

Assessing the distribution, exploitation and marketing of bush mango (*Irvingia gabonensis*) in and around the Kimbi-Fungom National Park, Cameroon

Amos Fang Zeh ^{1, *}, Nkwatoh Athanasius Fuashi ², Kamah Pascal Bumtu ², Zang Stephanie Sih ¹, Ukah Bonaventure Ngong ³ and Buh Emmanuel Nong ⁴

¹ Department of Geography, University of Buea, Cameroon.

² Department of Environmental Science, University of Buea, Cameroon.

³ Disaster and Risk Management, Department of Environmental Science, University of Buea, Cameroon.

⁴ Natural Resources and Environmental Management, Department of Environmental Science, University of Buea, Cameroon.

International Journal of Science and Technology Research Archive, 2022, 03(01), 100–109

Publication history: Received on 30 June 2022; revised on 01 August 2022; accepted on 03 August 2022

Article DOI: <https://doi.org/10.53771/ijstra.2022.3.1.0072>

Abstract

The harvest, cultivation and marketing of bush mango (*Irvingia gabonensis*) is one of the promising economic activities in the Kimbi Fungom National Park today. Though it has a seasonal market, it is very much appreciable in terms of economic viability of the population. This paper is set to assess the harvest rate, the cultivation and the economic benefit of bush mango in and around the Kimbi Fungom National park, Cameroon. The study employ the use of transects and recce walk to assess the distribution of the plant in the forest, structured questionnaires, interviews and focus group discussion to assess the exploitation and marketing of bush mango. The park was divided into 20 blocks and 10 blocks were selected in lowland area of the park for this flora survey in which the Bush mango plants were sorted. In each block, a 1 km line transect was established with 5 quadrates of 20 × 20 m. These transects were laid to cut across the lowland rainforest where the presence of bush mango is found. A recce survey was also employed in which preexisting roads in the forest were followed. Purposeful sampling was also employed where bush mango dealers were identified and interviewed across the 10 selected villages in the park. Questionnaires were purposefully distributed and focus groups were organized with those involved in harvesting, cultivation and trading. A total of 300 questionnaires were administered in 10 villages that are 30 per village. Interviews were granted to the chiefs, farmers, hunters, forest guards and traders of bush mango. Results revealed that half of the park occupants are involved in the bush mango exploitation, 0.3% involved in the cultivation and 10% involved in trading. Average price range between 7500 FRS and 9500 FRS per 5 litre and 90% of the products is sold to Nigeria across the Taraba State and 10% returned to Cameroonian territory. The naira is the main currency used for exchange. Accessibility through the River Katsina Ala accounted for the easy trade with Nigerians than the steep hills and poor route network into the Cameroon communities. It is however recommended that with the increasing exploitation and cultivation, the trade could be harmonized for a better sales and economic benefits.

Keywords: Assessing; Distribution; Exploitation; marketing Bush mango; Purposefully

1 Introduction

There is growing rate at which world forests are exploited today. The forests are exploited both for timber and non-timber forest products. It is noted that about 75% of poor people of the world living in rural areas depend on NTFPs for their subsistence with 80 per cent of developing countries use NTFPs daily [Marcus *et al.*, 2009]. The forests in the

* Corresponding author: Amos Fang Zeh
Department of Geography, University of Buea.

humid lowlands of Central and West Africa are ecosystems where timber, wildlife and other forest products are exploited [Edouard *et al.*, 2017]. The exploitation and utilization of non-timber forest products is one of the growing economic activities in many tropical countries today. It is associated with keeping the forest intact, preserving the resource base of the forest, providing financial benefits unlike the exploitation of the forest for timber which is associated with clear- falling of wide forest areas [Nkwatoh, 1998; Jimmy, 2007].

The African continent is a haven for Non Timber Forest Products (NTFPs). Among the NTFPs exploited in tropical Africa is bush mango (*Irvingia gabonensis*). It is one of the highly valuable and extensively exploited Non timber Forest Products in tropical African. It has been known to be a high priority species in the continent. In Central Africa, 65 million people live in or around rain forests and depend on natural resources for their feeding [Noubissie Elise *et al.*, 2008]. Recently, research has shown that bush mango kernels can reduce obesity, control appetite, and reduce fat and cholesterol in humans. It has been used for time immemorial for subsistence, income generation, medicine, and wood for construction [Tataw, *et al.*, 2017] Bush mango had experienced an increasing market demand in the last twenty years but production is limited to traditional processing techniques and this and other problems have constrained productivity, output and income earned by collectors [Tataw *et al.*, 2017]. The collection and trade of the resource has evolved overtime with more stakeholders getting involved in the business as well as individuals exerting ownership of trees in farmlands acquired from conversion of forest. Majority of collectors collect rainy season bush mango from the wild or communal lands and very few collected from bush mango plantations. There was need to integrate the bush mango species into different cropping systems in order to reduce pressure on the protected species in the national parks [Chah *et al.*, 2014]. The economic benefits drawn from the trade of the dry seeds have culminated to an increased cultivation of the *Irvingia* tree leading to a shift from it being uniquely a wild tree species to on-farm tree. The benefits of *Irvingia* to farmers are cultural, nutritional, financial and environmental [Anegbah *et al.*, 2003; Agrofor *et al.*, 2003].

