional medicine, they are used in decoctions, infusions or for the extraction of pure substances for medicinal direct use or hemi-synthesis of medicinal compounds including peel of *Alstonia boonei, Enanthia chlorantha* and *Cylicodiscus gabunensis*, which are most valued for the treatment of diseases as malaria, typhoid fever, cough, wounds, etc. In a broader context, the FAO (1999) lists over 500 species inventoried that are used in the pharmacopoeia Cameroon. Other uses NTFPs contribute indirectly in nutrition because they can permit getting some food as fish, bush meat, etc. Many other products can be sold and income is used to purchase food. Use trees to the health needs vary according to locality.

Table 5. NTFPs processed for consumption and marketing.

NTFP Proceeded	Parts used	Final products
Moabi (*Baillonella toxisperma* Pierre 1890)	Seed	Vegetable oil of Djabe
Ovoga (*Poga oleosa* Pierre)	Seed	Ovoga Vegetable oil
	Seed	Kernel pastry and Bush mango oil
Andok ((*Irvingia gabonensis* (Aubry-lecomte ex O'Rorke) Baill.)		
Palm tree *(Elaeis guineensis Jacq.)*	Seed	Kernel oil
Palm tree *(Elaeis guineensis Jacq.)*	Fruit	Palm Oil
Palm tree *(Elaeis guineensis Jacq.)*	Exudate	Palm wine

20 species for other uses as tool for construction of houses, roofing, beds and chairs using plant such as *Anthonota macrophylla*, raphia (*Raphia hookeri*), bamboo (*Arundinaria alpina*), construction of bridges and manufacture of farm and hunting baskets using rattan (*Lacosperma secundiflorum* and *Calamus deeratus*). The use of plants for cultural purposes, including ceremonies and religious events, tattoo, spiritual ability against witchcraft and ornamental neck chains (*Autranella congolensis* and *Lophira alata*). Leaves of some species are used for wrapping up traditional meals such as Maranthaceae leaves (*Maranthocloa purpurea* and *Megaphrynium macrostachyum*). Others are use as poison during fishing (*Massularia acuminata* and *Strychnos spinosa*) and chewing stick (*Massularia acuminata*) mostly exploited to be exported to Nigeria, brooms and cocoa drier (*Elaeis guineensis*).

Table 6. Harvesting effort for collecting NTFPs.

Villages	Harvesting distances (km)	Harvesting time (days)
Nkogho	2-10	1-3
Adjayukndip	5-20	1-5
Ewelle 1 & 2	3-15	1-3
Djeke 1 & 2	2-15	1-3
Kembong	5-30	1-7
Nfuni	6-17	1-7
Ossing	6-25	1-7
Talangaye	3-17	1-5
Bayenti	4-15	2-7
Etinkem	3-8	1-3
Bayip asibong	2-9	1-3
Akak	1-15	1-4
Bakogo	2-10	1-3
Mbinda tabo	2-12	1-3
Okoroba	2-15	1-3

They are also use for manufacturing mortar and drums (*Ptedocarpus soyauxii, Dacryodes edulis* and *Uapaca guineensis*), bow carrier and stick use to beat cattle (*Carpolobia alba*) also exported to Nigeria. NTFP can be used as farm demarcation (*Draceana arborea*), as fire lighter (*Canarium schweinfurthii*).

Table 7. Prices of NTFPs sold locally.

Species	Commercialized goods	Sales unit	Mean price (F CFA)
Baillonella toxisperma Pierre	Seeds	Bottle of 65cl	2 000
Cola acuminate	Seeds	Piece	25
Elaeis guineensis Jacq.	Cacao dryers	Piece	4 000
Garcinia kola Heckel	Fruits	Piece	25
Gnetum africanum Welw.	Sliced leaves	Small pile of 1 kg	100
Gnetum africanum Welw.	Leaves	Package of 1 kg	175
Irvingia gabonensis (Aubrey-Lecomte ex O. Rorke) Baill.	Dried almond	Pile	100
Irvingia gabonensis (Aubrey-Lecomte ex O. Rorke) Baill.	Dried almond	Basin of 15l	30 000
Irvingia gabonensis (Aubrey-Lecomte ex O. Rorke) Baill.	Paste of almond	Bowl of 5l	3 000
Irvingia gabonensis (Aubrey-Lecomte ex O. Rorke) Baill.	Fruit	Piece	25
Irvingia wombulu Vermoesen. D. Harris	Dried almond	Basin of 15l	35 000
Lacosperma secundiflorum	Country baskets	Piece	2 000
Megaphrynium macrostachyum (K.Schum.) Milne-Redh.	Slipping mats	Piece	600
Monodora myristica (Gaertn.) Dunal.	Seeds	Pile of 4-5 fruits	50
Piper guineensis Schumach. & Thonn	Seeds	Package of seeds	50
Poga oleosa Pierre	Seeds	Bottle of 65cl	2 000
Raphia hookeri G.Mann & H.Wendl	Roofing mat	Piece	100
Ricinodendron heudelotii (Baill.) Pierre	Seeds or almond	Can	275
Ricinodendron heudelotii (Baill.) Pierre	Seeds	Basin of 15l	30 000
Scorodophloeus zenkeri Harms	Seeds	Package of 3 fruits	50
Scorodophloeus zenkeri Harms	Barks	Piece of 10-15cm	300
Tetracarpidium concophorum Mull. (Arg)	Seeds	Pile of 10 fruits	25

Overall, it appears that the use of NTFPs varies from one area to another depending on eating habits, product availability and ease of access to the NTFP. One can note a great similarity in the use of certain products when going from one region to another. These results corroborate with the assertion of Guedje (1999) which lists a dozen of NTFPs generally contributing to making homes and more specifically to cover roofs. Food NTFPs provide more income for local residents,

especially during periods of intensive harvesting of bush mango and also contributes to subsistence. All kinds of society regardless of age harvest these products for consumption and/or sale. It should be noted that Tchatat (2002) had identified in Cameroon about 500 plant species for 1200 different uses.

