Agriculture, Forestry and Fisheries
2014; 3(6): 469-480
Published online December 27, 2014 (http://www.sciencepublishinggroup.com/j/aff)
doi: 10.11648/j.aff.20140306.16
ISSN: 2328-563X (Print); ISSN:2328-5648 (Online)

The ecological status and uses of *Ricinodendron heudelotii* (Baill.) Pierre and *Gnetum* species around the Lobeke National Park in Cameroon

Roseline Gusua Caspa[1, 3, *], Isaac Roger Tchouamo[2], Jean-Pierre Mate Mweru[1], Joseph Mbang Amang[3]

[1]Regional Postgraduate School of Integrated Tropical Forest and Landscape Management (ERAIFT), University of Kinshasa, P.O. Box 15373 Kinshasa, Democratic Republic of Congo
[2]Department of Economics and Rural Sociology, University of Dschang, Dschang, Cameroon
[3]Institute of Agricultural Research for Development (IRAD), P.O. Box 2123 Yaounde, Cameroon

Email address:

rcgusua@gmail.com (R. G. Caspa), rogetchouam@yahoo.fr (I. R. Tchouamo), jpmatemweru@gmail.com (J. P. Mate Mweru), mbang4@yahoo.com (J. M. Amang)

To cite this article:

Roseline Gusua Caspa, Isaac Roger Tchouamo, Jean-Pierre Mate Mweru, Joseph Mbang Amang. The Ecological Status and Uses of *Ricinodendron heudelotii* (Baill.) Pierre and *Gnetum* Species around the Lobeke National Park in Cameroon. *Agriculture, Forestry and Fisheries.* Vol. 3, No. 6, 2014, pp. 469-480. doi: 10.11648/j.aff.20140306.16

Abstract: *Ricinodendron heudelotii* (Baill.) Pierre (Euphorbiaceae), *Gnetum buchholzianum* Engl. and *Gnetum africanum* Welw. (Gnetaceae) are among the major species of non timber forest products (NTFPs) of the Lobeke National Park (LNP). The growing demand for these products has led to an increase in exploitation; but no information exists on the status of the resource base. There is equally very little information on the importance of these resources to the local population. A survey was conducted in 152 households to get the perception of locals on the availability and use of these resources in the Lobeke landscape. An inventory was also conducted to determine the abundance of the species in three forest systems including protected area, production forest and agroforest. Productivity of *Ricinodendron heudelotii* was assessed by counting fruits from fifteen trees in each forest system. 88 % of respondents collected *Ricinodendron heudelotii*, mostly for sale and earned between 69300 and 1002000 FCFA per year. All respondents collected *Gnetum* leaves, and up to 35 % of collectors solely for consumption. Sale of *Gnetum* leaves ranged from 200 to 9200 FCFA per week. 99 % of collectors thought that the quantity of *Gnetum* in the wild has reduced over the years while *Ricinodendron heudelotii* is still abundant. There were more trees of *Ricinodendron heudelotii* in the production forest and agroforest than in the protected area. No significant difference was observed in mean diameter at breast height (DBH) of trees in all forest systems. Mean number of fruits was significantly higher for trees in the agroforest than for those in the production forest and protected area. A significantly higher number of *Gnetum buchholzianum* vines was observed in the production forest than in the agroforest and protected area while the growth of *Gnetum buchholzianum* seedlings were significantly lower in the agroforest than in the protected area and production forest which showed no significant difference. The presence of productive individuals of *Ricinodendron heudelotii* is an indication that the resource will be available for some time but the near absence of younger individuals is unfavorable for the perpetuity of the species. It is recommended that the local population be sensitized on the importance of domesticating these species and trained on appropriate techniques to propagate and incorporate them into suitable agro systems.

Keywords: Non-Timber Forest Products, Resource Base, Forest System, Baka Pygmies, Bangando

1. Introduction

The Congo basin forest is the second largest contiguous area of tropical rainforests in the world [1]. These forests extend over 228 million ha, storing 36.815 billion tons of carbon and providing habitats for over 11000 species of plants (many of which are endemic to the area) and associated fauna, including endangered species such as gorillas and chimpanzees [2]. Cameroon has a tropical dense forest of about 19 million hectares which forms part of the Congo basin forest [1]. In 2003 there were almost 80 million

inhabitants in the Congo basin with 62 % of them living in rural areas and deriving their livelihoods from natural resources [3]. The international community has recognized that the conservation of biodiversity and the reduction of greenhouse gas emission are global environmental issues that affect the future of the entire human society; thus the conservation of tropical rainforests has attracted global concern [4]. Non timber forest products (NTFPs) are a major source of livelihoods for forest communities. They are sources of food, income, medicine, construction materials and are also of cultural and spiritual value to forest dwellers [5, 6, 7]. About 80 % of the population in developing countries uses forest products on a daily basis and about 75 % of poor people that live in rural areas depend on forests for subsistence [8, 9]. These forest products are available during times of scarcity of staples and are often used as safety nets where the rural community depends on the resources to bridge the hunger gap [10]. NTFPs provided employment for an estimated 283,000 people in Cameroon and generated a market value of US$ 54 million in the 2007-2008 seasons [6]. According to [11], the management of NTFPs has been recognized as a way of ensuring forest conservation and as an alternative to conversion of forests into agricultural or other land use. NTFP harvest can affect ecological processes at many levels, from the genes, individual and population to community and ecosystem, all of which have important consequences [12, 13]. The fragile ecological balance maintained in a tropical forest is easily disrupted by human intervention and extractive activities that at first glance appear very benign but can later have a severe impact on the structure and dynamics of forest tree populations [14]. The NTFP sector in Cameroon is also negatively affected by inconsistent legal and institutional policies that do not favor effective management and commercialization of the resources [15, 16]. Conflicting and overlapping customary and formal regulations make management difficult and recognition of positive customary regulations could aid sustainable management [17]. *Ricinodendron heudelotii* and *Gnetum* species (*Gnetum buchholzianum* and *Gnetum africanum)* were identified among priority NTFPs in the study area because they were major sources of food and income [6].

Ricinodendron heudelotii (Baill.) Pierre (Euphorbiaceae) is a fast-growing late secondary forest tree found in the Guinea-Congolean humid forests of West and Central Africa, reaching a height of up to 50 m and girth of 2.7 m [18]. It occurs typically as a species of the fringing, deciduous and secondary forests, common throughout the semi-dry, wooded savannah zone, where it is scattered in gaps at forest edges and in secondary scrub and thickets [19]. *Ricinodendron heudelotii* trees first produce fruits after about 4 years of existence [20]. On the other hand, [21] and [22] reveal that trees first produce fruits at 6-7 years and 8-10 years of age respectively. *Ricinodendron heudelotii* trees fruit once in every two to three years between September and October, although some can fruit every year [23]. [24], however observed ripe fruits of the species from late August to end of December in the humid forest zone of Cameroon.

According to [25], *Ricinodendron heudelotii* has four major use categories including consumption, medicinal, sociocultural and soil fertility improvement. It is valued for its distinctively flavored seeds, commonly called 'njansang' which are dried and used as flavoring and thickening agent in food. *Ricinodendron heudelotii* bark is used to treat yellow fever, anemia, malaria, stomach pain and disease of infants. It is also used as aphrodisiac in parts of Cameroon and in pregnancy to ease delivery [25]. The decoction of *Ricinodendron heudelotii* bark is used to treat hernia and abdominal pain in the Lobeke area [26]. It is grown by farmers for soil fertility improvement, forage, shade, poles and light wood work; and is a major source of income [18, 23]. About 71585 metric tons of *Ricinodendron heudelotii* kernels were produced and traded in the humid forest zone of Cameroon between 2003 and 2010; and valued at about equivalents to US$ 708770 [27].