In Cameroon, bush mango is one of the important NTFPs harvested and commercialized in the humid lowlands with it large expands of forests. Bush mango in Cameroon has been noted to have a lot of economic value with many people around protected areas getting into the activity. A number of studies have been conducted on bush mango and have ranked bush mango first in terms of its economic value in the lowland humid forest area of Cameroon [Tchoundjeu *et al.* 2007; Tajoacha, 2008]. A study of bush mango] indicated that bush mango yielded the highest net margin of 30% as a percentage of the total value of sales when compared to other NTFPs such as *Dacryodes edulis*, *Cola acuminata* and *Ricinodendron heudelotii* in 28 markets of the humid forest zone of Cameroon [Ndoye *et al.*, 1997, 1998] Bush mango is an important NTFP whose kernels are popularly used as soup thickener and for slimy consistency of sauces in African cuisine. Recently, research has shown that bush mango kernels can reduce obesity, control appetite, and reduce fat and cholesterol in humans [Tataw, *et al.*, 2017]. It has been used for time immemorial for subsistence, income generation, medicine, and wood for construction. Rainy season and dry season bush mangoes are two local forest tree species, economically important for their fruits which are both called “bush mango”. The importance of bush mango in the humid lowlands of South West and East Cameroon is for its food use in thickening of soups and for the income generated from its commercialization. The two main varieties of bush mango produced and commercialized in the humid lowlands of Cameroon are *Irvingia gabonensis* and *Irvingia wombolu* [Marcus *et al.*, 2009].

In the South West Region, Bush mango value chain has been studied and established that the added value from collections, processing, storage, transformation and marketing [Ewane *et al.* 2010]. The income made by the different actors involved in the chain was also accessed. Similar studies were conducted on bush mango which they identified the main production zones and market chains in the South West Region [Tataw *et al.*, 2017]. Another study examined bush mango sustainability and indigenous knowledge promoting kernels exploitation and their influence on resource conservation in the Takamanda National Park (TNP) and found that the local people organised themselves through their village traditional councils to create bush mango governance, which enables them resolve conflicts, increase production, ensures sustainability of bush mango [Nfornkah *et al.*, 2018].

This National Park is an ecoregion which five major vegetation types that are each noted for their outstanding richness in NTFPs. However, the study of bush mango in the grass-field (western Highland) of Cameroon still remains skeletal as there is little knowledge on the extensive lowland forest in the Kimbi Fungom National Park. Most often, this lack of knowledge has left a lot of uncovered work which need the commitment of young researchers to exploit the Kimbi Fungom National Park and documents fascinating resources which can help solve the hunger crisis in our local communities.. There is the exploitation, cultivation and marketing of bush mango in the park. Unfortunately, 90% of the products are exported to Nigeria through the easy waterway using the River Kimbi as a major trade route between Cameroon and Nigeria. Thus this paper is set to fill the knowledge gap in bush mango harvest rate, the cultivation and the economic benefit of bush mango in the Kimbi-Fungom National Park of Cameroon.

2 Material and methods

2.1 Description of the Study Area

The Kimbi-Fungom National Park is located between latitude 6.5- 6.9° N and longitude 9.8-10.5° E in the North West Region of Cameroon covering a total land surface of 95,380 ha. This national park is located in three divisions of the North West Region of Cameroon cutting across four sub divisions. These divisions are Menchum, Boyo and Donga Mantung and found in the respective sub divisions of Fungom and Fru Awa, Misaje and Bum. The Kimbi-Fungom National Park (K-FNP) is a newly created national park and the only national park in the region (Figure 1). This region experiences two seasons; a long rainy season from mid-March to mid-November and a short dry season from mid-November to mid-March. The wettest months are July, August and September and the driest months being January and February. Hawkins and Brunt [1995] described the climate as a “sub-montane cool and misty climate” with an annual mean maximum temperature of 20 to 22°C and mean minimum of 13 to 14°C. Annual rainfall varies between 1780 and 2290 mm with most of the rainfall occurring between July and September. A dry season occurs from mid - October to mid-March [Zeh, 2019]. Geographically, the Kimbi-Fungom National Park has a heterogeneous landscape. The Fungom area lies east of Weh-Esu and South of Esu to Kung and Fang reaching a height of 1524 m. This area is made-up of woody savanna with hills running from Weh to Kuk. It is characterized by a rugged terrain from steep rolling hills into extensive flat valley at lower altitude. The Munkep-Gayama axis is an extensive valley about 6 km wide in the Munkep area to over 10 km in Gayama zone.