NTFPs logged by the logging company

The forest concession has a management plan and is under sustainable management (Table 4). Looking at Annual permits of 2006 to 2009, species like *Baillonella toxisperma, Cylicodiscus gabonensis*, *Ricinodendron heudelotii* and *Irvingia gabonensis* are granted by Ministry of Forestry and Wildlife for logging.

Table 8. Economic potential of some NTFPs.

NTFP	Selling unit	Selling price (FCFA)	Productive capacity of tree	Economic potential of a tree (FCFA/tree)
Andok	Bowl de 15 L	32500	5 Bowl	162500
Djansang	Bowl of 15 L	30000	3 Bowl	90000
Moabi	Bottle of 65 cl	2000	25 Bottles of 65 cl	50000

Even dough they are priorities of local communities as food, medicine and income generating, the annual logging proportion shows their main interest as wood to the logger. Looking at *Irvingia* spp., only a unit was granted for logging by the Ministry in charge of forest in 2007 permit. The only unit given was not harvested but due to its high livelihood value for domestic and market consumption, is the first marketed NTPF in this area. Because communities enter into the forest concession to harvest this products, it can create direct conflict related on space. Globally, they are conflict linked on the resources (case of *Baillonella toxisperma, Cylicodiscus gabonensis* and *Ricinodendron heudelotii*) and conflicts linked on the space (case of *Irvingia* spp.). Looking the priority of these four species, they are classified as criteria 4. Consequently, there are considered as competitive species because they can cause short or long term conflict. They are chosen as targeted NTFPs for inventory survey in order to access impact of logging in their availability.

Table 9. Trees densities in various plots.

Species	Control plots (CP)				Disturbed plots (DP)			
	RP (250mx20m)	Density (Tree/ha)	SRP (20mx10m)	Density (Tree/ha)	RP (250mx20m)	Density (Tree/ha)	SRP (20mx10m)	Density (Tree/ha)
Andok	17	1,06	12	6,3	13	0,81	4	2,08
Djansang	2	0,13	2	1	9	0,56	5	2,6
Moabi	4	0,25	4	2,1	1	0,06	2	1,04
Okan	18	1,13	3	1,6	1	0,06	0	0
Medium density	10	0,64	5,3	2,7	6	0,38	2,8	1,43
Standard deviation	8,42	0,53	4,57	2,41	6	0,38	2,22	1,15

With: RP is Rectangular Plots with an area of 5 000 m² and SRP is Small Rectangular Plots with an area of 200 m²

NTFPs processed for consumption or commercialization

Some NTFPs cannot be directly consumed by humans and must undergo preliminary transformations before consumption. Processing allows for better valorisation and provides an added value to the products. Many secondary products are produced out of different NTFPs (Table 5).

Surveys show that only four NTFPs (*Baillonella toxisperma, Poga oleosa, Irvingia gabonensis* and *Elaeis guineensis*) are convertible for vegetable oil depending on the part used. From *Elaeis guineensis,* the processing of fruits gives crude oil, while when processing its seeds, they obtained Kennel oil. After tapping the trunk of *Elaeis guineensis*, the sap collected is used as palm wine for local consumption. Concerning *Irvingia gabonensis*, the seeds can be transformed into Bush mango oil and kernel pastry for better conservation and added market value. Looking at *Baillonella toxisperma* and *Poga oleosa*, the processing of their seeds can give respectively products like Djabe oil and Ovoga oil. When a products undergo processing, it is more conserved and its market value is improved.