Gnetum buchholzianum Engl. and *Gnetum africanum* Welw. are gymnosperms of the family Gnetaceae. They are understorey lianas found in the humid tropical forest from Nigeria through Cameroon, Central African Republic, Gabon, and Democratic Republic of Congo to Angola [28]. In Cameroon, these *Gnetum* species are often found in fallow farmlands, secondary forests and closed forests. The vines climb on trees, saplings and shrubs for support in the complex tropical humid forest where they grow luxuriantly and produce great quantities of leaf biomass [29]. *Gnetum* plays a significant nutritional and social role across the sub-region where the plant is found and is consumed by people of all social strata [30]. In Cameroon, leaves of *Gnetum* species are harvested on a daily basis for sale in local and regional markets. They are evergreen and therefore available throughout the year [29]. However, there are increasingly reports of destructive and unsustainable harvesting through cutting and removal of the entire plant and/or felling of support trees [31]. [32] point out that the vulnerability of some major traded species is exacerbated by the lack of knowledge about sustainable harvest techniques such as in Cameroon where 40 % of *Gnetum* species are harvested using unsustainable techniques. The high volume of trade in *Gnetum* species combined with low levels of domestication results in unsustainable harvests [33, 18]. *Gnetum* species were declared endangered by the Ministry of Environment and Forestry (MINEF) in Cameroon in 1995 [34]. However, no action has been taken to protect the species. Although it is listed as a special forestry product, no particular protection measures other than a quota system which is not based on any inventory has been put in place [32]. Likewise, both species of *Gnetum* are Red List classified as near threatened [35, 36]. In Cameroon, harvesters of *Gnetum* species can earn US$ 98 to 110 per month, which is higher than the guaranteed minimum wage [37]. According to [38], about 607900 metric tons of *Gnetum* leaves were traded between 2002 and 2008, and valued at about 631,167,345 F (CFA) which is equivalent to US$1,262,334. Incomes from sales of *Gnetum* leaves allow families to pay for food, healthcare and

children's education [7]. *Gnetum* species exist in a wide range of habitats and are harvested in both fallow farm areas and closed canopy forests. These species contribute to food security, for harvesters who consume them directly and for households that buy leaves in the markets, and income diversification. In the South west, coastal and central areas of Cameroon, the annual harvest is estimated at 4,180 tons. The *Gnetum* species sector directly involves at least 1,885 people in Cameroon. It represents a valuable trade that is estimated at US$ 3.8 million per year in South west Cameroon [7]. However, the growing importance of *Gnetum* species both for the purposes of nutrition and for earning income increases the pressure placed on the resource. Improved harvesting and domestication techniques are therefore required to ensure the sustainability of this non-timber forest product [7]. A survey in southern Cameroon found that 86 % of 200 households surveyed ate *Gnetum* more than 3 times a week [18]. In addition to being a major source of food and income, *Gnetum* species also have a number of medicinal properties. In Cameroon it is recorded as being used in the South west to ease childbirth [39] and the leaves are used as a disinfectant for wounds, to treat hemorrhoid and as an anti-hangover agent when the fresh leaves are crushed and used to neutralize the effects of alcohol [32]. The Bulu ethnic group uses the leaves to treat colds, increase blood production and to treat spleen problems [40]. The leaves are used to treat nausea and act as an antidote to certain types of poison [7]. The leaves also have very high nutritional value as their cellulose can extend digestion periods and reduce cholesterol levels [42].

These species feature in most lists of priority NTFPs in Cameroon [43, 44, 18, 45]. [46] identified *Ricinodendron heudelotii* among trees preferred in cocoa agroforests whereas [47] proposed these species as appropriate for inclusion into multi strata agroforests and for domestication. Surveys carried out by ICRAF (World Agroforestry Center) and partners to find farmers' preferences for multipurpose trees ranked *Ricinodendron heudelotii* third among species considered useful for domestication in the West African humid lowlands [48], and were ranked fourth in other such surveys in Onne, Nigeria and Mbalmayo, Cameroon [49]. *Gnetum* species are ranked among the main NTFPs in terms of their high economic importance in Central and West Africa [6, 7]. The high economic value of these species to the local population is the cause of high exploitation pressure hence; this study was aimed at determining the status of their resource base, the possible impact of harvesting on these species and their uses within the Lobeke landscape.

2. Materials and Methods

2.1. Study Site

This study was carried out at the Lobeke National Park in Cameroon. The LNP is situated between latitudes 2°05' to 2°30'N and longitudes 15°33' to 16°11'E. It has a surface area of about 217 854 hectares and found in the Moloundou Sub Division of the Boumba and Ngoko Division of the East Region of Cameroon. The LNP forms a part of the Sangha Trinational Landscape (28000 km^2), a forest conservation area established by three African countries, including Cameroon, the Central African Republic and the Republic of Congo, with the objective of protecting the native tropical rainforests with their diverse flora and fauna [50] . It is rich in forest resources and habitats of diverse and unique wildlife on which generations of indigenous communities have depended for millennia [50] and was recently designated a UNESCO world heritage site. The climate of the area is typically equatorial with four seasons - two rainy and two dry seasons. The long rainy season extends from September to November with its peak in October while the short rainy season extends from late March to June with its peak in April. The maximum precipitation is about 1500 mm per year. The long dry season extends from December to February while the short dry season is between July and August [51]. The mean monthly temperature varies between 23 and 25°C with a mean annual temperature of 24°C. The relative air humidity also varies from 60 to 90 % [52]. This area was chosen for the study because of the increasing importance of NTFPs to the local population in the Lobeke landscape.

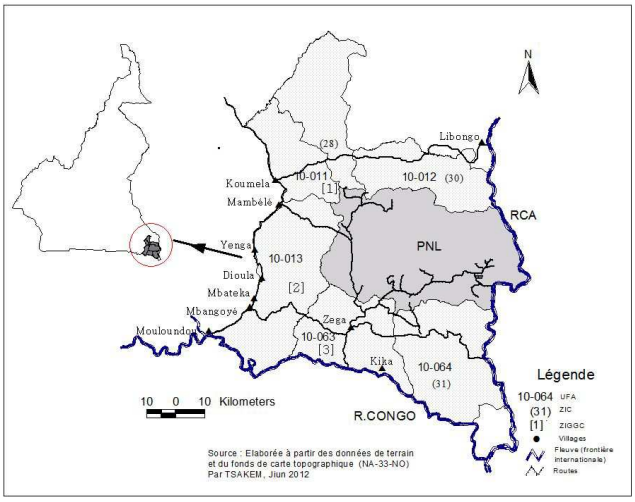

Figure 1. *Map of the Lobeke National Park (LNP)*

2.2. Survey

Nine villages (Koumela, Mambele, Yenga, Dioula, Mbateka, Mbangoye 2, Zega, Kika and Libongo) were chosen around the LNP by virtue of their close proximity to the park for administration of questionnaires. This was to ensure that villagers had a high possibility of collecting NTFPs within the Lobeke landscape. Semi structured interviews were conducted between June and August 2012 in 152 households which had been involved in the exploitation of *Ricinodendron heudelotii and/or Gnetum* species for at least five years, with the objective of getting the perceptions and attitudes of respondents towards the management and use of these resources.