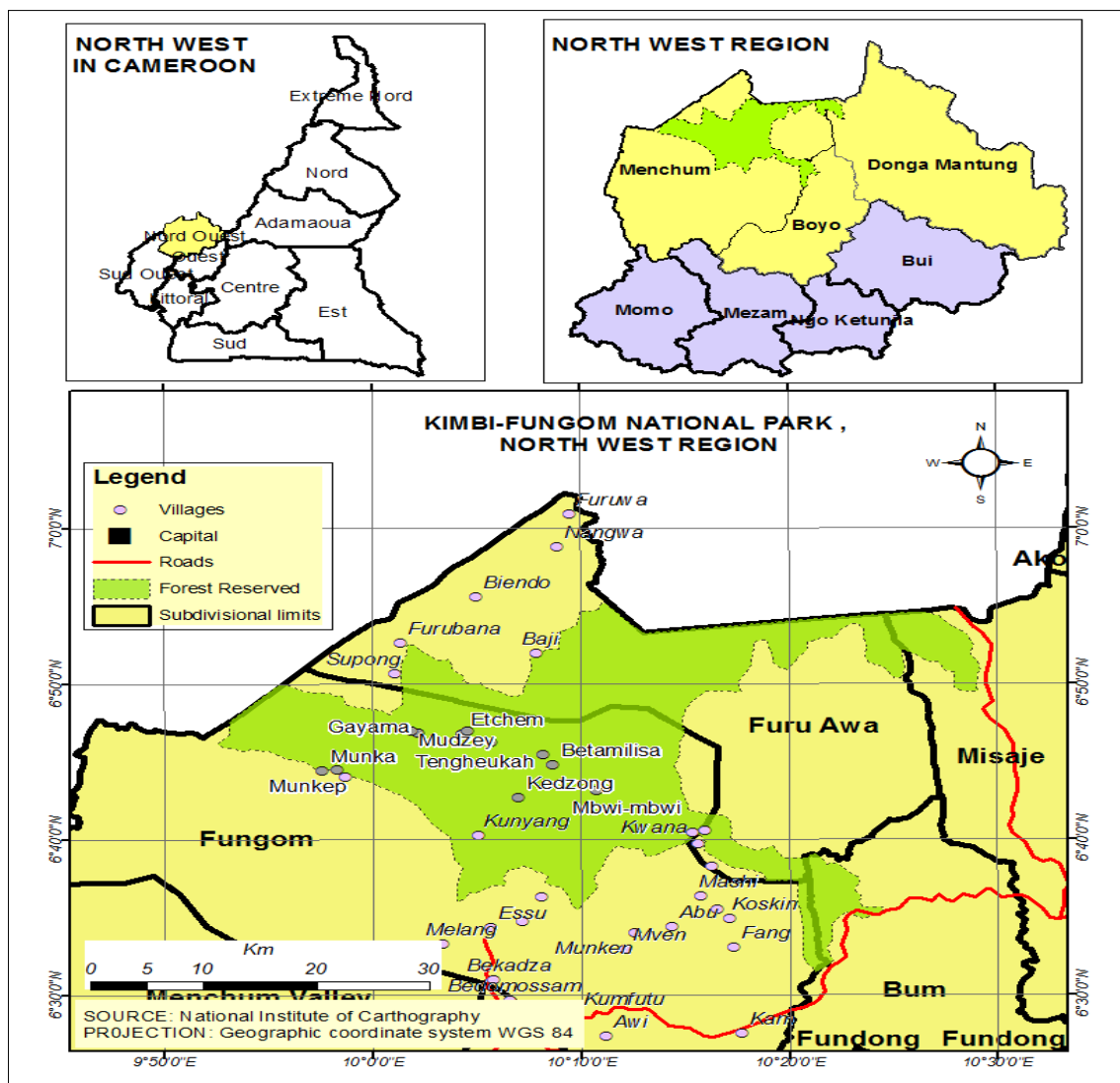


Figure 1 Kimbi Fungom National park

It is in the midst of chains of some steep rocky hills which are almost impassable. The lowlands take another orientation from Munkep at a place called "Last Town" towards the eastern forest. The valley starts behind the eastern forests where it extends for more than 15 km wide to over 30 km long. This extensive eastward valley is fertilized by alluvial silts from the Southern near Escarpment chain of long hills that stretched from the West towards the East in the Fungom Reserve. This relief has greatly influenced the vegetation types and distribution within the park. The Munkep Gayama axis lies on an extensive valley between chains of two hills. These valleys gradually protrude into near long rolling steep hills which are characterized by the woody vegetation. The hills are sandwiched by gallery forests which form the basis for the numerous tributaries in the park. It is drained by a wide range of rivers and streams, notably the Kimbi, the Katsina Ala, and the Kendassamen Rivers, along with significant streams that include: the Batum, Akum, Bissaula, Kenda, Yemene and Imia. These streams flow into the bigger ones that eventually flow through the Katsina Ala River and finally enter the River Benue. The soil types in this area include; Acrisols, andosols (Black soils of volcanic landscapes), Ferrasols (red and yellow tropical soils with a high content of sesquioxide), Leptosol (shallow soil) and Nitisols (deep, well-drained, red, tropical with a clayey subsurface) [Birdlife, 2010]. The vegetation is principally lowland tropical rainforest at the Fungom low altitude area of the park and gradually progress into tropical deciduous forest to savanna and the grassland savanna. It has many tree species of economic values.