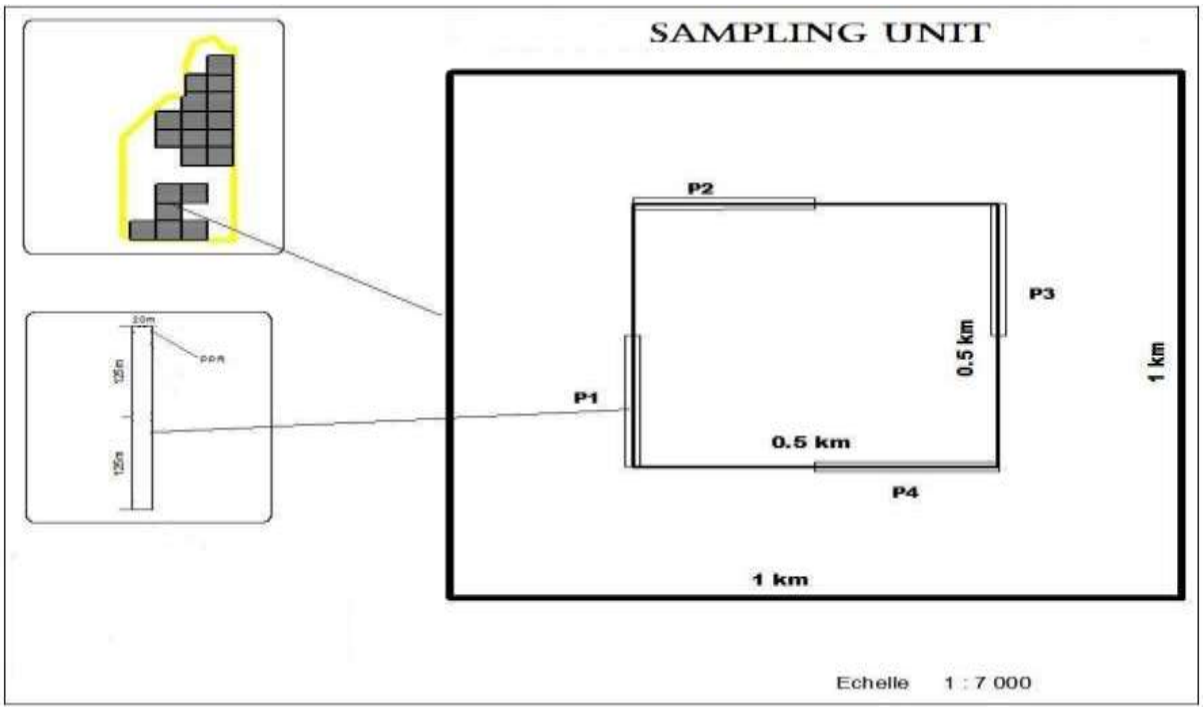

Fig. 2. Schematic representation of the sampling unit.

This transformation adds value to the product price will be increased by a certain value. These results are consistent with statements of Mbolo (1990), Debroux and Dethier (1993), Nlegue (1994), Fouda (1995), De Wachter (1995) and Debroux *et al.* (1998), who reported that some products are locally processed before consumption or use. In turn, Okafor (1980) mentions that *Irvingia gabonensis* is used for making jam, chocolate etc.

Sustainability of harvesting and distance of collection

Harvesting methods

It is clear that, a variety of harvesting methods depends on the part of the resource collected. To avoid that some products languish, gathering which is the main method of harvesting is necessary mostly when fruits (*Irvingia wombulu, Tetrapleura tetraptera, Poga oleosa* etc.) are concerned. As for seeds, they are picked-up directly under trees as they felt down (*Monodora myristica*) when ripped or rotten. When fruits and seeds reached physiological maturity, they fall and can be stored for long periods after picking-up. This gathering or picking-up has a diminished impact on resources. Some fruits are directly cut-off from trees (*Treculia africana, Myrianthus arboreus, Massularia acuminata, Cola acuminata, Cola lepidota* and *Cola nitida*) or might be picked-up and cracked fresh (*Irvingia wombulu*) or kept for days waiting for decaying (*Cola acuminata, Baillonella toxisperma, Ricinodendron heudelotii* and *Poga oleosa*) before cracking.

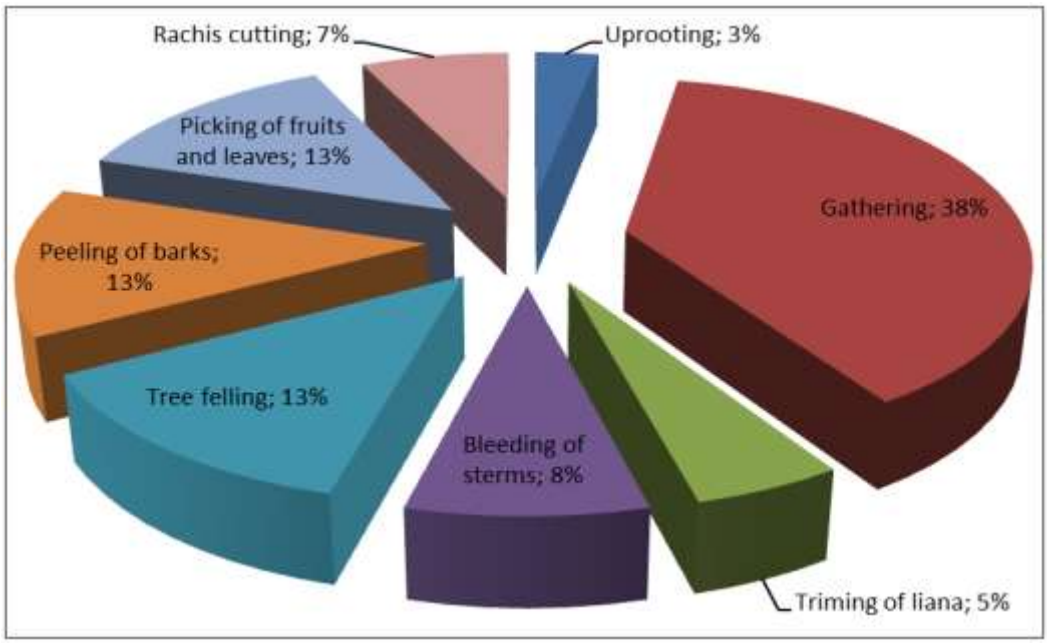

Fig. 3. Different methods of NTFP harvesting.

Trees are felled down in other to harvest their seeds (*Xylopia aethiopoca* and *Piper guineense*) or leaves (*Gnetum africanum*) and their uprooting when immature can lead to the disappearance. But to maximize profit during harvesting seasons, local communities proceed to picking. Far in the forest, peasants clean around the base of the tree, an area equivalent to the crown of ground projection when fruits are mature.