2.3. Ecological Assessment

The materials used for this assessment included a 100 m measuring tape for setting up the plots for inventory, a diameter tape for measuring the girth of trees, cutlasses for clearing and opening up paths for movement and delineating plots, a meter ruler for measuring the heights of seedlings nylon ropes and wooden poles to set up plot limits and calipers for measuring seedling diameter. An inventory was carried out to assess the structure, abundance, distribution and regeneration of *Ricinodendron heudelotii* and *Gnetum buchholzianum* in the study area. (Inventory was carried out on *Gnetum buchholzianum* because locals indicated that they preferred harvesting it to *Gnetum africanum*). Six plots of 100 m x 100 m were systematically set, separated from each other by a distance of 200 m in three systems including protected area, production forest (community forest) and agroforest (old fallow/active agricultural land), making a total of eighteen (18) plots [53]. A community forest in Cameroon is a forest forming part of the non-permanent forest estate, which is covered by a management agreement between a village community and the forestry administration. Management of such forest – which should not exceed 5,000 ha – is the responsibility of the village community concerned, with the help or technical assistance of the forestry administration.

All individuals of *Ricinodendron heudelotii* with at least 10 cm diameter at breast height (DBH)) were tagged, counted and measured for DBH in each plot. Each plot was divided into sub plots of 5 x 100 m. Younger trees of 5 – 9 cm DBH and saplings (young plants of *Ricinodendron heudelotii* greater than 1 m height but less than 5 cm DBH) were counted and measured in ten alternating sub plots per plot. *Gnetum buchholzianum* vines were also counted in ten alternating sub plots per plot. Regeneration plots of 2 x 2 m were set at 50 m into each sub plot for enumeration of seedlings of both species [53]. Twenty five (25) seedlings of *Ricinodendron heudelotii* were selected and tagged under five widely separated productive trees (within and out of sample plots depending on availability) in all three forest systems making a total of three hundred and seventy five (375) seedlings. Seedling survival and growth were determined by counting number of surviving seedlings, number of leaves per seedling and measuring seedling height and collar diameter every three months for eighteen months. On the other hand, one hundred (100) seedlings of *Gnetum buchholzianum* were identified and tagged in all forest systems making a total of three hundred (300) seedlings (both within and outside sample plots) and assessed for survival and growth for eighteen months (March 2013 to September 2014). Fruit production from *Ricinodendron heudelotii* was assessed on a weekly basis by counting fruits throughout the production period. Fifteen producing trees were identified and tagged in each forest system, making a total of forty five trees. Fifteen 1m x 1m plots were demarcated and cleared under each fruiting tree, from which fallen fruits were collected, counted and removed on a weekly basis for a period of 2 months (September and October).

2.4. Data Analysis

Data was analyzed using Excel and the SAS statistical package Version 9.0, with the General Linear Model Procedure (GLM) and the Student-Newman-Keuls test to separate the means.

The abundance was determined by counting the total number of individuals of *Ricinodendron. heudelotii and Gnetum buchholzianum* in the site while the density was estimated by determining the total number of individuals of each species per hectare.

3. Results and Discussion

3.1. Demographic Information

3.1.1. Ethnic Origin, Age Range, Sex, Marital Status and Level of Education of Collectors of Ricinodendron Heudelotii and Gnetum Species

Collectors of *Ricinodendron heudelotii* and *Gnetum* species came from two major ethnic groups Bangando (53 %) and Baka (29 %) who are indigenes of the area. A small proportion (18 %) of collectors came from 6 other groups in the East region of Cameroon. These have probably migrated from their villages of origin and settled in the area in search of jobs in the logging and mining companies found there.

The survey revealed that 49 % of collectors belonged to the 40 to 55 age group exclusive, while 35 % belonged to the 25 to 40 age group. 10 % of producers were 25 years old or younger, while a minority 6 % was 55 years old or more. This indicates that mostly individuals of the middle aged group are involved in NTFP collection in the Lobeke landscape. An almost equal proportion of men and women collect NTFPs in the study area, with 51 % of women and 49 % of men involved. A distribution of NTFP collectors according to marital status indicated that 87 % of respondents were married while 10 % were single. A small proportion (2 %) was divorced while a minute 1% was widowed. This indicates a stable society in which the development of NTFP enterprises can be successful. It was observed that 24 % of NTFP collectors had no formal education, while 43 % had been to primary school. 33 % of respondents indicated that they have been to secondary school. This is an indication that new ideas or innovations can to an extent be adopted in the community at least at individual level. This study revealed that 48 % of collector households had 6 to 9 members, while 22 % of households had 10 to 14 members. 17 % of households were made of more than 15 individuals while a small 13 % was made of less than 5 members. Family sizes are generally medium to large and this is possibly as a result of the high level of polygamy observed in the zone. This also explains why most households depend on family members as a source of labor for their NTFP collection and agricultural activities.

It was observed from this study that respondents' major

sources of income include collection of NTFPs (43 %) and crop production (39 %). This result is in line with [66] who found that 44.44 % of income of people in villages around the LNP is made of forest income while 18.34% is made of income from agriculture. Fishing also makes a modest contribution to household incomes with 7 % of respondents involved in this activity. The near absence of development, with mainly logging and mining companies; and no other industries in the area leaves only exploitation of NTFPs and agriculture as the mainstay of the people. The fact that different species of NTFPs produce at different periods of the year, and usually when staples are scarce also explains why the populace is highly involved in NTFP collection. Most NTFPs in the study area, unlike in the past now have market (monetary) value thereby attracting many people into their exploitation. [26] observed that some collectors of NTFPs take their produce to the border towns of Moloundou and Kika for sale as prices are higher than in their villages.

3.1.2. Collection of Ricinodendron Heudelotii and Gnetum Species (Gnetum Buchholzianum and Gnetum Africanum)

All respondents in this study indicated that they had free access into the forest to collect both *Ricinodendron heudelotii* fruits and *Gnetum* leaves. *Ricinodendron heudelotii* fruits are collected by picking from the forest floor. The fact that fruit collection does not harm the parent plant is a positive indication for the sustainability of the species in the zone. Only 88 % of respondents indicated that they collected this product in marketable quantities while 12 % did collect in small quantities for household consumption. The later explained that their reticence towards collecting this product is because the extraction of its kernels from the hard shell is very tedious and time consuming.

Gnetum species were also collected by all respondents in this study, either just for food or for both food and trade. Collectors indicated that they harvest *Gnetum* leaves mostly in the secondary (production) forest (112 citations), followed by fallows (70 citations) and farms (50 citations). The most common methods of harvesting *Gnetum* leaves were felling support trees (95 citations) and pulling vines from support trees (84 citations) which are very destructive and detrimental to the sustainability of the species and also those of support tree species. Some respondents indicated that they climb up big support trees (67 citations) by use of larger vines on such trees to collect *Gnetum* leaves. These were mostly the Baka pygmies who have lived in the forest for centuries. Others indicated that they collect mature leaves from accessible vines without destroying the vines (52 citations). This seemed to be the most sustainable harvest method cited by respondents, but nearly all respondents indicated that they also used the destructive harvest method indicated above. This result agrees with [31, 32, 33] who observed destructive harvest of *Gnetum* species in the South West region of Cameroon. In this study, 89 % of respondents indicated that they collect *Gnetum* leaves 2 to 5 times per week while 11 % of respondents indicated that collection is done on a daily basis. 98 % of collectors indicated that although they collected both *Gnetum* species, they preferred *Gnetum buchholzianum* to *Gnetum africanum.* Their reasons were that *Gnetum buchholzianum* has larger leaves, is easier to harvest and slice; and also has a better taste than *Gnetum africanum* which has smaller leaves, is more difficult to collect and slice; and has a slight bitter taste when cooked.