2.2 Method

Data collection were done in two parts; biological and socio-economical methods. Biologically, we identify the distribution of bush mango plants and farms along transects, recce through and opportunistically in the park. Secondly we did the survey with the use of questionnaires, interview and focus group discussion.

Data collection on the flora took place in two different times; November to December 2017 for the dry season and May to July 2018 for the wet season. The park was divided into 20 equal blocks of 7×7 km each (4900 ha) with ten blocks randomly selected for this study. In each block, a 1-km transects as described by Tchouto [2004] and Buckland *et al.* [2007] was established. In each transect, 5 quadrates of 20×20 m were established at interval of 200 m (this gives a total of 0.2 ha of land sampled per block). The quadrates along transects were placed in alternate manner (that is, if quadrate one is on the left of the transect, quadrate two is placed at the right). A total of fifty 20×20 quadrates were sampled giving 2 ha of total land covered (representing 0.0002 ha of total park). These transects were laid to cut across four major vegetation types (lowland forest, gallery forest, woody savanna and grassland) at different elevations [Zeh *et al.*, 2019]. Identification of plants was done in the field using various methods. The trees were identified using a combination of characters such as the general form of the tree (buttresses, roots systems, bark texture; slash colour, smell and exudates, leaf type and shape) as well as the flowers, and fruits of the trees. In each transect, records of all species of vascular plants was done with the use of a pre-prepared data sheet. Bush mango plants were thus sorted from the data collected from the field. A recce walk was purposely undertaken to detect bush mango plants in the field to augment data from the transect survey.

After the transect walk, socioeconomic survey was done in 10 villages including Esu village, Munkep, Gayama 1, Gayama 2, Etchem, Mudzey, TENGHUKAH, Abar Nser, Kmbi and Subuum, around the KFNP. A focused group discussion was held in each village considered for this study to identify collectors, cultivators and traders in the bush mango exploitation. In each of the villages, 30 questionnaires were administered to different household dealing with bush mango of age from 20 and more of involving both sexes. A total of 300 questionnaires were distributed across the study area. The selection of a household for this survey was based on active involvement in the collection of bush mango during this study period. Interviews were granted to the chiefs of the villages, management of the Park, ordinary bush mango buyers and bush mango farmers. Interview was also granted to the leader of each village traditional council. Questionnaires were structured to gather information on types and actors involved with bush mango exploitation processes and marketing; constraints encountered, local remediation and expected solutions to the constraints, and secondary activities in the national park (those illegal activities collectors would do behind bush mango collection). Actors of bush mango considered in this study were those operating within the KFNP (internal and external). Bush mango value chain in this study was limited within the KFNP i.e. collection, marketing and cultivation. This study was purposely designed to better understand types of bush mango harvesting and trade. This information gathered with the questionnaires permitted us to propose recommendations which would improve the local people's living condition with the aim to dissuade them from illegal exploitation of the protected resources in the Kimbi-Fungom National Park.

3 Results

3.1 Distribution of Stems

Results revealed a total of 194 bush mango stems were recorded in the field. The highest numbers of stems were detected at Mudzey with a total of 32 stems. This was followed by Kedzuh with a total of 30 stems. The least number of stems were detected in Munkaa with just 5 stems recorded. This is summarized in figure 2. The stems were not evenly distributed owing to the fact that there is high degradation of the forest in some areas due to agricultural expansion. Some of the plants were usually felled at early stages due to the ignorance from new farmers who have not known the plant in the wild. This is the case in places such as Gayama, Munkep, Kedzong and Kedzuh where farmer flooded the areas for agricultural purposes due to it fertile alluvial soils.