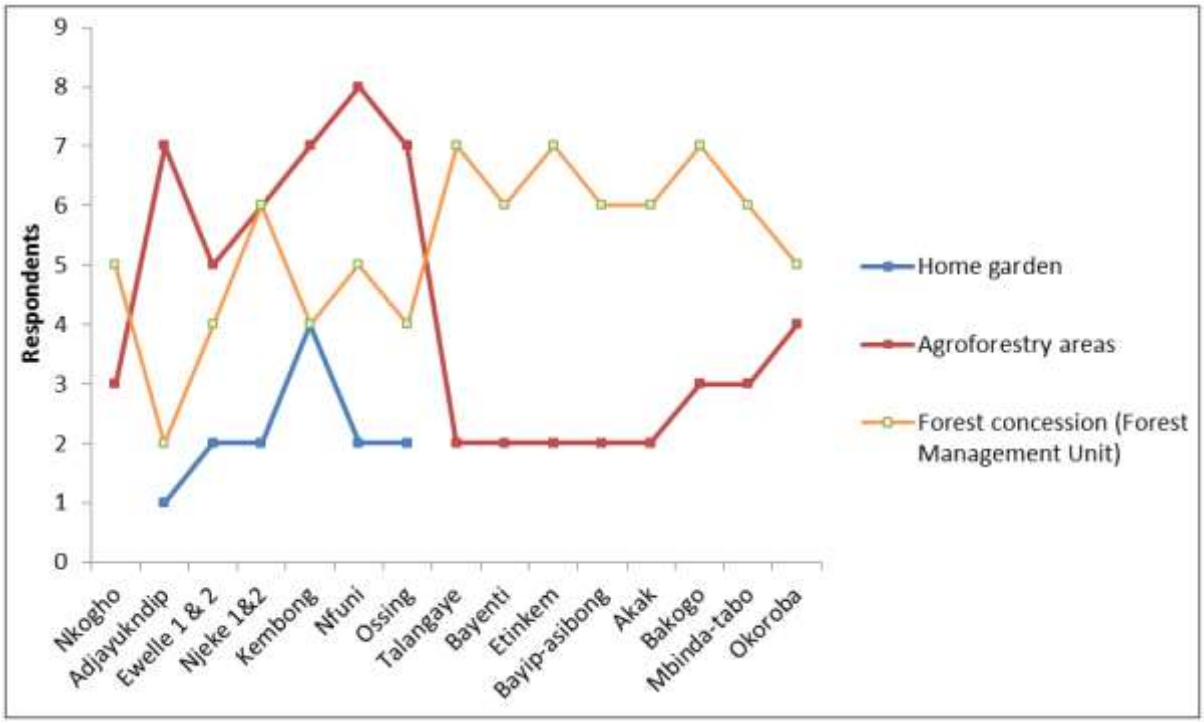

Fig. 4. Harvesting sites of NTFPs.

They simply distress themselves to make it as evenly as possible around labelled trees to collect fallen fruits. Some NTFPs like liana or climbers are either uprooted directly during harvesting (*Gnetum africanum, Draceana arborea, Afromomum giganteum, Afromomum melegueta,* and *Afromomum* spp) or harvested sustainably by cutting of leaves (*Gnetum africanum, Maranthocloa purpurea* and *Megaphrynium macrostachyum*) and stipe (*Elaeis guineensis* and *Raphia hookeri*). Rattan (*Dendrocalamus strictus*) is cut-out for direct use and other liana (*Lacosperma secundiflorum* and *Calamus deeratus*) are cut-out either for direct use or for sap (*Tetracera alnifolia*).

Peeling of barks of trees is implemented during harvesting of traditional medicine (*Cylicodiscus gabonensis, Enanthia clorantha* and *Alstonia boonei*), for tattoo during rituals (*Lophira alata*) or to obtain exudate as medicine (*Diospyros crassiflora*) and fire lighter (*Canarium schweinfurthii*).

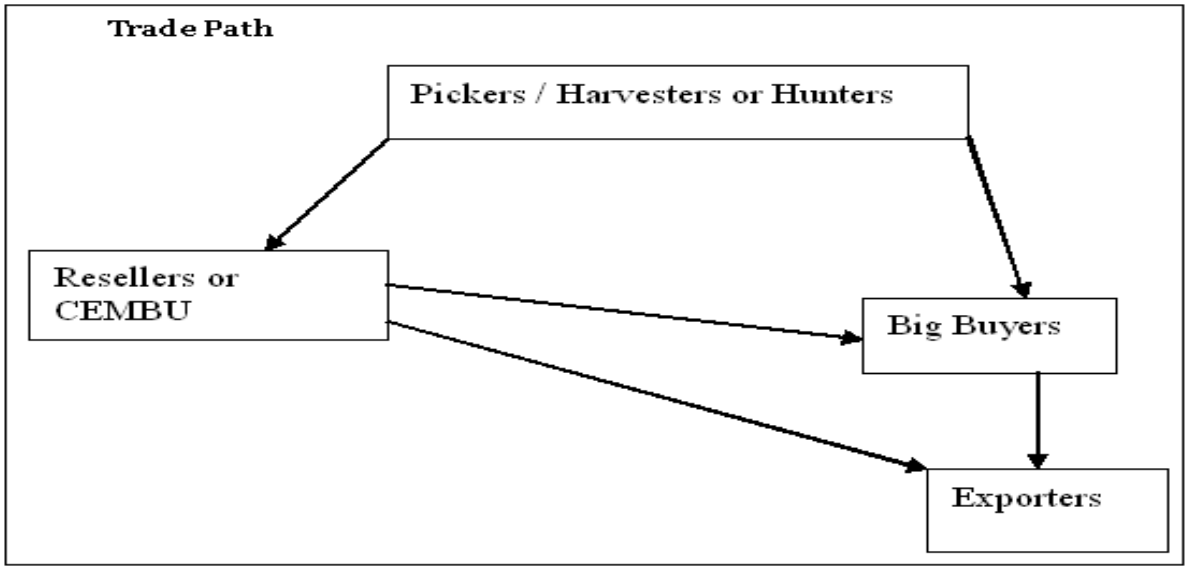

Fig. 5. NTFPs trade chain.

Therefore, peeling of barks is unsustainable when peeling is round along the tree as belt.