Collectors' views regarding the availability of *Gnetum* species in the Lobeke landscape showed that 99 % of respondents observed a reduction in the availability of the resource while 1 % declared that the resource was still abundant as in the past. Respondents identified agriculture (79 citations) and increased collection (60 citations) as the most possible reasons for a reduction in the stock of *Gnetum* species in the Lobeke landscape. Deforestation (43 citations), establishment of cocoa plantations and use of chemical inputs (23 citations) and prohibition on hunting (20 citations) were other reasons mentioned for the dwindling stock of *Gnetum* species. The need to feed the ever growing rural population and increased cash cropping (cocoa) for financial gains, establishment of the protected area which has led to a restricted access to forest resources and reduction in peoples' extractive activities have all resulted in increased agriculture and consequently destruction of some of the species' habitat. Respondents pointed out that *Gnetum* is one of the vegetables that can be prepared without meat, so prohibition on hunting certain species of wildlife and the increased market value of this resource are possible reasons for increased collection. This agrees with [26] who indicates that *Gnetum* leaves are considered a meat substitute in the area and that frequency of collection is higher during the dry season when wild meat is scarce.

Problems encountered by collectors of *Gnetum* species in the Lobeke landscape include walking long distances into the forest where the resource abounds, (103 citations). This was followed by threats from wild animals such as gorillas, elephants, and chimpanzees, (78 citations) that are said to also consume this resource. Difficulty climbing large support trees (39 citations), limited markets (8 citations) and high perishability of product (5 citations) were to a smaller extent identified as hindrances to the collection of *Gnetum* leaves.

3.1.3. Conservation of Ricinodendron Heudelotii and Gnetum Species by Collectors

All collectors of *Ricinodendron heudelotii* indicated that they conserve the species mostly by protecting wildlings on their farms. They also protect mature and producing trees during farm creation by not burning around them. Up to 59 % of respondents had less than 10 trees of *Ricinodendron heudelotii* on their farms while 37 % of respondents indicated they had between 10 and 20 trees of this species on their farms. A minute 3 % had between 21 and 30 trees while 1 % had more than 30 trees on their farms. Those with more than 20 trees in their farms are probably those who also own cocoa farms where these trees also serve for shade provision and soil fertility improvement [25]. This reveals that respondents have a poor attitude towards planting the species,

probably because they think it is abundant in the forest. On the other hand, *Gnetum* species were conserved by collectors only through the protection of wildlings.

3.1.4. Uses of Ricinodendron Heudelotii and Gnetum Species in the Lobeke Landscape

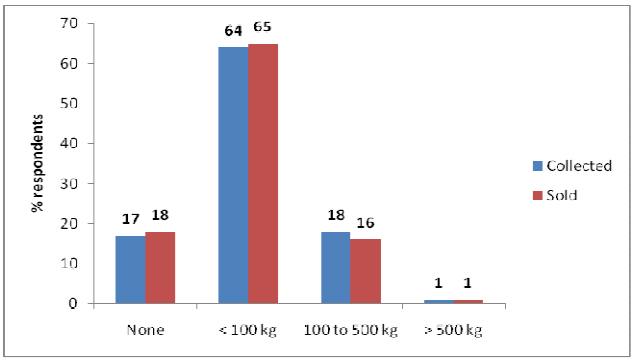

Figure 2. *Estimates of Ricinodendron heudelotii seeds collected and sold around the LNP*

Figure 2 shows that 67 % of collectors ranked *Ricinodendron heudelotii* as the second major source of income while 11 % ranked it third among four major NTFPs including *Irvingia gabonensis*, *Gnetum* species and *Aframomum pruinosum*. Up to 65 % of collectors sold less than 100 kg of *Ricinodendron heudelotii* kernels meaning that they earned at most from 69300 FCFA to 198000 FCFA for at most 99 kg of product, considering that the price of a kg ranged between 700 FCFA when the product is abundant and 2000 FCFA when the product is scarce. Only 16 % of collectors sold between 100 kg and 500 kg for at least 70000 FCFA and at most 1000000 FCFA while a minute 1 % earned between 350700 FCFA and 1002000 FCFA for at least 501 kg of the product. Figure 2 also reveals that this product is mostly collected in small quantities. Collectors indicated that this is because the collection, cleaning and cracking to get the kernels is very tedious and time consuming. Almost all of the *Ricinodendron heudelotii* kernels collected are sold. This can be explained by the fact that indigenes of the area consume this product is very small quantities, except the Baka pygmies who use it as a major condiment in some meals. Those who collected in appreciable quantities indicated that they do this by drying the nuts after having boiled, and then crack gradually almost throughout the year. Income earned from the sale of *Ricinodendron heudelotii* is used for buying household needs, education of children through payment of tuition fees and other school requirements, provision of health care, buying of clothing, farm tools and payment of hired labor on-farm. This result is consistent with those of [7 and 67] who found that incomes from forest products play roles in buying agricultural implements and purchasing basic household needs as well as sending children to school.

Figure 3 reveals that 76 % of collectors harvested less than 15 kg of *Gnetum* leaves per week while 17 % harvested between 15 to 30 kg of the product per week. Only 2 % of collectors harvested between 30.5 and 45 kg while 5 % of collectors harvested more than 45 kg of this product per week. Up to 35 % of collectors indicated they did not sell but consumed the product whereas 51 % sold less than 15 kg per week, earning between 200 FCFA and 2800 FCFA for at least 1 kg and at most 14 kg of the product respectively per week, being that 1 kg costs 200 FCFA. 9 % of collectors sold between 15 and 30 kg of *Gnetum* leaves between 3000 FCFA and 6000 FCFA per week, 1 % sold between 30.5 and 45 kg between 6100 FCFA and 9000 FCFA per week while 4 % of respondents sold at least 46 kg at 9200 FCFA per week. *Gnetum* is also highly consumed in households in the area on a year round basis. It is not sold in large quantities because of the perishability of the product and poor state of roads to major markets in the country where this product has very high demand.

Exchange rate:

1 €=Approximately 650 FCFA; 1 $US = Approximately 500 FCFA.

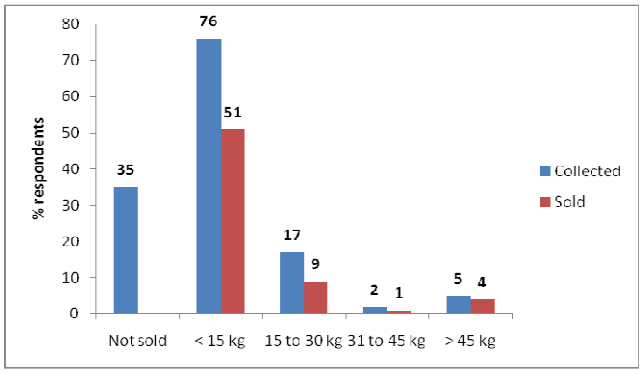

Figure 3. *Collection and sale of Gnetum leaves around the Lobeke landscape*

Up to 61 % of NTFP collectors indicated that *Ricinodendron heudelotii* had some medicinal values and used variously for the treatment different ailments notably the decoction of bark for anemia. On the other hand, 12 % of respondents indicated that *Gnetum* species have some cultural values especially during the "jengi" religious festival and initiation rites of Baka pygmies. 7 % of respondents indicated that *Gnetum* leaves are used as charm to influence peoples' decisions while 25 % of respondents indicated that *Gnetum* leaves have medicinal values and used particularly to speed up walking in slow children.

Respondents indicated that they preferred consuming NTFPs to other conventional food stuffs such as groundnut and cassava leaves which are used in the absence of *Ricinodendron heudelotii* and *Gnetum* leaves respectively because NTFPs are freely collected from nature; and also because they form part of their traditional meals. This is supported by [50], who observed that dependence on forest products is not related to individual household incomes, as wealthier households remain dependent on forest-derived products. This indicates that the traditional link to forests cannot be easily changed through subsidies and compensations.