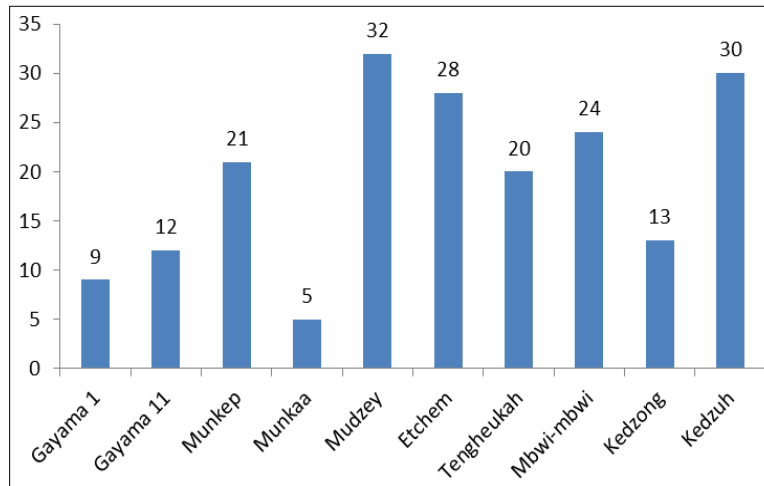


Figure 2 Distribution of stems across the different villages

3.2 Structure of the Plant

The structure of the plants detected was divided into 11 classes. Results on the distribution of species according to the Classes or circumference, that is diameter at breast height (dbh) in the 11 classes showed disparity amongst individual plants. The distribution of the number of stems differs among circumference classes. The variation was determined by the result of the variance which shows a significant difference ($p < 0.001$). The class with the highest number of stems was the class between 61 and 70cm with a total of 25 stems. This was followed by the class between ≤ 9.9 cm and 21 an 30cm with 24 stems each. The least was the class of 100 and above with a total of 10 stems recorded. The number of stems with big circumference above 100 cm was low throughout the different communities. Among the range of stems, 10 stems had large dbh class of above 100 cm with four stems having a remarkable large average circumference of 130 and beyond. The distribution of plants according to classes is presented in Figure 3.

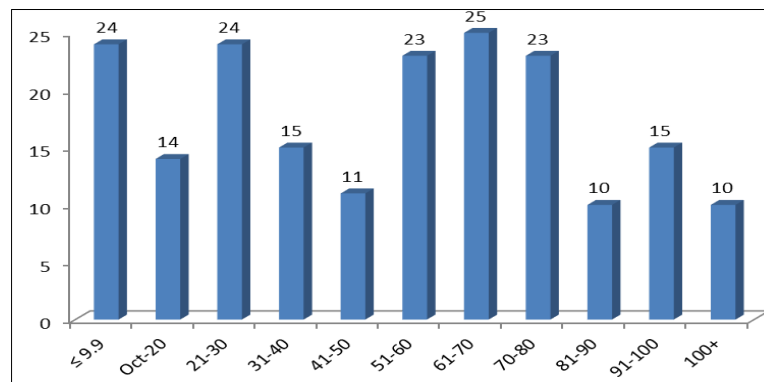


Figure 3 Distribution of DBH Classes (cm)

3.3 Exploitation of Bush Mango

Bush mango is exploited by many in the park. Out of the 300 respondents, 300 access the forest for the harvesting of the bush mango. From children at 19 years through adults to the aged at 66+, bush mango remains the fruit well exploited in the park. A total of 300 respondents' confirmed that they exploit bush mango on small to large scale both for domestic and commercial purpose it was discovered that 58% of the respondents exploiting bush mango were male while 42% were female. The exploitation was mainly through hand picking under the trees through a random search and also routes to already identified trees. A majority of the respondents (63%) disclosed that they already know their direction towards exploitation while 37% were of the fact that they just search randomly to pick the bush mango in the park. The output per respondent revealed that the highest quantity per respondent for the year under study was 215 litres recorded in Mudzey. The minimum at Mudzey was 15 litres while the average is 86.8 litres. The village with the lowest average output was Munkaa with the average output record of 22.5 litres while the village with the highest average output was Mudzey with a record of 115.5 litres. This is summarized in table 2

Table 1 Quantity of Bush mango exploited

Village	Number	Min Out put	Max Output	Average Output
Gayama 1	30	15 litre	80 litres	52.1 litres
Gayama 11	30	10 litres	92 litres	58.1 litres
Munkep	30	23 litres	103 litres	77.4 litres
Munkaa	30	5 litres	40 litres	23.1 litres
Mudzey	30	15 litres	215 litres	86.8 litres
Etchem	30	23 litres	152 litres	66.2 litres
Tengheukah	30	15 litres	142 litres	62.5 litres
Mbwi-mbwi	30	25 litres	205 litres	75.1 litres
Kedzong	30	10 litres	18 litres	23.7 litres
Kedzuh	30	12 litres	178 litres	66.7 litres
Total	300	153 litres	1225 litres	673 litres

3.4 Cultivation of the Bush Mango

Table 2 Number of farmers cultivating of bush mango and farm sizes

Village	Number	Min Farm size	Max Farm size	Average Farm size
Gayama 1	3	0.25ha	2.5ha	1.4ha
Gayama 11	5	0.2ha	2ha	1.1 ha
Munkep	8	0.5ha	3ha	1.9 ha
Munkaa	00	0.0	00	00
Mudzey	7	0.25ha	3ha	2.1 ha
Etchem	12	0.5ha	2.5ha	1.9 ha
Tengheukah	6	0.2ha	2ha	1.5 ha
Mbwi-mbwi	4	0.4ha	2.2ha	1.2 ha
Kedzong	00	0.00	00	00
Kedzuh	3	0.25ha	1ha	0.6 ha
Total	48	2.55ha	18.2h	11.7

Statistics from the field shows that a total of 48 individuals have planted bush mango in the park in different scales. Some are solely bush mango farms while some are mixed with other Non-Timber Forest Products (NTFPs). Some of these farms have existed for over 20 years today while new ones are being created. The individual farm sizes ranges from 0.25 hectares to 3ha of land. The community with the highest number of bush mango farms was Mudzey with a total number of 12 bush mango farmers recorded while the least was Gayama 1 and Kedzuh with 3 farmers each. Some 10 farmers however confirmed that they started harvesting their fruits while the rest confirmed that their farms are still very young.