The harvesting practices that partially or wholly strip bark from live trees expose them to ring-barking and exposure to stem boring insects that can result in considerable postharvest tree mortality. Some peasants cut-down trees for direct use as construction materials (*Anthonota macrophylla*).

Artisanal cutting-down of trees for manufacture drums is unsustainable (*Dacryodes edulis*). Carpophore of fungus used as food are uprooted during harvesting and tapping is used to have exudate or sap as medicine (*Milicia excelsa*) or wine (*Elaeis guineensis* and *Raphia hookeri*).

In general, these useful parts of plants have been identified through the work of the CE-FAO (1999) and Walter (2001). They identified in higher plants, plant organs the most essential in the diet. Profizi *et al.* (1993) proportioned vegetative parts relevant to human needs.

Removal of tree barks is used to obtain traditional medicine products but if the tree is belt pilled, then the sustainability is not guarantee. This concord with the statement of Tchatat (1999), saying harvesting methods by felling of trees is extremely harmful and unsustainable. In the same sense, Tchatat (1999) suggest that the harvesting by picking of all fruits as they exist for some rare fruiting trees is also very dangerous practice for the dynamics of species and seeds.

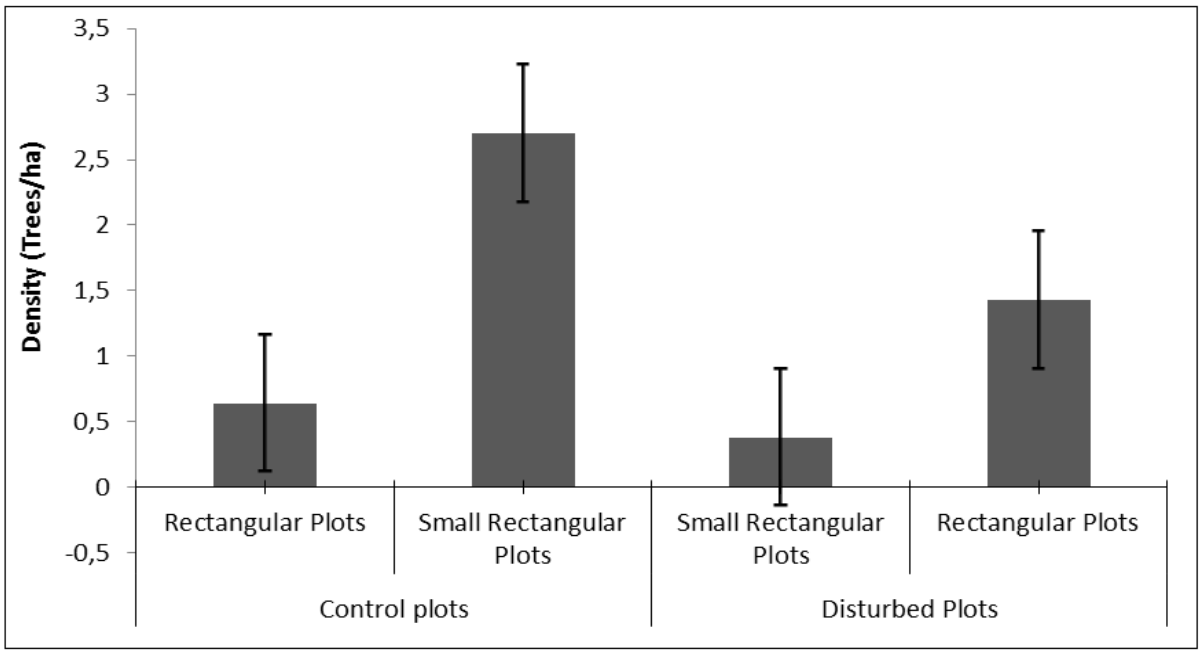

Fig. 6. Competitive NTFPs densities in various plots.

Location of NTFPs harvesting sites

When a local resident discover first, some trees in the forest having productive age, he marks and appropriates them to his family.

Those marked trees are carefully managed and the surroundings are constantly cleaned. When fruiting periods are near, these trees are constantly visited by the owner or another family member. As *Baillonella toxisperma* is concerned, we talk of "owner control" and the ownership is transferred from generation to generation provided that they are always maintained. Population harvest their products in three different production systems (Fig. 4).

Local residents walk for miles to collect NTFPs. These products are valued in terms of financial support for improving their income.

The harvesting of some products as fruits is mostly seasonal (*Ricinodendron heudelotii, Irvingia gabonensis, Baillonella toxisperma, Poga oleosa, Canarium schweinfurthii* etc.). The majority of respondents say they harvest most of their NTFPs inside the forest concession (proportion of 55%) and in a least case in home gardens (proportion of 8%).

It is mostly observed in southern villages of forest concession and 02 villages of northern part. In villages like Nkogho, Talangaye and Njeke 1&2, harvesting is concentrated in the forest concession because they are located at less than 4 miles from the concession boundaries and the agroforestry zone is too restraint. While harvesting predominates in agroforestry areas in northern villages of the forest concession because boundaries of this concession is not nearer (more than 5 miles) and population are conscious of domestication technics of NTFPs implemented in their farms located in agroforestry areas for products as *Baillonella toxisperma, Ricinodendron heudelotii, Irvingia* spp. and *Dacryodes edulis*. The forest concession is naturally and potentially rich in NTFPs while in home gardens, domestication of products like *Dacryodes edulis and Elaeis guineensis* is mostly implemented. The population are used to picking-up than farming mostly during harvesting season. This pressure on NTFPs can lead to a problem of sustainability. Some species as *Baillonella toxisperma* and *Poga oleosa* require dissemination by animals (zookory) like elephant for their regeneration. This is why people walk more than 10 km before seeing some products and sometimes camp for months in order to gather important quantities of NTFPs before coming back for marketing.