3.2. Inventory

3.2.1. Size of Ricinodendron Heudelotii in Three Forest Systems

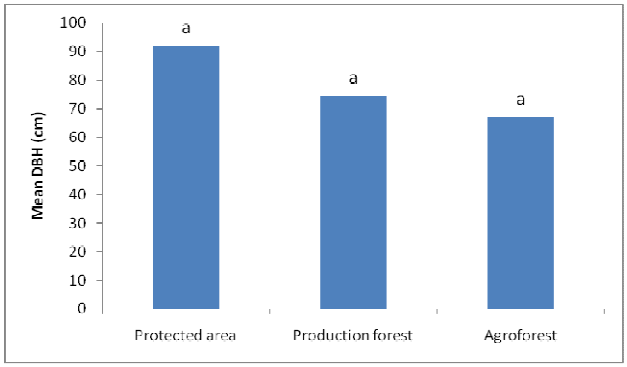

Figure 4. *Mean DBH of Ricinodendron heudelotii trees in three forest systems around the LNP. Means with the same letter are not significantly different*

There was no significant difference in mean tree DBH of *Ricinodendron heudelotii* in all forest systems, although trees within the protected area were larger than those in the production forest and agroforest (Figure 4). This is probably because only the fruits of this tree species are mostly exploited and not the wood, such that even in zones of frequent human intervention like the agroforest and production forest, people have the tendency to protect it for its fruits.

More trees of *Ricinodendron heudelotii* were observed in the production forest and agroforest than in the protected area (Figure 5). Most trees recorded in this inventory had a DBH of at least 10 cm, meaning that mainly productive individuals of this species are found in the forest in the study area. This is possibly due to younger plants being hindered at some point in their growth process by some natural or biological factors such as pests from attaining the larger size classes. Very few seedlings were recorded in this inventory. This could be as a result of the high gathering pressure by the local population, and the fact that rodents and other small mammals found in the area also feed on the seeds. *Ricinodendron heudelotii* was also observed to suffer from attack of the psyllid *Diclidophlebia xuani* which led to the death of many seedlings within two months. This is in line with [54] who stated that this species suffers severe attack from this psyllid. According to [14], the extraction of commercial quantities of fruits and seeds can cause notable changes in the structure and dynamics of a tree population, which are typically precipitated by a reduction in seedling establishment due to over-harvesting. Human intervention harvesting fruits of species such as *Ricinodendron heudelotii* from the forest may have an impact on the species' population structure. [55] have found some evidence that over-gathering of fruits, combined with the length of time needed for the seed to reach germination point, is having an impact on natural regeneration rates. According to [56], the stony endocarp may lie for more than two years after the pulp has rotted if it does not germinate or get carried away by rodents.

In this study, more individuals of *Ricinodendron heudelotii* were observed in the agroforest and production forest than in the protected area. This result confirms the observation by [23] that *Ricinodendron heudelotii* is mostly found as a pioneer species in the secondary forest. According to [57], this species occurs in fringing deciduous and secondary forests, and is found throughout the South West of Cameroon in forest, fallow, cocoa and other farms [18]; environments which meet the light requirement of the species. *Ricinodendron heudelotii* also possibly enjoys some protection within the agroforest and production forest by the local population who frequent these areas more, because of its economic value. The density of *Ricinodendron heudelotii* which was considered as the number of individuals of this tree species per hectare was 3.4 trees per hectare overall. On the contrary, [58] reported a density of 10.3 stems/ha for *Ricinodendron heudelotii* around the Boumba-Bek National Park in Southeastern Cameroon. In the South Province of Cameroon, an average density of 2.1 stems/ha was observed in secondary forest, with a maximum density of 4.1 stems/ha [59] while in the Mbalmayo Forest Reserve in Cameroon, a higher density of 5 individuals/ha was recorded [60]. Likewise, [18] reported densities of 2.4 stems/ha for trees with DBH greater than 10 cm and 0.5 stems/ha for trees of DBH greater than 70 cm at an altitude of 1650 m in the Dja Fauna Reserve in East Cameroon.

3.2.2. Abundance of Ricinodendron Heudelotii Trees

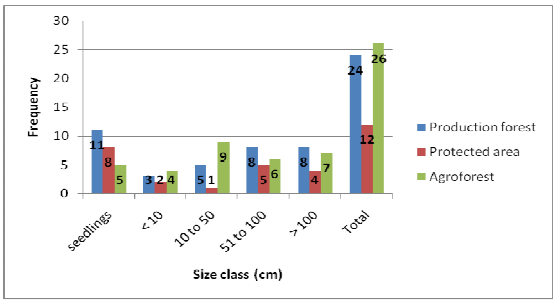

Figure 5. *Size class distribution of Ricinodendron heudelotii trees in three forest systems around the LNP*

The survival and growth assessment of *Ricinodendron heudelotii* seedlings ended within two months as seedlings were attacked by a psyllid (*Diclidoplebia xuani*) and died out completely within this period as seen in plate 1.

Plate 1a. *Healthy seedlings of Ricinodendron heudelotii .*

Plate 1b. *Infected seedlings of Ricinodendron heudelotii*

3.2.3. Fruit Production of Ricinodendron Heudelotii

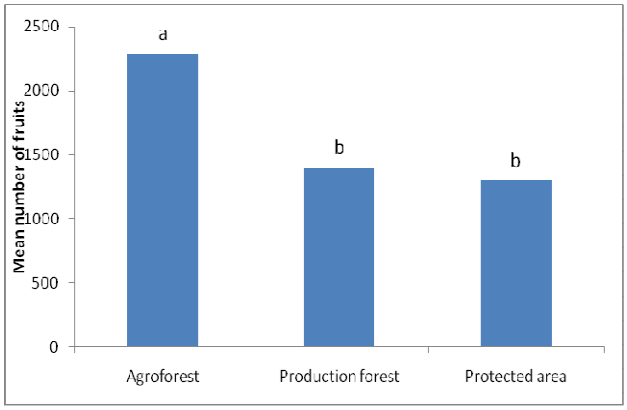

Figure 6. *Fruit production by Ricinodendron heudelotii trees in three forest systems around the LNP. Means with the same letters are not significantly different.*

The mean number of fruits from *Ricinodendron heudelotii* trees within the agroforest (approximately 2300 fruits) was significantly higher than for trees in the production forest and protected area (approximately 1500 fruits) between which there was no significant difference (Figure 6). [18] point out that fruits of *Ricinodendron heudelotii* are produced in large quantities, while [23] and [21] observed that an individual tree can produce up to 900 fruits in a fruiting year while kernel yield varies between provenances. On the other hand, [24] observed more than 4000 fruits (172 kg) per tree in the fallows of the humid forest zone of Cameroon in line with [62]. The fruits are eaten by animals [20] and are dispersed by bats, hornbills and rodents [18].

3.2.4. Abundance of Gnetum Buchholzianum Vines

Gnetum vines were observed to be significantly higher in number in the production forest than in the agroforest and protected area (Figure 7). The low vine population in the agroforest could be as a result of overharvesting of the resource over the years and its accessibility to the population, in line with [41] who notes that in Gabon, the Central African Republic and the Democratic Republic of Congo, overharvesting is shrinking wild populations of *Gnetum*. The very reduced *Gnetum* vine population in the protected is probably due to the presence of an important population of large mammals such as gorillas, elephants and chimpanzees who also feed on the leaves of *Gnetum* species, in line with the observations of [62] who observed that the leaves of *Gnetum africanum* and *Gnetum buchholzianum* are consumed by gorillas in the Nouabali-Ndoki forest of the Republic of Congo. [41] also notes that *Gnetum* leaves also play a role in the diet of other forest dwellers such as chimpanzees and gorillas. Very few seedlings were recorded in all forest systems during the inventory. This could be as a result of the fact that ripe fruits of this species are eaten by birds or due to poor germination as the seeds take too long to germinate [33]. [31] reports observing birds, squirrels and other rodents eating the fruit as they ripen, reducing the availability of seeds for regeneration. However, [41] suggests that it may be necessary for the seeds of *Gnetum* species to pass through the intestines of a bird, fruit bat or other animals before they can readily germinate. *Gnetum* vines were however observed to regenerate mainly by the production of new shoots and root suckers. This is confirmed by [63] who indicated that *Gnetum* species are capable of generating root suckers, as offshoots of lateral adventitious roots. [64] report production of suckers from *Gnetum* provenances growing in the *Gnetum* gene bank of the Limbe Botanic Garden in Cameroon. This suckering can be quite prolific in the wild, suggesting that vegetative regeneration is important [65]. However, *Gnetum* species may be favored by forest disturbance, a probable explanation for its abundance in degraded forest, bush fallow and crop fields [34].