3.5 Marketing of Bush Mango

Marketing of bush mango is one of the issues of concern. From the survey, it is realized that 90% of the produce are sold to Nigerian communities through the Kimbi-River. The products produced at Gayama 1, Gayama II and Munkep go through the Gayama Road to the River Katsi-na Ala, while those produced from Mudzey, Tengheukah, Mbwi-mbwi are transported to Etchem by motorbikes to the banks of the River Katsina Ala. The bush mango harvested in other areas like Kedzuh and its environs transported by head due to the absence of motorable roads. Here, only footpaths are presence with a lot of small streams and the Emia River making it difficult to access through motor bikes. This has led to the fluctuating prices and benefits from bush mango dealers in the landscape. Although the farmers try to stabilize prices, these prices affect those transporting their products through head load and later motor bikes and also those transporting their products to Etchem which is the main entrance point. Averagely, 5 litres of bush mango is sold for 8000 FRS in Gayama which is equal to 1600 FRS per litre of bush mango. At Kedzuh, the average price per 5 litres is 9500 FRS which is equal to 1900 FRS per litre. This average price varies with the year in question. These prices according to the respondents are for the normal harvest with all things being equal. In years of excess, prices dropped while in years of scarcity, prices increase. This is summarized in table 3.

Table 3 Prices of Bush mango in and around the park

Village	Av. Price per (5 litres in thousand (FCFA)	Av. Quantity of kernel per household in litre)	Total output village in litres	Total revenue generated per village in FCFA
Gayama 1	8000	52.1	1564	2,502,400
Gayama 11	8000	58	1740	2,784,000
Munkep	8500	77.4	2322	3,947,400
Munkaa	8500	28.1	842	1,431,400
Mudzey	9000	86.8	2605	4,689,000
Etchem	9000	66.2	1986	3,574,800
Tengheukah	9000	62.5	1875	3,375,000
Mbwi-mbwi	9000	75	2250	4,050,000
Kedzong	9000	23.7	710	1,278,000
Kedzuh	9500	66.7	1970	3,743,000
mean	8750	67.3	1786.4	3,137,500
Total	87,500	596.5	17864	31,375,000

Besides the distance effect, the quality of bush mango kernels determined the selling price in the National park. According to 100% of buyers and sellers kernels are graded before buying. (a) Grade a from fruit splitting technique, sun dried; the kernels showed whitish colour, shiny, firm and solid cotyledons. (b) Grade B from fruit splitting or squeezed-cracked seeds, fire or barn dried, with yellowish colour, and solid cotyledons. (c) Grade C obtained from squeezed-cracked seeds, brownish yellow or dark brown in due to poor sun light or during drying.

4 Discussion

The kimbi Fungom National Park, though location in the grass field is a very fertile ground for Non Timber Forest Product (NTFPs). Bush mango is one of the lucrative NTFPs in and around the Kimbi Fungom National Park. From our

transect and recce walk, we detected 194 stems in the park but gatherers confirmed that there are more than 500 stems in the park. We recorded more stems at mudzey and the least at Munka. Though unevenly distributed, bush mango exploitation has been a preoccupying activity throughout the park. The uneven distribution of these plants is due to the geographical location as well and the increase in land use changes from agricultural expansion. This is owing to the long term forest degradation that has occurred for the time being. In Gamaya 1 and II, there have been few trees left in the wild according to the survey while those identified in other areas are being preserved. In Mudzey, there is the great availability of bush mango in the wild as well as farms which makes this area one of the high producing villages in the park.

The exploitation of bush mango is mainly done in the dry season (February and March). Few from individual farms are exploited in the rainy season. The exploitation was mainly through hand picking under the trees through a random search and also routes to already identified trees. A majority of the respondents (63%) disclosed that they already know their direction towards exploitation while 37% were of the fact that they just search randomly to pick the bush mango in the park. The output per respondent revealed that the highest quantity per respondent for the year under study was 215 litres recorded in Mudzey. The technique for bush mango collection in the study area is through the gathering of fruits (fruit picking) only under the trees. This result is in line with Gadinga *et al*, [2019] who examined Bush Mango (*Irvingia spp.*) as an Important Alternative Livelihood Source for the Indigenous of the Korup National Park Communities, South West Cameroon and remarked that collection of bush mango is mainly through hand pick. Collectors spent averagely maximum of 5 days in collection and processing of rainy season bush mango. Drying took averagely 2-3 days on sunny days, while storage took averagely 4-5 months before selling of kernels. This different time intervals permitted the collectors to maximised bush mango exploitation before marketing. It was observed that collectors who spent these intervals well produced great quality and quantities of bush mango per household. They often produced grade A and B. This also affects positively the household's income and livelihood [Gadinga *et al*, 2019].