All residents surveyed say they are respectful to different assignments allocated as forest concession vocation. This is consistent with the mode of access to the resource indicated by Tsague (1995), Tchatat (1999) and Ngwasiri *et al.* (2002). They state that, depending on the mode of access to the resource, the local people respect the open access regime or the access system controlled by series devoted to the FMU. Sunderland and Obama (2000) suggest that NTFPs from wildlife and/or cultivated and domesticated, and most come from the forest, non-forest areas such as agricultural fields, cocoa plantations. This distribution meets the criteria of Clark and Sunderland (2004), which confirmed that NTFPs are collected in quite diverse habitats. In a general framework, the collection is linearly along roads in northern FMU. These villages have not yet been logged and residents are very active in the systems of domestication through cultivation trials. this corroborate with the allegation of Schreckenberg *et al.* (2006) which states that the domestication plays a very important role in reducing poverty as it purvey farmers with local forest products that are used daily for their food, medical care and construction. While in the southern FMU, logging has promoted access to the mountains. Tree felling causes floristic erosion when the resource cannot naturally regenerate due to poor environmental conditions.

Harvesting effort of NTFPs collection

The harvesting effort is represented here by the distance to reach the resource and the time of collection (Table 6). People can enter the forest at about 30 km and sometimes spend more than a week in the forest in order to collect NTFPs (*Gnetum africanum* and *Scorodophleus zenkeri*) not just for subsistence consumption but also for marketing of surplus (Table 6). *Pepper guineensis* and *Ricinodendron heudelotii* are encountered at distances up to 3-5 km, *Irvingia* spp., *Poga oleosa* and *Baillonella toxisperma* meet at more than 25 km while the collection of *Gnetum africanum* and *Scorodophleus zenkeri* which are encountered hazardously is done at distances of about 20 or 30 km in the concession because it is a permanent product always available regardless of the season. Human pressure on resources varies depending on product availability and taking into account the economic value of these products. The proximity and easy access to the concession favoured harvesting of traditional medicine products or food as *Irvingia* spp. by the presence of old tracks created by logging. During the harvest seasons of these high economic value products, people are abandoning farming to concentrate on the *Irvingia* spp. harvest, considered as the main revenue generator in this area. The harvesting of some NTFPs requires too much muscular effort regarding their collection and processing. Must often, men focused on their harvest. The manufacture of mortars and drums required muscular effort and it is more practiced by men.The residents around the concession may neglect some NTFPs that generate a double income than those generated by the most exploited NTFPs. Their harvest is seasonal while most valorised ones like *Gnetum africanum* is permanent. Some products (*Lacosperma secundiflorum* and *Calamus deeratus*) are considered as permanent because of their availability at any season of the year. Some permanent products (*Tetrapleura tetraptera, Maranthocloa purpurea* and *Megaphrynium macrostachyum*) are neglected while considered as criteria 3 on NTFP priority and are mostly sold in agglomerations like Douala and Yaoundé. Population around the forest concession are not aware of economic potentials of these products which are numerous and perish with time.

Economic value of NTFPs

Local market chain of NTFPs

The markets of Kembong, Nfuni, Adjayukndip and Ossing are considered as intermediate or transitional markets linking to the Aba-Nigeria international market. In the southern FMU, there is absence of real markets. As marketing chain is concerned, harvesters are represented by local residents and are the most numerous of the circuit. Retailers and big buyers or exporters who are Nigerians are less represented (Fig. 5).

Most rural communities have less access to opportunities and are highly dependent on retailers who are best connected to urban areas. Here, NTFPs are sold in very small quantities but permanently and trading is intensified during Bush mango and Njabe harvesting season and at least cost. While in the northern FMU, markets are of large size. This is explained by the presence of large villages called street villages and buyers are organized to an association called *Central Edjagham Mango Buyers Union* (CEMBU) concentrated mostly in the purchase of bush mango and sometimes other NTFPs depending of their availability. This association sets prices and sale their goods only to Nigerian buyers. All the active members are resellers.

Many people sell their goods in the village at very modest prices because they don't have enough money to cover the costs of transportation to urban markets. This is consistent with the allegation of Pérez *et al.* (1998) reporting that NTFP markets from a vast hierarchical network can be divided into four categories according to their size, specialization and their geographical coverage. Some products are expensive and require too much work and involving gender. Men sold bush mango as fruit and kernel, while women process the seeds into paste before selling. It is in this sense that Perez *et al.* (1999) find that there is also a clear division of roles between the sexes in the market: men focus on the largest and more lucrative products, while the least attractive products are usually left to women. Even though the marketing of NTFP is intense around the FMU; no actor of the marketing chain have business license to operate legally in concordance with forestry regulations demands.

Prices of NTFPs around the forest concession

Many species are used for one or more of their useful parts. But only the most important ones are sold at the local, national and international level (Table 7). Sixteen species are sold locally. Their prices vary depending on sales unit. In the southern FMU, retailers or big buyers dictate goods prices according to same products prices in Aba-Nigeria market. While in the northern FMU, CEMBU imposes prices for Nigerian buyers. As *for Irvingia gabonensis* and *I. wombulu*, their cost ranges from 25 to 35 000 FCFA. This fluctuation depends on the level of processing, the sales unit (quantity) and the harvesting and selling season. Only *I. gabonensis* can be sold as fruit for direct consumption while *I. wombulu* is more costly than *I. gabonensis* because of his low productivity rate and harvesting season (January to march). *Scorodophloeus zenkeri* Harms is sold as seed and bark. The bark is mostly coming from the male species and is permanently viable, while the seed coming from the female species is seasonal and more expensive.