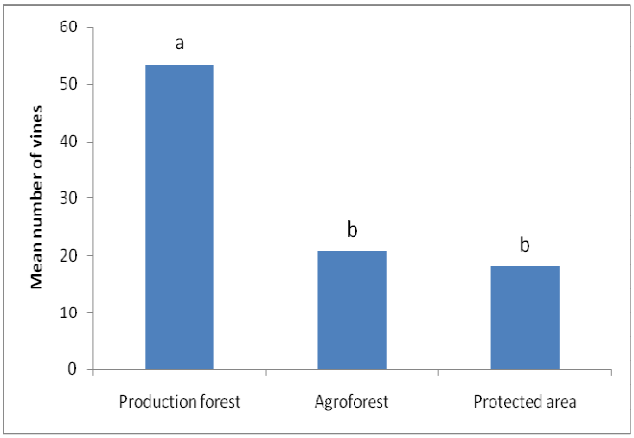

Figure 7. *Mean number of Gnetum buchholzianum vine in three forest systems around the LNP. Means with the same letter are not significantly different*

3.2.5. Growth of Gnetum Buchholzianum

3.2.5.1. Vine Length

There was a continuous increase in the vine length of *Gnetum* seedlings in all three forest systems with time. No significant difference was observed in mean *Gnetum* vine lengths in the production forest and protected area, which were each significantly higher than mean *Gnetum* vine length in the agroforest. This is possibly due to the higher shade levels in the production forest and protected area, unlike in the agroforest with higher sunlight; as *Gnetum* species are known to grow better in shaded environments[30] .

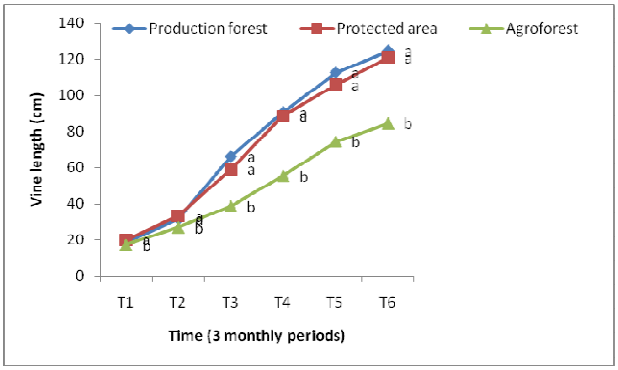

Figure 8. *Mean increase in vine length of Gnetum buchholzianum in 3 forest systems around the LNP. Means with the same letter are not signifcantly different*

3.2.5.2. Number of Leaves

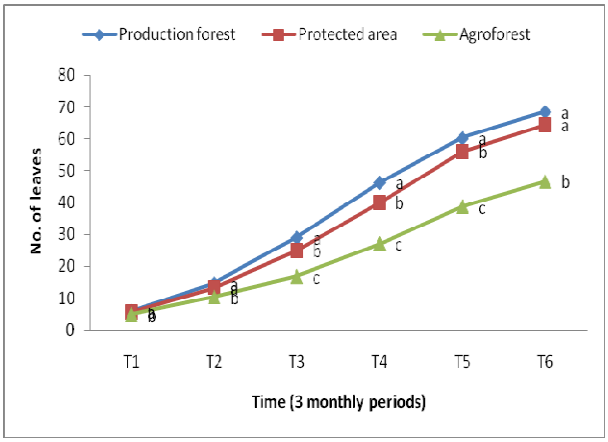

Figure 9. *Mean increase in number of leaves of Gnetum buchholzianum in 3 forest systems around the LNP. Means with the same letter are not significantly different*

According to Figure 9, there was a continuous increase in the the mean number of *Gnetum* leaves in all three forest systems, but a significantly higher mean number of *Gnetum* leaves was observed in the protected area than in the production forest at 9, 12 and 15 months of observation. It is possible that side shoots developed at vine nodes at these periods and led to big increases in leaf number. There was also a significantly higher mean number of *Gnetum* leaves in the production forest and protected area than in the agroforest. *Gnetum* vines in these forest systems were longer and therefore had many nodes for leaf development.

3.2.6. Survival of Gnetum Buchholzianum Seedlings

According to Figure 10, a general decrease in survival was observed for *Gnetum* seedlings in all three forest systems, with the protected area having the least survival rate (64 %) and the production forest having the highest survival rate of 82 % after 18 months of observation. The high incidence of large mammals in the protected area could lead to trampling of seedlings while the high humidity in this environment can provide suitable conditions for microbial attack, which may lead to death of some seedlings.

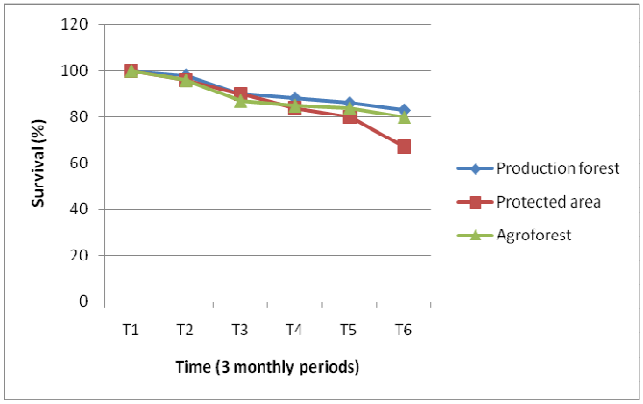

Figure 10. *Survival of Gnetum buchholzianum seedlings in three forest systems around the LNP.*

3.3. Conclusion

The result of this study shows that the abundance of these species is possibly witnessing a reduction. This is because these products which in the past were mainly exploited for home consumption currently have market (money) value, and are one of the major sources of income in the locality. The increase in demand will lead to an increase in the number of people collecting the products and also an increase in the quantity collected per person. It is recommended to educate the local population on the importance of domesticating these species of NTFPs, different methods of producing improved planting materials and appropriate agro systems in which they can be planted.

Acknowledgment

We are grateful to the Congo Basin Forest Support Program (PACEBCo) and Wallonie Bruxelles International for providing funds for this research

References

[1] de Wasseige C., de Marcken P., Bayol N., Hiol Hiol F., Mayaux Ph., Desclée B., Nasi R., Billand A., Defourny P. and Eba'a Atyi R. 2012 The forests of the Congo basin-state of the forest 2010. Publications Office of the European Union. Luxembourg. 276 p. ISBN: 978-92-79-22716-5, doi:10.2788/47210

[2] FAO, 2007. State of the World's Forests 2007. Rome. ISBN: 978-92-5-105586-1.144pp.

[3] FAO, 2005. State of the World's Forests 2005. FAO-Rome. ISBN: 92-5-105187-9. 153 pp.

[4] Ichikawa, M. 2012. Central African forests as hunter-gatherers' living environment: An approach to historical ecology. *African Study Monographs Supplementary Issue*, 43: 3−14.