The growing importance of bush mango cultivation as a sustainable livelihood NTFP is very significant owing to the fact that many indigenous people in and around the Kimbi Fungom National park have realized that going to search in bush mango in the wild remains a disturbing factor. They preferred to grow them so as to have easy access to it at their convenience. This observation was also made by Nfornekah *et al*, [2018] who examined Indigenous knowledge on bush mango (*Irvingia gabonensis*) sustainability in the Takamanda National Park (TNP) communities, South West Cameroon. This also supports the fact that the cultivation of NTFPs in agroforestry plots is a better option to ensure resource availability and enrich smallholders [Dupuy, 2015]. The cultivation of bush mango in the park give right to ownership and reduce distances to the resources. More importantly, cultivation of bush mango reduces friction (conflicts) in exploitation. This result falls in line with those of Tataw *et al*. [2017] who assessed on 'forest and on-farm resource availability and market chains in the South West Region of Cameroon and concluded that '34% of the total respondents had already collected fruits from their planted trees, which suggests that cultivation is a recent phenomenon'.

Marketing of bush mango in and around the Kimbi Fungom National Park is one of the issues of concern. The exploitation and marketing of the products are enduring. From the survey, it is realized that 90% of the produce are sold to Nigerian communities through the accessible Kimbi-River. The products produced at Gayama 1, Gayama II and Munkep go through the Gayama Road to the River Katsi-na Ala, while those produced from Mudzey, Tengheukah, Mbwi-mbwi are transported to Etchem by motorbikes to the banks of the River Katsina Ala. This trade in bush mango indicate that bush mango in the park is a very popular product. The potential and demand for large scale production is high and respondents were of the fact that it has significant positive effects on their lives [Elah. 2010]. As the trade in bush mango increases, market efficiency has also increased due to improvements in transport infrastructure from the head load through motor bikes to water transport through large engine boats complemented by the flooded River Katsina Ala which has facilitated transport vehicles to patrol the banks. The disturbing situation is that despite the demand of bush mango across the North West Region of Cameroon, little from the peripheral communities or from inside the park can be supplied because of the difficulties in transportation. The communities produce an annual income of 31,375,000 FRS approximately 62,750 U S dollars. This amount is quite small compared to US \$ 770,578 generated around the Korup National Park per year [Gadinga *et al*, 2019]. The economy has further enhanced by greater demand for labour, packaging plants and other industrial products required in the bush mango trade. For large scale production to occur, farmers need credit to spend on improvements to existing production methods. Thus it is important that the potential of bush mango and is recognized now and a case made for domestication and improvements to the current trade system, so that the producers can be assisted in raising production to meet demand especially to those at Etchem, Mudzey Munkep and Mbwi-Mbwi.

5 Conclusion

The Kimbi-Fungom National Park is an ecoregion with a lot of potentials as far as NTFPs are concerned. These potentials have not been exploited and need thorough research to have a baseline assessment of the NTFPs in the park. Bush mango which is one of the NTFPs is distributed throughout the Fungom Lowland Forest. It is exploited by many and has remained one of the seasonal lucrative businesses in the park. Dealers of this resource were both internal and external. The internal constituted the collector and the cultivators while the external were made up of the buyers who are mainly Nigerians. Because of the highly beneficial value of bush mango as food, medicine, timber and income generation among others to the collectors, local people in the park started establishing mixed agroforestry plantations to ensure sustainable production of bush mango in the park for over two decades. Because of the difficult landscape especially the steep hills, communities in and around the park produced more bush mango kernels but sold at prices determined by foreigners which most of the times are lower than what is expected. Exploitation and marketing of bush mango has been constrained by several factors needing rescue for the improvement of bush mango sector. Based on the difficulty identified in this study we recommend the cultivation and domestication of both bush mango species outside of the park to increase economic returns in both seasons and reduce pressure on protected resources. Should the Fru-Awa road is graded, it could also serve as the main access road for bush mango to be transported to Cameroon through Menchum Division.

Compliance with ethical standards

Acknowledgments

We want to acknowledge the contributions of the park authority especially the conservator, Mr. Ashu Walters for their collaboration with the research team. We also want to thank the villagers in the park for providing us with information towards the realization of this project

Disclosure of conflict of interest

Authors declare that there is no conflict of interest among them.