Economic potential of NTFPs

Some NTFPs are potentially valuable and can improve annual income of livelihoods. Only economic potential of competitive tree species is evaluated (Table 7). The productive capacity of *Andok* is the highest compared to *Moabi* and *Djansang*. This is because *Andok* produced annually while *Moabi* flowers during the long rainy season and fruits during the short dry season and it fruiting rate occurs once in two successive years.

This character of productivity is related to the biology of each species. Looking at annual productivity and species density, *Andok* represents the most economic valued species of the FMU, even though the economic potential of a Moabi tree is higher if the assessment is done on a two years period. Nevertheless *Moabi* represents the less profitable species because its extraction as oil requires more time and energy. It density decline over time because of the intensive logging of the species while *Andok* and *Djansang* are less logged. It is therefore necessary to leave some *Moabi* to be used as seedlings.

Impact of logging on NTFPs availability

The realization of a multi-resource inventory through a network of 16 plots installed on 1 ha each, allowed us to identify different NTFPs following the appropriate devices. Counting focused on competitive NTFP trees (*Andok, Djansang, Moabi* and *Okan*)

with more than 20 cm in diameter in rectangular plots of 250 m x 20 m (RP) arranged on a total area of 4 ha and trees with 10 cm<DBH<20 cm (DBH: Diameter Breast Height) in small rectangular plots of 20 m × 10 m (SRP), all in disturbed and control plots (Table 8.).

An evaluation on competitive NTFPs trees with DBH> 20 cm shows that, the quantity and density of *Andok, Moabi* and *Okan* reduces after logging but *Djansang* species increases in number as forest is destroyed. Looking at same species with 10 cm<DBH<20 cm in diameters, their densities decrease as the forest is affected by anthropic activities. In RP, the medium density of NTFPs is not higher than 1 tree/ha in both controlled and disturbed plots. However in SRP, based on the previous criterion in disturbed plots, we have more than 3 trees/ha without *Okan* species. Thus, regardless of the sampling method used, the average density of NTFPs in the residual stand decreases. The destructible potential of *Andok* is the lowest because their natural regeneration is easy and their dissemination is facilitated by animals. The destruction is more pronounced on *Moabi*. This is because *Moabi* is a species of primary natural forest and is considered as the main competitive NTFP. It is very popular for residents and logging which intensively contribute to its disappearance. Damages caused by logging can indirectly impact the sustainability of the resource. There is a need to change to Reduced Impact Logging (RIL) than practicing selective logging to perpetuate the forest resource and to maintain the environmental stability of the area (Buenaflor, 1990). When the subject of sustaining wood production over a number of cutting cycles is considered, it becomes obvious that planned exploitation is the key to ensuring that the growing stock is maintained at a desirable level (d'Oliviera and Braz, 1995). *Okan* has the higher affected potential while *Djansang* has a growing potential fostered by logging. *Okan*, hydraulic wood is highly prized for the harvesting of its timber and requires several years for its natural regeneration. Its disappearance can also be accentuated by the method of harvesting as belt pilling. *Djansang* is not exploited for its timber in the FMU. It regenerates quickly in destroyed forest because it is a hyper - light-demanding pioneer plant. According to Vivien and Faure (1985 and 1996) , the growth of *Djansang* seedling is very fast in bright light and the first fruiting takes place four years after planting.

Regarding trees with DBH> 20 cm, the average densities of NTFPs in the two types of forests are different. But then, at 95% confidence interval of the Student test (*t*), the difference in the two types of plots is not significant. Similarly, in the SRP of 20m × 10m, the difference in mean density is still insignificant (Fig. 6.). This is explained by the implementation of sustainable management through Reduced Impact Logging (RIL) practices and the ongoing process of Forest Stewardship Council certification of this forest concession. Multipurpose species, like the *Andok, Djasang*, *Moabi* and *Okan* have the distinction of interest to both the timber industry and the production of NTFPs. Most often, the greatest interest is focused on the wood rather than NTFP. Thus, logging completely eliminates the harvesting potential of NTFP, though more beneficial to local populations in the long term for both the harvesting into NTFPs for food.

Fruiting state of trees

Knowing that future producers are trees respecting the constraints 10 cm<DBH<MFD (MFD: Minimum Fruiting Diameter) and producible trees satisfy the constraint DBH>MFD (Table 10.). Based on these criteria, *Irvingia gabonensis* occupies the bigger proportion because it is the most economic valued species represented in sampled plots. This because, it is not the covetousness of the logging company. Looking the MFD, which is the diametrical range where trees have the ability to be productive and the criterion for fixing logging diameters, *Moabi, Okan* and *Djansang*, have their DBH>MFD . Conversely *Andok* has a DBH<MFD (between 55 to 70 cm). It is necessary that Andok falls into the category of species with DBH>MFD so that if the company start logging of this species,

the impact on his regeneration will be less. This category includes most producible trees, unless future producers must meet at least the MFD to be able to convert solar energy into organic substances.

During evaluation of trees fruiting states, we saw respectively 4 and 5 cases for *Andok* and *Djansang* respecting the constraint DBH>MFD. At MFD, flowering and fruiting are generally scarce. It is important to know the diameter of regular fruiting, which is essential for the maintenance of seed potential in forests undergoing logging. To determine this diameter, a threshold of 70% fertile trees must be retained (Doucet, 2003). During logging, management diameter set outweigh the RFD (Regular Fruiting Diameter). Otherwise, the operation may result in a significant depletion of the number of seed quality. It is particularly difficult to enact standards for a number of seedlings to maintain a given surface. These standards should reflect the terms of pollination (wind, insects, and mammals), ability to disperse seeds, gregariousness, temperament, etc.