[5] Hoare, A.L. 2007. The use of non timber forest products in the Congo basin, Constraints and opportunities. http://www.rainforestfoundationuk.org/files/Forest%20Products%20Low%20PDF.pdf

[6] Ingram, V. and Schure, J. (2010). Review of Non Timber Forest Prouducts (NTFPs) in Central Africa, Cameroon. Center for International Forestry Research.

[7] Ingram, V., O. Ndoye, D.M. Iponga, J. C. Tieguhong, R. Nasi, 2012. Non-timber forest products: contribution to national economy and strategies for sustainable management In: de Wasseige C., de Marcken P., Bayol N., Hiol Hiol F., Mayaux Ph., Desclée B., Nasi R., Billand A., Defourny P. and Eba'a Atyi R. 2012 The forests of the Congo basin-state of the forest 2010. Publications Office of the European Union. Luxembourg. 276 p. ISBN: 978-92-79-22716-5, doi:10.2788/47210

[8] IFAD 2004. Commerce et developpement rural: enjeux et perspectives pour les ruraux pauvres. 31pp.

[9] Noubissie E.T., Chupezi, J., Ndoye, O. 2008. Studies on the Socio-Economic Analysis of non-timber forest products (NTFPs) in Central Africa. Synthesis of reports of studies in the Project GCP/RAF/398/GER. Fao. Yaounde, Cameroon, FAO GCP/RAF/398/GER Enhancing Food Security in Central Africa through the management and sustainable use of NWFP: p. 43.

[10] Neumann, R. P., Hirsch, E. 2000. Commercialization of non-timber forest products: review and analysis of research. Bogor: Centre for International Forestry Research.

[11] Ankila, J.H. 2004. The Ecological Consequences of Managing Forests for Non-Timber Products. *Conservation & Society* 2 (2) 211-216

[12] Ticktin, T. 2004. The ecological implications of harvesting non-timber forest products. *Journal of Applied Ecology,* 41, 11–21

[13] Brites, A. D., Morsello, C. 2012. The Ecological Effects of Harvesting Non-Timber Forest Products from Natural Forests: a Review of the Evidence. VI Encontro Nacional da Anppas 18 a 21 de setembro de 2012, Belém - PA – Brasil

[14] Peters, C.M. 1994. Sustainable harvest of non-timber plant resources in tropical moist forest: An ecological primer. Washington, Biodiversity Support Program.

[15] Ndoye O., and Awono A., 2009. Regulatory policies and *Gnetum* spp. trade in Cameroon: Overcoming Constraints that Reduce Benefits and Discourage Sustainability. In: Wild Product Governance: Finding Policies that Work for Non-Timber Forest Products, edited by S.A. Laird, R. McLain and R.P. Wynberg. London: EarthScan.

[16] Tieguhong J.C., Ndoye O., Vantomme P., Zwolinski J., and Masuch J., 2010. Coping with crisis in Central Africa: enhanced role for non-wood forest products. Unasylva 233 (60):49-54.

[17] Laird S., Ingram V., Awono A., Ndoye O., Sunderland T., Lisinge E., and Nkuinkeu R., 2010. Integrating customary and statutory systems: The struggle to develop a legal and policy framework for NTFPs in Cameroon. In: Laird S.A., McLain R., and Wynberg R.P., 2010. Wild Product Governance: Finding Policies that Work for Non-Timber Forest Products, London: Earthscan.

[18] Clark, L. E., Sunderland, T. C. H. 2004. The Key Non-Timber Forest Products of Central Africa: State of the Knowledge. Technical Paper No. 122, SD Publication Series

[19] Orwa, C., Mutua, A., Kindt, R., Jamnadass, R., Anthony, R. 2009. Agroforestry Database: a tree reference and selection guide version 4.0 (http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp)

[20] Eyog-Matig. O, O. Ndoye, J. Kengue, A. Awono, (eds). Les fruitierscomestibles du Cameroun. International Plant resources Institute.

[21] SCUC, 2006. Ndjanssang: Ricinodendron heudelotii, Field manual for extension workers and farmers. Southhampton, UK; Southhampton Center for Underutilized crops, University of Southhampton.

[22] Lemmens, R.H.M.J, Louppe, D and Oteng-Amoaka, A.A. 2012 (eds.).Plant resources of tropical Africa 7 (2). Timbers 2. PROTA Foundation/CTA, Wageningen, Netherlands.

[23] Tchoundjeu, Z., and Atangana, A.R. (2006). *Ricinodendron heudelotii (Baill.)* Southampton Centre for Underutilized Crops. University of Southampton: Southampton, UK; 74p.

[24] Ngobo, M.P., Weise, S.F., Macdonald, M.A. 2003. Non-wood forest products in short duration fallow lands of Southern Cameroon. Paper presented at the XII world forestry congress, 2003, Quebec, Canada.

[25] Fondoun, J.M. Tiki Manga, T. Kengue, J. 1999. *Ricinodendron heudelotii* (Djansang): ethnobotany and importance for forest dwellers in southern Cameroon. *Plant Genetic Resources Newsletter* 118: 1–6

[26] Jell, B. 1998. Utilisation des produits secondaires par les Baka et les Bangando dans la region de Lobeke au Sud Est Cameroun. Etude de cas. Report submitted to GTZ on Projet de conservation des forets naturelles au sud-est Cameroun (PROFORNAT). September 1998.

[27] Nkwatoh, A.F., Labode, P., Ebobenow, J., Nkwatoh, F.W., Ndumbe, N.L., and Ewane, M.E. (2011). Gathering Processing and Marketing of *Ricinodendron species* (Bail) in the humid forest zone of Cameroon. *Agric. Sci. Res. Journal 1(9).* 213 – 221.

[28] Mialoundama, F. 1980. Corrélations intervenant dans la croissance des rameaux chez *Gnetum africanum* Welw. Compte Rendus des Sceances Academie Scientifique serie D, 291, 509-512.

[29] Shiembo, P.N., Newton, A.C., Leakey, R.R.B. 1996. Vegetative propagation of *Gnetum africanum* Welw., a leafy vegetable from West Africa. *Journal of Horticultural Science* 71(1): 149–55.

[30] Mialoundama, F. 1993. Nutritional and socio-economic value of *Gnetum* leaves in Central African forest. In: *Tropical forests, people and food: biocultural interactions and applications to development*. Carnforth, UK: Parthenon Publishing Group.

[31] Shiembo, P.N. (1997). Domestication of *Gnetum* spp.by vegetative propagation techniques. In R.R.Schippers and L. Budd (eds.) *African indigenous vegetables*. Workshop proceedings. January 13–18, 1997, Limbe, Cameroon.IPGRI and NRI.

[32] Ndumbe L., Ingram V., and Awono A., 2009. Baseline study on *Gnetum* spp. in the South West and Littoral Regions of Cameroon, edited by CIFOR. Yaoundé, Cameroon: FAO CIFOR-SNV-World Agro-forestry Center- COMIFAC.

[33] Shiembo, P.N. 1999. The sustainability of eru (*Gnetum africanum* and *G. buchholzianum*): an overexploited non-wood forest product from the forests of Central Africa. In: Sunderland, T.C.H. Clark, L.E., Vantomme, P (eds.) .*Non-wood forest products of Central Africa: current research issues and prospects for conservation and development*. Rome: Food and Agriculture Organization, pp. 61–66.

[34] Fondoun, J. M., Tiki-Manga, T. 2000. Farmers indigenous practices for conserving *Garcinia kola* and *Gnetum africanum* in Southern Cameroon." *Agroforestry Systems* 48: 289-302.

[35] Lakeman Fraser, P., Bachman, S. 2008. *Gnetum africanum*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. http://www.iucnredlist.org. Accessed 20 February 2014.