References

- [1] Agrofor Syst Leakey, RRB, Z Tchoundjeu, RI Smith, RC Munro, JM Fondoun et al. Evidence that subsistence farmers have domesticated indigenous fruits (*Dacryodes edulis* and *Irvingia gabonensis*) in Cameroon and Nigeria. *Agrofor. Syst.* 2004; 60: 101-111.
- [2] Anegbah PO, C Usoro, V Ukafor, Z Tchoundjeu, RRB Leakey, K Schreckenber. Domestication of *Irvingia gabonensis* 3: Phenotypic variation of fruits and Kernels in a Nigeria village. 2003.
- [3] Awono A, Djouguep A, Zapfack L, Ndoye O. The potential of *Irvingia gabonensis*: Can it contributes to the improvement of the livelihoods of producers in Southern Cameroon? *International Journal of Social Forestry.* 2009; 2(1): 67-85.
- [4] BirdLife International. Important Bird Areas factsheet: Mbi Crater Faunal Reserve Mbingo forest. 2010.
- [5] Buckland ST, Borchers DL, Johnston A, Henrys PA, Marques TA. Line transect methods for plant surveys. *Biometrics.* 2007; 63: 989- 998.
- [6] Edouard Kengni, Carl MF. Mbofung, Zac Tchoundjeu and Felicite M. Tchouanguiep. Sensory Evaluation of tropical bush mango (*Irvingia gabonensis*) fruits. *Pak. J. Nutr.* 2017; 16: 562-570.
- [7] Dupuy J. Collaborative management of protected areas, PSMNR-SWR approach and concepts. Programme for Sustainable Management of Natural Resources, South West Region (PSMNR- SWR), Buea, Cameroon. 2015.
- [8] Ewane M, Ingram V, Awono, A. Market chain baseline for Bush Mango (*Irvingia* spp.) in the Southwest and Eastern Regions of Cameroon. Center for International Forestry Research. 2010; 117.
- [9] Elah ME. Markets and market chain analysis for bush mango (*Irvingiasp.*), in the South West and East Regions of Cameroon. Master's thesis, Department of Geology and Environmental Science, Faculty of Science, University of Buea. 2010; 144.
- [10] Gadinga W Forje, Tchamba Martin, Barnabas N Nfornkah, Chimi C Djomo, Reeves M. Fokeng. Bush Mango (*Irvingia* spp.) As an Important Alternative Livelihood Source for the Indigenes of the Korup National Park

Communities, South West Cameroon. Environmental and Earth Sciences Research Journal. December 2019; 6(4): 141-148.

- [11] Marcus E, Verina I, Abdon A. Market Chain Baseline for Bush Mango (*Irvingia* Spp.) In the Southwest and Eastern Regions of Cameroon. Cifor Market Chain Baseline *Irvingia* Spp. Southwest and East Regions, Cameroon. 2009.
- [12] Tataw O, Nkongho RN, Awono A, Levang P. Bush mango (*Irvingiaspp.*): Forest and on-farm resource availability and market chains in the Southwest Region of Cameroon. *Forests, Trees and Livelihoods*. 2017; 26(3).
- [13] Jimmy N. Etude sur la potentiel du production de PFNL dans la forêt communautaire de Massens. Memoir FASA, Dschang, Cameroun. 2007; 67.
- [14] Nfornkah BN, Tchamba M, Chimi DC, Gadinga W, Mairong F. Indigenous knowledge on *Irvingia gabonensis* (bush mango) sustainability in the Takamanda National Park (TNP) communities, South West Cameroon. *Forests, Trees and Livelihoods*. 2018; 27(4): 257-263.
- [15] Okafor JC, Ujor G. Varietal differences in *Irvingia gabonensis*. Bush mango and close relatives. Proceedings of a West African Collection Workshop held in Ibadan, Nigeria. Ladipo, D.O. and Boland, D. (Eds.), ICRAF, Nairobi, Kenya. 1997; 5-10.
- [16] Nkwatoh AF. The role of processing and storage in NTFPs market price determination in Ejagham Forest Reserve Cameroon. Paper presented at the International workshop on Non-wood-forest-Products at the Limbe Botanic Garden, Cameroon. 1998; 17.
- [17] Tajoacha A. Market chain analysis of the main NTFPs in the Takamanda/Mone forest reserves, South West of Cameroon and the Cross River State of Nigeria. Unpublished M.Sc. Thesis, University of Dschang, Dschang, Cameroon. 2008; 96.
- [18] Tataw O, Nkongho RN, Awono A, Levang P. Bush mango (*Irvingiaspp.*): Forest and on-farm resource availability and market chains in the Southwest Region of Cameroon. *Forests, Trees and Livelihoods*. 2017; 26(3): 170-182.
- [19] Tchouto MGP. Plant diversity in a Central African rain forest, implications for biodiversity conservation in Cameroon. PhD thesis, Wageningen University, Wageningen, The Netherlands. 2004.
- [20] Tchoundjeu Z, Atangana AR. *Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke). In Van der Vossen, H.A.M. & Mkamilo, G.S. (eds). *Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill. Record from Protabase. PROTA (Plant Resources of Tropical Africa), Wageningen, Netherlands. 2007.
- [21] Zeh AF, Fuashi NA, Maurice ME. Flora composition, structure and diversity in the Kimbi Fungom National Park, North West Region, Cameroon. *Journal of Ecology and the Natural Environment*. 2019; 11(1): 1-13.