Compared to the minimum administrative cutting diameter of these species determined by forestry ministry, *Moabi, Okan* and *Djansang* meets the standard for natural regeneration. This may not be harmful given the abundance of *Andok* trees in the plots and non-logging of his wood but rather for its bark. Debroux (1998) found in natural conditions in Dja forest that *Moabi* fructify systematically from 70 cm diameter because at this diameter, it already reaches the light. Doucet and Koufani (1997) observed in the Kompia community forest, that the MFD of *Djansang* is 45cm. The proportion of producible trees dominates by far that of future producers.

The growth of future producers which is related to the structure of the forest can be changed by logging or natural mortality of trees because when the tree is older, he is vulnerable. Indeed, the impact of current harvesting technics of bark acts much on the abundance and diameter distribution by a significant reduction in the number of adult trees in large diameter classes.

This corroborates the allegation of Tchatat (1999) which states that the severity of the impact depends on the sampling technique, the species and the amount of bark removed and Buenaflor (1990) saying some of the trees in the 50-60 cm DBH class need to be retained as future crop trees to maintain adequate forest cover and seed trees. He says minimum DBH for felling is 50 cm, although for export markets operators do not generally fell trees below 60 cm DBH.

The densities of *Moabi* (0.06 tree/ha in disturbed plots and 0.25 tree/ha in controlled plots) and *Okan* (0.06 tree/ha in disturbed plots and 1.13 tree/ha in controlled plots) in RP are higher than those mentioned in the management plan of the forest concession (0.04 tree/ha for *Moabi* and 0.19 tree/ha for *Okan*). These differences result from the fact that the research plots were located in areas of preference of these species. If we only based on average densities of NTFPs in disturbed plots, we see that these results are consistent with those found by Tchatat (2002), who thinks that almost 40% of devastated spaces by human activity are those which have a high density of NTFP in the natural forest and the density of NTFP is low, even for the most popular species of the order of 0.5 tree/ha. Logging, natural mortality and other anthropogenic factors can destroy up to 83% of residual stand. This proportion is in line with the results of Buenaflor (1989) which states that over 30% of most logged areas are destroyed by uncontrolled skidding and 40% of the residual trees 20-50 cm DBH are damaged by uncontrolled current logging.

Conclusion

If tropical forests are to be retained as forest, then for the most part their resources must be utilized. Otherwise, they risk being perceived by local people and government decision-makers as having less value than other land-use options. Improper harvesting practices can so degrade the forest that future timber and non-timber values may be substantially reduced. Fifty four species encountered are used as food,

traditional pharmacy, etc. Just some vegetative organs of the tree are useful. Harvesting sites are located in agro-forestry sites, home gardens and concession. NTFPs are locally sold permanently or weekly and most seasonally. Multipurpose species, like the *Andok, Djasang*, *Moabi* and *Okan* have the distinction of interest to both the timber industry and the production of NTFPs. Most often, the greatest interest is focused on the wood rather than NTFP. During logging, management diameter set outweigh the RFD (Regular Fruiting Diameter). Compared to the minimum administrative cutting diameter of these species determined by forestry ministry, *Moabi, Okan* and *Djansang* meets the standard for natural regeneration.

Looking the contribution of NTFPs in human nutrition, medicinal care and income generating, rational and sustainable management measures has to be strongly implemented in order to conserve them. Many factors occur in the damage of these products as well as anthropic activities which are the more pronounced. More specifically, logging is impacting directly the structure of the forest. Therefore, the implementation of sustainable management practices trough reduced impact logging (RIL) define as intensively planned and carefully controlled implementation of harvesting operations to minimize the impact on forest stands and soils, usually in individual tree selection cutting, influences long term availability of plant non-timber forest products. They also facilitate participatory forest management by integrating local communities in decision making for annual logging planning. Residents can therefore fulfill their user's rights while respecting forest management objectives. But Cameroon's forest law should allow marketing of harvested NTFPs by residents to improve their living condition. Harvesting of NTFPs is mostly influenced by the sustainability of the collecting method.

The forest concession 1089 is under management and ongoing certification. Certification standards prohibit impact less activities and recommend those favoring long term durability of forest.

To improve income of livelihoods of residents, NTFPs must be sold at expensive prices and the marketing chain reduced. People have to organize themselves as cooperatives and imposed selling price of competitive NTFPs. To maintain long term availability of NTFPs intensively influenced by logging, harvesting of trees is recommended after regular fruiting diameter. This may be consider as 10cm added to minimum fruiting diameter (RFD=MFD + 10cm). Based on destroyed landscape, logging is not significantly degrading NTFPs density when reduced impact methods exist. Where RIL techniques are not implemented, the volumes extracted in second and third cuts will be much reduced from those of the first cut. Globally, it is important to undergo certification systems of Cameroon's forest if the aim of conserving forest stand is necessary.

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Appendices

Almond of *Irvingia gabonensis*

Leaves of *Gnetum africanum*

Fruits of *Irvingia gabonensis*

Sliced leaves of *Gnetum africanum*

Fruits of *Ricinodendron heudelotii*

Grains of *Ricinodendron heudelotii*

Fruits of *Aframomum giganteum*

Fruits of *Baillonella toxisperma*

Grains of *Cola acuminate*

Grains of *Baillonella toxisperma*

Fruits of *Cola lepidota*

Liana of *Laccospermun secundiflorum*

Grains of *Scorodophloeus zenkeri* Cluster.

Grains of *Garcinia kola*