[36] Baloch, E. 2009. *Gnetum buchholzianum*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. http://www.iucnredlist.org. Accessed 20 February 2014

[37] Awono A., Manirakiza D. and Ingram V., 2009. Étude de base de la filiere *Gnetum* spp. (*Fumbwa*) dans les Provinces de L'Équateur et de Kinshasa, RDC. FAO-CIFOR-SNVWorld Agro-forestry Center-COMIFAC, February 2009. Web site: http://www.fao.org/forestry/ enterprises/45716/en/.

[38] Nkwatoh, A.F., Labode, P.,Iyassa, S.M., Nkwatoh, F.W., Ndumbe, N.L., Ewane M.E. 2010. Harvesting and marketing of *Gnetum* species (Engl) in Cameroon and Nigeria. *Journal of Ecology and the Natural Environment* 2(9) 187-193.

[39] Jiofack, T., C. Fokunang, V. Kemeuze, E. Fongnzossie, N. Tsabang, R. Nkuinkeu, P. M. Mapongmetsem and B. A. Nkongmeneck (2008). "Ethnobotany and phytopharmacopoea of the South-West ethnoecological region of Cameroon." Journal of Medicinal Plants Research 2(8): 197-206.

[40] CIFOR (2008). *Gnetum* spp (Okok or Eru) Fact Sheet. CIFOR. Yaounde, CIFOR: 2

[41] Schippers, R.R. (2000). *African indigenous vegetables: an overview of the cultivated species*. U.K.: Natural Resources Institute/ACP/EU Technical Centre for Agriculture and Rural Cooperation.

[42] Toirambe B., 2002. Utilisation des feuilles de *Gnetum* spp. Dans la lutte contre la pauvreté et l'insécurité alimentaire dans le Bassin du Congo, cas de la RDC. Kinshasa, FAO: 32.

[43] Ayuk, E.T., Duguma B., Franzel, S., Kengue, J., Mollet, M., Tiki-Manga, T., Zenkeng, P. 1999. *Forest Ecology and Management* 113. 1-9.

[44] ICRAF, 1999. Diversification of Tree crops: Domestication of companion crops for poverty reduction and environmental services.

[45] Egbe, E.A., Tabot,P.T., Fonge, B.A. 2012. Ethnobotany and prioritization of some selected tree species in south-western Cameroon. *Ethnobotany Research and Applications* 10:235-246

[46] Asare, R. 2005. Cocoa agroforests in West Africa. A look at activities on preferred trees in the farming system. *Forest and Landscape*. Working Paper No. 6, 2005.

[47] Leaky, R.R.B. 1998. Agroforestry in the humid lowlands of West Africa: some reflections on future directions for research. *Agroforestry Systems* 40: 253–262.

[48] Leakey, R. R. B., Tomich, T.P. 1999. Domestication of Tropical Trees: from Biology to Economics and Policy. Agroforestry In: *Sustainable Agricultural Systems*. L. E. Buck, J. P. Lassoie and E. C. M. Fernandes. Nairobi, ICRAF: 319-338.

[49] Adeola, A. O. 1995. The process of multipurpose tree species prioritization for agroforestry research. Forestry and the small scale farmer, Kaduna, Kaduna State, Nigeria, Forestry Association of Nigeria

[50] Tieguhong, J.C. and Zwolinski, J. (2008). Unrevealed economic benefits from the forests in Cameroon; IUFRO 4.05.00: emerging needs of society from forest ecosystems, University of Ljubljana, Slovenia, May 22-24, 2008

[51] Ekobo, A. 1995. Conservation of the African forest elephant (*Loxodonta africana cyclotis*) in Lobéké, Southeast Cameroon. PhD. Thesis, University of Kent, 151.

[52] WWF, 2006. Plan d'Amenagement du Parc National de Lobeke et de sa zone peripherique. Période d'exécution : 2006 – 2010. WWF.

[53] Wong, J.L.G. 2001. The biometrics of Non-Timber Forest Product resource assessment: A review of current methodology.

[54] Alene, D .C., Djieto-Lordon, C., Burckhardt, D., Messi, J., 2008. Population dynamics of the Ricinodendron psyllid, *Diclidophlebia xuani*, and its predators in Southern Cameroon. *Mitteilungen Der Schweizerischen Entomologischen Gesellschaft* 1 (2) 87-103

[55] Sunderland, T. C. H. and P. Tchouto (1999). A Participatory Survey and Inventory of Timber and Non-Timber Forest Products of the Mokoko River Forest Reserve, SW Province, Cameroon.

[56] Shiembo, P. (1994). Domestication of multipurpose tropical plants with particular reference to *Irvingia gabonensis* Baill., *Ricinodendron heudelotii* (Baill.) Pierre ex Pax and *Gnetum africanum* Welw. Edinburgh.

[57] Burkill, H.M. (2000). The useful plants of west tropical Africa, vol 5. London: Royal Botanic Gardens, Kew.

[58] Fongzossie, F.E., Ngansop, T.M., Zapfack, L., Kameuze, V.A., Sonwa, D.J., Nguenang, G.M., Nkongmeneck, B.A. 2014. Density and natural regeneration potential of selected non-timber forest products species in the semi deciduous rainforest of southeastern Cameroon. African study monographs, suppl. 49:69-90

[59] van Dijk, J.F.W. 1999. An assessment of non-wood forest product resources for the development of sustainable commercial extraction. In T.C.H. Sunderland, L.E. Clark and P. Vantomme (eds.). Non-wood forest products of Central Africa: current research issues and prospects for conservation and development. Rome: Food and Agriculture Organisation, pp. 37–50.

[60] Musoko, M., Last, F.T. and Mason, A. (1994). Populations of spores of vesicular-arbuscular mycorrhizal fungi in undisturbed soils of secondary semideciduous moist tropical forest in Cameroon. *Forest Ecology and Management* 63 (2–3): 359–77.

[61] ICUC, 2004. Fruits for the future. Ndjanssang. International Centre for Underutilized Crops. Factsheet No. 10. April 2004. 1-2pp.

[62] Moutsamboté, J.M. 1994. Végétation et plantes alimentaires de la région de la Sangha (Nord-Congo). In L.J.G. van der Maesen, X.M. van der Burgt & J.M. van Medenbach de Rooy (eds.). *The biodiversity of African plants:proceedings of XIVth AETFAT Congress.* Kluwer Academic Publishers, pp. 754-756.

[63] Halle, F., Oldemann, R.A.A. and Tomlinson, P.B. (1978). Tropical trees and forests. An architectural analysis. Springer-Verlag Berlin Heidelberg, New York, 242-244,441.

[64] Nkefor, J., Ndam, N., Blackmore, P , Engange, F. and Monono, C. (2000). Transfer of eru *(Gnetum africanum* Welw. and *G. buchholzianum* Engl*.)* domestication model to village-based farmers on and around Mount Cameroon. (Unpublished.) Report for CARPE.

[65] Sunderland, T.C.H.(2001). *Cross River State Community Forest Project: non-timber forest products advisor report*. Department for International Development/Environmental Resources Management, Scott Wilson Kirkpatrick & Co Ltd.

[66] Tieguhong, J.C. 2008. Ecotourism for sustainable development: Economic valuation of recreational potentials of protected areas in the Congo Basin. Unpublished PhD Thesis. University of KwaZulu Natal**.**

[67] Tieguhong J.C. and Ndoye O. 2006. Transforming subsistence products to propellers of sustainable rural development: Non-timber forest products (NTFPs) production and trade in Cameroon. *Africa-Escaping the Primary Commodities Dilemma*. *African Development Perspective Yearbook Vol. 11*. Unit 1. VERLAG Berlin. Pp. 107-137. ISBN 3-8258-7842-2